FACTORS INFLUENCING ADOPTION OF ROOFTOP RAIN WATER HARVESTING AMONG HOUSEHOLDS IN MASINGA SUB-COUNTY, MACHAKOS COUNTY, KENYA

BY

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A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN PROJECT PLANNING AND MANAGEMENT OF THE UNIVERSITY OF NAIROBI

2017

DECLARATION

The undersigned person declares that this is my original work and has not been submitted in any other institution or university for grading

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DEDICATION

This research project is dedicated to my beloved wife Elizabeth Mbithe Muli and my dear children Michael Levy Muli, Emmanuel Jeff Muli and Linnet Mutanu Muli for their spiritual and moral support during this study.

ACKNOWLEDGEMENT

I must start with thanking God for His grace and favour; for keeping me inspired and courageous to go through this work. My special thanks go to my supervisor Dr. Angeline Sabina Mulwa for her technical and moral support as well as guidance without which I would not have completed this thesis. I acknowledge all the lecturers of the University of Nairobi, School of Continuing and Distance Education for shaping me positively and impacting on me skills and knowledge. My special thanks go to all the staff of the ODeL and the UoN Library for being there for me whenever I needed their support. I sincerely thank all the students of 2015 Master of Arts Degree in project planning and managements for their encouragement, cooperation and team spirit.

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ABBREVIATIONS AND ACRONYMS

ASAL's	Arid and semi-arid land
CBO	Community Based Organization.
DFID	Department for International Development
FAO	Food and Agricultural Organization
GOK	Government of Kenya
IEBC	Independent electoral and boundaries commission
KNBS	Kenya National Bureau of Statistics
MDGs	Millennium Development Goals
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
RRWH	Rooftop Rainwater Harvesting
RWHT	Rain Water Harvesting Technologies
SPSS	Statistical Package for Social Sciences
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Scientific and Cultural Organization

ABSTRACT

Water scarcity remains to be a major development challenge in Kenya and particularly in the Arid and Semi-Arid lands (ASALs). Availability and access to quality water for domestic and agricultural use has posed even a greater challenge to the communities living in such areas. Rainwater harvesting, as a means of acquiring and storing quality water, has been in existence for many years and has positively impacted life, agriculture and economies. Despite these known benefits of rainwater harvesting, the pace at which many Kenyan households have been adopting these noble technologies is slow and mostly with uncoordinated efforts. Water scarcity still remains a major constraint to decent livelihood and economic development in most parts of the country. The aim of this study paper is to evaluate factors influencing the adoption of rooftop rainwater harvesting among households in Masinga Sub-County, Machakos County, Kenya. Various rainwater harvesting technologies (RWHTs) are used within Masinga Sub-County including macro-catchment (earth dams, sand/sub-surface dams), micro-catchment (strip catchment, tillage, contour bunds) and rooftop rainwater harvesting technologies with rooftop catchment being the most commonly used technique. However, adoption of Rooftop RWHT in Masinga Sub-County has been slow irrespective of its potential to improve livelihoods. The study was conducted in the five wards that make up Masinga Sub-County, Machakos County within the Eastern Region which lies within the arid and semi-arid ecological zones of Kenya. A total of 384 household questionnaires were administered and key informant interviews were also conducted during data collection exercise. The data was analyzed using Statistical package for social sciences (SPSS). A logistic regression analysis was conducted to predict factors affecting adoption of RWHTs within the 26,892 households in Masinga Sub-County. A sample of 397 households was drawn. The study found out that there is a significant positive relationship between adoption of rooftop rain water harvesting and economic factors (0.773), with the financial challenges playing a big role in decision making. Further, the study found out that there is a weak positive relationship between adoption of rooftop rain water harvesting and socio-cultural factors (0.463) and that there is a significant positive relationship between adoption of rooftop rain water harvesting and ecological factors (0.618). Further, the study found out that there is a significant negative relationship between adoption of rooftop rain water harvesting and availability of other sources of water (0.652). Availability of quality and sufficient water from other sources weakens the people's resolve to adopt rooftop rainwater harvesting among households in Masinga sub-county, Machakos County, Kenya. The study recommends that institutions be put in place to assist households to access funds for rainwater harvesting structures; such assistance should include subsidized material. Farm incomes should as well be diversified and other support mechanisms put in place with a view of increasing the level of adoption of the rain water harvesting techniques. The study also recommends that institution to work with the local community or households to provide guidance on right size of water storage tank to enable storage of water to last up to dry season and that there is need to improve access to water by reducing the distance covered to get water for domestic use.

CHAPTER ONE
INTRODUCTION

1.1 Background to the study

Water is one of the main substances on the earth. It covers about 70% of Earth's surface, makes up about 70% of human mass making it very essential for life. According to Worm and Hattum (2006), millions of people throughout the world do not have access to clean water for domestic purposes and in many parts of the world conventional piped water is either absent, unreliable or too expensive. Past reports indicate that, in approximation, there is 30 % of the global uses for groundwater as their primary supply (CSE 2003). Its overuse has led to reduction in the table levels and subsequently, increased the cost of water. Access to safe drinking water contributes majorly towards health, productivity and social development. However, growth in population, pollution and climate change have resulted in the reduction in the available safe water for each person in majority of the developing countries. According to the International Rainwater Catchment Systems (2004) over 1.1 billion people in the world do not have access to the improved supply of water as a result of population growth and urbanization.

According to UNEP (2006), African countries facing water shortages have a massive potential in rainwater harvesting, with nations like Ethiopia and Kenya capable of meeting the needs of six to seven times their current populations. UNEP further reported that the quantity of rain falling across the continent is equivalent to the needs of 9 billion people, one and half times the current global population. About a third of Africa is deemed suitable for rainwater harvesting if a threshold of 200 millimeters of rainfall, considered to be at the lower end of the scale, is used. The report therefore, indicates that the water crisis in Africa is more of an economic problem from lack of focused planning and not a matter of physical scarcity. This suffering is likely to be witnessed more, if there are no appropriate and timely efforts to address the issues. The report, (UNEP 2006) concludes that many communities and countries suffering from water shortages as a result of climate change could dramatically boost supplies by collecting and storing rainwater falling freely from the clouds.

UNEP, for instance, reports that Ethiopia where just over a fifth of the population is covered by domestic water supply and an estimated 46% of the population suffers hunger, has potential for rainwater harvesting equivalent to the population needs of over 520 million people. Similarly, Kenya with a population of approximately 40 million people actually has enough rainfall to supply the needs of six to seven times its current population (UNEP 2006).

Water and sanitation are key component of Kenya's vision 2030 with the main objectives of ensuring that improved water and sanitation are available and accessible to all, increasing access to safe water and sanitation in both rural and urban areas beyond the present levels, promoting agricultural productivity and introducing specific strategies to raise the standards of the country's overall water resource management, storage and harvesting capability. In Machakos, one of the 47 counties in Kenya, the ground and surface water supplies have not been adequately planned for in terms of both quality and quantity. This is due to several economic and political factors. In order to address the perennial water shortage to the households in the county, collection and storage of rooftop rainwater is viewed as a practical solution due to its simplicity and flexibility. Local people can be trained to build, operate and maintain a RWH system. In Masinga Sub-County, rooftop rainwater harvesting presents potential to the households to get enough safe water, in which, the other sources of water may be limited. However, to this extent, the adoption of this noble technology is slow for a number of reasons. Therefore, this study was aimed at investigating the factors that influence adoption of rooftop rainwater harvesting technologies among households in Masinga Sub-County.

1.1.1 Rooftop rainwater harvesting

Rainwater harvesting is defined as an intentional collection of water from the surfaces where rain falls and its subsequent storage for use in later times (Worm and Hattum 2006). It is an old technique that is getting much attention in the recent past as a result of the high demand for quality water. This technology makes optimum use of rainwater at the place in which it falls in order to get self-sufficiency in the supply of water without depending on the remote sources.

This practice is more common in areas where there is low annual rainfall and precipitation and therefore there is scarcity of safe and quality water for domestic use. Globally, the economic conditions have influenced the low income class towards harvesting rainwater for the households and also for other essential purposes (Waswa and Mapinduzi 2007). There are several countries across the world which have shown increased usage of this technology. Political and social discrimination in the exploitation of the groundwater and reduction of the levels of ground water have resulted in frustrations to many rural households in their efforts to access quality water over the year round (Wanyonyi, 2002).

According to Smith (2002) rooftop rainwater harvesting for the household purposes only shows a little portion for the total water balance. In the areas where there are significant changes in the annual pattern of rainfall, it is quite challenging to match the supply of water to its demand. However, based on the economic and human welfare, RRWHT has several advantages including; It's cost effective i.e. reduces water bills, it's a simple yet flexible technology in which local people can be trained to build, operate and maintain a RHW system, it does not depend on terrain, geology or infrastructure management schemes (UNEP, 1997). In most cases, rain water harvesting in the developed nations is essential for the non-potable uses for instance toilet flushing, laundry cleaning, watering the garden or washing the cars. However, in the developing nations, it is often used as the potable water for instance in drinking and cooking or for non-potable purpose in rare cases.

1.1.2 Masinga Sub-County

Masinga Sub-County lies around 37° 37' 00" S latitude and 0° 55' 60" E longitude in Machakos County which is among the regions classified as Arid and Semi-Arid Lands (ASALs) in Kenya. Even though Masinga experiences prevalent water scarcity, more than 80% of the people practice rain fed subsistence farming as their source of livelihood (Global Development Research Center 2002). The area experiences erratic and highly variable rainfall coupled with long dry spells after which the existing water sources become inadequate. On average, the Sub-County receives a biannual rainfall of 600 mm per year, falling in November - December and again in March– April, but with wide fluctuations from year to year.

Administratively, Masinga Sub-County is one of the eight sub-counties that make up Machakos County with the others being Yatta, Mwala, Kangundo, Matungulu, Machakos town, Kathiani and Mavoko sub-counties. The Sub-County covers an area of approximately 1,402.9km^2 and has a Population of approximately 125,940 people (Census 2009). It's divided in to 5 wards; Kivaa, Masinga Central, Ekalakala, Muthesya and Ndithini ward. The study covered the five wards making up Masinga Sub-County.

1.2 Statement of the problem

Rainwater harvesting (RWH), in its broadest sense, is the use of simple techniques to collect and store rainwater on-site rather than allowing it to run off. It has its history going back to more than four thousand years when the farming communities in Baluchistan and Kutch, India started finding new methods of irrigating crops (Mishra et al, 2011). Although rainwater harvesting witnessed a decline some years back in the western world after the advent of large centralized water supply systems that provided cheap, reliable and abundant water, large parts of rural Asia and Pacific have dependent on RWH as an important system of water supply for domestic purposes (Mendez et al.,2010).

Availability of water or its scarcity is directly related to economic and social progress of any society and the development of the people is greatly influenced by the availability of water and its management. As a result of growth in population, climate change and unreliable rainfall, available water for each person in the developing countries has greatly reduced, negatively affecting livelihoods. With such life-stifling challenges, the need for RWH for household purposes has gained a renewed importance. In most developing countries, Rooftop RWH is a necessary water acquisition technology, especially in areas that experience unreliable rainfall and prolonged dry periods, areas that lack conventional and centralized government supply system as well as in areas where good quality surface water or groundwater is lacking (Anjos, 2010).

In Kenya, many households have started adopting this old age water preservation technology for domestic purposes, especially in the ASALs. Studies carried out on factors influencing the adoption of RWH both locally and internationally indicate that economic, social and environmental factors have a major impact on the pace of the technology adoption. The United Nations (UN) has invested billions of dollars in to improving rain water harvesting practices for household use (Mogensen, 2000). Despite the fact that coverage has indicated that there is considerable improvement in the last ten years, the level of adoption is still inadequate in terms of fully satisfying the demand for safe drinking water in the country. More still, from the available studies, it is evident that Rooftop RWH as an essential RWH technology remains understudied. Therefore, this study sought to examine some of the factors that influence the adoption of rooftop rainwater harvesting technologies with its target population being households in Masinga Sub-County, Machakos County, one of the Kenyan regions identified as ASALs.

1.3 Purpose of the study

The purpose of this study was to examine the factors that influence the adoption of Rooftop Rainwater Harvesting by the households in Masinga Sub-County, Machakos County.

1.4 Research objectives

This study was guided by the following specific objectives:

1. To establish how economic factors influence the adoption of rooftop rainwater harvesting among households in Masinga Sub-County, Machakos County.
2. To examine the influence of sociocultural factors on the adoption of rooftop rainwater harvesting among households in Masinga Sub-County, Machakos County.
3. To establish how ecological factors influence the adoption of rooftop rainwater harvesting among the households in Masinga Sub-County, Machakos County.
4. To examine the influence of availability of other sources of water on the adoption of rooftop rainwater harvesting among households in Masinga Sub-County, Machakos County.

1.5 Research Questions

This study was guided by the following study questions:

1. How do economic factors influence the adoption of rooftop rainwater harvesting among households in Masinga Sub-County?
2. How do sociocultural factors influence the adoption of rooftop rainwater harvesting among households in Masinga Sub-County?
3. How do ecological factors influence the adoption of rooftop rainwater harvesting among households in Masinga Sub-County?
4. How does the availability of other sources of water influence the adoption of rooftop rainwater harvesting among households in Masinga Sub-County?

1.6 Significance of the study

The study was important to the people and employees of Masinga Sub-county because it provided an opportunity for them to learn and appreciate the benefits of Rooftop RWH in their social and economic development. It would also enable the target people to learn the various factors that do influence their rate of adoption of Rooftop RWH and be able to navigate around them in order to benefit from this technology. This learning was important since it opens up exploitation of opportunities in this area so as to improve quality water supply to the local population.

The findings of this study would also guide the formulation of policies for both the County and the national Government on enhancing the existing supply of water by promoting the adoption of rooftop rainwater harvesting technologies so as to cope with the growth in population as well as the local social-economic needs.

The study would also be significant to the academicians and other researchers as they would use them as existing factual literature to research further in this field. Moreover, they can use the gaps and limitations of this study as a threshold for future studies. This will help to improve future findings in these areas as the gaps of the present study would already be known. This research was also important to the researcher as it opened him up to Rooftop RWH, its benefits to the households, its adoption challenges and their solutions.

1.7 Basic assumptions of the Study

This research study was based on several assumptions; One, all respondents would be available and answer the questions correctly without any bias. Two, the interpreters (where need be) would clearly understand the questionnaire and interpret correctly to the respondents. Three, contrary to popular expectation, the practice of small-scale water harvesting in Masinga Sub-County has had little positive impacts on communities' livelihoods and the environment and five, community livelihoods can be enhanced through appropriate investment into potentially significant water harvesting and saving technologies that farmers are yet to take advantage of.

1.8 Limitations of the study

The study was limited by the research design that was employed. Descriptive survey only examines the situation of the sampled households of Masinga Sub-County as they will not be changing or modifying in any way their situation. The research tools and instrument may also be limited to only acquiring information about opinions, attitudes and experiences of the household respondents on how availability of other sources of water may have influenced them to adopt this technique of rainwater harvesting and storage, their perceptions on how economic, sociocultural and ecological factors affected and/or influenced them to adopt the technique. This was done by administering questionnaires and conducting interviews to the sampled household respondents after which their responses were tabulated through the SPSS.

1.9 Delimitation of the study

The study was confined to Masinga Sub-County in Machakos County, Kenya. From the KNBS data, 82.3% of households have roofed with corrugated iron sheets which is a quality material for rooftop RWH. However, the level of adoption of the RRWH technology is low. This indicates the presence of other factors other than the roofing material do influence the adoption of rooftop rainwater harvesting in this area. The study specifically examined factors influencing adoption of rooftop rainwater harvesting among households in the study area. The data on the main roofing material in Masinga Sub-county is tabulated below.

