FACTORS INFLUENCING SUSTAINABLE WATER RESOURCE MANAGEMENT PRACTICES IN AMALO AND MULOT LOCATIONS, MARA RIVER BASIN, KENYA

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DECLARATION AND RECOMMENDATION

This thesis is my original work and has not been presented in this or any other University for the award of any degree.

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DEDICATION

To my beloved parents, my dear husband Cyrus Gitonga Ngare and children, Socrates Ngare and Einstein Muhoro.

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ABSTRACT

Globally there has been a growing concern on the decrease in water quantity in surface waters during the prolonged dry spells leading to impact on household's wellbeing and ecosystem. Mara River Basin (MRB) in Kenya is not an exception. It has been estimated to have an annual population growth rate of more than 3%. This compounded by associated effects of water abstractions, for livestock, irrigation agriculture and domestic purposes have been on the rise leading to decreased water quantity in Mara River, with major impacts on household socio-economic human wellbeing. The objectives of the study were to determine the influences of household's characteristics and community institutions on sustainable water resources management practices in Amalo and Mulot locations. Purposive sampling was used in the selection of Amalo and Mulot locations as study sites. From these sites Amalo, Kiptaragon, Mulot and Olchoro-Oiruwa sub-locations were then selected for study because of their location along the river. The last stage used simple random sampling to list proportional number of households living along the river from each of the four sub-locations. A sample of 189 households was selected. Means, standard deviations, frequencies, percentages and cross tabulations were used for descriptive statistics, while multiple regression analysis was used for inferential statistics at 5% level of significance. Results from the study indicated that the household's awareness of conservation activities significantly influenced on adoption of sustainable water resource management practices and that there was a significant influence of households' membership in Water Resource Users' Associations on adoption of sustainable water resource management practices ($\beta=0.214$, $p<0.05$). In conclusion, membership of household and community members in Water Resource User Associations is likely to promote adoption of sustainable water resource management practices. The study recommends the need for Kenya government to empower Water-Users Associations and organizations through awareness creation and capacity on sustainable water use and support them in implementing the sustainable water resource management practices so as to optimize local water resources management.

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LIST OF ABBREVIATIONS AND ACRONYMS

BSAP	Biodiversity Strategic and Action Plan
CBOs	Community Based Organzations
CBS	Central Bureau of Statistics
EAC	East African Community
FAO	Food and Agriculture Organization
GoK	Government of Kenya.
IFAD	International Fund for Agricultural Development
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
Km	Kilometres
KNBS	Kenya National Bureau of Statistics
KWAHO	Kenya Water for Health Organization
LVBC	Lake Victoria Basin Commission
LVSCA	Lake Victoria South Catchment Area
MEA	Millennium Ecosystem Assessment
MRB	Mara River Basin
NWNL	No Water No Life
OECD	Organization for Economic Co-operation and Development
PES	Payment for Environmental Services
RWH	Rain Water Harvesting
SPSS	Statistical Package for the Social Sciences
SSA	Sub-Saharan Africa
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
WCED	World Commission for Environment and Development
WDM	Water Demand Management
WRM	Water Resources Management.
WRMA	Water Resources Management Authority
WREM	Water Resources and Environmental Management.

WWAP	World Water Assessment Programme
WRUAs	Water Users Associations
WWF-ESARPO	World Wide Fund for Nature - Eastern and Southern Africa Regional Programmed Office

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Water is a critical resource that is not only a finite resource but is also vulnerable and its scarcity and efforts to address and improve its availability has been elevated on national and international development agenda (Connor & Stoddard, (2012); Balaji *et al.,* (2012)).

Freshwater resource is a fundamental need for human health and welfare, food security and economic development. Water is very critical in achieving the Global Millennium Development Goals as envisaged by United Nations. The Goal No. 7 where water resources fall is emphasizing environmental sustainability but target 3 of this goal is more specific to water and aims at halving the number of people without access to safe drinking water by 2015 (WHO/UNICEF, 2010). Chapter 18 of Agenda 21 of Dublin Convention highlights the importance of water and indicates the way to secure and sustainable water for the future. It advocates that humans must change the way they manage water so as to achieve sustainable use (WCED, 1987). Poor water resource management and utilization can pose a serious threat to the country's social and economic development.

With regard to water resource management, the use of participatory approach is one of the principles of the Dublin Convention (Cosgrove & Rijsberman, 2000). The concept partly reflects the observation that people who inhabit an environment over time are often the ones most able to make decisions about its sustainable use. However, the vast majority of people have become passive observers, and a few people are taking decisions for everyone else. That is one of the prime reasons why the water resources are being destroyed (McLvor, 2000). The real revolution in water resources management will therefore come when all stakeholders, where possible, have the power to manage their own water resources. Efforts should be made to maximize productive water use. This could be through water conservation strategies, enhancing diverse water harvesting techniques, implementing wastewater recycling, and overall conservation of water catchment areas (Mitchell *et al.*, 2004).

At a global level, Integrated Water Resource Management (IWRM) approach promotes the coordinated development and management of water, land and related resources in order to optimize socio-economic welfare in an equitable manner without compromising the sustainability of vital ecosystems (USAID, 2005). In Kenya, the Water Act of 2002 (GoK, 2002) provides a legislative and institutional framework for effective management and sustainable utilization of water resources leading to the formation of the Water Resource Management Authority (WRMA). Kenya's new Water Policy provides various policies and strategies towards improving river water management. One of the policies is to decentralize decision making to sub-basin and catchment institutions. At the individual river catchment level, one type of institution, namely the River Water Users Association, can be used as a mechanism of introducing community participation in the management of the river water resources. This would bring the principle stakeholders, who have a vested interest in sustainable management of their river resources, into the process of monitoring, allocating and managing the resource in a way that can complement the official role of the Ministry of Water and irrigation (GoK, 2012). As a mechanism to promote stakeholder participation in water resource management and sustainable use, this Act spells out the need for formation of Water Users' Associations at local levels. This is in view of the need for proper management of this resource in face of continuing scarcity and increased demand. Under the water Act, several policies have been developed to support the implementation of water resource management to maximize benefits. For example, the target of the National Water Harvesting and Storage Policy is to increase national water storage from the current $124Mm^3$ to $4.5Bm^3$ to that per capita storage can be increased from $5.3m^3$ to $16m^3$ over the next ten years (WRMA, 2012).

The Constitution of Kenya (GoK, 2010) also recognizes the need to manage water resources and efforts are also underway to review the Water Act 2002 and align it with the two levels of Government that the new constitution WRMA, (2012). The Constitution considers water as a human right issue with respect to per capita use and quality. The national government has been bestowed with the ownership of water resources charged with among other the responsibility of water resource management. Included in these responsibilities is water protection, securing reserve flow and water policy formulation among others (GoK, 2010).

At a national level, water is critical in achieving Vision 2030 which articulates the need for conservation and effective use of water resources for the achievement of the environmental sustainability, target c, which aims to reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015, (GoK, 2007). Climate change is going to compound the problem of water scarcity in many parts of the world. A basic water management challenge is to find ways to satisfy human needs while coping with environmental changes and protecting the water resource from long-term degradation.

Many parts of the world, markedly the Middle East and the sub-Saharan Africa are experiencing serious water shortage and scarcity (WWAP, 2006). The situation in Kenya is not any better. Kenya receives less than 647/m^3 of fresh water per capita per year, making it one of the most water scarce countries in Africa and the world (WRI, 2005; UNDP, 2005). Competition over water between agricultural, industrial, domestic and municipal needs has worsened, stretching the recovery of hydrological systems (Orie, 1995). According to Akech (2008), it is thus unfortunate that in many parts of the world, human activities have severely undermined the sustainability of fresh water resources. Kenya experiences high rainfall variability, low investment in water resources development and poor protection of the existing water resources resulting in extensive degradation (Were *et al.*, 2006).

Mara River Basin in Kenya is located between (0° 28' S, 33° 47' E) and (1° 52' S, 35° 47'E) and is depended upon by local communities, domesticated animals, and wildlife for their well being. It is a home to 1.1 million people (LVBC & WWF-ESARPO, (2010b); GoK, (2009)). The human population in the Mara River Basin has been estimated to be growing at an annual rate of more than 3% (Hoffman, 2007). This accompanied by the associated effects of deforestation, environmental change, increased water abstraction for human and agricultural use, and other activities requires efficient and sustainable water use strategies. For example, river bank cultivation has led to declined water quantity in the main sources during the prolonged dry season. The implications of these environmental impacts on local communities and wildlife include increased poverty, loss of human and animal life and heightened environmental degradation as well as loss of key habitats for species. The Mara River is likely to become severely degraded in the near future due to ever increasing water abstractions, and this will impinge on the most basic ecological and socio-economic needs of the people (Alison, 2010) and wildlife. According to Gereta *et al.*, (2002) previous studies showed that low water flows and subsequent water shortages during the dry season may have significantly affected biodiversity in the Mara River Basin (MRB). An assessment by Lake Victoria Basin Commission and World Wide Fund for Nature-Eastern and Southern Africa Regional Programme Office (LVBC &WWF-ESARPO, (2010a)) indicated that there were temporal variations in water demand that created a negative balance between demand and supply during the dry season in Amalo and Mid Mara River.

Since 2000, the Kenyan government has been working to decentralize water management responsibilities to local authorities (GoK, 2000; GoK, 2012). Although the emerging institutions continue to address the effects of water management on quantity in Mara River Basin during the dry spells; a comprehensive approach is needed to address it. The objectives of the study were to find out the major sources of water used for domestic purposes, livestock farming and irrigated farming during the dry season and their effect on adoption of water management practices, and the effects of households' characteristics and community institutions on adoption of water management practices.

1.2 The Statement of the Problem

Amala River is one of the major tributary of the Mara River. Mara River is the only perennial river in the MRB during dry spells when the other rivers and other water sources dry up. It is depended upon by the local communities, domesticated animals, and wildlife for their well being. Mara River flows, during the dry season have been reported by LVBC & WWF ESARPO in 2010 to be too low such that the reserves do not sustain both human and ecosystem needs. The continued deterioration in water quantity has been caused by unsustainable water abstractions for use in irrigation farming, livestock farming and domestic purposes in the upper and middle catchment of MRB. In addition, there has been 3% rise in population growth in upper catchment from Mau Forest to Mulot, leading to increased demand for river waters and an indication of more abstractions occurring in the future (Hoffman, 2007). Forest loss in critical catchment areas for the Mara Rivers will result in ecological and hydrological changes, which threaten the sustainable future of areas downstream. In addition, people have encroached into some 43 700 ha in the Mau Complex's remaining protected forests. The desirability of many of these areas for agriculture attracts a rapidly growing population and has led to rapid conversion of large areas of forest to farmland (GoK, 2007). The Mara River therefore, faces degradation during prolonged dry spells and thus calls for sustainable water resource management practices in the upper and middle catchment. This is because Mara is not a large river, and ever increasing abstractions are certain to, at some point in the future, severely degrade the riverine ecosystem and even impinge upon the most basic water needs of people living along the river. Mara River is a source of water for local communities and populations in Kenya and Tanzania and is of great economic importance. It also serves Mara-Serengeti ecosystem which is a World Heritage Site and Biosphere Reserve of global conservation significance. The existing water resource use and management practices by households and community contribute to the continued decrease in water levels during dry spells. An assessment of household water use strategies and sustainable water management practices as well as the socio-economic factors affecting their adoption and human wellbeing is therefore a priority.

1.3 Objectives

1.3.1. Broad objective

The broad objective of this study was to determine factors that influence adoption of water resource management practices in Amalo and Mulot locations Mara River Basin, Kenya.

1.3.2. Specific objectives

The specific objectives were:

i. To determine the influences of households characteristics on adoption of sustainable water resources management practices in Amalo and Mulot locations.
ii. To investigate the influences of community institutions on adoption of sustainable water resources management practices in Amalo and Mulot locations.
iii. To find out the major sources of water used for domestic purposes, livestock farming and irrigated farming during the dry season in Amalo and Mulot locations.

1.4 Research Questions

The study was guided by the following research questions which were intended to accomplish the specific objectives listed above.

i. What is the role of the household's characteristics on the adoption of sustainable water resources management?

ii. What is the role of the community institutions on the adoption of sustainable water resources management in Amalo and Mulot locations?

iii. What are the major sources of water used for domestic purposes, livestock farming and irrigation farming during the dry season and how do they affect adoption of sustainable water resources management in Amalo and Mulot locations?

1.5 Justification / Significance of the Study

Kenya is a water scarce country and its per capita fresh water availability has declined with per capita supply at 650 m^3/year and future projections showing a drop to 359m^3/year by the year 2020 against global benchmark of 1000m^3 per person due to population growth (UNDP, 2005; UNEP, 2007b). Kenya's Water Act of 2002 underpins ways to realize national efficient water resource management, its goal is to improve water quantity and make it accessible and available beyond present levels by 2015 in accordance with the United Nations Millennium Declaration Goals (MDGs). Water availability and access in right quantities and quality is a human right issue as far as the Constitution of Kenya is concerned. Over-abstraction of water in the upstream of the MRB increases its scarcity in the downstream, thus non-attainment of these goals. Few studies have been done on Amala River to determine the factors that affect water resource management practices adopted by the communities and households in the upstream. The Amala River is one of the main perennial tributary of the Mara River. It is an important source of water for people living along the river where they use the water for various purposes including irrigation crop farming, domestic purposes and livestock keeping. It is a source of water for the wild animals in the Maasai Mara National Reserve. Due to its significance during times of severe drought, when the other water sources dry up, maintenance of its flows through sustainable water management practices at its upper and middle catchment is important. This will ensure that the river can continue with its critical ecological roles, socio-economic roles and basins resources sustainability in whole (LVBC&WWF ESARPO, 2010a; Alison, 2010).

There are only few studies that have examined the effect of both household and community characteristics on adoption of sustainable water resource management practices. The relationships between these factors were established in Amalo and Mulot locations of the MRB. This study generated data on how the household and community factors affected on adoption/non-adoption of sustainable water resource management. This derived information that may be used in enhancing sustainable water resource management practices at household and community level in Amalo and Mulot locations of the MRB.

1.6 Scope of the Study

The study was conducted in Amalo location in Olenguruone Division and Mulot location in Mulot Division. The study focused on sustainable water resource management and assessed whether they were sustainable. The study found out the major sources of water used for livestock purposes, domestic purposes and irrigated farming; determined their influences as well as those of household's characteristics and community institutions on adoption of sustainable water resource management practices. The households' characteristics were household size, level of formal education of household head and members, household land size, household land ownership, distance to the water source and households' awareness level of water conservation activities. The community institutions were the number of Community Based Organizations (CBO's) including Water Resource Users' Associations (WRUAs) active in water conservation and membership and registration of household's members in WRUAs and CBO's.

1.7 Operational Definition of the Terms

For the purpose of this study, the variables referred to in the specific objectives and research questions, were defined as follows, and were measured through the community's own views, impressions and activities.

Household. A household refers to a group of individuals who eat together and live under one roof or in different houses within the same compound and sharing most of the domestic responsibilities as a means of survival (Ellis, 1992). In this study a household referred to a group of people living and eating together, under one head of household and usually related by blood.

Household characteristics are a measure of household's factors as indicated by wealth, land size, farm enterprise. (Ruth *et al.*, 2005). In this study it referred to a measure of household's characteristics as indicated by their size, formal education level of the household head, land size, land tenure and distance to their water source.

Community institutions. These are strong and powerful traditional authorities and decision-making structures which are very important for indigenous and local communities to protect them against external threats to their lands and livelihoods and to maintain or facilitate decision-making for resource (Miller, 2012). In this study it referred to number of Community Based Organizations (CBO's) and Water Resource Users' Associations (WRUAs) active in water conservation and the number of household members or heads registered as members in them.

Sustainable water resource management. It is a knowledge based procedure that deals with integrated water resource management, so that to support the ability of human society to endure and flourish into the indefinite future without undermining the integrity of the hydrological cycle or the ecological systems that depends on it (Mitchell, 2011; Gleick, 1995). In this study it referred to adoption of Rain Water Harvesting (RWH), tree planting, programmes on Water Demand Management, construction of Riparian of buffer zones.

CHAPTER TWO
LITERATURE REVIEW

2.1 Population Size and Growth

Population growth creates some of the greatest pressure on water resources quantity. It directly affects water availability through increased demands and consumption resulting from water use patterns with significant implications at local, regional and global levels. Water withdrawal per person is a best indicator of the impact of human population on water. Water withdrawals per person range from 20m^3 a year in Uganda to more than 5000m^3 in Turkestan with a world average of 600m^3. Water withdrawals are highest in Arid and Semi-Arid areas where irrigation is most needed for agricultural production and is lowest in tropical countries (WWAP, 2009).

According to UNEP (2010), the world's population is growing by about 80 million people a year, implying increased fresh water demand of about 64 billion cubic meters a year. An estimated 90% of the three billion people who are expected to be added to the population by 2050 will be in developing countries, many in the regions where the current population does not have sustainable access to safe drinking water. The worst hit areas are in the Middle East, North Africa and Sub-Saharan Africa (Rosengrant *et al.,* 2002). According to UNDP (2008), Kenya is in sub-Saharan African and the population has doubled over the last 25 years to over 40 million people and rapid population growth is set to continue. Per capita available water is about 650 m^3/year. Future projections show that by the year 2020, per capita water availability will drop to 359 m^3 as a result of population growth (UNDP, 2005; UNEP, 2007b). Mara River Basin in Kenya is no exception. Its population is estimated to be growing at a rate of more than 3% per annum (Hoffman, 2007). In the absence of alternative livelihood opportunities and strategic management of the environment, this rapid population growth has resulted in environmental degradation and water resource degradation. Due to this, it is imperative that population growth and its structural changes are addressed to reduce environmental degradation (UNEP, 2010). In addition, vision 2030 should plan for and ensure an equivalent economic growth to accommodate its growing population (UNPD, 2008).

2.2 The Mau Forest Complex and illegal settlement.

Mau Forest Complex (4,000 km) is the largest remaining forest matrix in Kenya. It is considered one of Kenya's key "water towers," which serves as a national benchmark for monitoring the critical processes of rainwater catchment and distribution in this semi-arid country (Kenya Forests Working Group, 2006). It feeds major water arteries that extend as far as lakes Turkana, Natron, and Victoria, and support critical economic activities including hydropower, tourism, and agriculture.

In spite of its national importance, many areas of the Mau Forest Complex have been deforested or degraded; much of this damage taking place in the past few decades. Degazettement of forest reserves and continuous widespread encroachment have led to the destruction of over 100 000 ha of forest since 2000, representing roughly one-quarter of the Mau Complex's area. Between 1973 and 2005, Mau Forest lost over 8 214 ha of forest within its official boundaries, which were established to protect the forest (GoK, 2007). Almost 43 per cent of that loss occurred in just two years from 2003 to 2005. Just outside the gazetted boundaries of Maasai Mau Forest nearly 32 000 ha were lost during the same time period (Kenya Forests Working Group, 2006). The Western slopes of the Maasai Mau are a crucial catchment for the Mara River. Forest loss in critical catchment areas for the Mara Rivers will result in ecological and hydrological changes, which threaten the sustainable future of areas downstream. In addition, people have encroached into some 43 700 ha in the Mau Complex's remaining protected forests. The desirability of many of these areas for agriculture attracts a rapidly growing population and has led to rapid conversion of large areas of forest to farmland. Extreme land cover changes such as these can have serious consequences both within the forest and downstream in the form of water shortages, health risks and desertification. Loss of forest at this rate is unsustainable and threatens the security and future development of Kenya. Realizing the goals of Vision 2030 will depend in a very significant way upon the sustainable management of Kenya's natural assets. This water tower is a key among those assets (GoK, 2007).

The pressure currently placed on water resource in the basin has resulted in various environmental impacts. These include increased water demand as a result of population increases, increased human activities in the basin leading to water degradation (of both quantity and quality) through illegal logging, increased farming activities, charcoal burning, and encroachment. The implications of these environmental impacts on local communities include increased poverty, loss of human life, and destruction of human property. Unfortunately, these impacts serve to increase negative community attitude towards environmental conservation (WREM, 2008). As a result, Mara River basin has experienced environmental degradation leading to poor water quality and quantity and biodiversity loss. The decline in water quantity in the main sources has been attributed to deforestation, vegetation cover clearance, increased water abstraction for human and agricultural use, and other activities such as river bank cultivation (Gereta *et al.*, 2003).

This degradation limits efforts to reduce poverty, improve health, improve food security, increase economic development, and protect natural resources. There is significant loss of forest cover in the upper catchment and along the Mara River caused by unsustainable expansion in irrigated farming, fast population growth, poor planning of water resource use, and pollution loads (romp farming, urban centers, and tourist facilities). All these factors hinder sustainable conservation of the biodiversity and landscape. Other important contributing factors are weak legislation and institutional framework, lack of environmental education and awareness, and alternative means of livelihood that promote environmental conservation. All stakeholders should be actively involved in planning and implementation of environmental management activities. There is need for Kenyan and Tanzanian Governments to coordinate existing environmental regulations, policies and all environment-related sectors to be able to address the common challenge of sustainable environment (WREM, 2008).

2.3 Land Size and Productivity

According to World Bank (2007a), land is one of the household's assets and determines household productivity. Households without any access to land are excluded from the farming pathway. Lack of land can thus trap households to long-term poverty. The size of the land holdings is a critical factor that determines the type of farming system and use that will be practiced in a given area and the economic efficiency of the farm production. Land size is greatly influenced by the system of land tenure prevalent in an area. Under the individual tenure system and inheritance method of land acquisition, fallow length periods are either reduced or no more practiced. Large scale and animal production are difficult without sufficient land. With rapid population growth and enforcement of land tenure system, fragmentation of land has become rampant, and this has reduced farm size holdings and thus agricultural productivity (World Bank, 2007a). The mean land holding size in the upper catchments of the MRB is 46.0 ha ranging between minimum sizes of 0.6 ha and a maximum size of 630 ha. By contrast, in the middle catchment, land holding size ranges from 1.0 to 2.0 ha (Aboud *et al.*, 2002).

The Government of Kenya had adopted a policy promoting subdivision of group ranches in this region. This policy had serious implications for the Maasai people and natural resources sustainability within the Mara River Basin. Land size of the household positively affects the adoption of soil and water conservation practices by the household (Ersado *et al.,* 2004; Bekele & Drake, 2003). However, it can have differential effects on conservation investment as was studied in India across the three villages (Pender & Kerr, 1998). According to Abadi *et al.*, (2005), property size like the land size is often, but not always, related to innovation adoption. The larger areas tend to increase the overall benefits of adoption of beneficial innovations and so increase the likelihood of adoption. Alternatively, social issues related to adoption may also lead to people having larger properties. In North Central Victoria, the adoption of tree planting was not related to property size. D'Emden *et al.*, (2006), found a lack of relationship between farm size and adoption of conservation tillage in Western Australia.

2.4 Water Contribution to Household Well-being

According to Faures and Santinis (2008), water importance as an asset is determined by the quantity available daily for domestic use, agriculture and livestock consumption and by its ability to stimulate economic and social returns. For rural people, who make up some 75% of the world poorest people, access to water is essential both for basic needs and for productive purposes. Lack of access is often the main factor limiting their ability to secure their livelihoods. Destruction of watersheds impacts negatively on the entire society but more so on women. Degraded watersheds mean reduced water supply. Water shortage will in turn translate to longer walking distances as women fetch water far away from their usual water points (Stocking, 2001). According to Tacoli (2007), questions remain about how best to realize the potential benefits of water management opportunities to assist the poor. Although interventions are needed in several areas, water is a key factor because it plays a central role in agriculture, it is a frequent constraint in production and it provides a focal point around which other interventions can be organized. Strategies to reduce rural poverty need to focus on improving productivity in agriculture which is the main source of income. Gains require substantial intervention to improve farm level access, control and management of water resources (Faures & Santini, 2008). However, multiple use approach to meeting water needs of poor communities can bring multiple benefits. Poor households throughout the world depend on subsistence activities that require water. These activities also provide a much needed source of income. Better water access for domestic and agricultural use is likely to result in improved outcomes for poor households, by improving household productivity and health and releasing labor into the household production system, stimulating household income growth (Renwick *et al.*, 2007). Also according to Thompson *et al.*, (2001) productive uses of water have particular value for low-income households and communities and have health and wellbeing benefits. Direct health benefits are derived for example from improved nutrition and food security from gardens crops that have been watered. Indirect health benefits arise from improvements in household wealth from productive activity.

Investing in more reliable, higher quality, and more conveniently located domestic water or more reliable irrigation can quickly and significantly improve the lives of the poor (Soussan, 2004). Water-related diseases are only one component of an array of direct and indirect health impacts related to water resources that can be improved through sustainable watershed management. For example, in many developing countries, providing access to improved drinking-water sources has the potential to considerably reduce the time spent by women and children in collecting water and to trigger a range of educational and economic benefits that improve the social determinants of health (Bunch *et al.*, 2011). Food and nutritional security are the foundations of a decent life, a sound education and the achievement of the Millennium Development Goals. (FAO, 2008).

2.5 Land Tenure Rights

Land tenure is the relationship, whether legally or customarily defined, among people, as individuals or groups, with respect to land. (For convenience, "land" is used here to include other natural resources such as water and trees). Land tenure is an institution, i.e., rules invented by societies to regulate behavior (World Bank, 2008). Rules of tenure define how property rights to land are to be allocated within societies. They define how access is granted to rights to use, control, and transfer land, as well as associated responsibilities and restraints (FAO, 2002). Resources are usually categorized into management regimes so as to understand the manner, in which they are owned, accessed, controlled, and used (World Bank, 2008). Investments in natural resource management practices are long term, requiring secure long-term property rights over resources. Formalizing individual or community land rights is important, as is access to credit for longer-term investments (Gebremedhin *et al.*, 2006). Property rights to water and land are often interrelated, as when rights to agricultural land are accompanied by presumptive rights to its surface and groundwater flows (Swallow *et al.,* 2005). Often, however, water rights are more dynamic, flexible, and contested than land rights. Property rights to land resources generally vary across the different types of land that make up watersheds. Insecure property rights to cropland can reduce incentives to invest in land improvements and conservation structures such as terraces or trees that could reduce soil erosion and sediment flows. Usually more important for watershed management outcomes are property rights for small areas of land that help to check, divert, absorb, or stop an undesirable flow of soil, sediment, or pollutants within a watershed (Meinzen-Dick & Pradhan, 2002).

Most natural resource management practices have both long time and large spatial scales. They also require longer time horizons between their adoption and their payoff. In those situations, farmers need secure tenure (property rights) to have the incentive and authority to adopt. Both property rights and collective action are therefore crucial for the management of forests, rangelands, fisheries, watersheds, or irrigation systems that serve more than a single farm. In some cases, the scale of the resource to be managed may go beyond what can be done by voluntary collective action by a community. Federations of user groups may sometimes be able to manage larger resources, but often the state or even international bodies become critically important partners. In these cases, co-management between the community and government, rather than government management alone, often leads to better outcomes (Meinzen-Dick *et al.*, 2002).

Devolution programs that transfer management responsibility for natural resources from government agencies to farmers often fail to transfer corresponding rights (Oosterveer & Vliet, 2010). Yet rights over the resource are needed to provide groups with the incentives to conserve and even invest in the resources. Without recognized decision making rights, the groups lack the authority to manage the resource or to stop members or outsiders from breaking the rules. Recognized property rights not only reinforce collective action that is needed for collective management, but also provide security for individuals and households. Several briefs in this collection suggest ways of strengthening property rights for the poor (Meinzen-Dick *et. al.*, 2001).

2.6 Legal and institutional frameworks

There has been an increasing recognition of the role that policy and institutions play in sustainable management of natural resources and the environment (Reddy, 2005; Shiferaw *et al.*, 2006). At a global level, development instruments have been developed and timelines for achieving agreed targets set. For example, the MDGs target 2015. Water has a huge contribution to attaining MDGs such as eradicating extreme poverty and hunger, achieving universal primary education, reducing child mortality, improving maternal health, combating major diseases, ensuring environmental sustainability and developing a global partnership for development (WHO & UNICEF, 2012). The failure to provide safe drinking water and adequate sanitation services to all people is perhaps the greatest development failure of the 20th century. In an attempt to remedy this failure, the United Nations established the Millennium Development Goals (MDGs), eight targets designed to tackle extreme poverty by the year 2015. At the direction of United Nations member countries, UN organizations and multilateral and bilateral development agencies have worked to achieve these goals by 2015. While many of the MDGs are widely acknowledged to be associated with water, including those related to improving gender equality and reducing child mortality, target 7C specifically aims to reduce by half the proportion of the population without sustainable access to safe drinking water and basic sanitation by 2015. Although not without their critics, the MDGs have served to highlight the importance of water, sanitation, and hygiene for improving health and economic opportunities (UN 2012).

The institutional factors affecting the adoption of conservation technologies mainly relate to the prevailing property rights system (Shiferaw & Bantilan, 2004). This relates to the right of access and security of rights to land, water and other natural resources. Policy and institutional factors condition and shape farmer conservation decision. In agriculture, proper policies and institutional mechanisms induce the process of farmer innovation and adoption of the conservation practices (Rockstrom & Oweis, 2009).