Table 1.1: Main Roofing Material by County Constituency and Wards

Constituency/ Wards	Corrugated Iron Sheets	Tiles	Concrete	Asbestos sheets	Grass	Makuti	Tin	Mud/ Dung	Other	Households
Masinga Constituency	**82.3**	**0.7**	**0.0**	**0.5**	**16.2**	**0.1**	**0.0**	**0.0**	**0.0**	**26,892**
Kivaa	80.9	0.9	0.0	1.3	16.8	0.1	0.0	0.0	0.0	7,296
Masinga Central	76.4	0.8	0.0	0.5	22.1	0.1	0.1	0.0	0.1	6,803
Ekalakala	86.4	0.7	0.0	0.1	12.8	0.0	0.0	0.0	0.0	4,133
Muthesya	82.0	0.6	0.0	0.0	17.0	0.2	0.0	0.0	0.0	3,698
Ndithini	89.5	0.7	0.0	0.1	9.5	0.1	0.0	0.0	0.0	4,962

Source: 2013 (KNBS) and Society for International Development (SID)

1.10 Definitions of Significant Terms to be used in the Study

Adoption: It's the process of accepting and implementing something new; in this case, it's the process by which new technology is embraced over time among the members of a social system.

Economic factors: A consideration regarding how a consumer's disposable income and other financial resources tend to impact their buying decisions

Ecological factors: The science of the relationships between organisms and their environment. These include water, air, soil, temperature, light and presence of their relationships to organisms.

Household Groups of individuals who perform and share most of the domestic responsibilities as a means of survival such as living together.

Rainwater This is the precipitation of water from the clouds through the relief or conventional methods.

Rainwater harvesting This is a technology used for collecting and storing rainwater from rooftops, the land surface or rock catchments using simple or complex techniques

Rainwater harvesting technologies Refer to initiatives undertaken to collect water. In this study the technologies will be rooftop rainwater harvesting.

Storage technologies: These are the apparatus used for collecting and storing water. They include water tanks, plastic storage, cisterns and underground storage technologies.

Sociocultural factors: These are customs, lifestyles and values that characterize a society and can affect quality of life, business, health or well-being of the household members in relation to water harvesting technologies for example religion, attitudes, social class, language, politics and law.

1.11 Organization of the study

This study comprised of five chapters. Chapter one covered the background of the study, statement of the problem then setting of the research objectives and the relevant research questions. These were followed by the significance of the study, the limitations of the study, delimitation of the study and the assumptions made in the study. In concluding chapter one, key terms were defined then the chapter ended with the organization of the study. Chapter Two covered the literature review from various authentic sources to establish and acknowledge work done by scholars and other researchers, their findings, conclusions and identification of knowledge gaps which formed the basis of setting objectives and research questions for the study. The theoretical and conceptual frameworks were also explained in this chapter. Chapter Three covered the research design, target population, sample size and sampling procedures. This was followed by data collection methods, data collection instruments, validity and reliability of the instrument, data analysis procedures, ethical considerations and Operational definition of variables. Chapter four focused on data analysis, data presentation and interpretation of the findings. Chapter five gave the summary, conclusions and the recommendations that were derived from the study.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of empirical literature from different scholars on factors influencing adoption of rooftop rainwater harvesting. From the review, broad categories were drawn which were important in identifying the major factors that influence the adoption of rooftop rainwater harvesting among the households in the study area. The chapter also reviews the theoretical framework on which the study was anchored and the conceptual framework which forms the structure of the study ideas and objectives.

2.2 Adoption of Rooftop rainwater harvesting

Rainwater harvesting, just like any other technology, is adopted over time among the members of a social system. Generally, it has been a common practice by different civilized countries for about four thousand years mainly used for domestic purposes or agricultural practices. Resources for safe and quality water are limited and therefore, due to the ever-increasing demand in proportion to the rapidly increasing population, water continues to become a scarce and expensive commodity. There is a renewed effort to conserve this resource across the globe. One of the Millennium Development Goals (MDGs) for combating poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women is Goal number 7 which pursues Environmental Sustainability and focuses on water. The achievement of this noble goal depends on the availability of water in acceptable quality and adequate quantities to meet the goal's targets.

Rainwater harvesting may be done through collecting and storing water at the point on which rain falls. This old age technology is called rooftop rainwater harvesting. The earliest known evidence of the use of the technology in Africa comes from northern Egypt, where tanks ranging from 200-2000m3 have been used for at least 2000 years (Smet & Moriarty, 2001). In essence rooftop rainwater harvesting systems have three main components; the catchment surface (roof) to which collects the rainwater, the delivery system to transport the water from the roof to the storage reservoir (gutters and drainpipes) and the reservoir to store the rainwater until it is used (Smet & Moriarty, 2001). This study sought to examine some of the factors that influence the adoption of rooftop rainwater harvesting technologies in Masinga Sub-County, Machakos County, one of the Kenyan regions identified as ASALs.

2.3 Economic Factors and the adoption of rooftop rainwater harvesting

Economic factors are the consideration regarding how a consumer's disposable income and other financial resources tend to impact their buying decisions. According to the Global Applied Research Center (2002) economic factors may constitute the social capital, income generation, the type of roof commonly used in the area labor among others. The knowledge and cost of harvesting and storing water from the rooftops in relation to other economic priorities provides the structure for the economic factors. This study focused on two economic factors; level of income and the type of roof.

Generally, in the rural set up, there are common livelihood activities such as farming and trading which generate some limited level of income on which the family budget is based. Therefore, the level of income is an important factor that influences the adoption of rainwater harvesting. The cost mechanism in any investment decision is considered to be important and this is how the choice of adopting a new technology is typically viewed. The availability of the funds required to make this capital investment, which is typically outside normal family budget, in this context often related to family income level, is a critical factor, especially in a context where income is usually budgeted for seemingly more important family needs (Barr, 1993, Chapman, 1997). According to Mati et al (2007) capital is considered as a major limitation by the farmers in the adoption of modern technologies. Marenya and Barrett (2007) found out that resource constraints limited many households' capacity to adopt new practices and that such capacity is linked to farm size, livestock value, off-farm income, family labor supply, and education. Households in rural areas are confronted by other economic priorities like purchase of basic needs such as food, clothing and funding education for their children. Another consideration made by households is the limited access to credit. Increased income by the households shows greater incentive for investment in the rainwater harvesting technologies (CSE 2003). The level of income also determines the water storage facilities that a particular household can afford and therefore the overall volumes of rainwater that can be harvested in the household in a particular season. These economic factors have major effects on the adoption of rainwater harvesting technologies or otherwise.

The type of roof used to construct a house does influence the quality of rainwater harvested. Contamination in harvested rainwater is affected by roof type, including roofing materials, slope, and length (Mendez et al., 2011). Due to the acidic nature of ambient rainwater, chemical compounds from roofing materials may leach into the harvested rainwater (King and Bedient, 1982). In addition to leaching chemicals, rooftops also can release contaminants that accumulate during dry and wet deposition, such as organic and fecal compounds (Chang et al., 2004). Thatched houses also pose a challenge to rainwater harvesting because of the permeability of the thatched structures. Organic and fecal contaminants from insects such as moths are difficult to control. Again, since most thatched roofs do not usually have capture structures attached setting up gutters under such thatches is also challenging. However, polythene coverings or other materials can be used to reduce the permeability of thatched structures. According to Professor Mary Kirisits of Cockrell School, galvanized metal and concrete tile roofs produce the highest quality of harvested rainwater for indoor domestic use (Mendez et al., 2011). Professor Kirisits continues to show that while some roofing materials perform better than others in harvesting quality water, rainwater harvested from each of the roofs would still have to be treated if the consumer is to be certain of its safety. Most of the households in Masinga Sub-County have roofed with iron sheets which provide adequate material and surface for rainwater harvesting.

2.4 Sociocultural factors and the adoption of rooftop rainwater harvesting

Sociocultural factors are customs, lifestyles and values that characterize a society such as religion, attitudes, social class, language and politics. Worm and Hattum (2006), states that sociocultural factors also include gender, age, and the level of literacy, social capital, household land and marital status. This study specifically focused on two sociocultural factors; assigned gender roles and social capital.

From birth, children are assigned a gender and are socialized to conform to certain gender roles based on their biological sex. Gender roles are based on norms or standards, created by society. Generally masculine roles are usually associated with strength, aggression, and dominance, while feminine roles are associated with passivity, nurturing, and subordination (Gender & Sociology, 2016). Fetching water is an assignment, which, in most societies, has been approved in everybody's mind-set, men and women alike to be for women and girls. But with reversed gender roles, most men are finding the role of fetching water very demanding and time consuming. This has caused many male house heads to think of enhanced means of getting water for domestic use such as rooftop rainwater harvesting.

Social capital focuses on social relations that have productive benefits (Dolfsma and Dannreuther 2003). It serves in reducing transaction costs, creating new forms of information exchange and influencing behaviour through norms. It’s about the value of social networks, bonding similar people and bridging between diverse people, with norms of reciprocity (Dekker and Uslaner 2001). Higher social capital induces innovation. Sander (2002), states that in social capital, more people get their economic innovation from whom they know, rather than what they know. The family represents one of the major ways that human populations organize and adapt to meet goals and needs and communicate values in diverse environmental circumstances (Bubolz 1991). The family unit is the organizing unit for the exchange of valuable resources, human labour, as family members assume different economic and productive roles within the household, the marketplace and the formal & informal workforce.
Significantly, activities involving the socialization of families in the space of the household provide an excellent opportunity for teaching economic values, attitudes and behavior to other families and children (Steady 1993). As the building block of rural communities, the family is the nexus for the transfer of social and economic behavior patterns, survival skills, and environmental values across the generations. Agricultural skills, resource conservation techniques, and many other forms of indigenous technical knowledge are handed down from one generation to the next. Under social capital, new technologies for rainwater harvesting and management allow for higher transfer of knowledge and innovation across the different households (FAO 1993).

2.5 Ecological factors and the adoption of rooftop rainwater harvesting

Ecological factors explain how organisms relate to the environment. According to the (IRCSA, 2004), various ecological issues for instance the seasonal variations of rainfall and human activity influence the adoption of rainwater harvesting. These ecological factors need to be considered in order to understand the kind of rainwater harvesting technology that has been adopted in an area. This study focused on two ecological factors; rainfall patterns and sand harvesting.

Some areas experience erratic and highly variable rainfall coupled with long dry spells after which the existing water sources become inadequate (Luwesi, 2004). Communities in these areas are more likely to seek alternative and enhanced means of getting water for their domestic and economic purposes. The seasonal changes influence the need for harvesting more water; when it is dry or there are fewer annual rainy days, there would be need for more and larger storage units for water.

Therefore, different alternatives to harvest rainwater would be required. On average, the Masinga Sub-County receives a biannual rainfall of 600 mm per year, falling in November - December and again in March– April, but with wide fluctuations from year to year. The unpredictable rainfall patterns and long dry spells necessitate the need for alternative and more reliable means of harvesting and storing water for the households. RRWHT comes as one of the most reliable technology to provide safe water for domestic purposes.

From human activity, water resources face some serious man-made threats including sedimentation, pollution, climate change, deforestation, landscape changes among others (Greenfacts, 2017). One of the most serious threats to water resources is the degradation of ecosystems, which often takes place through changes to landscapes such as the clearance of forests, the conversion of natural landscapes to farmland and surface mining. Each type of change to a landscape will have its own specific impact, usually directly on natural ecosystems and directly or indirectly on water resources. Human activity such as felling of tree for fuel or building material and sand mining for commercial interests has been shown to cause severe negative environmental impacts that are not reversible (Kondolf, 1997; Rovira, *et.al.,* 2005; Rinaldi, *et.al.,* 2005; Nabegu, 2012). One of the negative consequences of sand mining is its effect on ground water recharge and quality as a result of the extraction process. Also, sand mining within an aquifer recharge area will increase the vulnerability of the aquifer to be contaminated because it decreases the distance between the ground water table and land surface. In some cases, the excavation actually penetrates the shallow aquifers, leading to a direct access to ground water (Depreeze, 2000). Sand has a good quality of trapping and retaining rainwater. According to Prof. Ponce, when sand on the river banks is mined, the water source is disturbed and therefore alternative means of harvesting and storing water become necessary (Ponce, 1999). Rooftop rainwater harvesting technology relieves the high demand for and reduces reliance on underground sources and surface waters and if it's harvested in excess of the storage capacity, it can as well be used to replenish ground water aquifers

2.6 Availability of other sources of water and the adoption of rooftop rainwater harvesting

This study also examined the influence of availability of other sources of water on two areas; land surface catchment and rock catchment. According to Weatherall (1999), approximately 30% of the world especially in the rural settings uses groundwater as its primary supply of water. Weatherall continues to indicate that large amounts of contaminants are likely to filter into groundwater depending on the type of soil through which the water is filtering (Weatherall, 1999). Over-use of groundwater has resulted in a drop in water table levels and has made the cost of water to rise. From a study done by Development Technology Unit, there are other sources of water that are naturally being contaminated by fluoride, arsenic or salt especially in coastal areas for example in Bangladesh, arsenic has affected 18 million people already and millions more are susceptible (DTU1987).

Land surface waters such as wells and ponds could be contaminated from industry, mining and agricultural waste, for example in northern Mali, pesticides were found to have polluted lots of water while in Mauritius, industrial and sewage pollution threatened the livelihood of fishermen (Smith, 2002). The dependence of the people on unsafe or unmaintained wells and pond water for domestic purposes opens them up to a high risk of contaminating water borne diseases (Karim et al, 2005). It is also difficult and consequently expensive to put up infrastructure for water supply where terrain is hilly or otherwise unleveled (UNEP, 1997). Cost is usually a limiting factor to the implementation of high-tech and large scale RWH systems in many developing countries (DTU, 1987).

Mati et al (2007) asserts that rooftop rainwater harvesting (RRWH) is cheap, sustainable, has less operational and maintenance cost. The technology avoids many surface-water pollutants (Gabana et al, 1997). It also allows water to be collected and stored just next to its point of consumption, relieving the households from the burden of carrying it, utilizing time and energy (IRCSA, 2004). Harvested water can be used for agricultural purposes and can be used for ground water replenishment. RRWHT reduces reliance on underground sources and surface waters. Rooftop rainwater gets collected as well as controlled through individual households and therefore it's not open to the abuse by the other users.

2.7 Moderating variable: Government policies

Adoption of any new technology is closely tied to its relevant policy framework. The framework comes as the prerequisite for officially adopting new or existing technologies. Policies define the legal framework and control the management and use of water resources. Although Kenya has a long tradition of RWH, policies are lagging behind the effective practices. However, in 2006, the

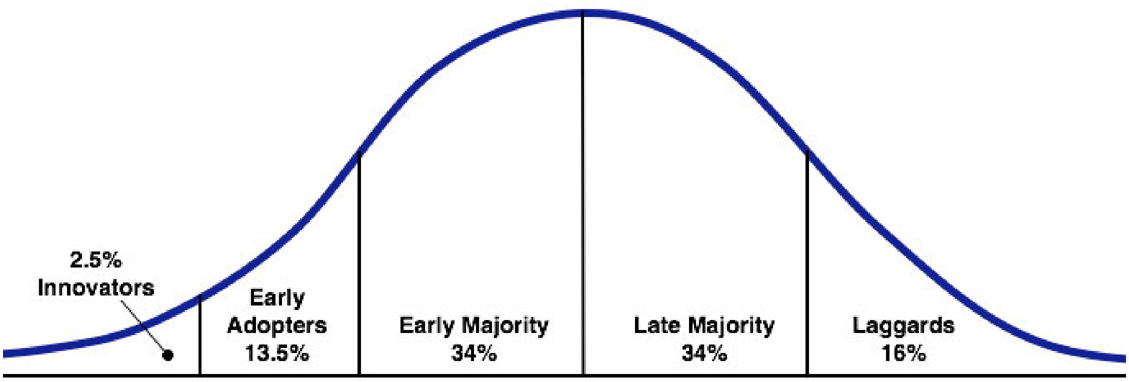
Kenyan Government made an encouraging announcement to make RWH mandatory in all new large buildings like factories, schools or bungalows (Mutua 2010:16).