In Kenya, the Water Act (2002) is principal law that governs the management, conservation, use and control of water resources. The Act stipulates that every water resource is vested in the State. The Act separates water resources management and development from water supply services delivery, through a detailed institutional framework which promotes a decentralized system composed of multi-level institutions. For example, at the national level the Ministry of Water and Irrigation (MWI) takes the role of policy formulation leaving the Water Resources Management Authority (WRMA) to take the lead role in the management of all water resources in Kenya. At the local level, the WRUAs are responsible for administering cooperation and conflict resolution by bringing all water users together in their respective areas (WRMA, 2007). The Mara River falls under the management of the Lake Victoria South Catchment Area (LVSCA), a regional WRMA office located in Kisumu, Western Kenya. Issues of the Mara such as issuance of abstraction permits and regulating and enforcing WRM are handled at the Sub-Regional office of LVSCA located in Kericho town.

Other related legal frameworks that support the water acts in Kenya are the Environment Management and Coordination Act (EMCA) of 1999; the Environment Policy; the Forest Act (2005), the Agriculture Act (CAP 318); National Land Policy and Land Control Act (CAP 406); The Fisheries Act (CAP 378); the Wildlife Management and Conservation Act (2013), the

Irrigation Act (CAP 347), among others. For example EMCA demands that Environmental Impact assessment (EIA) should be carried out for proposed interventions that may have impacts on the environment. The Forest Act (2005) in Kenya promotes sustainable use of forest products and participatory afforestation through Community Forest Associations (CFAs). The Land Act promotes protection and sustainable use of riparian lands (Water Rules 2007). The Constitution of Kenya 2010 provides for right to clean and safe water in adequate quantities for everyone hence promoting the on-going water scarcity control measures within the water resources management rules. The draft Water Act 2012 has emphasized separation of regulation from management of water resources which is envisaged to improve efficiency in IWRM processes including water scarcity control so that the right to clean and safe water can be realized in adequate quantities. This is meant to align the Water management and align it with two levels of government (national and county government respectively) and the current constitution.

The Water Resource Management Authority (WRMA) is a state corporation under the Ministry of Water and Irrigation established under the Water Act 2002 and charged with being the lead agency in water resources management. In order for WRMA to undertake its stipulated responsibilities, the Act provides for decentralized and stakeholder involvement. This is implemented through regional offices of the Authority based on drainage basins (catchment areas) assisted by Catchment Area Advisory Committees (CAACs). At the grassroots level, stakeholder engagement will be through Water Resource User Associations (GoK, 2002). According to the Water Act, 2012 Water Resource Users Association shall be community based associations for collaborative management of water resources and resolution of conflicts concerning the use of water resources. They shall be established as association of water resource users at the sub-basin level based on rules issued by the Water Resource Regulatory Authority (GoK, 2012).

2.7 Water governance.

Adoption of many natural resource management practices requires collective action at community or higher levels. There has been a veritable explosion of community organizations for natural resource management in recent years, driven largely by governments and NGOs that have become active in many less-favored regions. They have also been encouraged by some international development agencies (e.g.IFAD) to empower poor people, particularly poor women, and to ensure that they participate in new growth opportunities. According to IFAD (2005), some governments have also turned to local communities to take over roles formerly fulfilled very inadequately by the state. Community approaches can provide the secure property rights and collective action for improving natural resource management. They can also help manage local externalities and mediate between local people and the project activities of governments, donors, and NGOs. Collective action for resource management often needs to be at landscape levels, requiring cooperation by groups of farmers or even entire communities (Jackson, 1993). Watershed management requires cooperation among all the key stakeholders in a watershed, and this may involve one or more entire communities. But ensuring broad participation and sustainable outcomes is challenging because watershed management programme often have winners and losers (Knox, Meinzen-Dick & Hazell, 2002).

The national water, forest and environmental laws in Kenya and Tanzania were revised to recognize and enable the establishment of local and regional resource users associations, government and semi-government advisory and expert committees, and public-private partnerships. These grassroots institutions are useful players in implementing PES. Because of their familiarity with local issues and problems, they can play a critical role in a basin-wide initiative through promotion of best management practices, training, knowledge dissemination, monitoring and monetary transfers. Involving grassroots organizations will also help promote resource users' trust in the PES (Bhat & Michael, 2008). Results from involvement of users associations in water management are mixed. In certain areas, they have provided mechanism for allocating water to different users (as water rights are usually given to organizations and companies) and solving conflicts that arise from the competing uses while in other areas, they have encouraged excessive extraction of water by organized groups especially where members pay for the water as they try to maximize from their water rights. It is therefore important that adequate measures are put in place to ensure that WRUAs help in promoting equitable water distribution among the different groups. Given adequate local leadership and commitment, some communities are able to rise above the constraints of poverty and provide viable services as alliances can help disadvantaged groups have a stronger negotiating position (Meinzen-Dick & Pradhan, 2002).

As much as formal natural resource-based associations may provide a significant step towards improved management systems, they are not necessarily equitable or representative unless positive steps are taken to make them so. Public access points or rights should be provided to those who do not own riparian land where such association exists to avoid excluding local rural population from accessing water (Onyango *et al.*, 2007).

2.8 Sustainable Water Resource Management Practices

Integrated Water Resource Management emphasizes stakeholder participation and gender mainstreaming as key to water resource management. Sustainable Water Management (SWM) involves managing our water resources while taking into account the needs of present and future users. SWM attempts to deal with water in a holistic fashion, taking into account the various sectors affecting water use, including political, economic, social, technological and environmental considerations (Mitchell, 2011). Sustainable, basin-scale water management therefore requires cooperation between upstream and downstream users in the MRB, where upstream users apply suitable water and land management practices that preserve watershed services and do not impact downstream users (Smith *et al.*, 2006). Several management tools have been proposed or recommended to facilitate changes in upstream human actions. But the more innovative approach which has received considerable attention lately is paying incentives to upstream users to implement river-friendly management practices (Bhat & Michael, 2008).

2.8.1 Payment for Environmental Services

Payment for Environmental Services (PES) in the context of watershed management is a market-based scheme wherein the beneficiaries or users of watershed services will pay a fair compensation to those upstream parties who provide such services (Bhat & McCLain, 2008). The 40 case studies conducted by FAO, (2004) in South America, showed that PES can be implemented at various geographic and functional levels, from a localized watershed level to a national level. Most schemes did not have legal backing from national legislation, but rather depended on the commitment made by local governments or non-governmental organizations. The lack of a legal framework at the national level did not impede the initiation of a PES scheme as long as institutional and community support existed at the local level. The problem that undermined PES schemes was the lack of clear understanding of the connection between land and water management practices and the desired environmental outcomes. Ross *et al.,* (2004) also found that without adequate support from the local communities, both among service users and service providers, a PES scheme cannot succeed. Bond, (2008) compared 10 PES schemes in the developing world and identified some reasons for success and failure. The schemes where the actual payments occurred involved an active user negotiation process, which provided a basis for building trust and lowering administrative costs. Six other cases where PES failed lacked a clear hydrological rationale and demand from potential buyers.

Watershed services in the MRB include (a) efficient infiltration of rainwater, resulting in a more uniform flow of river water throughout the year, (b) stabilization of soils to prevent erosion and undesirable sediment loads, and (c) protection of riparian buffers to prevent contamination of rivers by agrochemicals, resulting in cleaner water for human and wildlife consumption downstream. Productive activities like planting trees and pasture grasses, maintaining riparian buffer zones, avoiding excessive upstream water abstraction and constructing farm filtration ponds are undertaken in order to deliver more reliable clean water downstream (Bhat & McCLain, 2008). Service users (or buyers) are economic entities who benefit from the service through increased and/or more uniform water flow, improved water quality, increased production of consumable goods (e.g., food, fish, mining products) and finally, appropriate compensation must be paid by service users to service providers (Field & Field, 2006). According to FAO (2004), watershed-level PES schemes emphasize specific environmental services: reservoir water recharge, sediment control and year-round river flows.

While PES schemes, especially international schemes, may not become implemented in the near future, there is a growing sense of optimism among stakeholders in Kenya and Tanzania. National water resources management legislation in both countries has enabled the formation of water users associations (Bhat & McClain, 2008). Legislative provisions for introducing payment for watershed services and water uses have been made. Various government agencies, nongovernmental organizations (e.g., World Wildlife Fund), as well as other organizations (e.g., the Global Water for Sustainability (GLOWS) program) have been conducting extensive studies to estimate minimum environmental service flow needs of the basin through water users associations (Bhat & McClain, 2008). There is definitely no consensus among user groups as to who should be the lead agency for implementing intra-country or inter-country payment schemes as yet. The current political stability in Kenya and the governmental and non-governmental efforts indicates that PES implementation in the MRB is going to be promising (Bhat & McClain, 2008).

2.8.2 Rainwater harvesting

Rainwater management, also known as harvesting, is receiving renewed attention as an alternative to or a means of augmenting water sources. Intercepting and collecting rainwater where it falls is a practice that extends back to pre-biblical times (Pereira *et al.*, 2002). Recently in India, it has been used extensively to directly recharge groundwater at rates exceeding natural recharge conditions (Mahnot *et al.*, 2003). An advantage of the technique is that its costs are relatively modest and that individual or community programmes can locally develop and manage the required infrastructures (collection devices, basins, storage tanks, surface or below-ground recharge structures or wells). The various methods of rainwater harvesting that have the potential to satisfy local community and crop demands are described by UNEP (2005). Irrigating crops, pastures and trees with rain runoff can significantly improve both yields and the reliability of agricultural production. Experience in Burkina Faso, Kenya and the Sudan shows that rain harvested from one hectare for supplementary irrigation of another hectare can triple or quadruple production (Oweis & Hachum, 2009). Techniques vary from large scale water catchment to simple "eyebrow terraces", mounds of earth that trap rain runoff at the base of trees (FAO, 2001).

Small-scale rainwater harvesting projects lose less water to evaporation because the rain or run-off is collected locally. Technologies to capture water and bolster supplies are necessary. Conserving and rehabilitating freshwater ecosystems is vital (Mkandla, 2003). Large-scale infrastructure can often by-pass the needs of poor and dispersed populations. Rainwater harvesting *acts as a buffer against drought while also supplementing supplies in cities* (White, 2009). The rainwater harvesting project installed in a Maasai community can store over half a million litres of water, and has led to the development of small gardens and improved agriculture contributing to food security. In a pilot in Kisamese, Kenya, women, , are gaining four hours in a day because of the reduced demands on their time to find and fetch water (Mkandla, 2003). Overall, Africa has more water resources per capita than Europe. However, much of Africa's rain comes in bursts and is never collected. The time has come to realize the great potential for greatly enhancing water supplies. In South Australia, over 40% of households use rainwater as their main source of drinking water. This is a first rate, low cost technology (Steiner, 2006). In Kenya, the ministry of water made a directive that all new buildings should install rainwater harvesting technology and similar plans have been drawn up in India. An important component towards meeting the African Water Vision is the need for managing rainwater resources for "drought proofing" communities subject to regular climatic variability and uncertainty. Rainwater harvesting and storage has been recognized as one way of achieving this. In total, 874 million hectares of land in Africa could benefit from increased agricultural production by increasing the managed use of water, which also includes rainwater harvesting and storage (de Graaff *et al.,* 2011). A study conducted by Evans *et al.,* (2013) at Bankuru District, West Bengal India showed that collecting rainwater for use in the dry season had major implications for agriculture and livelihoods. Storage ponds were designed to cover 5% of farmers land. The benefits realized from adopting this were higher average annual income as a result of increased production, diversified crop mix, better nutrition and social status, more livestock, more agricultural labor jobs and reduced risk associated with climate variability.

Aftab *et al.*, (2012), concluded that rainwater harvesting (RWH) systems were relatively low-cost option for temporal access to a water source. RWH minimizes some of the problems associated with irrigation, such as the competition for water between various uses and users, low water use efficiency, and environmental degradation. RWH is a simple, cheap, and environmentally friendly technology that can easily be managed with limited technical skill (Ngigi, 2003). Supplemental irrigation during dry spells with micro-catchment rainwater harvesting could improve the soil water content of the rooting zone by up to 30% (Biazin *et al.*, 2012). Rainwater harvesting techniques such as *jessr* or *jessour* in Tunisia and the Middle East decreased the amount and velocity of the runoff and consequently reduced soil erosion, and ameliorated the soil water storage capacity and soil fertility (Al-Seekh & Mohammad, 2009). The micro-water harvesting system requires a large area to collect water, and thus, its construction requires more labour. The plastic used to mulch the ridges also poses environmental problems; therefore biodegradable plastic film should be used (Wang *et al.*, 2008). Ngigi (2003), stated that the impacts of a RWH system in Ethiopia, Kenya, Tanzania, and Uganda were still marginal because the adoption rate was low in spite of the success of a number of RWH systems. The increased withdrawals of water in rain fed and irrigated agriculture may have negative implications on downstream water availability within a river basin scale, and this needed to be studied further (Glendening & Vervoort, 2010).

A total of 40 billion working hours are lost each year in Africa carrying water during the dry season (Lenton *et al.,* 2005; Ray, 2007). This causes "water poverty" which affects mostly women. This problem can be reversed by supplying water close to home. In areas with dispersed populations and where the costs of developing surface or groundwater resources are high, rainwater harvesting and storage have proved a more affordable and sustainable intervention. However, despite its proven uses for domestic, agricultural, commercial and environmental purposes, rainwater has not been fully utilized in Africa (WHO, 2010).

However, the biggest challenge with using rainwater harvesting is that despite being included in water policies in Kenya it has not been fully implemented. Water management has been based on renewable water, which is surface and groundwater with little consideration of rainwater. Rainwater has been taken as a 'free for all' resource. For the sustainable use of water resources, it is critical that rainwater harvesting is included as a water sources as is the case for ground and surface water (Wanyonyi, 1998a).

2.8.3 Implementation of Streamside Management Zones

Streamside Management Zones are specific practices implemented in the riparian zones of rivers and streams to stop agricultural eroded soils and chemicals from reaching the rivers. Streamside Management Zones need to be of a certain width along the rivers depending on the slope of the farms. More gentle slopes require small zones and steep slopes require larger zones. According to Li *et al.*, (2006), this reduces farm incomes by 3% per hectare.