2.8 Theoretical framework

Theoretical framework is the structure that holds the theory of this study and explains why the research problem under study exists. A number of theories have been proposed in order to understand how individuals in a society adopt new applications such as technology. This study was anchored on one of the foundational theories known as the diffusion of innovations theory. According to this theory developed by Everett Rogers (1962), there are four major elements which affect the spread of a new idea which include: the innovation itself, communication channels, time and social system (Rogers 1962). These elements work in conjunction with one another in a process that generally goes through five key stages: Knowledge, persuasion, decision, implementation and confirmation. The time between awareness of an innovation and its adoption is the adoption period. However, according to McConville, the length of adoption differs from person to person and from practice to practice (McConville 2006). Therefore, households are categorized based on their tendency to adopt a new technology.

The innovation-decision is made through a cost-benefit analysis with the major obstacle being uncertainty (Rogers, 1995). People will adopt an innovation if they believe that it will, all things considered, enhance their utility. Therefore, the decision to or not to adopt any technology is based on effective examination of a large number of technical, economic or social factors. According to Rogers (1962) the extent to which individuals or an entity makes use of technology has shown to be influenced by the ease of its usage. This means that an individual can take advantage of new technology in order to improve their livelihood. Previous findings indicate that technology diffusion is affected by compatibility as well as simplicity on use of new technology. The ability of individuals to improve their day to day livelihoods in the households is constantly based on how efficiently they can apply the new technology. At the decision stage, an individual makes a decision either to adopt or fail to adopt the new technology. The decision that a person makes is as a result of weighing the advantages verses disadvantages, costs verses benefits and the trade-offs. This process of adoption over a period of time is typically illustrated as a classical normal distribution (bell curve).

Figure 2.1: A graph of Everett Rogers Technology Adoption Lifecycle model



Source: Everest Rogers; diffusions of innovations cycle

From the above model, the first people to use a new product are referred to as innovators, followed by early adopters, then early majority, then late majority and finally laggards.

Innovators are venturesome people who are fulfilled by being on the cutting edge (Rogers, 1995). In the above model they constitute 2.5%. Early adopters use the data provided by the innovators' results to make their own adoption decisions. They constitute 13.5% of the adopters. This group is where most opinion leaders in a social system reside. If they observe that the innovation has been effective for the innovators, then they will be encouraged to adopt and since they command respect and are perceived to be judicious and well-informed for decision-making, they would influence their followers, ushering in the third group of adopters. The third group of early adopters represents a tipping point, where the rate of adoption rapidly increases. The high rate of adoption continues as, even for those who are cautious or have particular qualms with the innovation make the adoption a necessity. They constitute 34%. The late adopters who constitute 34% start with a high rate of adoption and constitute those who are affected by other factors such as economic factors. Rodgers argues that the last adopters, laggards, can either be very traditional or be isolates in their social system. If traditional, they are suspicious of innovations and often interact with others who also have traditional values. If they are isolates, their lack of social interaction decreases their awareness of an innovation's demonstrated benefits (Rogers, 1995).

2.9 Conceptual framework

A conceptual framework is the system of ideas and objectives that lead to the creation of a consistent set of rules and standards. This study examined the literature review on the factors that influence adoption of rooftop rainwater harvesting technologies among the households in Masinga Sub-County. It established a number of variables that influence the adoption of rooftop rainwater harvesting technologies.

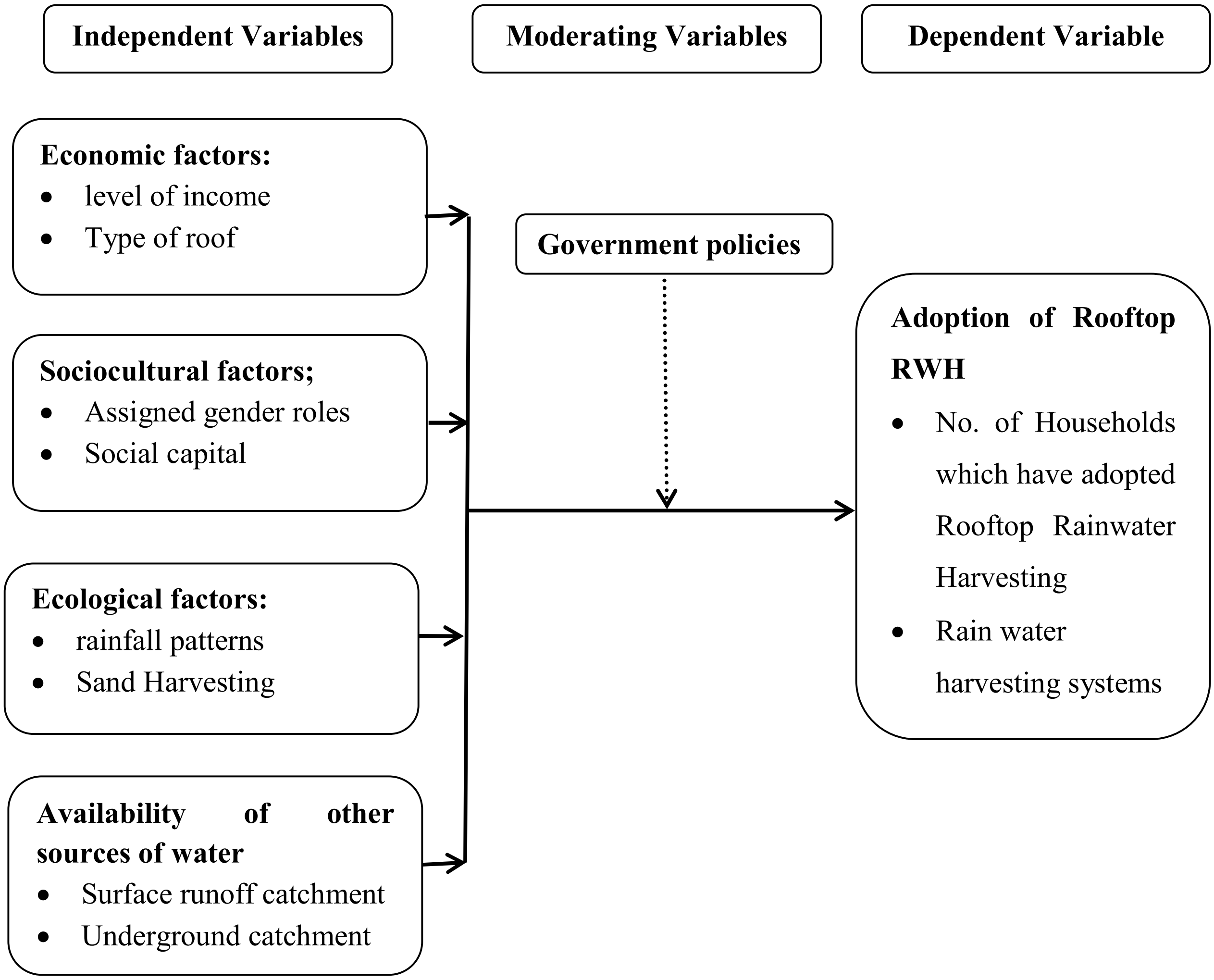


Figure 2.2: An illustration of the Conceptual Framework

The above mentioned factors influence the extent to which rooftop rainwater harvesting technologies are adopted. The study reflected on these variables and their influence on the adoption of rooftop rainwater harvesting which were to be applied to Masinga Sub- County in Machakos

County. The study did not analyze the influence of government policies, weather and altitude on the adoption of this kind of rainwater harvesting which may need further evaluation in future studies.

The dependent variable was the adoption of rooftop rainwater harvesting technologies among households and the independent variables were economic factors (level of income and type of roof), Sociocultural factors (assigned gender roles and social capital), ecological factors (rainfall patterns & sand mining) and effect of availability of other sources of water (land surface catchment and rock catchment). The moderating variable was Government policies.

2.8 Explanation of relationships of the variables in the Conceptual Framework

The economic factors in the conceptual framework include levels of income or the types of roof and they affect the extent to which the adoption of rooftop rainwater harvesting is done economically. This is because of the cost related to the adoption of this technology, the human or land resources endowment. The sociocultural factors limit the level of adoption of rooftop rainwater harvesting. The adoption of rainwater harvesting is influenced by social capital which is perceived to be a tool for information consumption. Fetching of water for domestic use is socially assigned to women and girls even though it is very tedious and time consuming. These factors affect the decision-making process in the adoption of Rooftop RWHT. The ecological factors are related to availability of water in the environment. They include rainfall patterns, which varies from season to season and sand mining which is a human activity. These factors will affect the extent of adoption of Rooftop RWH because they form part of the environment for water harvesting. Availability of other sources of water such as wells and ponds provide alternatives on water provision. When water is available, it implies that the extent of adoption of rooftop rainwater harvesting may be low.

2.9 Knowledge Gaps in literature reviewed

Many families and professionals now endorse the adoption of rainwater harvesting and storage technologies in households for food security. According to Nega and Kimeu (2002) Rainwater harvesting is one solution to the problems of water shortage in the drier areas of Africa, but its implementation presents a number of challenges, of which storage is a major one. Many people in rural areas who would like to harvest rainwater lack the resources to do so. Conventional stone, brick or Ferro cement tanks are costly, and therefore there is a great need for cheaper alternatives. The study reflected on how economic factors; sociocultural factors; ecological factors and availability of other sources of water have influenced adoption of water harvesting in Masinga Sub County. The study didn't analyze the influence of Government policies on the adoption of rooftop rainwater harvesting. These unstudied factors present a gap for further studies.

2.10 Summary of Literature Review

The literature review of this study shows that the adoption of rainwater harvesting in households will play a great role in contributing to the achievement of Millennium Development Goals (MDGs) with a view to eradicating poverty and hunger, providing safe drinking water, promoting gender equity and empowerment of women.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter covered research design, target population, sample size and sampling procedure, instruments for data collection, methods of data collection, analysis and data presentation.

3.2 Research design

This study adopted a descriptive survey design. According to Mugenda and Mugenda (2003) descriptive research design is defined as a systematic inquiry into which a researcher evaluates a particular issue the way it is without any further changes. The researcher chose this particular design because of its capability in developing a profile for a particular issue. It also provided a large pool of information which, if collected using observation, for instance, would take long to collect. Kothari (2005) asserts that descriptive study is more related to determining the frequency in which something takes place or the inferential relationship of a number of variables.

3.3 Target population

The study constituted all households in Masinga Sub-County in Machakos as at 30th December 2015. The records from the KNBS show that as of that date, there were 26,892 households in Masinga Sub County which consists of five ward: Kivaa, Masinga central, Ekalakala, Muthesya and Ndithini ward with their respective number of households as in Table 3.2:

Table 3.2: Target Population

Sub-County	Ward	Area (Sq.km)	Population	Number of Households
Masinga	Kivaa	522.5	34,092	7,296
	Masinga Central	388.5	32,963	6,803
	Ekalakala	177.4	19,013	4,133
	Muthesya	190.0	17,153	3,698
	Ndithini	124.5	22,719	4,962
Total		**1402.9**	**125,940**	**26,892**

Source: 2013 (KNBS) and Society for International Development (SID)

3.4 Sample size and Sampling procedure

A sample is a smaller group or sub-group obtained from the accessible population (Mugenda and Mugenda, 1999). Sampling is the process of choosing a sub-group from a population to participate in the study; it is the process of selecting a number of individuals for a study in such a way that the individuals selected represent the large group (population) from which they were selected (Ogula, 2005). The study used stratified and proportionate sampling since five wards were covered. The sample frame of the study included a representative sample of the households living in each of the five wards.

3.4.1 Sample Size

The sample size for the households was calculated based on Yamane's formula (Yamane, 1967)

$$n = \frac{N}{1+N(e)^2}$$

Where n = The sample size

N = The size of the population

E = The error of 5 percentage points

Because of the huge target population and time constraint, this study was restricted to the representative portion of the target population. According to Yamane's formula (1967), a total of 26,892 households required a sample to be used in this study resulting to 397 households. The study used stratified and proportionate sampling. It was done in a way that offered an optimal sample size for the population in order to improve the validity and reduce the sampling error.

Table 3.3: Sample size from Masinga Sub-County

Sub-County	**Ward**	**Number of Households**	**Sample size**
Masinga	Kivaa	7,296	108
	Masinga Central	6,803	100
	Ekalakala	4,133	61
	Muthesya	3,698	55
	Ndithini	4,962	73
Total		**26,892**	**397**

Using this sampling formula, the researcher got 108 households from Kivaa ward, 100 from Masinga Central ward, 61 from Ekalakala ward, 55 Muthesya ward and 73 from Ndithini ward.

3.4.2 Sampling Procedure

The researcher identified the population of interest and since it was large enough to call for sampling, he specified a sampling frame and the sampling method. This was followed by determining the sample size then implementing the entire sampling plan. The researcher used the research instruments to implement the plan.

In total, 397 respondents were given questionnaires by the researcher's two assistants; Daniel and Joel. The Study used stratified and proportionate sampling since five wards were covered. Proportionate sampling was used because each ward was allocated a sample of households depending on its proportion to the total number of respondents. Proportionate sampling enabled the researcher to achieve greater representativeness in the sample of the population. This was accomplished by selecting individuals at random from subgroups (stratified random sampling) in proportion to the actual size of the group in the total population (Van Dalen, 1979).

3.5 Research instrument

Data was collected using open and closed- ended questionnaires and structured interviews.

3.5.1 Questionnaires

Questionnaires are easy to administer with the help of an interpreter for the respondents who may be spread over a large area. They are convenient for collecting information from a large population within a short period of time. The close-ended questions conserved time and facilitated easier analysis since they were in their immediate usable form. The open-ended questions were aimed at encouraging the respondent to give in-depth and felt responses without feeling limited in giving out any information.

3.5.2 Structured interviews

The researcher used structured interviews in the cases of any illiterate respondents. Structured interview means that specific questions would be asked in a set order to ensure no variation between different interviews. The respondents' answers were recorded on a questionnaire form during the interview process and the completed questionnaires were analyzed quantitatively.

3.5.3 Pilot testing of the instruments.

The Pilot study is a small scale trial run which is carried out with an aim of pre-testing a particular research instrument (Baker 1994). It was conducted in Masinga Sub-county randomly among the population households but those households were not to be used in sampling for the study. In this study, the pilot study would pre-test the validity and reliability of the data collection instrument. The researcher would randomly pick ten households from the study area and administer questionnaire for the pilot testing.

3.5.4 Validity of the instrument

Validity is the degree of accuracy, soundness and effectiveness with which an instrument measures. The researcher in this discussed the instrument with the supervisor in order to get an expert advice and ensure the instrument measures what it's intended to measure (Kumar 2005). The researcher, guided by the supervisor, ensured that the concepts represented here cover relevant issues and are adequate for investigation as per the recommendations of Mugenda and Mugenda (2008).

3.5.5 Reliability of the instrument

Reliability is a measure of the level to which a research instrument produces consistent result on a number of trials. A pilot study resulted in randomly picking ten households from the entire Sub-county. The researcher used the spit-half method which involved administering the same scale or measure to the same group of respondents at two different times for example after two weeks. Correlation between the two sets of scores was computed using Pearson's Product-Moment correlation coefficient Formula. This formula attempts to draw a line of best fit through the data of two variables, and the Pearson correlation coefficient, *r*, which takes a range of values from +1 to -1, indicates how far away all these data points are to this line of best fit. However, it's very rare to see values 0, -1 or 1. The closer the value of r gets to zero, the greater the variation the data points are around the line of best fit. High correlation will be between *0*.5 to 1.0 or -0.5 to -1.0 while *m*edium correlation ranges between *0*.3 to 0.5 or -0.3 to -0.5 then *l*ow correlation will be between 0.1 to 0.3 or -0.1 to -0.3. The researcher accepted results at the level of high correlation

3.6 Data collection procedure

The study made use of primary data collected from the sampled households and officials from the water department in Masinga Sub-County. Open and close-ended questionnaires were used to get the respondents' views. Semi-structured questionnaires guided the respondents to give consistent responses. The questionnaires were placed into six sections A, B, C D, E and F in line with the objectives of the study. Section A was the profile of the respondents, section B was on the extent of adoption of rainwater harvesting among households in Masinga Sub-County, section C was on the economic factors that influence adoption of rain water harvesting among the households, section D was on the Sociocultural factors that influence adoption of rainwater harvesting among the households, section E was on the ecological factors that influence adoption of rain water harvesting among the households and section D was on the influence of the availability of other sources of water on the adoption of rain water harvesting among the households. Questionnaires were administered through the drop and pick-later method and the respondents were given a two-week's period to respond. As a way of increasing the response rate, call ups were made to the respondents.

3.7 Data analysis techniques

The collected data was edited for completeness, clarity and consistency in answering research questions after which it was coded and then fed to the SPSS. Analysis of data was done by use of descriptive statistics for instance the mean scores and percentages. Every objective was analyzed using descriptive analysis. The findings were compared to the present literature on the study topic in order to find out whether the study really addressed the research gaps.

A multi regression analysis was conducted so as to find out the relations between each independent variables and the dependent variable in the study area. The regression model was computed as follows:

$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \varepsilon$.. (i)

$\beta 0$=Constant

$\beta 1, \beta 2, \beta 3, \beta 4$ = Coefficients of determination

X1 = Economic factors:

X2= sociocultural factors

X3 = ecological factors

X4 = Availability of other sources of water

ε = Error term

3.8 Ethical considerations

Ethics are norms which govern the human conduct and have a major effect on the human welfare (Kothari, 2005). The researcher obtained a letter permitting him to carry out the research in Masinga Sub-County. He also ensured that the research tools were used solely for the purpose of this research and the respondents' identities were concealed. All respondents were be informed of the purpose of the study and were treated with courtesy and respect.

3.9 Operational definition of the variables

The independent variables included: Economic factors (income and types of roof), sociocultural factors (assigned gender roles and social capital), ecological factors (rainfall patterns and sand harvesting) and effect of availability of other sources of water (surface run-off water and underground water). The dependent variable was the adoption of rooftop rainwater harvesting. These variables were moderated by government policies. The operational definition of variables is given in Table 3.3.

Table 3.3 Operational definition of variables

Objectives	Variable	Indicator (s)	Measurement	Level of scale	Tool of analysis	Type of analysis
To identify factors influencing the adoption of RRWH by the households in Masinga Sub-County	Adoption of Rooftop rainwater harvesting	Homesteads with Rooftop catchment systems. Water storage facilities Available	No. of households harvesting rainwater	Ratio: Absolute Zero is possible	Mean: Measure of central tendency Standard deviation: Measure of variability	Descriptive Statistical summary of data Descriptive Statistical summary of data
To assess economic factors influencing the adoption of RRWH by the households in Masinga Sub-County	Economic factors	Households with rooftop water harvesting Type of roof	No of households rooftop harvesting & storing rainwater Observation	Ratio: Absolute Zero is possible Interval: Distance has a meaning	Percentage Proportion of the whole Range: Measure of variability	Descriptive Statistical summary of data Descriptive Statistical summary of data
To assess socio-cultural factors influencing the adoption of RRWH by the households in Masinga Sub-County	Socio-cultural factors	Males or females harvesting water Availability of grouping structures	No. of male/female tasked with water provision No. of community forums where info is shared	Nominal Attributes only named Ratio: Absolute Zero is possible	Percentage Mean: Measure of central tendency Range Percentage Proportion of the whole	Descriptive Statistical summary of data Descriptive Statistical summary of data

To assess ecological factors influencing the adoption of RRWH by the households in Masinga Sub-County	Ecological factors	Available records of Rainfall pattern River basins with harvested sand	Recorded rainfall pattern in the last 3 years. No. of households affected by sand harvesting	Ratio: Absolute Zero is possible Ratio: Absolute Zero is possible	Mean: Measure of central tendency Percentage Proportion of the whole	Descriptive Statistical summary of data Descriptive Statistical summary of data
To assess the influence of the availability of other sources of water on the adoption of RRWH by the households in Masinga Sub-County	Availability of other sources of water	Available mechanisms for land surface catchment Available mechanisms for underground catchment	No. of households doing surface water catchment No. of households depending on underground water sources.	Ratio: Absolute Zero is possible Ratio: Absolute Zero is possible	Percentage Proportion of the whole Percentage Proportion of the whole	Descriptive Statistical summary of data Descriptive Statistical summary of data

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

Chapter four contains data analysis, presentation and interpretation of the research findings. It gives the results and interpretation of the study in the following areas: return rate of questionnaire, respondents' profiles and the dependent variable which was the adoption of rooftop rainwater harvesting. Further analysis is done on the independent variables which include economic factors (income and types of roof), sociocultural factors (assigned gender roles and social capital), ecological factors (rainfall patterns and sand harvesting) and effect of availability of other sources of water (surface run-off water and underground water).

4.2 Questionnaire Return Rate

Out of the 397 questionnaires dropped, 386 were adequately filled and collected indicating a (97.2%) return rate. This high return rate was achieved because the researcher used trained research assistants to administer and collect the questionnaires immediately after the respondents completed them. The return rate was above 90% of the administered questionnaire and therefore was deemed adequate for the analysis as cited by Mugenda and Mugenda (2003).

4.3 Profile of the respondents

This section analyzes the respondent's profiles which include their gender, how long they have lived in the area, head of household, age, marital status, size of household and highest academic qualifications. This profiling is important and relevant to the study because it gives the researcher an opportunity to get information that is valid, reliable and that indicates social trends in the society.

4.3.1 Distribution of the respondents by gender

The respondents from the research area were asked to indicate their gender. Their responses are shown in Table 4.4.

Table 4.4: Distribution of gender of the respondents

Gender of the respondent	Frequency	Percentage
Male	263	68.1
Female	123	31.9
Total	**386**	**100.0**

Table 4.4 Shows male respondents were 263 (68.1%), way more than the female respondents who were 123 (31.9%). These results indicate that males were the major decision makers within the households and therefore more appropriate in undertaking rooftop rainwater harvesting. Adoption of this new technology calls for effective decision making.

4.3.2 Distribution of the respondents by the length of time they had lived in the area

The respondents were asked to indicate for how long they had lived in Masinga sub-county. Their responses are shown in Table 4.5

Table 4.5: Respondent's Length of Time they had lived in the Area

	Frequency	Percentage
0 - 2	4	1.0
3 - 5	17	4.4
6 - 10	18	22.3
Above 10	279	72.3
Total	**386**	**100.0**

Table 4.5 shows that most of the respondents 279 (72.3%) had lived in the area for more than 10 years. 22.3% indicated for 6 – 10 years, 4.4% indicated for 3 – 5 years while 1.0% indicated that they have lived in their current area for 0 – 2 years. This is an

implication that most of the respondents had lived in the area for more than 10 years meaning that majority had permanent ownership of the lands and other resources. Permanent ownership of land and other related resources forms the basis for development, enhances authority for decision making and increases economic opportunities of the family units.

4.3.3 Respondents by household head or not

The respondents were asked to indicate whether they were the heads of their households. Their responses are shown in Table 4.6

Table 4.6: Respondents by household head or not

	Frequency	Percentage
Yes	324	83.9
No	62	16.1
Total	**386**	**100.0**

Table 4.6shows that 324 (83.9%) respondents were the heads of their household while 62 (16.1%) respondents were not the heads of their household. This is a clear indication that most of the respondents were household heads and are very crucial when it comes to decision making on development issues including the adoption and implementation of rooftop rainwater harvesting.

4.3.4 Age distribution of the respondents

The respondents were asked to indicate their respective ages from categorized age brackets. Their responses are shown in Table 4.4

Table 4.7: The age distribution of respondents

	Frequency	Percentage
30 and below	46	11.9
31 - 50	212	54.9
51 - 70	106	27.5
Above 70	22	05.7
Total	**386**	**100.0**

Table 4.7 shows that 46 (11.9%) respondents were 30 and below years of age, 212 (54.9%) respondents were in age bracket of 31-50 years while 106 (27.5%) respondents were between 51-70 years of age, then 22 (05.7%) respondents were above 70 years of age. The results indicate that majority of the respondents fell in the middle age bracket. People in this age bracket are energetic and effective in decision making on adoption of new technologies including rooftop rainwater harvesting.

4.3.5 Marital status of the respondents.

The respondents were asked to indicate their marital status. Table 4.8 shows the distribution of the respondents by marital status.

Table 4.8: Marital status of the respondents

Marital status	Frequency	Percentage
Married	325	84.2
Single	35	9.1
Divorced/Separated	8	2.0
Widow(er)	18	4.7
Total	**386**	**100.0**

Table 4.8 shows that 325 (84.2%) respondents were married, 35 (9.1%) respondents were singles, 8 (2.0%) respondents were divorced/ separated and 18 (4.7%) respondents

were widowed. Most respondents were in a marriage which ascribes familial responsibilities relating to everyday household resources.

4.3.6 Number of household members of the respondent.

The respondents were asked to indicate number of members of their households on a categorized size bracket. Table 4.9 shows the number of the respondents' household members.

Table 4.9: Number of household members

Number of household members	Frequency	Percentage
Below 3	21	5.4
3 - 5	264	68.4
6 - 8	83	21.5
Over 8	18	4.7
Total	**386**	**100.0**

Table 4.9 shows that 21 (5.4%) respondents had less than 3 household members, 264 (68.4%) respondents had 3 - 5 household members, 83 respondents had 6-8 household members while only 18 respondents had more than 8 household members. Most respondents' families had what would be perceived to be an average African family size. Family members would be very instrumental in fetching water and in constructing a rooftop rainwater harvesting system. Also, the larger the size of the family, the higher the demand for water for domestic use

4.3.7 Highest academic qualification of the respondents.

The respondents were asked to indicate their highest academic qualification. Table 4.10 shows their responses.

Table 4.10: Highest academic qualification

Highest academic qualification	Frequency	Percentage
Primary	97	25.1
Secondary	264	68.4
University	18	4.7
Others	7	1.8
Total	**386**	**100.0**

Table 4.10 shows that majority of the respondents 264 (68.4%) had attained secondary education while 97 (25.1%) respondents had attained primary level of education. A small percentage (4.7%) had gone beyond secondary education and another smaller percentage (1.8%) may indicate the illiterate. This indicates that majority of the respondents had acquired basic education and would easily understand the importance of this technology and therefore could be trained to undertake rooftop rainwater harvesting.

4.4 Adoption of rooftop rainwater harvesting among households in Masinga Sub-County

This section analyzes the level of adoption of rooftop rainwater harvesting among households in Masinga Sub-County. The level of adoption is dependent on varied factors that influence the households either positively or negatively.

4.4.1 Size of respondent's house

The respondents were asked to indicate the size of their houses based on the number of rooms. Table 4.11 shows their responses.

Table 4.11: Size of the respondents' houses

Size of the respondent's house	Frequency	Percentage
One bedroom	88	22.8
Two bedrooms	170	44.0
Three bedrooms	89	23.1
Others	39	10.1
Total	**386**	**100.0**

Table 4.11 shows that 88 (22.8%) respondents indicated that they had one bed roomed houses, 170 (44.0%) respondents had two bed roomed houses, 89 (23.1%) respondents had three bed-roomed houses and 39 (10.1%) respondents could have more than three bed-roomed houses or alternatively could have bedsitters. Most houses had large enough roofs, sufficient as catchment surfaces, to collect enough rainwater for the households' requirements throughout the year.

4.4.2 The respondent Practice of harvesting rooftop rainwater

The respondents were asked to indicate whether they practiced rooftop rainwater harvesting. Table 4.12 shows their responses.

Table 4.12: The respondent Practice of harvesting rooftop rainwater

	Frequency	Percentage
Yes	246	63.7
No	140	36.3
Total	**386**	**100.0**

Table 4.12 shows that 246 (63.7 %) respondents practiced rooftop rainwater harvesting while 140 (36.3%) respondents did not practice rooftop rainwater harvesting. A considerable percentage of households practice rooftop rainwater harvesting even though the volumes harvested were varied. Rooftop rainwater harvesting enabled the respondents to conserve water for domestic use in the

dry seasons. This triggered the question of the volume of water held in their storage containers. Table 4.13 shows their responses.

4.4.3 Volume of water the respondent stored in water storage containers

The respondents were asked to indicate the volume of water which they were able to harvest and store in their water storage containers. Table 4.13 shows their responses

Table 4.13: Volume of water held in water storage containers

Volume of water (Ltrs)	Frequency	Percentage
Less than 100	14	5.7
100 – 1,000	82	33.3
1,000 – 5,000	111	45.1
5001 – 10000	31	12.6
More than 10,000	8	3.3
Not applicable	140	0.0
Total	**386**	**100.0**

Table 4.13 shows that of majority of the residents who harvested rainwater from their roofs (78.4%) could store between 100 litres and 5,000 litres. Harvested water saves the time which otherwise would have been used in fetching water from distance places. The household members could use the saved time to do other important and productive work.

4.4.4 Adoption of rooftop rainwater harvesting

The respondents were interviewed on their level of agreement on the adoption of rainwater harvesting in the area. Table 4.14 shows their responses on a likert's scale

Table 4.14: Adoption of rooftop rainwater harvesting

Adoption of rooftop rainwater harvesting	Strongly agree: Freq.	Agree: Freq.	Neutral: Freq.	Disagree: Freq.	Strongly disagree Freq.
Adoption of Rooftop RWH can greatly improve the welfare of the households	223 (57.8%)	113 (29.3%)	44 (11.4%)	6 (1.5%)	0 (0.0%)
Many households are able to afford setting up the rooftop RWH system	38 (9.8%)	66 (17.1%)	23 (6.0%)	172 (44.6%)	87 (22.5%)
Rooftops provide the highest quality water among the water sources available to us	95 (24.6%)	188 (48.7%)	73 (18.9%)	21 (5.5%)	9 (2.3%)

Table 4.14 shows that most respondents (87.1%) agree that rooftop RWH is a technology that can greatly impact their lives in a positive way. They (73.3%) further agree that rooftops provide the highest quality of water among the water sources available to them. The respondents indicated that there is a challenge of affordability in initially setting up this noble water harvesting system.

4.5 The economic factors influencing the adoption of rooftop rainwater harvesting

This section analyzes the economic factors that influence the adoption of rooftop rainwater harvesting among households in Masinga Sub-County. In this study, the economic factors analyzed are the level of income and the type of roof with both questionnaire and interviews being conducted.

4.5.1 The respondents status of house ownership

The respondents were asked to indicate the status of their house ownership. Table 4.15 shows their responses.

Table 4.15: The respondents' status of house ownership

Status of house ownership	Frequency	Percentage
Private	363	94.0
Rented	12	3.1
Others	11	2.9
Total	**386**	**100.0**

Table 4.15 shows that majority of the respondents (94.0%) privately own their houses. Private ownership accords the house owners absolute authority to make decisions in relation to rooftop rainwater harvesting

4.5.2 The respondents' source of income

The respondents were asked to indicate their source of daily income. Their responses are shown in Table 4.16

Table 4.16: The respondents' source of daily income

Source of daily income	Frequency	Percentage
Farming	232	60.1
Business	80	20.7
Employment	67	17.4
Others	7	1.8
Total	**386**	**100.0**

Table 4.16 shows that most of the respondents (60.1%) were engaged in farming activities as their source of income. Another 20.7% were engaged in business as their economic activity and 17.4%

were employed. With proper training farmers can use mechanized and better methods of storing water for irrigation.