2.9 Surface Water Use

Fresh water is fundamental requirement for human use, survival and the socio-economic development. Chapter 18 of agenda 21 of Water Commission for Environment and Development highlights the importance of water and indicates the way to a secure, sustainable water future (WCED, 1987). According to Margat and Andreassian (2008), water use refers to water that is being put into beneficial use by humans. Total freshwater use is estimated at about 4,000 cubic kilometers (km^3) a year. According to WWAP (2006), part of what human use is only what is known: only the volume of water used off-stream (withdrawn) is generally measured (or estimated) and only part of what is withdrawn is effectively consumed. The consumptive uses of freshwater from agriculture (crop and livestock farming), industry and domestic sectors place greatest pressure on water systems, both in quantity (withdrawals) and quality (returns of lower quality) (WWAP, 2009). According to Vorosmarty and Sahagian (2000), increasing water withdrawn from surface waters (rivers, lakes and basins) have led to increasing number of basins lacking sufficient water to meet all the demands placed on them and competition among users. There are many instances where consumptive use and water diversion have severely degraded downstream wetlands or closed basins like shrinking of Arab Sea in Central Asia (Shibuo *et al.*, 2006; Aral Sea, 2014). With some of the largest rivers becoming small streams close to their mouth (such as the Colorado, Murray Darling, Nile and Yellow), flows are no longer sufficient to maintain health of aquatic ecosystems (Zhang *et al.*, 2008; Quiggin *et al.*, 2010, WWAP, 2009a).

There exist some lakes and inland sea areas which have been decreasing dramatically in size and volume (e.g. L. Nakuru in Kenya) or dramatically lowered water levels in aquifers have been increasingly reported in various parts of the world (World Bank, 2007b, WWAP, 2009).

According to UNEP (2007a), the problems of over- abstraction in surface water bodies and ground water, sometimes tied directly to upstream diversions, reservoirs and deforestation, are well documented. The problems commonly become exacerbated when combined with extended dry periods. Kenya is a water-scarce country and its surface waters cover only 2% of Kenya's total surface area (UNDP, 2005). An assessment carried out in 2007, indicated that during drought years, reserve flows were not being met in the upper and middle reaches of the Mara River, Kenya (LVBC and WWF- ESARPO (2010a). This was a clear evidence of a trend towards unacceptable alterations of the Mara Rivers flow regime. Increased competition for water resources and shortcomings in its management to meet the needs of the society and the environmental calls for enhanced water resources management efforts (OECD 2008).

Managing water use is made more difficult by the lack of knowledge and information required for decision making and long-term planning. Few countries know how much water is being used and for what purposes, the quantity and quality of water that is available and that can be withdrawn without serious environmental consequences and how much is being invested in water management and infrastructure. Monitoring systems and modeling abilities require substantial improvement to measure progress in addressing challenges of water use. Water use information can be used to evaluate the impacts of population growth and effectiveness of alternative water management policies, regulations and conservation activities (WWAP, 2009).

2.10 Selected Factors Influencing Adoption of Water Management Practices

Understanding why small-scale farmers' adopt Sustainable Water Conservation Practices (SWCPs) is complex. Biophysical and socioeconomic factors are important in this process. Studies show that such factors include age, education level, gender, ethnicity, cultural influence and practices, household income, farm size, farm slope, land tenure, access to extension information, distance to markets, access to labor, attitudes and perceptions, and population density (Huckett, 2010).

Berger (2001) examined innovation adoption dynamics and concluded that cost benefit analyses or household-decision models alone could not explain the patterns here observed. Diffusion of innovations depends on the interactions among individual farm households which, in turn, determine the rate of information exchange. Interactions facilitate the probability of experiential learning by individuals because they then see innovations first hand (Berger, 2001) and are therefore better able to develop a belief in the potential benefit of adopting SWCPs (Bodnár *et al.*, 2006).

In a study of programmatic approaches to successful adoption of SWCPs in Southern Mali, Bodnár *et al.,* (2006) found that farmers take several steps to learn about and accept innovations before they adopt them. First, they must have an awareness of particular problems affecting their land (i.e., recognizing soil erosion symptoms or water quality impairments), and they must be willing to undertake measures to correct the root problem(s) that cause such problems. Farmers then need to recognize what the possible solutions are and be able to acquire the skills to implement these corrective measures. Most importantly, they need to believe in the potential benefits of SWCP implementation before any are undertaken (Bodnár *et al.*, 2006).

Anley *et al.* (2007), analyzed 101 smallholder farmers in western Ethiopia and found that farmers' conservation decisions, and the utilization rate of both improved and traditional soil conservation measures, were influenced by a host of social, economic, institutional, and agro ecological factors. These included age, level of formal education in the household, farm size, tenure security, labor availability, number of extension visits, and natural resource management policy. In this study, age of the head of household showed a significant, but negative, effect on use of soil bunding methods; older farmers were less likely to adopt innovations, probably due to shorter planning horizons and inability to invest the required labor in implementation (Anley *et al.*, 2007).

Land tenure is a complex and often ill-defined issue in developing countries, especially where varied cultural perceptions of ownership are involved. Rights of tenure (i.e., title deed) and perceived tenure security are thought to be strong indicators of a farmer's attitude and willingness to implement SWCPs. In several studies, tenure was found to be a significant explanatory variable influencing farmers' decisions to adopt SWCPs (Gebremedhin & Swinton, 2003; Tenge *et al.*, 2004; Kabubo-Mariara, 2007). However, other authors offer a competing view in reporting that land tenure is not a strong indicator of adoption behavior (Place & Swallow, 2000; Asrat *et al.*, 2004; Hagos & Holden, 2006).

Cramb *et al.*, (1999) also found that farmer-specific agro ecological circumstances, rather than personal perceptions or attitudes, served as primary constraining factors to adoption of conservation programs and practices. Income generation from on-farm and off-farm sources (total income), access to markets, and access to credit are generally reported as important ancillary variables in the process of innovation adoption. Cramb *et al.* (1999) found that household-level cash flow, rather than access to labor, was considered an important explanatory variable for adoption when on- and off-farm income was accounted for. Income was also reported as an important variable in previous work (Ervin & Ervin, 1982; Cramb *et al.*, 1999).

A study conducted by Kilpatrick (2000), indicated that there were relationships between education and the adoption of conservation practices. It concluded that beneficial innovations tended to be adopted more quickly by landholders with higher levels of education. However, in the case of a complex technology or practice that was actually disadvantageous when all of its effects were considered, education tended to reduce or delay adoption by allowing the limitations of the practice to be recognized (Marsh *et al.*, 2006). The existence and strength of landholders' social networks and local organizations (Sobels *et al.*, 2001) and membership of organizations such as catchment groups were shown to be positively related to adoption of water conservation practices (Kington & Pannell, 2003). A study by Cary *et al.*, (2002), found a positive relationship between membership to land care groups and adoption of some conservation practices although the direction of causality was not clearly established. These authors generally conclude that identifying explanatory factors within the context of the farmers' environment is the key to understanding an individuals' adoption behavior, i.e., "behavior is a function of consequences" (Pierce & Cheney, 2004).

Kenya is one of the countries pursuing the achievement of the Millennium Development Goals with a 2015 target. The goals are to be realized on environment sustainability, sustainability of livelihoods and poverty by 2015. Progress towards fulfillment of the goals will slow if there is continued sluggishness in adoption of sustainable water resource use management practices & unsustainable use of surface water during the dry spell. This will interfere with household food security in the Mara River Basin and other arid environments. Food and nutritional security are the foundations of a decent life, a sound education and the achievement of the Millennium Development Goals. Aquatic ecosystems provide wide range of goods & services. However, in the past 50 years, human activity has changed the diversity of life on earth (biodiversity), more than any other time in history (MEA, 2005).

2.11 Theoretical Framework

The household size, formal education level of the household, households land size and tenure, distance to the water source, households income, level of awareness of conservation activities, number of Community-based Organizations including Water Resource Users' Associations active in water conservations; registration and membership in WRUAs and CBOs determine the adoption/non-adoption of the sustainable use of available natural resources (Mensah, 2011).

Decisions on household's water use strategies may invoke more use of water or vice versa. The potential outcomes can include increased sustainable use of water or otherwise. Stresses like seasonal shortages of water, rising populations and declining water resources constraints households water use strategies through its effects on households capital assets hence affecting management of water resources and household wellbeing (IFAD, 2011). However, the effect of these factors depends on the institutional processes and structures that dictate the order of economic interactions. Some of these include formal laws, social expectations and legislative regimes (Mensah, 2011).

Institutions, rules, norms and policy processes whose relative cumulative effect manifest adversely (positively) on households livelihood outcomes would generally be disapproved by household, irrespective of their true impact on long term societal aspirations such as sustainable exploitation of natural resources (Udry *et al.*, 2005; Mensah, 2011).

Institutions and policies directly or indirectly, mediate access to household land and water resources, which in turn affect the scope for adoption of sustainable water management practices. Currently, the available information is inadequate to understand the dynamics of the process and may not provide policy makers with much guidance about which of these intervention points will be strategically important in promoting adoption of sustainable water resource management and the most appropriate sequencing of policies, institutions and processes. There is inadequate evidence that indicates the relationship between these different levels of policy action and their actual effects on the sustainable water resource management. The study findings will provide empirical evidence by providing suggestions on sustainable water resource management practices at community and household level to policy makers and decision makers.

The concept of ecosystem provided a valuable framework for analyzing and acting on the linkages between the people and the environment. The ecosystem approach was a strategy for the integrated management of land, water and the living resources that promotes conservation and sustainable use in an equitable way. This approach recognized that humans with their cultural diversity were integral components of many ecosystems (Shepherd, 2004). The positive sign (+) denotes a positive relationship, the negative sign (−) denotes a negative relationship while the arrow (→) denotes a relationship between variables. The conceptual framework has four major components that were investigated: household's characteristics, community institutions, major sources of water use for irrigated farming, livestock and domestic purposes and adoption of sustainable water resource management practices.

Conceptual Framework

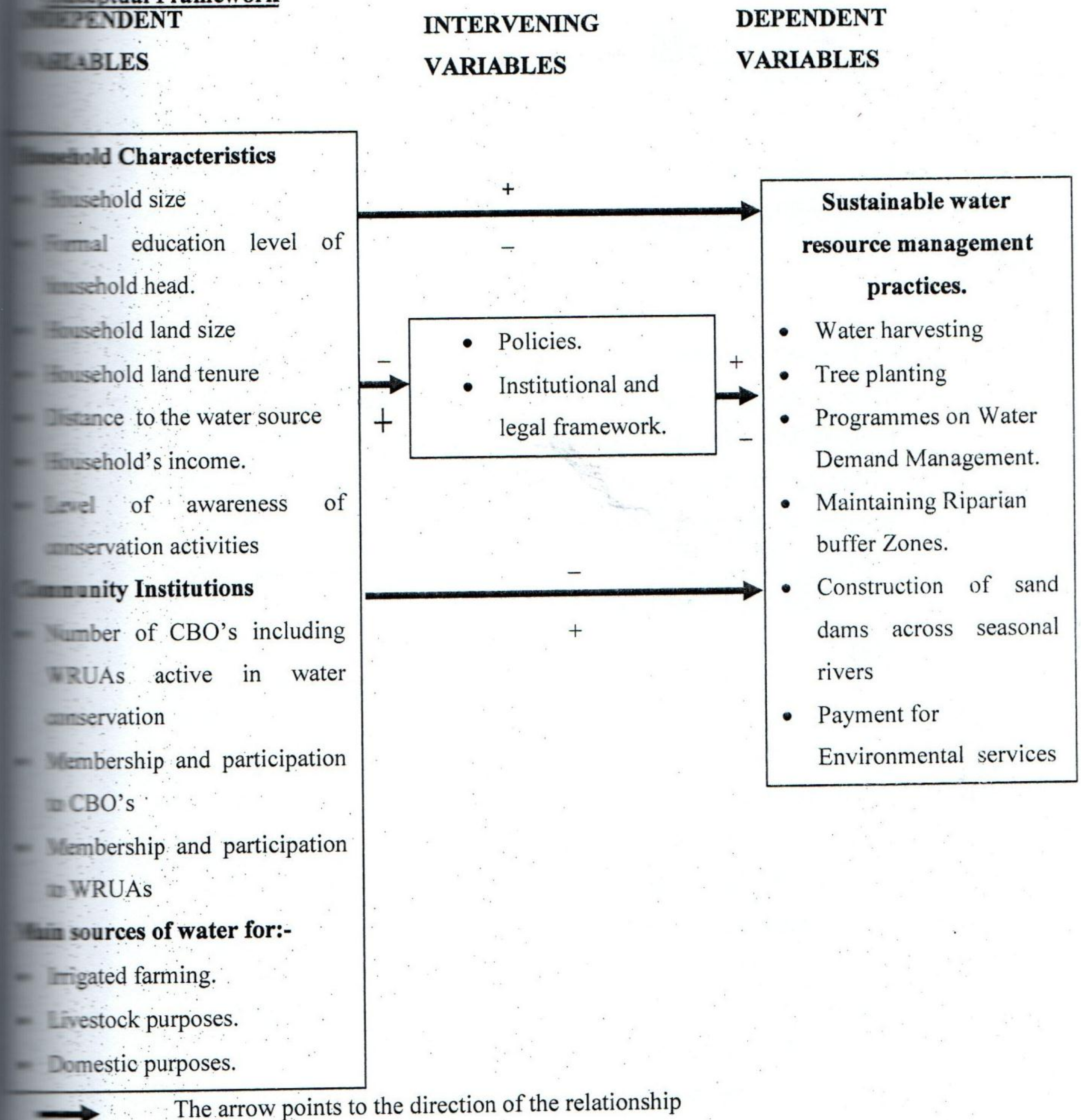


Figure 2.1: Conceptual framework relating household's characteristics and community institutions to adoption of sustainable water resource management practices.
Source: Author, 2012.

CHAPTER THREE

STUDY AREA AND RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the method that was used to carry out the study. It gives details on the research design that was employed, study area, population of the study area, sample size and sampling procedures, instrumentations and data analysis procedures.

3.2 Research Design

The study was designed based on a cross-sectional survey approach. Frankael and Wallen (2009), explains that a cross-sectional design involves collection of data from a sample that has been drawn from a predetermined and specific population. Secondly, the design allows the researcher to collect data faster and it is cost effective. Thirdly, it allows the researcher to ask the individuals to describe the existing phenomenon, enables one to get self-reported facts – respondents, feelings, attitudes, opinions and habits.

3.3 The Study Area

Mara River Basin covers approximately 13,750 km^2 and is shared between Kenya (65%) and Tanzania (35%). Kenya holds a key responsibility in determining the future of this basin, as the basin's headwaters stem from Kenya's Mau Escarpment and Loita Hills (LVBC & WWF-ESARPO, 2010b). The basin is located between 0° 28' S, 33° 47' E and 1° 52' S, 35° 47'E. The main perennial tributaries are the Amala and the Nyangores, which drain from the western Mau escarpment. As well, the Sand, Talek and Borogonja Rivers enter the Mara in Kenya's Maasai Mara Game Reserve. In Tanzania, the Mori, Kenyo, Tambora and Nyambire Rivers drain the basin. Mean annual rainfall ranges between 1,000-1,750 mm in the Mau Escarpment, 900-1,000 mm in the middle rangelands, and 700-850 mm in the lower Loita hills and around Musoma. There are two rainy seasons between March and June, and November and December. However, due to climate change impacts on this pattern, predictions are no longer very dependable (LVBC & WWF-ESARDO, 2010b). The Mara basin covers four administrative districts in Kenya namely; Molo, Bomet, Narok South and Trans-Mara districts (Hoffman, 2007).

Amalo location is located in Oleguruone division of Kuresoi district between 0° 13' S, 35° 28' E and 1° 10' S, 35° 36' E whereas Mulot location is located in Mulot Division of Narok South district between 0° 54' S, 35° 28') and 1°05' S, 36° 25' E (GoK, 2009). Amalo location is located on the upper catchment of the MRB and the main land use is small scale subsistence farming whereas Mulot location is located in the mid-course of the MRB and land use ranges from small-scale subsistence farming to large-scale farming.

MAP OF THE STUDY AREA

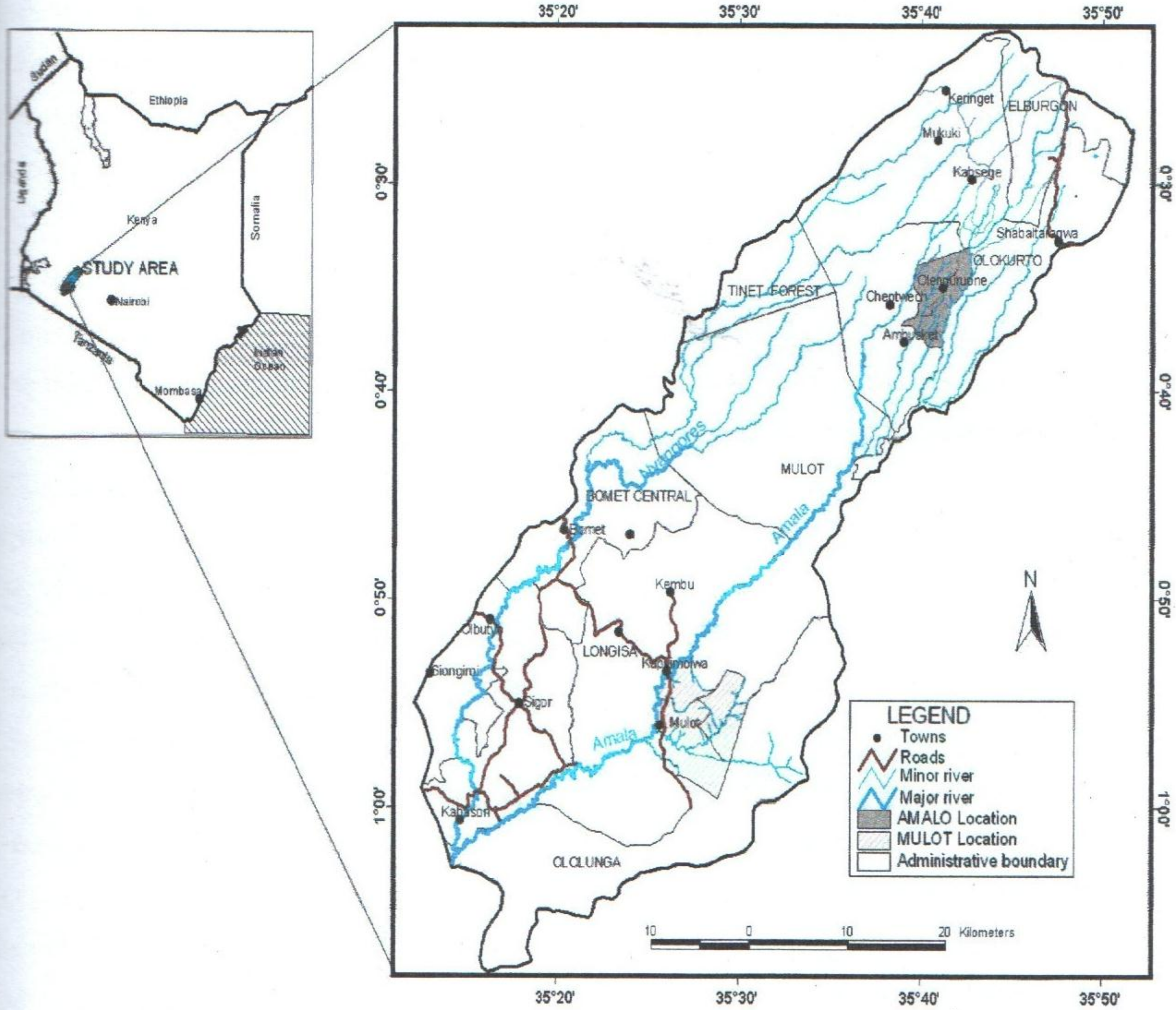


Figure 3.1: Map of the study area (Amalo and Mulot Locations).

Source- Maina , G.M, 2011 (Department of Environmental Science-Egerton University)

3.4 Mara River and other sources of water for households

The 395km long Mara River system originates in the mountain forests of the Mau Escarpment. It flows into the world-famous Masai Mara National Reserve, where it merges with the Talek, Engare and Engito rivers. On the Kenyan-Tanzanian border, the river flows into the Serengeti National Park and is joined by the fourth major tributary: the Sand (or Longaianiet) River then to Lake Victoria. The Amala River originates from the Eastern Mau Forest as Absege, Kipsomoro, and Shabaltaragwa streams, which converge in the Ol Pusimoru Forest to form the Amala River. The Amala River flows through the Transmara forest within which it is joined by other minor tributaries including the Nairotia stream. The Engare Engito stream is the last major tributary joining the Amala River approximately one kilometre downstream of the Mulot Market (WREM, 2008).

Rivers Amala and Nyangores form the headwaters of the Mara River. The Mara River with its perennial tributaries, minor tributaries, springs, and seasonal streams constitute the surface water resources in the catchment. Surface flows are the major sources of water for people living in the MRB, but in the more arid middle and lower reaches, the main channel of the Mara River is an especially important source of water for human populations. The water is mainly for domestic use, livestock watering, irrigation, tourism, and wildlife. Commercial enterprises in Bomet town and other growing rural market centres such as Longisa, Mulot, and Kapkimolwa fetch water directly from the rivers, utilizing both human and draught animal power (LVBC & WWF-ESARPO, 2010a). The most important sources of water for households in the upper and middle Mara basin during the wet season are unprotected springs. The trend changes during the dry season when the major source is the Mara River itself supported by unprotected springs that have not dried. This situation is as a result of water storage facilities at the household level for most of the population. Some well up households get their domestic water supplies from protected springs and open shallow wells, while others harvest rain water from their roofs. In addition to water, the river ecosystem provides other resources relied upon by local communities, including fish, wildlife, soil and vegetation (LVBC & WWF-ESARPO, 2010a; 2010b).

Springs and shallow wells are abundant in the upper catchment area of the basin indicating the availability of adequate groundwater resources. These resources are highly exploited for large scale irrigation, domestic water supplies, livestock, and wildlife watering. In Narok district including Narok South district, the average distance to the nearest potable water point during the wet season is 5 km, while in the dry season it increases to 15 km (WREM, 2008).

3.5 Climate and Agro-Ecological Zones

Amalo Location is in Olenguruone Division which is at approximately 2,400 meters above sea level. It is in the II agro-ecological zones, with approximately 1,270 mm of annual rainfall (Pratt *et al.*, 1977). The major crops grown are tea, potatoes, and pyrethrum. Dairy and wool sheep farming are also practiced. Mulot Location is in Narok South District. The Mara River flows within the boundaries of the newly created Narok South District at 1,000 -3,098 meters above sea level (WREM, 2008). This district is in high (over 1000 mm per annum), medium (between 750-1000mm of rainfall annually) and low rainfall zones (200-350 mm of rain annually) (LVBC & WWF-ESARPO, 2012). It is in the 1V agro-ecological zone with an annual rainfall averaging 500-1,800mm (Pratt *et al.*, 1977). The district is famous for its wheat production and boasts of large scale farms (exceeding 10,000 hectares) making up the landscape. The lower reaches of the district comprise the savannah grassland system that is home to the famous Maasai Mara Game Reserve (WREM, 2008).

3.6 Demographic profile and population size

The Mara River basin has experienced high growth rates for both people and livestock over the last few decades. Approximately 1.1 million people live within the Mara Basin. Of this total population, about 775,000 live in Kenya. At the current annual growth rate (3.3 %, 2.7% and 2.3% in Narok, Bomet, and Transmara districts respectively), the population will almost double in 20 years to 1.980 million (Mara area Master Plan, 2006-2036). High population densities exist in the upper and middle basin reaches, while the lower and middle reaches are sparsely populated. Narok district have approximately 20 persons per square kilometre, respectively. According to 2009 Housing and Population Census, Amalo location was estimated to have a population of 8,858 people with an average household size of four; while Mulot location had a population of 21,850 people with an average household size of five.

3.7 Data Collection

This study relied on both primary and secondary data sources. Primary data was obtained from households and key informants through personal interviews by use of semi structured questionnaire, interview schedule, Focus Group Discussions and making observations. The study focused mainly on household heads for interviewing to ensure uniformity of data collection process. During most of the home visits we found some of the women at home. The key informants were selected as follows:-

Table 3.1: The key informants interviewed in Amalo and Mulot Locations.

The key informants interviewed in Amalo and Mulot locations were as follows

Environmental officers	WRMA official	Ministry of Water Officials.	Government Administrators	Leaders of CBO's
1	1	1	1 Chief 1 Councilors 1 Village elder	1 WRUAs 1 Other CBO's

Source: Field survey, 2012

Key informants interviewed were purposely selected on the consideration that they had insights on the subject of sustainable water resource management practices. The data obtained were used to verify data collected through the household interviews.

A structured questionnaire containing both open and close ended questions were administered by the interviewer and collected data on household size, land size, type of tenure rights, sources of household's income, distance to the Mara River, numbers of the CBO's including Water Resource User Associations (WRUAs) active in water conservation, registration and membership in CBO's including Water Resource User Associations (WRUAs), awareness of household members in water conservation activities, major sources of water used for irrigated crop farming, livestock farming and domestic purposes.

Secondary data was obtained from books, journals, abstracts, internet, reports, theses, dissertations and other publications from (District, Divisional and Location) offices of the governmental and non-governmental organizations and documentary centers in various academic and research institutions.

3.8 Instrumentation

The data collection instruments were used either singly or in combination to obtain all the necessary primary and secondary data for the study. A semi-structured questionnaire was used to obtain the data. The questions captured data in line with the study objectives. Section A of the questionnaire captured information of the respondents socio-economic characteristics, section B, sustainable water resource management practices, section C, household characteristics, section D, community institutions and section E, major sources of water for irrigation, livestock farming and domestic purposes. The questionnaire items were set based on the study objectives and research questions that were tested. Appendix 1 is the questionnaire used for the key informants only.

3.8.1 Validity and Reliability.

Each question in the questionnaire was discussed with the peers, research supervisors and other lecturers in the Department of the Natural Resources Management so as to check for suitability of the questions, and that the questionnaire accurately measured the variables of interest of the study. Attention was given to how each of the specific study objectives was captured in the questionnaire and modifications were made accordingly. This ascertained that the intended responses were got, before implementing the Questionnaire fully into the study area.

To ensure consistency of the questionnaire, the instrument was pre-tested in Longisa Division, Kiplabotwa location in Simotwet villages, kejingo villages, Mulot-rural village, Kapuswa village, Kaproret villages and Kalyet villages. The pretest was then subjected to the spilt-half analysis technique according to Cronbach's formula. The study used Cronbach alpha as the reliability coefficient of at least 0.7 which is accepted (Fraenkel and Wallen, 2009). Since a reliability coefficient of 0.72 was obtained from the pre test, the instrument was therefore used for survey.

3.9 Observation

This method of data collection was used to supplement and enrich data collected through the interview. Observations were made of the various main water sources and containers used in collecting water, tree planting practices, water harvesting practices, major crops grown and animals kept. Information obtained through observation enabled comparing of the reported information with the actual occurrences in the study area. Additionally, photographs of the various main water sources and containers used in fetching water, tree nurseries, water harvesting practices, major crops grown and animals kept by the study households were taken by researcher. The photographs have helped to illustrate the various main water sources used and sustainable water resource management practices that were done by the households. The use of photographs augmented findings from other data collection procedures.

3.10 Focused Group Discussions.

Community meetings were held in two sites and at each venue the community representatives were subdivided into groups of discussion of seven people. The entire number of groups was 8. Focus groups are a useful method for those interested in reducing the demand for water to understand the knowledge, perceptions and needs of water users in the context of their daily lives, values and social expectations. They also provide opportunities to provide information and education to water users and for participants to learn from each other about the need to conserve water and methods of achieving it. While resource intensive, small discussion groups provide an alternative means of public education to the usual mass media, internet or mail out programmes.

3.11 Target Population and Sample Frame

The target population was the total number of households living in Amalo and Mulot locations. The Mara River cuts across these study sites. Amalo location was estimated to have a population of 8,858 people and 2,035 households; Mulot location had a population of 21,850 people and 4,212 households (KNBS, 2010). Amalo had two sub-locations namely Amalo and Kiptaragon with household populations of 1062 and 973 respectively. Mulot has four sub-locations namely

Mulot, Olchoro-Oiruwa, Kuto and Nkiito with household populations of 1765, 683, 1239 and [illegible] respectively. Although the study had proposed to use a list of households obtainable from the census data published by the Kenyan National Bureau of statistics regarding Amalo and Mulot locations, use of such list was inappropriate because the list could not reflect the latest number of households because of the fast growing population and subdivisions of plots and [illegible] households in extended families. For these reasons, the researcher decided to use the random sampling technique as used by Fraenkel and Wallen, (2009).

The sample frame comprised of the households in villages living at a distance of 0 to 3 km from the Amala River/Tributary of Amala River in Mulot, Amalo, Kiptaragon and Olchoro-Oiruwa sub-locations.

[illegible] Sampling Procedure and Sample Size

Multi-stage sampling was used to select the sampling units/respondents from the population. The first stage used purposive sampling in the selection of Amalo and Mulot locations as study sites. From these sites Amalo, Kiptaragon, Mulot and Olchoro-Oiruwa sub-locations were then selected for study because of their location along the river. Their households size was 1062, 973, 1765 and 683 respectively. The last stage involved listing of all households in villages within the four sub-locations living along the river. Simple random sampling was used to proportionally select a sample of 189 households. The actual composition of selected sample is shown in table [illegible] below.

Table 3.2: The number of households sampled per sub-location in Amalo and Mulot Location, Kenya.