4.5.3 The respondents' type of roof

The respondents were asked to indicate the type of roof they have used on their houses. Their responses are shown in Table 4.17

Table 4.17: The respondents' type of roof of their house

Type of roof	Frequency	Percentage
Corrugated Iron sheet	333	86.3
Tiles	18	4.6
Grass thatched	27	7.0
Others	8	2.1
Total	**386**	**100.0**

Table 4.17 shows that 86.3% of the respondents have roofed with corrugated iron sheets, 7.0% indicated grass thatched, 4.6% indicated tiles. This implies that majority of the respondents in Masinga Sub-County, Machakos County have roofed with corrugated iron sheets which is one of the best and safest materials for rainwater catchment so this greatly increases the ease of the harvesting rooftop rainwater

4.5.4 The respondents source of money to start rooftop RWH

The respondents were asked to indicate the source of money they used to set up the rooftop rainwater harvesting system. Their responses are shown in Table 4.18

Table 4.18: The respondents' source of money to start rooftop RWH

Source of money	Frequency	Percentage
Own money	138	56.1
Bank loan	24	9.8
Merry-go-round	62	25.2
Government support	13	5.3
Others	9	3.6
Not applicable	140	0.0
Total	**386**	**100.0**

Table 4.18 shows that majority of the people who have adopted this technology (56.1%) have used their earnings and savings from their local social groups (25.2%). This indicates that the economic activities of majority of the people do not earn them credit safety in lending institutions and the Government has covered little ground on this area

4.5.5 The respondents level of income

The respondents were asked to indicate their level of income on monthly basis . Their responses are shown in Table 4.19

Table 4.19: The respondents' level of income

The respondents monthly level of income (Ksh)	Frequency	Percentage
Below 1,000	24	6.2
1,000 – 5,000	134	34.7
5,001 – 10,000	126	32.6
10,000 – 30,000	83	21.5
Above 30,000	19	5.0
Total	**386**	**100.0**

Table 4.19 shows that majority of the respondents (67.3%) were earning between 1,000 and 10,000 a month. Financial constrains can greatly influence the decision-making especially where basic needs and other critical priorities are competing.

4.5.6 Economic factor influencing the adoption of rooftop RWH

The respondents were interviewed to indicate their level of agreement with the following statement on the economic factor influencing the adoption of rooftop RWH. Their responses are shown in Table 4.20

Table 4.20: Economic factor influencing the adoption of rooftop RWH

Economic factor influencing the adoption of rooftop RWH	Strongly agree: Freq	Agree: Freq	Neutral: Freq	Disagree: Freq	Strongly disagree: Freq
I believe the economic situation has a big influenced on the extent of adoption of rainwater harvesting in this area	99 (25.6%)	216 (56.0%)	31 (8.0%)	29 (7.5%)	11 (2.9%)
Water harvested from rooftops in this area is safe for drinking and other domestic uses	102 (26.4%)	198 (51.3%)	53 (13.7%)	18 (4.7%)	15 (3.9%)

Table 4.20 shows that many respondents (81.6%) agreed and strongly agreed that they believe the economic situation has a big influenced on the extent of adoption of rainwater harvesting in Masinga Sub-County, Machakos County. In addition, the study revealed that 77.7% agreed and strongly agreed that Water harvested from rooftops in this area is safe for drinking and other domestic uses. This implies that economic situation has a big influenced on the extent of adoption of rainwater harvesting in Masinga Sub-County, Machakos County and that water harvested from rooftops in this area is safe for drinking and other domestic uses

4.6 The Socio-cultural factors influencing the adoption of rooftop rainwater harvesting

This section analyzes the Socio-cultural factors that influence the adoption of rooftop rainwater harvesting among households in Masinga Sub-County. The Socio-cultural factors analyzed include assigned gender roles and social capital through questionnaires and interviews.

4.6.1 Individual Responsible for rainwater harvesting activity in the household

The respondents were asked to indicate who does the duty of fetching water in the family. Their responses are shown in Table 4.21

Table 4.21: Individual Responsible for rainwater harvesting activity in the household

Who does fetching of water in the family	Frequency	Percentage
Myself	86	22.3
My spouse	177	45.9
Children	81	21.0
House help	42	10.8
Total	**386**	**100.0**

Table 4.21 shows that most respondents, who were male, indicated that their spouses (45.9%) were viewed to have the biggest responsibility in fetching water for the households; however these numbers indicate a changing pattern of assigned roles as the number of men fetching water indicates (22.3%). 21% indicated their children, while 10.8% indicated their house help. This implies that in Masinga Sub-County, Machakos County women have the biggest responsibility in fetching water for the households

4.6.2 Response on the distance to nearest water point

The respondents were asked to indicate the distance they travelled to the nearest water point. Their responses are shown in Table 4.22

Table 4.22: Responses on the distance to nearest water point

Distance to the nearest water point	Frequency	Percentage
Less than 40 M	137	35.5
41-100 M	86	22.3
101–500 M	61	15.8
Over 500M	102	26.4
Total	**386**	**100.0**

Table 4.22 shows that quite a number of respondents (35.5%) had to travel a short distance to get to the water point. However, another considerable population (42.2%) still has to travel a long distance to the nearest water point. With rooftop RWH, a lot of time used to fetch water would be utilized to do other important activities for the benefit of the household.

4.6.3 Whether the respondents believe that fetching water is the role of women and girls

The respondents were asked to indicate whether they believed that fetching water for the household was the role of women and girls. Their responses are shown in Table 4.23

Table 4.23: Whether the respondents believe that fetching water is the role of women and girls

Do you believe it's the role of women and girls to fetch water for the household	Frequency	Percentage
Yes	159	41.2
No	227	58.8
Total	**386**	**100.0**

Table 4.23 shows that majority of the respondents (58.8%) believed that fetching water for the household was a shared responsibility among members of the family. However, a considerable number of respondents (41.2%) still believe the role of fetching water belongs to the females in the household.

4.6.4 Response on the number of neighbours who practice rooftop rainwater harvesting

The respondents were asked to indicate the number of neighbors who practiced rooftop rainwater harvesting. Their responses are shown in Table 4.24

Table 4.24: Responses on the number of neighbors who practiced rooftop RWH

No. of neighbors practicing RRWH	Frequency	Percentage
None	17	4.4
1 - 3	192	49.7
4 - 7	107	27.7
More than 7	70	18.1
Total	**386**	**100.0**

Table 4.24 shows that most respondent (77.4%) had knowledge that their neighbors practiced rooftop RWH. People who had adopted and benefitted from this technology would be an encouragement to their neighbors to adopt this noble technology.

4.6.5 Whether the respondent has discussed rooftop RWH with a neighbour

The respondents were asked to indicate whether they had taken a chance to discuss rooftop rainwater harvesting with their neighbors. Their responses are shown in Table 4.25

Table 4.25: Whether the respondent discussed RRWH with their neighbours

Whether you have consulted a neighbour on RRWH	Frequency	Percentage
Yes	241	62.4
No	145	37.6
Total	**386**	**100.0**

Table 4.25 shows that many respondents (62.4%) had taken time to discuss with their neighbors about rooftop RWH. Discussing adoption of this technology among the members of the

community is an indication of an interest to adopt the technology and that the community had strong mutual ties.

4.6.6 Socio-cultural factor influencing the adoption of rooftop RWH

The respondents were interviewed to indicate their level of agreement with the following statement on the Socio-cultural factor influencing the adoption of rooftop RWH. Their responses are shown in Table 4.26

Table 4.26: Socio-cultural factor influencing the adoption of rooftop RWH

Socio-cultural factor influencing the adoption of rooftop RWH	Strongly agree Freq.	Agree Freq.	Neutral Freq.	Disagree Freq.	Strongly disagree Freq.
Most people around here know about RRWH	100 (25.9%)	168 (43.5%)	28 (7.3%)	51 (13.2%)	39 (10.1%)
It's women and girls who fetch water in this area	66 (17.1%)	124 (32.1%)	46 (11.9%)	98 (25.4%)	52 (13.5%)
The responsibility of fetching water for the families is quickly shifting to men & boys	159 (41.2%)	104 (26.9%)	56 (14.5%)	42 (10.9%)	25 (6.5%)
We get the information about rainwater harvesting from our neighbours	94 (24.4%)	136 (35.2%)	68 (17.6%)	60 (15.5%)	28 (7.3%)
Social groups are important organs for innovation sharing in this area	106 (27.5%)	129 (33.4%)	77 (20.0%)	43 (11.1%)	31 (8.0%)

Table 4.26 shows that majority of the respondents interviewed (69.4%) have knowledge of this technology. It further indicates that the duty of fetching water is majorly relegated to women and girls by cultural and traditional assignment (49.2%) even though the role is fast shifting to the male members of the family as indicated by (68.1%) of the respondents. From the table, the

respondents also indicate that they get a lot of information on innovation from neighbors and social groups (60.9%).

4.4 The ecological factors influencing the adoption of rooftop rainwater harvesting

This section analyzes the ecological factors that influence the adoption of rooftop rainwater harvesting among households in Masinga Sub-County. The ecological factors analyzed in this section are rainfall patterns and sand harvesting through questionnaire and interviews.

4.7.1 Responses on the pattern of rainfall in the area

The respondents were asked to indicate the pattern of rainfall in the area. Their responses are shown in Table 4.27

Table 4.27: Responses on the pattern of rainfall received in the area

Pattern of rainfall received in the area	Frequency	Percentage
Evenly distributed	4	1.0
bimodal in nature	353	91.5
Uni modal	16	4.1
Another	13	3.4
Total	**386**	**100.0**

Table 4.27 shows that majority of the respondents (91.5%) indicate that the area receives a bimodal pattern of rainfall. This calls for water harvesting to carry the households through the dry spells of the year.

4.7.2 Whether rainfall received in the area is adequate

The respondents were asked to indicate whether the rainfall received in the area is sufficient throughout the year. Their responses are shown in Table 4.28

Table 4.28: Whether this rainfall enough for domestic water throughout the year

Whether rainfall received in the area is adequate	Frequency	Percentage
Yes	58	15
No	328	85
Total	**386**	**100.0**

Table 4.28 shows that majority of the respondents (85%) feel that rainfall does not provide enough water to take them throughout the year. Lack of enough water calls for alternative ways of conserving water for domestic purposes

4.7.3 The respondent alternative source of water

The respondents were asked to indicate their alternative source of water from categorized sources. Their responses are shown in Table 4.29

Table 4.29: Responses on their alternative source of water

Alternative sources of water	Frequency	Percentage
Piped water	89	23.0
Roof water harvesting	110	28.5
Borehole	96	24.9
Well/pond	91	23.6
Total	**386**	**100.0**

Table 4.29 shows that respondents rely on different sources to get water. However, the trend indicates that rooftop RWH is gaining prominence in the area.

4.7.4 Whether the respondent is aware of any sand harvesting in the area

The respondents were asked to indicate whether they were aware of sand harvesting in the area. Their responses are shown in Table 4.30

Table 4.30: Respondents' awareness of sand harvesting in the area

Awareness of Sand Harvesting in the Area	Frequency	Percentage
Yes	346	89.6
No	30	10.4
Total	**386**	**100.0**

Table 4.30 shows that majority of the respondents (89.6%) are aware of sand harvesting in the area. Sand harvesting is very detrimental to water conservation.

4.7.5 Responses on the sand harvesting methods used in the area

The respondents were asked to comment on the sand harvesting methods used to harvest sand in the area. Their responses are shown in Table 4.31

Table 4.31: Responses on the methods used in sand harvesting in the area

Method used in sand harvesting in the area	Frequency	Percentage
In-stream mining	360	93.3
Off-stream mining	7	1.8
Others	19	4.9
Total	**386**	**100.0**

Table 4.31 shows that majority of the respondents (93.3%) indicate that sand harvesting mainly takes place in the local rivers and streams. This form of sand harvesting negatively affects the ecosystem and destroys the available water aquifers.

4.7.6 Whether sand harvesting in the area is regulated

The respondents were asked to indicate whether sand harvesting in the area is regulated in by the Government. Their responses are shown in Table 4.32

Table 4.32: Whether sand harvesting in the area regulated by any institution

Is sand harvesting regulated in the area	Frequency	Percentage
Yes	74	19.2
No	312	80.8
Total	**386**	**100.0**

Table 4.32 shows that majority of the respondents (80.8%) did not know any form of Government regulation on sand harvesting. Unregulated sand harvesting can be very detrimental to the ecosystem

4.7.7 Whether the relevant stakeholders have been engaged before sand harvesting

The respondents were asked to indicate whether relevant stakeholders were consulted before sand harvesting was done. Their responses are shown in Table 4.30

Table 4.33: Whether the relevant stakeholders have been fully engaged before sand harvesting

Whether the relevant stakeholders have been consulted before sand harvesting	Frequency	Percentage
Yes	92	23.8
No	211	54.7
I’m not aware	83	21.5
Total	**386**	**100.0**

Table 4.33 shows that majority of the respondents (54.7%) don’t believe that the relevant stakeholders had been consulted before sand harvesting activities in the area. Extensive consultation is vital before the execution any activity that will have an impact on the livelihoods of the local community.

4.7.8 Ecological factors influencing the adoption of rooftop RWH

The respondents were interviewed their level of agreement with the following statement on the ecological factor influencing the adoption of rooftop RWH. Their responses are shown in Table 4.34

Table 4.34: Ecological factors influencing the adoption of rooftop RWH

Ecological factors influencing the adoption of rooftop RWH	Strongly agree Freq.	Agree Freq.	Neutral Freq.	Disagree Freq.	Strongly disagree Freq.
Rainfall pattern in this area is stable and predictable over the years	69 (17.9%)	127 (32.9%)	41 (10.6%)	116 (30.1%)	33 (8.5%)
More than 70% of the year (8 months) is usually dry in this area	93 (24.1%)	200 (51.8%)	21 (5.4%)	55 (14.3%)	17 (4.4%)
There is rampant and uncontrolled sand harvesting in this area	87 (22.5%)	130 (33.7%)	18 (4.6%)	84 (21.8%)	67 (17.4%)
Sand harvesting has greatly affected our amount and quality of water	114 (29.5%)	183 (47.4%)	62 (16.1%)	15 (3.9%)	12 (3.1%)

Table 4.34 shows the respondents interviewed had a divided opinion about the stability of rainfall in the area. However majority of the respondents (79.5%) indicated that there is a longer dry season in the area than the rainy season. Respondents (56.2%) also agree that sand harvesting is rampant and uncontrolled leading to dwindling levels of water in the local rivers and other water aquifers (76.9%).

4.8 Influence of availability of other sources of water on the adoption of RRWH

This section analyzes the influence of availability of other sources of water on the adoption of rooftop rainwater harvesting among households in Masinga Sub-County.