Locality	Households	Percent
Mulot sub-location	57	30.2
Olchoro-Oiruwa sub-location	49	25.9
Amalo sub-location	61	32.3
Kiptaragon sub-location.	22	11.6
Total	189	100.0

Source: Field survey, 2012.

3.13 Data collection procedure

The researcher visited Amalo and Mulot locations to familiarize herself with the area. Two males in Mulot location and one male in Amalo location familiar with the area were interviewed, selected and hired as interpreters to assist the researcher in data collection. All these interpreters had attained form four education level, had good command of local Kipsigis language and were familiar with the area and the people therein. They were thoroughly trained by researcher to understand the questions contained in the questionnaire. They were involved in pre-testing the questionnaire and the interview schedule to ensure validity and reliability and appropriate changes were made before the actual data collection.

The physical locations of the 189 households randomly selected for the study were identified with the help of the local leaders, and the women and men head of households were approached for briefing about the study. The objectives and details about the study were thoroughly explained to them, and their confidence solicited for and obtained. Individual visits were made with the households' woman and men that had been selected from the study area and the interpreters. If the expected household men/women were absent twice during the arranged interview, the particular households women was skipped and the replacement substituted. The researcher used the interview schedule and questionnaire to obtain data directly from the respondents.

3.14 Data Analysis

The Statistical Package for the Social Science SPSS® 17 for windows was used for analyzing quantitative data from the Questionnaire. The responses were coded for entry into the computer. The coded qualitative data were rated using a Lickert type scale to score the responses to express the magnitude of the variables for summary and analysis. The variables were then operationalized by use of the indices. The reliability of the indices was assessed using Cronbach's alpha to make sure they were reliable in their measurements. Both descriptive and inferential statistics were used in the analysis of data derived from the social survey. Frequency means, cross tabulations and standard deviation were used as descriptive statistics to summarize and describe qualitative data. Parametric tests were used as inferential statistics at 5% level of significance. Parametric tests including regression analysis and Chi-square were used to determine the influences and effects between the variables under study.

Data on household characteristics, community institutions, water resource management practices and sources of water used for different purposes were summarized using frequencies and percentages. Analytical procedures such as regression analysis were used to determine the influences of household characteristics on adoption of sustainable water resource management practices as well as investigate the influences of community institutions on adoption of sustainable water resource management practices. In addition, cross tabulation was used to indicate the associations of major sources of water used for irrigation crop farming, livestock purposes and domestic purposes on adoption of sustainable water resource management practices.

Water Management Index. Adoption of the sustainable water resource management practices was a continuous variable. The adoption of the sustainable water management practices was measured by coding 1 for adopting a practice and 0 for non-adopting a practice. In deriving the sustainable water management index, the variables codes were added up. The sustainable water management was a continuous index ranging from 0 to 7. Therefore the higher the value of the index the more the practices the household had adopted. 0 indicated non-adoption of any practice.

Coefficient of variation was computed to compare variability of each sustainable water management practice adopted among the respondents. Non-adoption of the management practices was considered insignificant because it represented only 1.1% of the total sampled households (Table 3.3). Therefore, only adoption was considered during the analysis.

Table 3.3: Percent distribution of water management index.

Water Management Index	Frequency	Percent
00	2	1.1
01	1	.5
02	27	14.3
03	64	33.9
04	73	38.6
05	12	6.3
06	7	3.7
07	3	1.6
Total	189	100.0

Source: Fieldwork, 2012

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This section presents results and discussions. It describes the influences of household characteristics, community institutions and major sources of water used for irrigation crop farming, livestock purposes and domestic purposes on adoption of sustainable water resource management practices in Amalo and Mulot locations using inferential statistics.

4.2 General characteristics of Survey Respondents

Sex, Age, Marital status and occupation of the Study population

The sample comprised males and females who were made up of 91% and 9% in Mulot location and 88% and 12% in Amalo location of the total respectively. Their mean age was 35 years with the minimum age being 20 and the maximum age being 64 in Mulot location while mean age was 36 years with the minimum age being 20 and the maximum age being 69 in Amalo location (Table 4.1). Age is of particular relevance to adoption of conservation practices that have long lags between investment and payoff. If a farm is not to be passed on to the farmer's children, and if the benefits of conservation practices are not expected to be fully reflected in the farm's sale price, then older farmers may have less incentive to invest in something that will be primarily of benefit to the subsequent owner (Gasson & Errington, 1993). However, age may also influence adoption via a correlation with physical health. However, the evidence of a relationship between adoption and age, stage of life or experience is mixed. The most extensive meta-review of socio-economic factors influencing adoption found both positive and negative relationships between age and adoption (Rogers, 2003). The limited research addressing the influence of age on adoption of conservation practices (Cary *et al.*, 2002; Curtis & Byron, 2002; Latta, 2002) is just as mixed.

The respondent's primary occupation is as shown in table 4.1. Most of the respondents were engaged in farming in Mulot and Amalo Locations. According to the results, only 3.61 % and 1% of respondents interviewed earned their livelihood from skilled labourer in Amalo and Mulot Locations respectively. The respondents who were self-employed/professional were 3.61% and

% in Amalo and Mulot locations respectively, while 2.41% and 6 % engaged in other forms of income generating activities such as large to medium business in Amalo and Mulot respectively (Table 4.1).

Table 4.1: Households general characteristics.

General characteristics	Amalo Location		Mulot Location	
	Frequency	Percent	Frequency	Percent
Sex				
Male.	10	88	10	91
Female	73	12	96	9
Total	**83**	**100**	**106**	**100**
Marital status				
Married	76	91	99	93
Single	3	4	2	2
Windowed	4	5	5	5
Total	**83**	**100**	**106**	**100**
Occupation				
Farmer	50	60.24	32	30
Skilled labourer	3	3.61	1	1
Non-skilled labourer	1	1.20	4	4
Large/medium business	2	2.41	6	6
Self employed/professional	3	3.61	1	1
Truck drivers/cleaners	1	1.20	36	34
Housewives	2	2.41	21	20
Unemployed	21	25.32	5	4
Total	**83**	**100.0**	**106**	**100**
Household size				
1-4	35	42.2	39	37.1
5-8	43	51.8	60	57.1
9-12	5	6.0	5	4.8
13-16	0	0	2	1.0
Total	**83**	**100**	**106**	**100.0**
Age				
20-30	28	34	39	37
>30-40	29	35	45	43
>40-50	14	16	13	12
>50-60	9	11	7	7
>60-70	3	4	2	1
Total	**83**	**100**	**106**	**100**

Source: Field survey, 2012.

Household's characteristics and adoption of sustainable water resources management practices in Amalo and Mulot locations.

The first objective of this study was to determine the influences of household's characteristics on adoption of sustainable water resources management practices in Amalo and Mulot locations.

The households characteristics used were household size, land size, level of the education of the household head; the level of water management practices the household's is aware of, household's income and distance to the water source. The major findings of the study were obtained using cross tabulations and Regression Analysis. Regression Analysis showed that there was significant influence of household's awareness level of water management practices on adoption of sustainable water resource management practices while other characteristics showed no influences (Table 4.13). Cross tabulations indicated the distribution of adoption of the sustainable water resource management practices across the household's socio-economic characteristics.

Land tenure/land ownership

The respondents who had title deeds in Amalo and Mulot Locations were 99.5% while those without title deed were 0.5%.

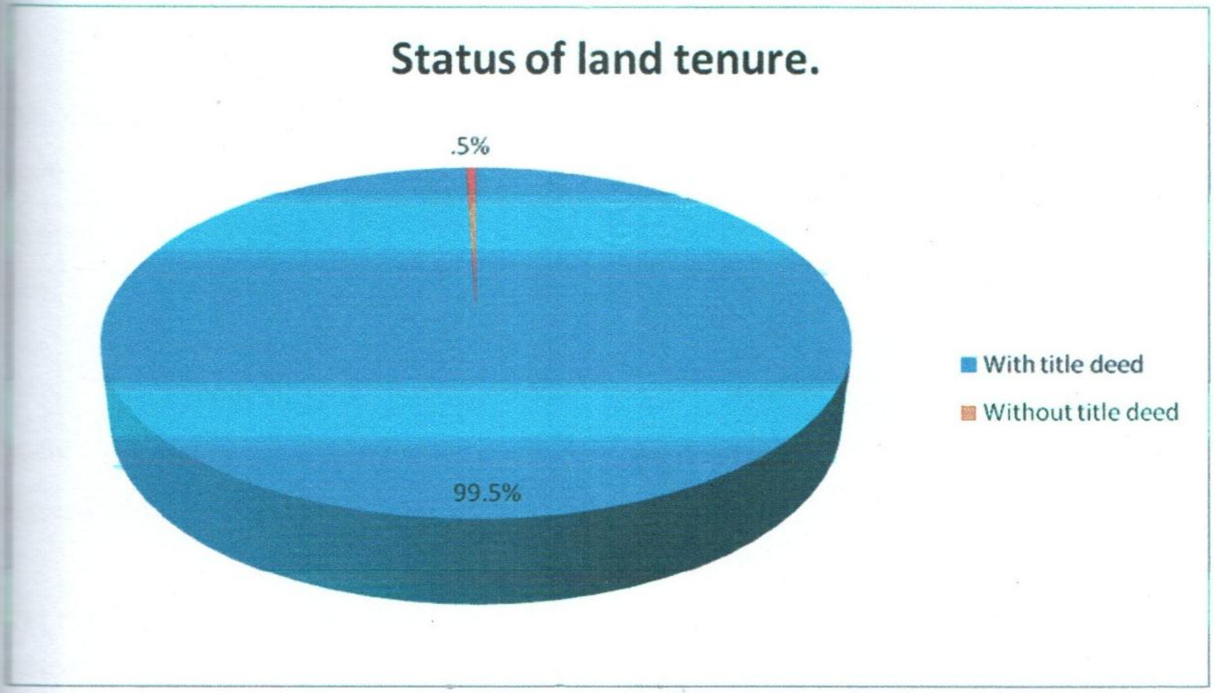


Figure 4.1: The status of land tenure for all the respondents in Amalo and Mulot Locations.
Source: Field survey, 2012

For those respondents with title deed 54.8% of them had acquired land through buying and 45.2% through inheriting (Table 4.2)

Table 4.2: How land was acquired by those who had title deeds.

How land was acquired	Frequency	Percent
Bought	102	54.8
Inherited	84	45.2
Total	186	100.0
System	3	
	189	

Source: Field survey, 2012.

In Amalo and Mulot Locations the status of the land tenure was different. All the respondents in Amalo Location had title deeds and in Mulot locations 99.0% had title deeds while 1% did not have title deeds (Table 4.3).

Table 4.3: Households land tenure in Amalo and Mulot locations, Mara River Basin, Kenya

Location	Ownership	Frequency	Percent
Mulot	with title deed	101	99.0
	without title deed	5	1.0
	Total	106	100.0
Amalo	with title deed	83	100.0

Source: Field survey, 2012

These results on land ownership in Table 4.3 differed with that of Aboud *et al.,* (2002), who reported that in the Mara River Basin land tenure system was mixed. In the highlands (upper catchments), where the small-scale farmers were found, were predominantly private holdings sold by the original title holders. In this upper section of the basin, land was mainly privately owned, with 46% of the population owning the land and having title deeds, and 22% owning the land without title deeds. In addition Aboud *et al.,* (2002) reported that in the middle section and the lowlands, landownership was still communal, family ranches, or group ranches. Rangelands were largely used as group ranches but with an increasing trend towards subdivision into individual holdings. Most of the high potential ranches had been leased to commercial wheat farmers.

The study further sought to establish the role played by the status of land tenure on adoption of sustainable water resource management practices. A cross tabulation was run between the households land tenure and adoption of sustainable water resource management practices. The results are summarized in table 4.4. The results indicated that 99.5% of the respondents with title deed adopted RWH; 99.5% tree planting; 99.4% programmes on Water Demand Management and 99.1% maintenance of the Riparian Buffer Zones. While those without title deeds, 0.5% adopted rain water harvesting, 0.5% tree planting, 0.6% programmes on Water Demand Management and 0.9 % maintenance of Riparian buffer zones (Table 4.4). These results indicated that there was a high rate of adoption for those respondents who had title deeds as compared to those without title deeds. An indication that land ownership can create short term to long term investment in adoption of water management activities (Wannasai & Shrestha, 2008; Kahsay, 2011).

Table 4.4: Percent distribution of adoption of water management practices in various categories of status of land tenure of households in Amalo and Mulot Locations.

Status of land tenure		**Percent adoption of water management practices**							
		Programmes on Water Demand Management		Tree planting		Rain water harvesting		Riparian buffer zones	
		Yes	No	Yes	No	Yes	No	Yes	No
With title deed	%	99.4	100.0	99.5	0	99.5	0	99.1	100.0
Without title deed	%	0.6	0.0	0.5	0	0.5	0	0.9	0.0
Total	%	100.0	100.0	100.	0	100.0	0	100.	100.

Source: Field survey, 2012 N=189 %= Percent.

4.3.2 Land size

The mean land size was 5.01ha with a minimum of 0.25ha and a maximum of 15.0 ha. In Mulot location the mean acreage size was 4.7ha with a minimum of 0.25ha and a maximum of 14 ha whereas in Amalo location the mean acreage size was 5.5 ha with a minimum of 1.50ha and a maximum of 15 ha. Land ownership distribution per households in terms of land size and percent of households are shown in figure 4.2.

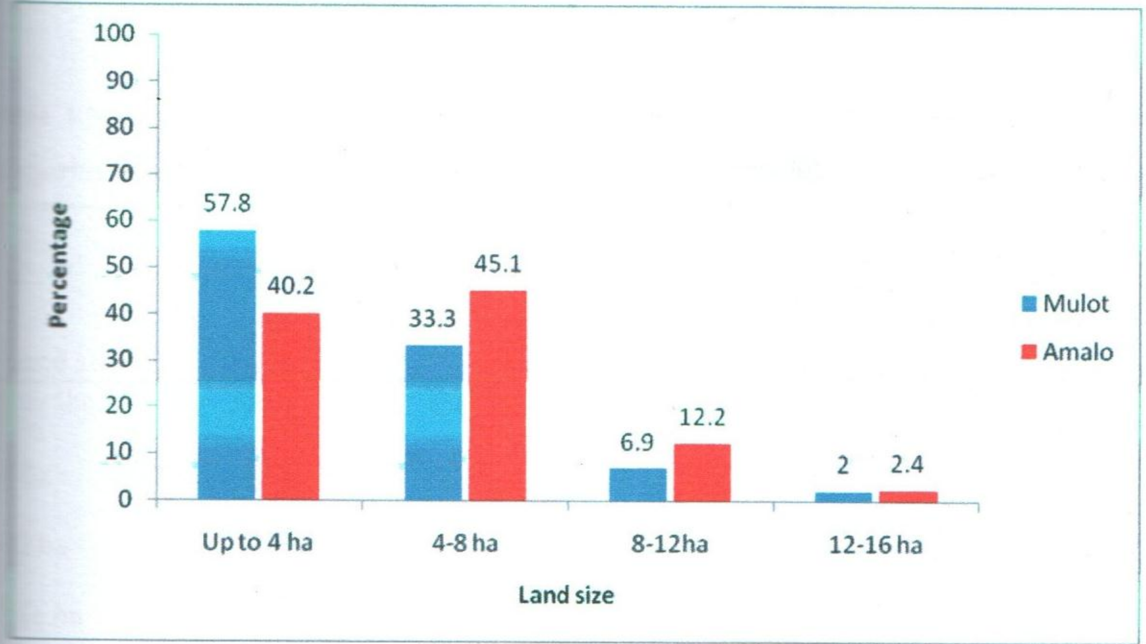


Figure 4.2: Households land sizes in Amalo and Mulot locations.

Source: Field survey, 2012

The study further sought to establish the role played by size of the land on adoption of the sustainable water resource management practices. The adoption rate for RWH, tree planting, programmes on Water Demand Management and planting Riparian Buffer Zones was above 86% for the land size up to 4 ha and 4-8 ha for all the interviewed respondents. However, for the land size categories' of 8-12 ha and 13-16 ha the adoption rate for all the practices was below 15% (Table 4.5). This was an indication that those respondents with small land sizes adopted most of the practices as compared to those with large pieces of land. This was in contrast with Abadi *et al.*, (2005), who argued that property size is often, but not always, related to innovation adoption and that larger areas tend to increase the overall benefits of adoption of beneficial innovations and so increase the likelihood of adoption. Alternatively, social issues related to adoption may also lead to people having larger properties. In North central Victoria, the adoption of tree planting was not related to property (Wilkinson & Cary 1992). D'Emden *et al.*, (2005) also found a lack of relationship between land size and adoption of conservation tillage in Western Australia.

Table 4.5: Distribution of adoption of water resource management practices in various categories of households land sizes in Amalo and Mulot Locations.

	Percent adoption of water management practices							
	Programmes on Water Demand Management		Water harvesting		Rain water harvesting		Riparian buffer zones	
Land size	Yes	No	Yes	No	Yes	No	Yes	No
Up to 4ha	50.6	46.4	50.0	0	50.0	0	43	59.7
4-8 ha	37.8	42.9	38.6	0	38.6	0	43	32.5
8-12 ha	9.6	7.1	9.2	0	9.2	0	10.3	7.8
12-16 ha	1.9	3.6	2.2	0	2.2	0	3.7	0.0
Total	100	100	100	0	100	0	100	100

Source: Field survey, 2012. N=189. %= Percent.

4.3.3 Distance to the main source of water

Most (50.3%) of the respondents relied on Amala river as the major source of water. Those who relied on tributary of the Amala River were 21.2%, spring 9.0% and borehole 19.6%. The minimum distance from the main source of water was 0.3 Km while maximum distance was 2.7 Km with a mean of 0.873 Km in Mulot location. The minimum distance from the main source of water was 0.1 Km and the maximum distance was 2 Km in Amalo location (Table 4.6). The households that fetched water from a source that was not immediately accessible to the household transported using a donkey and human-powered transport. The considerable labor involved in water collection was almost exclusively done by women and children. Girls carried large containers full of water on their backs (plate 4.5).

In Mulot location 85.4% cited that they walked for a distance of 0.9-1.2 Km to look for water during the dry season as compared to only 14.6% of the respondents in Amalo Location. In Amalo location 79.1% of the respondents walked for a distance of less than 0.3Km to look for water during the dry season as compared to 20.9% in Mulot location. Those respondents who walked for a distance of 1.8 to 2.1 Km to look for water during the dry season were 66.7% in Mulot location and 33.3% in Amalo Location (Table 4.6).

Table 4.6: Percent distribution of households distance to main sources of water in Amalo and Mulot locations, Mara River Basin, Kenya

		Distance to main source of water (Km)							
Location			0.3-	0.6-	0.9-	1.2-	1.8-	2.4-	
		Up to 0.3Km	0.6Km	0.9Km	1.2Km	1.5Km	2.1Km	2.7Km	Total
Mulot	%	20.9	66.7	73.3	85.4	83.3	66.7	100.0	56.2
Amalo	%	79.1	33.3	26.7	14.6	16.7	33.3	.0	43.8
Total	%	100	100	100	100	100	100	100	100

Source: Field survey, 2012 F=Frequency %= Percent. N=189

Distance to the water source and time taken to collect water as well as its reliability and cost of water determines the accessibility of water which dictates the volume of water to be used by the households (Thompson *et al.*, 2001).

The study further established the role of distance to the water source on adoption of sustainable water resource management practices. The results indicated that there was high rate of adoption in RWH, tree planting, programmes on Water Demand Management (Not pouring a lot of water and using water for the right use) and planting of Riparian Buffer Zones for those respondents who walked for a distance of 0 to 1.2 Km to water source as compared to a distance of 1.2 Km to 2.7 Km (Table 4.7). This indicated that the longer the distance to the water source the lower the adoption rate of the sampled management practices. This concurred with the study conducted by the Christopher *et al.,* (2011) that longer distance to the water source increases large time costs associated with gathering water hence minimizing time left to do other productive activities like water productive activities. A study conducted by WHO *et al.,* (2006), estimates that time savings from gathering water would account for 63 per cent of the total economic benefits from achieving the Millennium Development Goals target for water supply.

Table 4.7: Percent distribution of adoption of water resource management practices in the various households distance to main sources of water categories.

Distance to main source of water	Percent adoption of water management practices							
	Programmes on Water Demand Management		Tree planting		Rain water harvesting		Riparian buffer zones	
	%Yes	%No	%Yes	%No	%Yes	%No	%Yes	%No
Up to 0.3 Km	35.9	16.4	36.2	0	36.2	0	44.4	24.7
0.3-0.6 Km	19.2	20.7	19.5	0	19.5	0	20.4	18.2
0.6-0.9 Km	8.3	6.9	8.1	0	8.1	0	7.4	9.1
0.9-1.2 Km	27.6	17.2	25.9	0	25.9	0	18.5	36.4
1.2-1.5 Km	2.6	6.9	3.2	0	3.2	0	1.9	5.2
1.5-1.8 Km	0	0	0	0	0	0	0	0
1.8-2.1 Km	5.8	10.3	6.5	0	6.5	0	7.4	5.2
2.1-2.4 Km	0	0	0	0	0	0	0	0
2.4-2.7 Km	0.6	0.0	0.5	0	0.5	0	0.0	1.3
Total	**100.0**	**100.0**	**100**	**0**	**100**	**0**	**100.**	**100.**

Source: Field survey, 2012 F= Frequency %= Percent N=189

4.3.4 Household size

Household size was recorded by the number of children and full time dependents in the household. The mean family size for surveyed households was 5 with a minimum of one and a maximum of 13. The standard deviation was 1.99. The greater proportion of households (54.8 %) had 5-8 members. 5.8% had over 9 members. It would appear that majority of households have large families. Households with less than five family members constituted only 39.4 %. It was established that within the study area, the average household size is five (Figure 4.3). The results are in agreement with those reported by Ministry of Planning and National Development (2010).

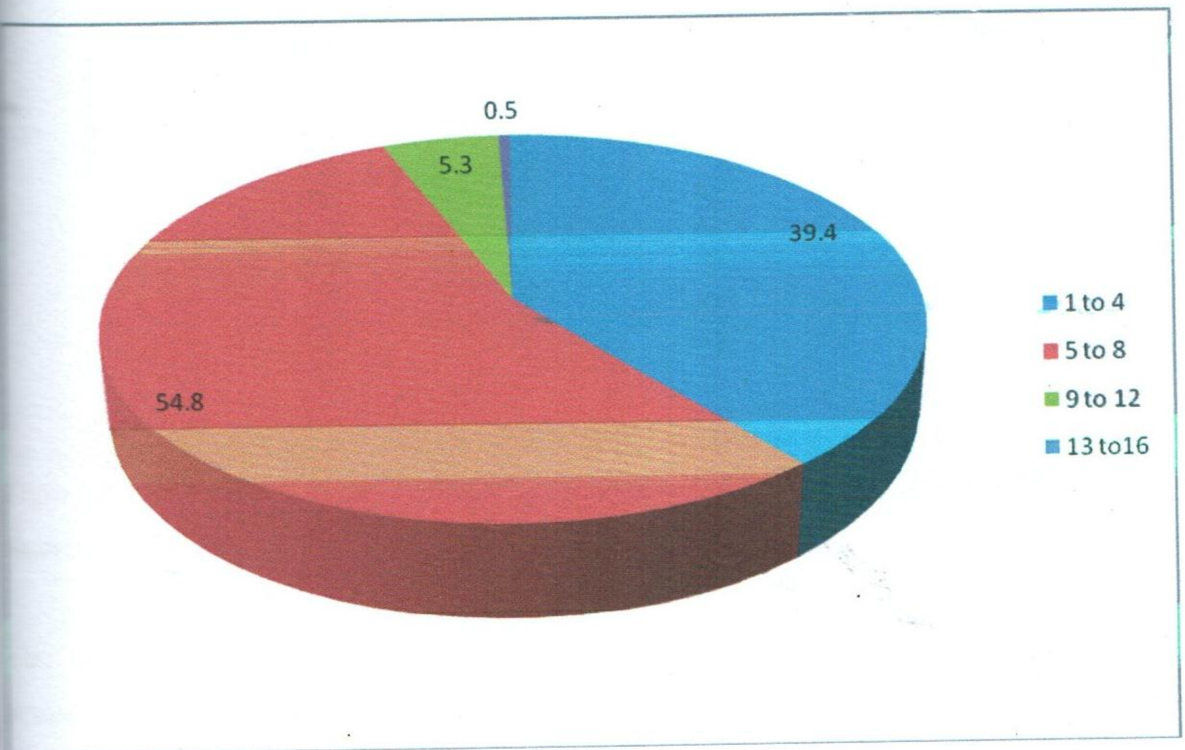


Figure 4.3: Percent categories of household size for all the respondents.

Source: Field survey, 2012

In Amalo and Mulot Locations the household sizes were as shown in figure 4.4.

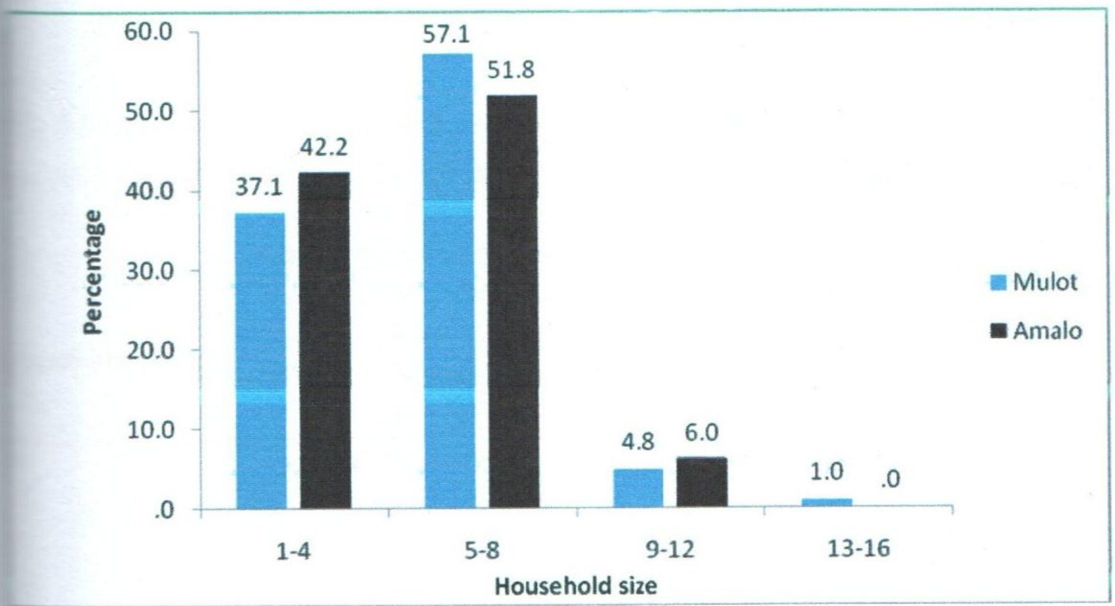


Figure 4.4: Households size for Amalo and Mulot locations, Mara River Basin, Kenya

Source: Field survey, 2012

The study further established the role of household size on adoption of sustainable water resource management practices. Cross tabulation was run between household sizes and adoption of sustainable water resource management practices. For those households with 1-4 members, 39.4% had adopted RWH, 39.4% tree planting, 38.4% programmes on water Demand Management and 38.5% planting of the Riparian Buffer zones. The highest adoption rate was for those with 5-8 family members: 54.8% had adopted rainwater harvesting, 54.8% tree planting, 55.3% programmes on water demand management and 56.0% planting of the riparian buffer zones. Those family members who were 9-12 and 13-16 had adoption rate below 6% in RWH, tree planting, programmes on Water Demand Management and planting of the Riparian Buffer Zones (Table 4.8). Household size is an important consideration in adoption of sustainable water resource management practices as it is a source of labor for implementing sustainable water resource management practices. The highest number of the respondents with household sizes between 1-4 and 5-8 had adopted most of the practices as compared to household size categories 9-12 and 13-16. This was because majority (94.1%) of the respondents had household size of 1 to 8 members while only less than 5.9% had 9 to 16 members.

Table 4.8: Percent distribution of households' size by the adoption of water management practices in Amalo and Mulot Locations

Household size		Percent adoption of water management practices. Programmes on Water Demand Management		Tree Planting		Rain water harvesting		Riparian buffer zones	
		Yes	No	Yes	No	Yes	No	Yes	No
1-4	F	61	13	74	0	74	0	42	32
	%	38.4	44.8	39.4	0	39.4	0	38.5	40.5
5-8	F	88	15	103	0	103	0	61	42
	%	55.3	51.7	54.8	0	54.8	0	56.0	53.2
9-12	F	9	2	10	0	10	0	6	5
	%	5.7	3.4	5.3	0	5.3	0	5.5	5.1
13-16	F	1	0	2	0	2	0	0	1
	%	0.6	0.0	0.5	0	0.5	0	0.0	1.3
Total (N)	F	159	30	189	0	189	0	109	80
	%	100.0%	100.0%	100.	0	100.0	0	100	100

Source: Field survey, 2012.

F= Frequency %= Percent Yes= Adoption No= Non-adoption

4.3.5 The level of formal education attained by the head of the household and adoption of sustainable water resource management.