4.8.1 Whether the respondent practices runoff rainwater harvesting

The respondents were asked to indicate whether they did practice runoff rainwater harvesting. Their responses are shown in Table 4.35

Table 4.35: Whether the respondent practiced surface runoff water harvesting

Whether you practice run-off water harvesting	Frequency	Percentage
Yes	99	25.6
No	287	74.4
Total	**386**	**100.0**

Table 4.35 shows that majority of the respondents (74.4%) do not practice surface runoff RWH while the remaining 25.6% indicated that they practice surface runoff water harvesting. This implies that majority of the households in Masinga Sub-County do not practice surface runoff RWH for the Surface runoff water may be easily polluted and contaminated and therefore may not be safe for domestic purposes

4.8.2 The volume of water harvested and stored from runoff

Among the respondents who indicated that they practices runoff rainwater harvesting were further asked to indicate the volume, in litres, of water which they harvested and stored from run-off. Their responses are as shown in Table 4.36

Table 4.36: The volume of water harvested and stored from runoff

Volume (M^3) of water harvested through run-off	Frequency	Percentage
Less than 400 litres	16	16.2
401-1000 litres	24	24.2
1001 -5000 litres	38	38.4

5001- 10000 litres	13	13.1
More than 10,000litres	8	8.1
Total	**99**	**100.0**

Based on the study findings as shown in Table 4.36, Majority of the respondents (38.45%) indicated the volume of water harvested and stored from runoff to be 1,001 -5,000 litres, 13.1% indicated 5,001- 10,000 litres, 24.2% indicated 401-1,000 litres, 16.2% indicated Less than 400 litres, while 8.1% indicated that they harvested more than 10,000 litres. This implies that the volume of water harvested and stored from runoff was not enough to run the household chores throughout the dry spell.

4.8.3 Safe and Sufficient Tap Water

The respondents were asked to indiOOOcate whether they did receive safe and sufficient tap water. Their responses are shown in Table 4.37

Table 4.37: Safe and Sufficient Tap Water

Whether you get quality and sufficient tap water	Frequency	Percentage
Yes	82	21.2
No	304	78.8
Total	**386**	**100.0**

Based on the findings on the Table 4.37 Majority of the respondents (78.8%) indicated that they don’t get quality and sufficient tap water while only 21.2% of the respondents get tapped water. This is an indication that most of the households in Masinga Sub-County don’t get quality and sufficient tap water. Tapped water is from a centralized Government system and may not reach the majority of the community members. This calls for alternative methods of water conservation for domestics use.

4.8.4 Adoption of roof top rain water harvesting

Among the respondents who indicated that they don't get quality and sufficient tap water were further probed to indicate whether they have adopted rooftop rainwater harvesting. The study findings are as shown in the Table 4.38 below

Table 4.38: Adoption of roof top rain water harvesting

	Frequency	Percentage
Yes	164	53.9
No	140	46.1
Not applicable	82	0.0
Total	**386**	**100.0**

From the responses, 53.9% of the respondents indicated that they have adopted rooftop rainwater harvesting, while only 46.1% were on contrary opinion. This implies that most of the respondents have adopted rooftop rainwater harvesting

4.8.5 Failure to adopt rooftop rainwater harvesting

The respondents were asked to state why they had not adopted rooftop rainwater harvesting. Their responses are shown in Table 4.39

Table 4.39: Failure to adopt rooftop rainwater harvesting

Why you have not adopted RRWH	Frequency	Percentage
Financial challenges	84	60
Availability of quality and sufficient water from other sources	31	22.2
Lack of awareness on rooftop rainwater harvesting technology	8	5.7
Problem of the space to put up the facility	17	12.1
Not applicable	246	0.0
Total	**386**	**100.0**

Table 4.39 shows that majority of the respondents (60%) who had not adopted rooftop RWH cited economic reasons as their main challenge. 22.2% cited availability of quality and sufficient water

from other sources, 12.1% cited problem of the space to put up the facility, while 5.7% cited lack of awareness on rooftop rainwater harvesting technology. This implies that financial challenges and availability of quality and sufficient water from other sources are the major challenges behind adoption of rooftop rainwater harvesting among households in Masinga sub-county, Machakos County, Kenya

4.8.6 Influence of availability of other sources of water on the adoption of RRWH

The respondents were asked to indicate their level of agreement with the following statement on how the availability of other sources of water had influenced the adoption of rooftop RWH in Masinga Sub-County. Their responses are shown in Table 4.40

Table 4.40: Influence of availability of other sources of water on the adoption of RRWH

Influence of availability of other sources of water on the adoption of RRWH	Strongly agree Freq.	Agree Freq.	Neutral Freq.	Disagree Freq.	Strongly disagree Freq.
We are supplied with sufficient and safe tapped water	18 (4.7%)	42 (10.9%)	11 (2.8%)	214 (55.4%)	101 (26.2%)
We have wells, ponds and boreholes to supply us with enough water in this area	16 (4.1%)	54 (14.0%)	20 (5.2%)	207 (53.6%)	89 (23.1%)
Water from boreholes and wells is safe for drinking	68 (17.6%)	81 (21.0%)	41 (10.7%)	101 (26.2%)	95 (24.6%)
Surface run-off water is highly contaminated and polluted	112 (29.0%)	138 (35.8%)	39 (10.1%)	55 (14.2%)	42 (10.9%)
Rooftop rain water provides the best quality water for drinking	125 (32.4%)	163 (42.2%)	13 (3.4%)	66 (17.1%)	19 (4.9%)

Table 4.40 shows that majority of the locals (81.6%) do not get piped water and do not have enough surface water sources to supply them with sufficient amount of water (76.7%). From the table, the respondents have a divided opinion on the quality of water from boreholes and wells in the area and surface run-off is highly contaminated for safe domestic use (64.8%). The

respondents largely indicate that rooftop rainwater is safe for domestic use (74.6%) implying that rooftop rainwater harvesting is quite important in this area.

4.9 Inferential Statistics

To evaluate the relationships between the dependent and independent variables, correlation and multiple regression analysis was done and the findings presented in the following subsections.

4.9.1 Correlation Analysis

In this subsection a summary of the correlation and regression analyses is presented. It seeks to first determine the degree of interdependence of the independent variables and also show the degree of their association with the dependent variable separately. These results are summarized in Table 4.41

Table 4.41: Correlation Matrix

	Adoption of rooftop rain water harvesting	**Economic factors**	**Social-cultural factors**	**Ecological factors**	**Availability of other sources of water**
Adoption of rooftop rain water harvesting (r)	1	0.773	0.463	0.618	0.652
(p) Sig. (2 tailed)		0.036	0.018	0.025	0.031
Economic factors (r)	0.773	1	0.316	0.163	0.161
(p) (2 tailed)	0.036		0.047	0.019	0.029
Social-cultural factors (r)	0.463	0.316	1	0.216	0.233
(p) Sig. (2 tailed)	0.018	0.047		0.047	0.0464
Ecological factors (r)	0.618	0.163	0.216	1	0.462
(p) Sig. (2 tailed)	0.025	0.019	0.047		0.014
Availability of other sources of water (r)	-0.652	0.161	0.233	0.462	1
(p) Sig. (2 tailed)	0.031	0.029	0.0464	0.014	

The correlation summary shown in Table 4.41 indicates that the associations between the independent variables were significant at the 95% confidence level and a strong comparison to their associations with the dependent variable. This means that the intervariable correlations between the independent variables were strong enough to affect the relationship with the dependent variable. Results of the Pearson's correlation coefficient depicts that there is a significant positive relationship between adoption of rooftop rain water harvesting and economic factors (rho=0.773, p-value <0.05). Therefore, it can be implied that an increase in economic factors is associated with increased adoption of rooftop rain water harvesting. Secondly, the study showed that there is a weak relationship between adoption of rooftop rain water harvesting and Social-cultural factors (rho=0.463, p-value <0.05). Thirdly, the findings showed that there is a strong positive significant relationship between ecological factors and adoption of rooftop rain water harvesting (rho=0.618, p-value <0.05). Finally, there is a weak negative relationship between availability of other sources of water and adoption of rooftop rain water harvesting (rho=-0.652, p-value <0.05)

4.9.2 Regression Analysis

In the endeavour, the study sought to determine the goodness of fit of the regression equation using the coefficient of determination between the overall independent variables and adoption of rooftop rain water harvesting. Coefficient of determination established the strength of the relationship. Coefficient of determination explains the extent to which changes in the dependent variable can be explained by the change in the independent variables or the percentage of variation in the dependent variable (Adoption of rooftop rain water harvesting) that is explained by the economic factors, social-cultural factors, ecological factors, and availability of other sources of water as the independent variables.

4.9.2.1 Model Summary

Model summary' table, provides information about the regression line's ability to account for the total variation in the dependent variable

Table 4.42: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.921[a]	.849	.845	.04131

Dependent Variable: Adoption of rooftop rain water harvesting

Predictors: (Constant), economic factors, social-cultural factors, ecological factors, and availability of other sources of water

Table 4.42 illustrates that the strength of the relationship between Adoptions of rooftop rain water harvesting and independent variables. From the determination coefficients, it can be noted that there is a strong relationship between dependent and independent variables given an R^2 values of 0.849 and adjusted to 0. 845. This shows that the independent variables (economic factors, social-cultural factors, ecological factors, and availability of other sources of water) accounts for 84.5% of the variations in adoption of rooftop rain water harvesting.

4.8.2.2 ANOVA Results

Analysis of variance (ANOVA) is a collection of statistical models used to analyze the differences among group means and their associated procedures (such as "variation" among and between groups)

Table 4.43: ANOVA of the Regression

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Regression	62.480	4	15.620	9.44949	0.0002719
Residual	629.793	381	1.653		
Total	692.273	385			

Dependent Variable: Adoption of rooftop rain water harvesting

Predictors: (Constant), ecological factors, economic factors, Social-cultural factors, and project Coordination

Analysis of Variance (ANOVA) was used to make simultaneous comparisons between two or more means; thus, testing whether a significant relation exists between variables (dependent and independent variables). This helps in bringing out the significance of the regression model. The ANOVA results presented in Table 4.43 shows that the regression model has a margin of error of p = .0002. This indicates that the model has a probability of 0.02% of giving false prediction. This point to the significance of the model.

4.8.2.3 Coefficient of Correlation

Multiple regression analysis was conducted as to determine the relationship between the adoption of rooftop rain water harvesting and the four variables.

Table 4.44: Coefficient of Correlation

	Un-standardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	3.77	0.451		8.3592	0.004
Economic factors	0.782	0.121	0.146	6.46281	0.003
Social-cultural factors	0.463	0.079	0.126	5.86076	0.001
Ecological factors	0.473	0.073	0.045	6.47945	0.005
Availability of other sources of water	-0.532	-0.073	0.142	7.28767	0.004

a. Dependent Variable: Adoption of rooftop rain water harvesting

Adoption of rooftop rain water harvesting= 3.77 + 0.782*Economic factors + 0.463*Social-cultural factors + 0.473*Ecological factors + 0.532*Availability of other sources of water

From the finding in Table 4.44, the study found that holding economic factors, Social-cultural factors, ecological factors, and availability of other sources of water , at zero Adoption of rooftop rain water harvesting will be 3.77. It was established that a unit increase in economic factors, while holding other factors (Social-cultural factors, ecological factors, and availability of other sources of water) constant, will lead to an increase in Adoption of rooftop rain water harvesting by 0.782 (p = 0.003). Further, unit increase in Social-cultural factors, while holding other factors (economic factors, ecological factors, and availability of other sources of water) constant, will lead to an increase in Adoption of rooftop rain water harvesting by 0.463 (p = 0.001). A unit increase in ecological factors, while holding other factors (economic factors, Social-cultural factors, and availability of other sources of water) constant, will lead to an increase in Adoption of rooftop rain water harvesting by 0.473 (p =0.005).

Moreover, unit increase in Availability of other sources of water , while holding other factors (Economic factors, Social-cultural factors, Ecological factors) constant, will lead to an decrease in Adoption of rooftop rain water harvesting by 0.532 ($p = 0.004$). This infers that Social-cultural factors contribute most to the Adoption of rooftop rain water harvesting followed by Economic factors. At 5% level of significance and 95% level of confidence, Social-cultural factors, Economic factors, and Availability of other sources of water are significant in Adoption of rooftop rain water harvesting.

CHAPTER FIVE
SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarized the study findings. The discussions provided a basis upon which conclusions and recommendations were advanced in order to address the factors influencing the adoption of rooftop rainwater harvesting among households in Masinga Sub-County, Machakos County, Kenya.

5.2 Summary of Findings

The summary of findings presented followed the profile of the respondents and the four specific objectives analyzed in the study.

The summary of the findings on the profile of the 386 respondents who are spread across the five wards of Masinga Sub-County.

Out of the 386 respondents who participated in this study, 263 (68.1%) were male and 123 (31.9%) were the heads of their households. Males, who are mostly the heads of their households and are the decision makers, are in a position to initiate and implement any new innovations to be adopted by the household. The findings also showed that 279 (72.3%) respondents had lived in the area for more than 10 years indicating absolute ownership of the land which is vital for decision making and 318 (82.4%) respondents fall in the productive age of between 31 and 70 years of the age. 325 (82.2%) of the respondents were in a marriage setup and therefore have the familiar responsibility of making progressive decisions for the household. The findings further indicated that majority of the respondents (68.4%) had between 3 – 5 members of their households. Members of a family are instrumental in fetching water, at the same time; the demand for water is commensurate to the family size. From the findings, 74.9% of the respondents had attained secondary education and therefore were in a position to be easily trained on the new technology. Summary of the findings of the level of adoption of rooftop rainwater harvesting among households in Masinga Sub-County, Machakos County

From the findings, most of the respondents' houses were from one bed roomed house to more than three bed roomed houses. A one bedroomed house roofed with the right material does provide sufficient catchment area to harvest rains water for the household. Most houses had large enough roofs, sufficient as catchment surfaces, to collect enough rainwater for the households' requirements throughout the year. The findings further revealed that 63.7% of the population practice rooftop RWH and 36.3% of the community has not adopted rooftop RWH. Rooftop rainwater harvesting enabled the respondents to conserve water for domestic use during the dry seasons which cover three quarters of the year. Among the community members who had adopted rooftop RWH majority (78.4%) could store between 100 litres and 5,000 litres. Harvested water saves the time which otherwise would have been used in fetching water from distance places. The household members could use the saved time to do other important and productive work. The findings further indicate that 87.1% of the respondents agree that rooftop RWH is a technology that greatly improves their livelihoods. They (73.3%) further agree that rooftops provide the highest quality of water among the water sources available to them. Rooftop rainwater is collected and stored on site and therefore not prone to pollution and abuse.

Summary of the findings on economic factors influencing the adoption of rooftop rainwater harvesting among households in Masinga Sub-County. The findings revealed that 363 (94 %) respondents privately owned the land on which their houses were built. Absolute ownership of the land gives the house owners a better opportunity to make and implement innovation and development easily. The findings further revealed that most of the respondents (60.1%) were engaged in farming activities as their source of income. Another 20.7% were engaged in business as their economic activity and 17.4% were employed. With proper training farmers can use mechanized and better methods of harvesting and storing water for domestic use and irrigation. Concerning the type of roof that the community embraced, the findings showed that 333 (86.3%) respondents roofed with iron sheets. Corrugated iron sheets are some of the best and safest materials for rainwater catchment.

Further findings on the source of capital revealed 138 (56.1%) respondents who had adopted this technology had used their personal earnings and 62 (25.2%) respondents had saved money through their local social groups. This indicates that the community had fewer alternatives in sourcing the capital for setting up the rainwater harvesting system. The findings also revealed most economic activities of the community do not earn them credit safety in lending institutions and the Government has covered little ground assisting the community to adopt this noble technology. The findings further revealed that 260 respondents, representing 67.3% of the respondents who had adopted rooftop RWH were earning between 1,000 and 10,000 a month and 140 respondents representing 36.3% of the total number of respondents had not adopted the technology. Financial constrains can greatly influence the decision-making especially where basic needs and other critical priorities are competing. The findings from the interviews conducted revealed that economic factors largely affected the people's ability to adopt rooftop RWH in Masinga Sub-County. 81.6% indicated that economic challenges were the largest impediment to their adoption of this technology despite the fact that majority of them (77.7%) agreed that rooftop water is safe for drinking and other domestic purposes. Economic factors play a big role in the welfare status of any society.

Summary of the findings on Sociocultural factors influencing the adoption of rooftop rainwater harvesting among households in Masinga Sub-County. The findings reveal that 58.8% believed that fetching water was a fairly shared responsibility among the members of the household. However, a considerable number of respondents, majority of whom were male, representing 45.9% indicated that women and girls were viewed to have the biggest responsibility in fetching water for the households; further still, these numbers indicated a changing pattern of assigned gender roles as the number of men and boys tasked with fetching water indicated an increase (22.3%). The findings also revealed that 42.2% of the population had to travel a long distance to the nearest water point. With rooftop RWH, a lot of time used to fetch water would be utilized to do other important activities for the benefit of the household. The findings further indicated that most respondent (77.4%) had knowledge that their neighbours practiced rooftop RWH and that 62.4% of the respondents had taken time to discuss the innovation with their neighbours. Discussing adoption of this technology among the members of the community is an indication of an interest to adopt the technology and that the community had strong mutual ties. These neighbours, who had adopted this technology, would be a source of encouragement to their neighbours to adopt and benefit from this innovation. From the findings of the interviews conducted, 60.9% of the respondents got information about rooftop RWH from neighbours and the community social groups. These groups provide social capital that determines which innovations have proven essential for the community.

Summary of the findings on Ecological factors influencing the adoption of rooftop rainwater harvesting among households in Masinga Sub-County. The findings revealed that 353 respondents representing 91.5% said that the area received a bimodal pattern of rainfall and 328 respondents representing 85% felt that rainfall did not provide enough water to take them throughout the year. Inadequate availability of water calls for alternative ways of conserving water for domestic purposes. Rooftop RWH becomes a good alternative since it provides quality and safe water for domestic use.

The findings also revealed that respondents rely on different sources to get water and rooftop RWH seemed to be gaining prominence in the community. The findings further showed that 346 respondents representing 89.6% were aware of rampant and uncontrolled sand harvesting in the area which took place in the local rivers and streams as indicated by 93.3% of the respondents. Sand harvesting is very detrimental to water conservation as it negatively affects the ecosystem and destroys the available water aquifers. From the findings, the respondent indicated that 80.8% of the respondents indicated that there was no any form of Government regulation on sand harvesting in the area and 54.7% of the respondents didn't believe that the relevant stakeholders had been consulted before sand harvesting activities in the area. Unregulated sand harvesting can lead to abuse of the ecosystem and extensive consultation with all the relevant stakeholders is vital before the execution any activity that will have an impact on the livelihoods of the local community. Findings from an interview conducted on ecological factors, the respondents held varied opinions about the stability of rainfall in the area but majority of the respondents (79.5%) indicated that there is a longer dry season in the area than the rainy season.

Summary of the findings on the influence of availability of other sources of water on the adoption of rooftop rainwater harvesting among households in Masinga Sub-County. The findings revealed that 287 respondents representing 74.4% didn't practice surface runoff RWH while 99 respondents representing 25.6% did practice. Those who practiced this form of RWH registered a varied range of storage capacities for the harvested water while 60% of the respondents who had not adopted rooftop RWH cited economic reasons as their main challenge. Economic factors may determine the volume of water to be stored because of the cost of the water storage utilities among other capital costs. Economic empowerment plays a crucial role in enhancing the development of a community. Surface runoff water can collect volumes of water in a short time but the water may be easily polluted and contaminated and therefore may not be safe for domestic purposes. The findings further indicated that only 21.2% of the respondents got tapped water. Tapped water is from a centralized Government system and may not reach the majority of the community members. This calls for alternative methods of water conservation for domestics use. From the interviews conducted, the respondents held a divided opinion on the quality of water from boreholes and wells in the area while 64.8% of the respondents felt that surface run-off is highly contaminated for safe domestic use. 74.6% of the respondents indicate that rooftop rainwater is safe for domestic use implying that rooftop rainwater harvesting is quite essential in this area.

5.3 Discussion of Findings

A discussion of the findings on the four objectives of the study is presented below.

5.3.1 The economic factors influencing the adoption of rooftop rainwater harvesting

The findings revealed that 363 (94 %) respondents privately owned the land on which their houses were built. Absolute ownership of the land gives the house owners a better opportunity to make and implement innovation and development easily. The findings further revealed that most of the respondents (60.1%) were engaged in farming activities as their source of income. Another 20.7% were engaged in business as their economic activity and 17.4% were employed. With proper training farmers can use mechanized and better methods of harvesting and storing water for domestic use and irrigation. Concerning the type of roof that the community embraced, the findings showed that 333 (86.3%) respondents roofed with iron sheets. Corrugated iron sheets are some of the best and safest materials for rainwater catchment. Further, the study found out that there is a significant positive relationship between adoption of rooftop rain water harvesting and economic factors. In tandem with the study findings, Marenya and Barrett (2007) found out that resource constraints limited many households' capacity to adopt new practices and that such capacity is linked to farm size, livestock value, off-farm income, family labor supply, and education. Households in rural areas are confronted by other economic priorities like purchase of basic needs such as food, clothing and funding education for their children. Another consideration made by households is the limited access to credit. Increased income by the households shows greater incentive for investment in the rainwater harvesting technologies (CSE 2003). The level of income also determines the water storage facilities that a particular household can afford and therefore the overall volumes of rainwater that can be harvested in the household in a particular season. These economic factors have major effects on the adoption of rainwater harvesting technologies or otherwise.

5.3.2 The Socio-cultural factors influencing the adoption of rooftop rainwater harvesting

The findings reveal that 58.8% believed that fetching water was a fairly shared responsibility among the members of the household. However, a considerable number of respondents, majority of whom were male, representing 45.9% indicated that women and girls were viewed to have the biggest responsibility in fetching water for the households; further still, these numbers indicated a changing pattern of assigned gender roles as the number of men and boys tasked with fetching water indicated an increase (22.3%). The findings also revealed that 42.2% of the population had to travel a long distance to the nearest water point. With rooftop RWH, a lot of time used to fetch water would be utilized to do other important activities for the benefit of the household. The findings further indicated that most respondent (77.4%) had knowledge that their neighbours practiced rooftop RWH and that 62.4% of the respondents had taken time to discuss the innovation with their neighbours. Discussing adoption of this technology among the members of the community is an indication of an interest to adopt the technology and that the community had strong mutual ties. These neighbours, who had adopted this technology, would be a source of encouragement to their neighbours to adopt and benefit from this innovation. From the findings of the interviews conducted, 60.9% of the respondents got information about rooftop RWH from neighbours and the community social groups. These groups provide social capital that determines which innovations have proven essential for the community. Further, the study found out that there is a significant positive relationship between adoption of rooftop rain water harvesting and socio-cultural factors. Similar to the study findings, Sander (2002), states that in social capital, more people get their economic innovation from whom they know, rather than what they know. The family represents one of the major ways that human populations organize and adapt to meet goals and needs and communicate values in diverse environmental circumstances (Bubolz 1991). The family unit is the organizing unit for the exchange of valuable resources, human labour, as family members assume different economic and productive roles within the household, the marketplace and the formal & informal workforce. According to Cheserek (2013), the socio-economic factors influencing farmers' decisions to adopt rain water harvesting techniques were categorized in household variables (gender, education and age) and economic variables (wealth status, access to credit, social status and household members' perception). All the factors have different effects on the adoption rate of the rain water harvesting techniques. The important role of financial, human and land resources endowment of a household is very vital in the decision of the household on whether to adopt any newly introduced agricultural techniques

5.3.3 The ecological factors influencing the adoption of rooftop rainwater harvesting

The findings revealed that 353 respondents representing 91.5% said that the area received a bimodal pattern of rainfall and 328 respondents representing 85% felt that rainfall did not provide enough water to take them throughout the year. Inadequate availability of water calls for alternative ways of conserving water for domestic purposes. Rooftop RWH becomes a good alternative since it provides quality and safe water for domestic use. The findings also revealed that respondents rely on different sources to get water and rooftop RWH seemed to be gaining prominence in the community. The findings further showed that 346 respondents representing 89.6% were aware of rampant and uncontrolled sand harvesting in the area which took place in the local rivers and streams as indicated by 93.3% of the respondents. Sand harvesting is very detrimental to water conservation as it negatively affects the ecosystem and destroys the available water aquifers. From the findings, the respondent indicated that 80.8% of the respondents indicated that there was no any form of Government regulation on sand harvesting in the area and 54.7% of the respondents didn't believe that the relevant stakeholders had been consulted before sand harvesting activities in the area. Unregulated sand harvesting can lead to abuse of the ecosystem and extensive consultation with all the relevant stakeholders is vital before the execution any activity that will have an impact on the livelihoods of the local community. Findings from an interview conducted on ecological factors, the respondents held varied opinions about the stability of rainfall in the area but majority of the respondents (79.5%) indicated that there is a longer dry season in the area than the rainy season. Further, the study found out that there is a significant positive relationship between adoption of rooftop rain water harvesting and ecological factors. In line with the study findings, Goyal (2005) further reported that the sustainability of the watershed project depends on the ecological and technical parameters like construction of water harvesting structures, soil and water conservation measures. Similarly, the economic parameters are like the benefits to the masses in comparison to the cost in terms of water and irrigation security, food security, fodder security and ensured employment through agriculture. But the major contribution is from people's participation or social sustainability of the project. If peoples' participation is achieved it can lead to better implementation of the project, growth of the project and maintenance of the created infrastructures on sustainable basis.

5.3.4 Influence of availability of other sources of water on the adoption of rooftop RWH

The findings revealed that 287 respondents representing 74.4% didn't practice surface runoff RWH while 99 respondents representing 25.6% did practice. Those who practiced this form of RWH registered a varied range of storage capacities for the harvested water while 60% of the respondents who had not adopted rooftop RWH cited economic reasons as their main challenge. Economic factors may determine the volume of water to be stored because of the cost of the water storage utilities among other capital costs. Economic empowerment plays a crucial role in enhancing the development of a community. Surface runoff water can collect volumes of water in a short time but the water may be easily polluted and contaminated and therefore may not be safe for domestic purposes. The findings further indicated that only 21.2% of the respondents got tapped water. Tapped water is from a centralized Government system and may not reach the majority of the community members. This calls for alternative methods of water conservation for domestics use. From the interviews conducted, the respondents held a divided opinion on the quality of water from boreholes and wells in the area while 64.8% of the respondents felt that surface run-off is highly contaminated for safe domestic use. 74.6% of the respondents indicate that rooftop rainwater is safe for domestic use implying that rooftop rainwater harvesting is quite essential in this area. Financial challenges and availability of quality and sufficient water from other sources are the major challenges behind adoption of rooftop rainwater harvesting among households in Masinga sub-county, Machakos County, Kenya. Further, the study found out that there is a significant negative relationship between adoption of rooftop rain water harvesting and availability of other sources of water. In tandem with the study Smith, (2002) opined that Land surface waters such as wells and ponds could be contaminated from industry, mining and agricultural waste, for example in northern Mali, pesticides were found to have polluted lots of water while in Mauritius, industrial and sewage pollution threatened the livelihood of fishermen. The dependence of the people on unsafe or unmaintained wells and pond water for domestic purposes opens them up to a high risk of contaminating water borne diseases (Karim et al, 2005). It is also difficult and consequently expensive to put up infrastructure for water supply where terrain is hilly or otherwise unleveled (UNEP, 1997). Cost is usually a limiting factor to the implementation of high-tech and large scale RWH systems in many developing countries (DTU, 1987). Mati et al (2007) asserts that rooftop rainwater harvesting (RRWH) is cheap, sustainable, has less operational and maintenance cost. The technology avoids many surface-water pollutants (Gabana et al, 1997). It also allows water to be collected and stored just next to its point of consumption, relieving the households from the burden of carrying it, utilizing time and energy (IRCSA, 2004). Harvested water can be used for agricultural purposes and can be used for ground water replenishment. RRWHT reduces reliance on underground sources and surface waters. Rooftop rainwater gets collected as well as controlled through individual households and therefore it’s not open to the abuse by the other users.

5.4 Conclusions

With regard to the first objective of the study which sought to establish the influence of economic factors on the adoption of rooftop rainwater harvesting among households in Masinga Sub-County, Machakos County, the study concludes that a considerable percentage of households in Masinga Sub-County, Machakos County practice rooftop rainwater harvesting even though the volumes harvested were varied. Rooftop rainwater harvesting enabled the respondents to conserve water for domestic use in the dry seasons and that there is a challenge of affordability in initially setting up this noble water harvesting system. The study also concludes that most of the households in Masinga Sub-County, Machakos County have been roofed with corrugated iron sheets which are one of the best and safest materials for rainwater catchment so this greatly increases the ease of the harvesting rooftop rainwater. Also, the study concludes that economic situation has a big influenced on the extent of adoption of rainwater harvesting in Masinga Sub-County, Machakos County and that water harvested from rooftops in this area is safe for drinking and other domestic uses

With regard to the second objective of the study which sought to establish the influence of social-cultural factors on the adoption of rooftop rainwater harvesting among households in Masinga

Sub-County, Machakos County, the study concludes that This implies that in Masinga Sub-County, Machakos County women have the biggest responsibility in fetching water for the households. However, majority of the respondents in Masinga Sub-County, Machakos County believed that fetching water for the household was a shared responsibility among the members of the family. The study also concludes that most households in Masinga Sub-County, Machakos County had knowledge that their neighbors practiced rooftop RWH and that most households in Masinga Sub-County, Machakos County has taken time to discuss with their neighbors about rooftop RWH. Discussing adoption of this technology among the members of the community is an indication of an interest to adopt the technology and that the community had strong mutual ties. Further, the study concludes that social groups are important organs for innovation sharing in Masinga Sub-County, Machakos County.

With regard to the third objective of the study which sought to establish the influence of ecological factors on the adoption of rooftop rainwater harvesting among households in Masinga Sub-County, Machakos County, the study concludes that Masinga Sub-County receives a bimodal pattern of rainfall. This calls for water harvesting to carry the households through the dry spells of the year. In addition, the study concludes that in Masinga Sub-County rainfall does not provide enough water to take them throughout the year and thus lack of enough water calls for alternative ways of conserving water for domestic purposes. Also, the study concludes that sand harvesting mainly takes place in the local rivers and streams. This form of sand harvesting negatively affects the ecosystem and destroys the available water aquifers. The study concludes that households in Masinga Sub-County don't believe that the relevant stakeholders had been consulted before sand harvesting activities in the area, therefore, extensive consultation is vital before the execution any activity that will have an impact on the livelihoods of the local community. Further, the study concludes that More than 70% of the year (8 months) is usually dry in this area, Sand harvesting has greatly affected our amount and quality of water and that there is rampant and uncontrolled sand harvesting in Masinga Sub-County.

With regard to the final objective of the study which sought to establish the influence of availability of other sources of water on the adoption of rooftop rainwater harvesting among households in Masinga Sub-County, Machakos County, the study concludes that majority of the households in Masinga Sub-County do not practice surface runoff RWH for the Surface runoff water may be easily polluted and contaminated and therefore may not be safe for domestic purposes and that the volume of water harvested and stored from runoff was not enough. In addition, the study concludes that most of the households in Masinga Sub-County don't get quality and sufficient tap water. Tapped water is from a centralized Government system and may not reach the majority of the community members. This calls for alternative methods of water conservation for domestics use. Further, the study concludes that financial challenges and availability of quality and sufficient water from other sources are the major challenges behind adoption of rooftop rainwater harvesting among households in Masinga sub-county, Machakos County, Kenya

5.5 Recommendations

The study recommends that institutions be put in place to assist households to access funds for rainwater harvesting structures; such assistance should include subsidized material. Farm incomes should as well be diversified and other support mechanisms put in place with a view of increasing the level of adoption of the rain water harvesting techniques

The study recommends that institution to work with the local community or households to provide guidance on right size of water storage tank to enable storage of water to last up to dry season

There is need to improve access to water by reducing the distance covered to get water for domestic use.

The future of RWH technologies in Masinga sub-county is bright among the resource-poor farmers if promoted using the participatory approaches and with some incentives to offset the initial investment costs and other problems that might be unique to the target group.

5.6 Suggestions for Further Research

This study further recommends that research be carried out on cost benefit analysis of rain water harvesting structures to inform the relevant government institution on best way forward.

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APPENDICES

APPENDIX I: QUESTIONNAIRE FOR THE RESPONDENTS

The role of this study is to evaluate the factors influencing the adoption of rooftop rain water harvesting among households in Masinga Sub County, Machakos County, Kenya. Your opinion will be kept private and confidential since this study is meant for academic purposes. Kindly do not indicate your name anywhere in the sheet. Answer by writing or ticking in the spaces provided below.

Yours faithfully

Jacob Musili

SECTION A: PROFILE OF THE RESPONDENTS

1. Please indicate your gender

   (a) Male [ ] (b) Female [ ]

2. How long have your lived / worked here (Years)

   (a) 0-2 [ ] (b) 3-5 [ ] (c) 6-10 [ ] (d) Above 10 [ ]

3. Are you the head of the household?

(a) Yes [ ] (b) No [ ]

4. Please indicate your age (years)

   (a) 30 and below [ ] (b) 31-50 [ ] (c) 51-70 [ ] (d) Above 70 [ ]

5. Please indicate your marital status?

   (a) Married [ ] (b) Single [ ] (c) Divorced [ ] (e) Widow(er) [ ]

6. What is the size of your household/family?

(a) Below 3 [ ] (b) 3-5 [ ] (c) 6-8 [ ] (d) Over 8 [ ]

7. Please indicate your highest academic qualification?

(a) Primary [ ] (b) Secondary [ ] (c) Tertiary [ ] (d) University [ ]

(e) Others (specify) ………………………………………

SECTION B: ADOPTION OF ROOFTOP RAINWATER HARVESTING

8. Please indicate the size of your house?

(a) One bedroom [ ] (b) Two bedroom [ ] (c) Three bedroom [ ] (e) Others [ ]

9. (a) Do you practice roof water harvesting?

(a) Yes [ ] (b) No [ ]

(b) If the answer to question (9) above is yes, please indicate the volume of water in litres which you can store in your containers

(a) Less than 100litres [ ] (b) 100-1000 litres [ ] (c) 1001-5000litres [ ]

(d) 5001- 10,000litres [ ] (e) more than 10,000litres [ ]

Adoption of rooftop rainwater harvesting	**1**	**2**	**3**	**4**	**5**
Water storage facilities are the only challenge to rainwater harvesting around this area					
Economic situation has a big influenced on the extent of adoption of rainwater harvesting in this area					
Harvested rainwater constitutes 70% of the domestic water used by households in this area					
Many households have roofed with materials that are safe and appropriate for water harvesting					

SECTION 2: ECONOMIC FACTORS

10. What is the status of your house ownership?

(a) Private [ ] (b) Rented [ ] (c) others (specify)…………………..

11. What is your source of income?

(a) Farming [ ] (b) Business [ ] (c) Employment [ ] (d) Others (specify)….. ………………………………………………………………

12. What is the type of roof of your house?

(a) Iron sheets [ ] (b) Tiles [ ] (c) Grass thatched [ ] (d) Others (specify)…………………………………………………………………

13. How did you raise money to start your water harvesting?

(a)Own money [ ] (b) Bank loan [ ] (c) Merry-go-round [ ]

(d) Government Support [ ] (e) others (please specify)……………………………

14 To what extent do you agree with the following statements on the adoption of rainwater harvesting in your household or area where:

1 = Strongly agree

2 = Agree

3 = Neutral

4 = Disagree

5 = Strongly disagree

Economic factor influencing the adoption of rooftop RWH	**1**	**2**	**3**	**4**	**5**
Many families can afford to set up the RWH systems					
Economic situation has a big influenced on the extent of adoption of rainwater harvesting in this area?					
In this areas, many houses are roofed with corrugated iron sheets					
Water harvested from rooftops in this area is safe for drinking					
The type of roof has never been a concern with rainwater harvesting					

SECTION 3: SOCIO-CULTURAL FACTORS

15. Who does the rainwater harvesting activity in your home?

(a) Myself [ ] (b) My spouse [ ] (c) Children [ ] (d) House help [ ]

16. Kindly indicate the distance to nearest watering point or a river

(a) Less than 40 M [ ] (b) 41-100 M [ ] (c) 101–500 M [ ] (d) Over 500M [ ]

18. Do you believe the role of fetching water for the household belongs to women and girls?

Yes [ ] No [ ]

19. (a) How many of your neighbours or friends do practice roof water harvesting?

(a) None [ ] (b) 1-3 [ ] (c) 4 -7 [ ] (d) More than 7 [ ]

(b) If the answer to question (21) above is yes, have you ever discussed it with them?

(a) Yes [ ] (b) No [ ]

20. To what extent do you agree with the following statements on the adoption of rainwater harvesting in your household or area where:

1 = Strongly agree

2 = Agree

3 = Neutral

4 = Disagree

5 = Strongly disagree

Sociocultural factor influencing the adoption of rooftop RWH	**1**	**2**	**3**	**4**	**5**
Most people around here know about rainwater harvesting					
It's women and girls who fetch water in this area					
The responsibility of fetching water for the families is quickly shifting to men & boys					

Many of us do get the information about rainwater harvesting from our neighbours					
Social groups are important organs for innovation sharing in this area					

SECTION 4: ECOLOGICAL FACTORS

21. Please indicate the pattern of rainfall received in your area?

(a) Evenly distributed [ ] (b) bimodal in nature [ ] (c) Uni modal [ ]

(e) Another (specify)……………………..

22. (a) Is this rainfall enough in offering adequate domestic water?

(a) Yes [ ] (b) No [ ]

(b. If the answer to question (23) above is No, please indicate your alternative source of water

(a)Piped water [ ] (b) Roof water harvesting [ ] (c) Borehole [ ]

(d) Well/pond [ ] (e) others (specify)……………….

23. Are you aware of sand harvesting in your area?

(a)Yes [ ] (b) No [ ]

24. Which methods are used in sand harvesting in your area?

(a) In-stream mining (b) Off-stream mining (c) Specify any other(s)

……………………………………………………………

25. If yes, is the sand harvesting in the area regulated by any institution?

(a)Yes [ ] (b) No [ ]

26. Have the relevant stakeholders been fully engaged in regulating sand harvesting?

(a) Yes [ ] (b) No [ ] (c) I'm not aware [ ]

27. To what extent do you agree with the following statements on the adoption of rainwater harvesting in your household or area where:

1 = Strongly agree

2 = Agree

3 = Neutral

4 = Disagree

5 = Strongly disagree

Ecological factors influencing the adoption of rooftop RWH	**1**	**2**	**3**	**4**	**5**
Rainfall pattern in this area is stable over the years					
More than 70% of the year (8 months) is usually dry in this area					
There is rampant and uncontrolled sand harvesting in this area					
Sand harvesting has greatly affected our amount and quality of water					

SECTION 5: AVAILABILITY OF OTHER SOURCES OF WATER

28. (a) Do you practice surface runoff water harvesting?

(a) Yes [ ] (b) No [ ]

(b) If the answer to question (30) above is yes, please indicate the volume of water you harvest per year from surface run off harvesting in M^3

(a) Less than 400 litres [ ] (b) 401-1000 litres [ ] (c) 1001 -5000 litres [ ] (e) 5001- 10000 litres [ ] (f) more than 10,000litres [ ]

29. (a) Do you get tap water at the desired time, quality and quantity?

(a) Yes [ ] (b) No [ ]

(b) If the answer to the above question is No, have you adopted roof top rain water harvesting?

(a) Yes [ ] (b) No [ ]

(c) If No, what is the reason?

A. Financial issues [ ]

B. Perception on the adequate supply of water [ ]

C. Limited awareness on rooftop rain water harvesting technology [ ]

D. Space problem [ ]

E. Others (specify)…………………….. [ ]

30. To what extent do you agree with the following statements on the adoption of rainwater harvesting in your household or area where:

1 = Strongly agree

2 = Agree

3 = Neutral

4 = Disagree

5 = Strongly disagree

Influence of availability of other sources of water on the adoption of rooftop RWH	**1**	**2**	**3**	**4**	**5**
We are supplied with sufficient and safe tapped water in this area					
We have wells, ponds and boreholes enough to supply us with enough water in this area					
Water from boreholes and wells is safe for drinking					
Surface run-off water is highly be contaminated and polluted					
Rooftop rain water provides the best quality water for drinking					

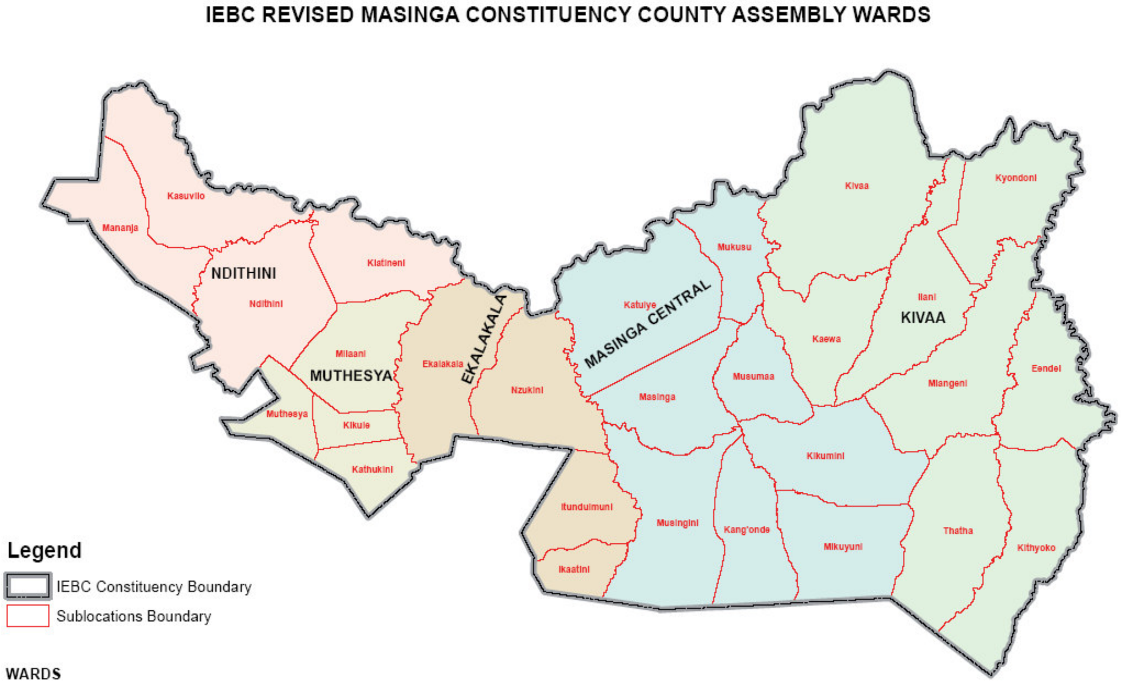
APPENDIX II: SAMPLE SIZE DETERMINATION FORMULA BY YAMANE

Precision Levels where Confidence Level is 95% and P=.5.

Size of Population	Sample Size (n) for Precision (e) of:			
	±3%	±5%	±7%	±10%
500	A	222	145	83
600	A	240	152	86
700	A	255	158	88
800	A	267	163	89
900	A	277	166	90
1,000	A	286	169	91
2,000	714	333	185	95
3,000	811	353	191	97
4,000	870	364	194	98
5,000	909	370	196	98
6,000	938	375	197	98
7,000	959	378	198	99
8,000	976	381	199	99
9,000	989	383	200	99
10,000	1,000	385	200	99
15,000	1,034	390	201	99
20,000	1,053	392	204	100
25,000	1,064	394	204	100
50,000	1,087	397	204	100
100,000	1,099	398	204	100
>100,000	1,111	400	204	100

Source: Yamane, Taro. (1967). Statistics, an Introductory Analysis, 2nd edition

APPENDIX III: AN ADMINISTRATIVE MAP OF MASINGA SUB-COUNTY



Source: Independent electoral and boundaries commission (IEBC)

APPENDIX IV: RESEARCH PERMIT

NATIONAL COMMISSION FORSCIENCE, TECHNOLOGY ANDINNOVATION

Telephone:+254-20-2213471, 2241349,3310571,2219420
Fax: +254-20-318245,318249
Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No. **NACOSTI/P/17/97560/18711**

Date: **12th September, 2017**

Jacob Muli Musili
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Factors influencing the adoption of rooftop rainwater harvesting among households in Masinga Sub-County, Machakos County, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Machakos County** for the period ending **12th September, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Machakos County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GKalerwa

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Machakos County.

The County Director of Education
Machakos County.

National Commission for Science, Technology and Innovation isISO9001: 2008 Certified

APPENDIX V: REQUEST LETTER FOR DATA COLLECTION

UNIVERSITY OF NAIROBI
COLLEGE OF EDUCATION AND EXTERNAL STUDIES
SCHOOL OF CONTINUING AND DISTANCE EDUCATION
DEPARTMENT OF EXTRA-MURAL STUDIES
NAIROBI EXTRA-MURAL CENTRE

Your Ref:
Our Ref:

Main Campus
Gandhi Wing, Ground Floor
P.O. Box 30197
N A I R O B I

Telephone: 318262 Ext. 120

REF: UON/CEES/NEMC/26/241

20th July, 2017

TO WHOM IT MAY CONCERN

RE: JACOB MULI MUSILI - REG NO L50/77829/2015

This is to confirm that the above named is a student at the University of Nairobi College of Education and External Studies, School of Continuing and Distance Education, Department of Extra- Mural Studies pursuing Masters of Art in Project Planning and Management.

He is proceeding for research entitled **"factors influencing the adopton of rooftop rain water harvesting among households in Masinga Sub-County, Machakos County, Kenya."**

Any assistance given to him will be highly appreciated.

UNIVERSITY OF NAIROBI C.E.E.S. P.O. Box 30197 20 JUL 2017 NAIROBI EXTRA MURAL CENTRE

CAREN AWILLY
CENTRE ORGANIZER
NAIROBI EXTRA-MURAL CENTRE

APPENDIX VI: ANTI-PLAGIARISM REPORT

FACTORS INFLUENCING THE ADOPTION OF ROOFTOP RAIN WATER HARVESTING AMONG HOUSEHOLDS IN MASINGA SUB-COUNTY, MACHAKOS COUNTY, KENYA

by Jacob Musili

Submission date: 05-Sep-2017 10:44AM (UTC-0400)
Submission ID: 843124898
File name: JACOB_MUSILI_Project_Report.doc (579K)
Word count: 19620
Character count: 108275

FACTORS INFLUENCING THE ADOPTION OF ROOFTOP RAIN WATER HARVESTING AMONG HOUSEHOLDS IN MASINGA SUB-COUNTY, MACHAKOS COUNTY, KENYA

ORIGINALITY REPORT

12%	9%	2%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Ikeogu, Dennis O., C.K.C Nwokolo, and Ifeyinwa B. Chidolue. "The Impact of Agriculture and Home Economics in National Development", Journal of Educational and Social Research, 2013. Publication	1%
2	Submitted to Kenyatta University Student Paper	1%
3	Submitted to University of Nairobi Student Paper	<1%
4	Submitted to American Intercontinental University Online Student Paper	<1%
5	www.strategicjournals.com Internet Source	<1%
6	Submitted to Saint Paul University Student Paper	<1%