The respondents in Mulot location who had secondary education were 28% and university education (2%). Those with primary education were 54% whereas those with tertiary education were 11%. Further, the other respondents were 1.0 %. Only 5% reported that they never went to school. In Amalo location, the respondents who had secondary education were 48% of the sample and those with University education were 5%. Those with primary education were 32% whereas those with tertiary education were 16% (Figure 4.5).

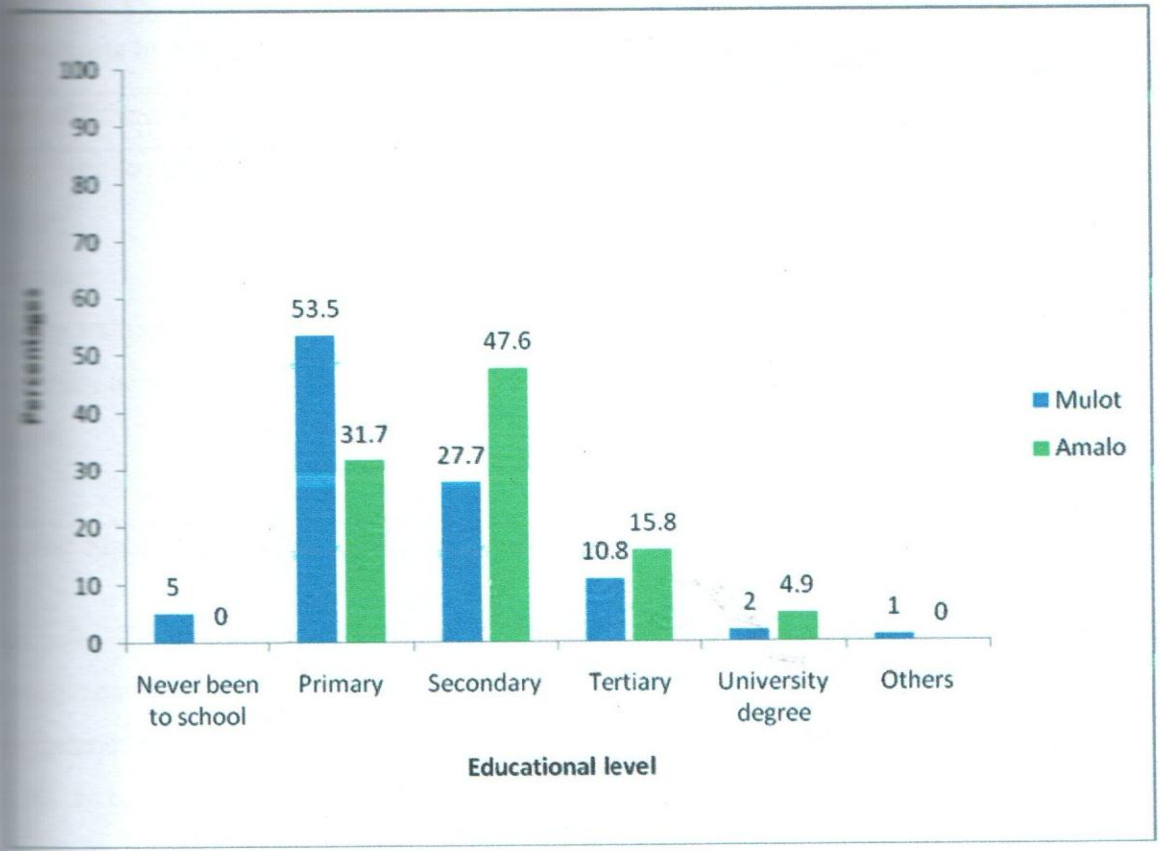


Figure 4.5: The education level of the household head in Amalo and Mulot Location, Mara River Basin, Kenya.

Source: Field survey, 2012.

For all the respondents in both Amalo and Mulot locations most (42.3%) of the household heads had attained primary and (35.4 %) had attained secondary level of the education. Only a few of them have never been to school (2.6 %), Tertiary training (12.7 %), University degree (3.3 %) and others were 0.5% (Table 4.9)

Table 4.9: Level of formal education attained by the head of the households for all respondents in Amalo and Mulot Locations.

Level of formal education	Frequency	Percent
Never been to school	5	2.6
Primary	80	42.3
Secondary	67	35.4
Tertiary training	24	12.7
University degree.	6	3.3
Others.	7	3.7
Total	189	100

Source: Field survey, 2012

The role of the household level of education on adoption of sustainable water resource management practices was also investigated. The rate of adoption for RWH, tree planting, programmes on water demand management and planting of the riparian buffer zones was above 77.7% as cited by those households' heads that had attained primary and secondary level of education. Those who had attained university degree and others with other education levels had the lowest level of adoption for RWH, tree planting, programmes on water demand management and planting of the riparian buffer zones (Table 4.10). This might have been contributed by the low number of people who had university degree and others with other education levels. There can sometimes be relationships between education and the adoption of conservation practices. It has often been concluded that beneficial innovations tend to be adopted more quickly by landholders with higher levels of education (Kilpatrick, 2000). However, in the case of a complex technology or practice that is actually disadvantageous when all of its effects are considered, education may tend to reduce or delay adoption by allowing the limitations of the practice to be recognized (Marsh *et al.,* 2006). These limitations may go unrecognized by less educated landholders, who consequently adopt the practice mistakenly. Kilpatrick, (2000) has shown the catalyzing impact of education in general on farmers' abilities and levels of interest in modifying soil and water conservation practices. Nevertheless, we suggest that a farmer's general level of education is likely to be less important as a predictor of adoption than their participation in specific relevant training courses.

Table 4.10: The role of the education level of the household head on adoption of water management practices.

		Percent adoption of water management practices							
Education level		Programmes on Water Demand Management		Tree planting		Rain water harvesting		Riparian buffer zones	
		Yes	No	Yes	No	Yes	No	Yes	No
Never been to school	%	3.2	.0	2.7	0	2.7	0	0.9	5.2
Primary	%	43.2	46.4	43.7	0	43.7	0	32.1	59.7
Secondary	%	36.1	39.3	36.6	0	36.6	0	45.3	24.7
Tertiary	%	14.2	7.1	13.1	0	13.1	0	17.9	6.5
University degree	%	2.6	7.1	3.3	0	3.3	0	2.8	3.9
Others	%	.6	.0	0.5	0	0.5	0	0.9	0.0
Total	%	100.	100	100.		100.	0	100.	100.

Source: Field survey, 2012 F= Frequency %= Percent N=189

Education is important in decision making regarding the adoption of sustainable water resource management practices. It offers alternative livelihood opportunities in off-farm activities thereby increasing the opportunity cost of labor and competing with labor use for implementing sustainable water resource management practices (Kilpatrick, 2000).

4.3.6 Household's income

The households' income in Amalo and Mulot Locations were as shown in figure 4.6. Cary *et al.*, (2001) found that profit expectations are an important influence on investment plans (and thus on adoption decisions). Lack of financial viability would be expected to inhibit adoption of innovations by reducing the capacity to adopt, rather than the benefits of adopting. Cancian (1979) conducted a meta-analysis of the relationship between income and adoption and concluded that it may not be linear.

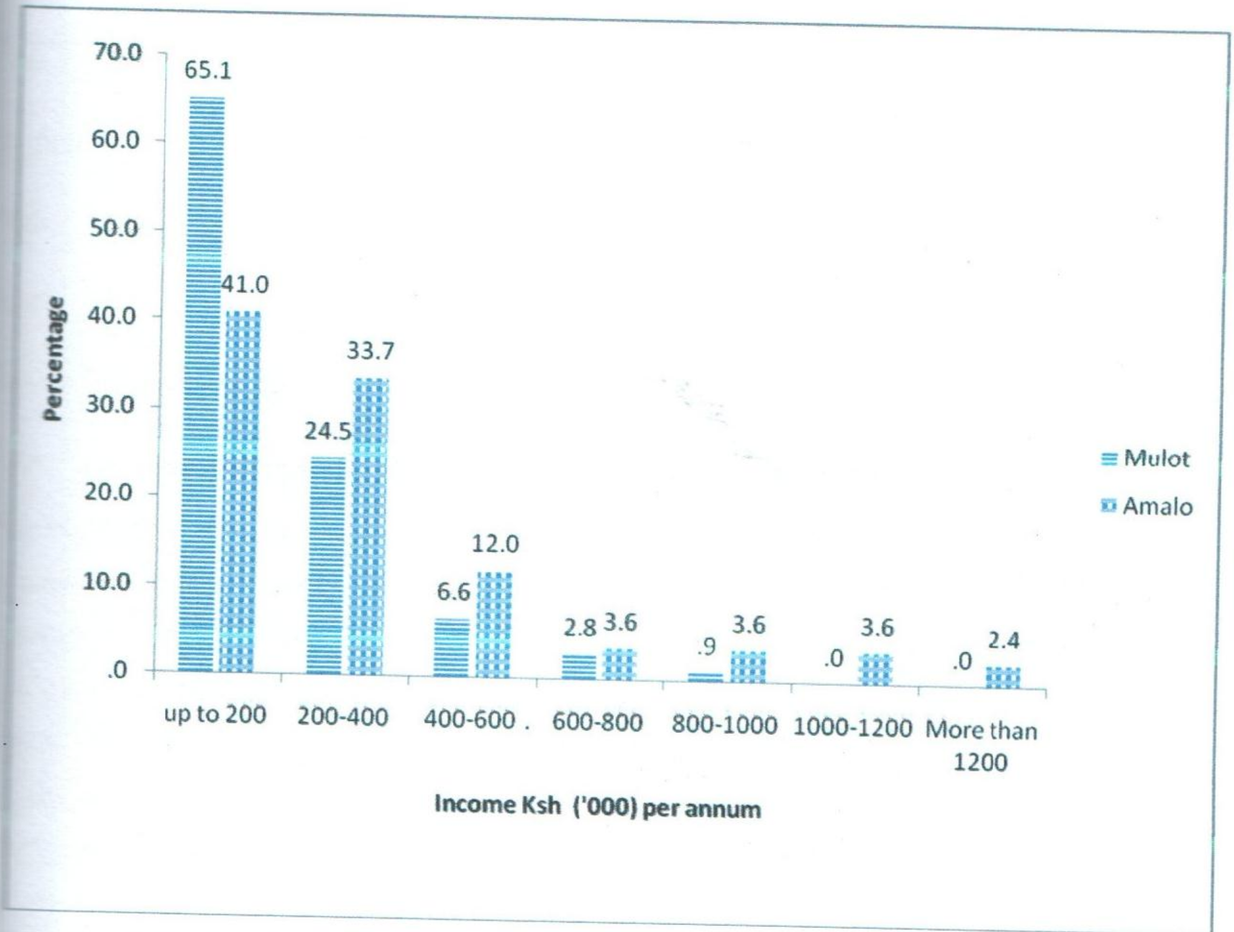


Figure 4.6: Households income.

Source: Field survey, 2012.

4.3.7 Level of awareness of conservation activities

Most (97.9%) of the respondents were aware of more than three water conservation activities, 1.6% were aware of three water conservation activities while 0.5% were only aware of one water conservation activity (Table 4.11).

Table 4.11: Level of awareness of conservation activities.

Level of conservation activities awareness	Frequency	Percent
Low	1	0.5
Medium	3	1.6
High	185	97.9
Total	189	100

Source: Field survey, 2012

4.3.8 Assessment of sustainable water resource management practices

The sustainable water resource management practices adopted by the households were also assessed and the results are presented in Table 4.12. The results indicated that water harvesting practices, tree planting and maintaining of riparian buffer zones were adopted more during the wet season while the programmes on water demand management was adopted during the dry season. However, the adoption of the maintenance of the riparian buffer zones was low during the dry and wet seasons (Table 4.12). The payment for the environmental services and the construction of sand dams across seasonal rivers had not been adopted by the households in Amalo and Mulot Locations. This was because there were no seasonal rivers in Amalo Location which is located in the upper catchment and have got abundant rainfall amount. In Mulot Location there were seasonal streams like Ngasiet.

Table 4.12: Sustainable water resources management practices

PRACTICES	DRY SEASON			WET SEASON		
	Adoption	Frequency	Percent	Adoption	Frequency	Percent
Water harvesting.	Yes	0	0	Yes	177	94
	No	0	0	No	12	6
	Total	0	0	Total	189	100
Tree planting	Yes	0	0	Yes.	166	88
	No	0	0	No.	23	12
	Total	0	0	Total	189	100
Programmes on Water Demand Management	Yes	157	83.1	Yes	51	27
	No	32	16.9	No	138	73
	Total	189	100	Total	189	100
Maintaining riparian buffer zones	Yes	47	24.9	Yes.	25	13
	No	142	75.1	No.	164	87
	Total	189	100.0	Total.	189	100

Source: Field survey, 2012

Rainwater collected from the roofs of houses and local institutions can make an important contribution to the availability of drinking water. Rainwater harvesting systems can, to some extent, help improve water provision where required and encourage water conservation, thereby reducing the demand on existing water sources (KWAHO, 2008). However, the biggest challenge with using rainwater harvesting is that despite being included in water policies in Kenya it has not been fully implemented. Water management has been based on renewable water, which is surface and groundwater with little consideration of rainwater. Rainwater has been taken as a 'free for all' resource. In the last few years there has been increase in over abstraction of surface and ground water hence causing drastic water reduction for downstream users including ecosystems. For the sustainable use of water resources, it is critical that rainwater harvesting is included as a water source as is the case for ground and surface water (UNICEF & WHO, 2010). Some of the tree nurseries that were used to produce seedlings for afforestation purposes and tanks for water harvesting in Amalo and Mulot locations are as shown in plates 4.1.

Tanks for rain water harvesting in Mulot Location

Tree nursery in Mulot Location

Tree nursery in Amalo Location.

Tanks for water harvesting in Amalo Locatior

Plate 4.1: Tree nurseries and tanks used for afforestation and water harvesting in Amalo and Mulot locations, Mara River Basin, Kenya

Source: Field survey, 2012

According to the Focus Group Discussions the most adopted water resource management practices were Water demand management (not pouring water unnecessarily or using the water wisely, ensuring that the animals do not drink directly from the river), planting trees and water harvesting. However these practices were not sustainable. In case of tree planting it was hard to maintain the newly planted trees during dry spells, because of lack of enough water. For the RWH it was adopted by many people during the wet season but the water collected was inadequate to support the households during the dry season. Most of the households lacked funds to buy large capacity tanks for storing water. This agreed with the study conducted by Raol *et al.*, (2014) in India which indicated that the straight forward solution to a big problem of RWH was storage; which was the key to maximize the potential savings of Rain Water Harvesting. In addition, it was an environmentally sound solution for water resource management as well as water shortage in the community and country in general. Some of the practices like the construction of the farm filtration ponds, payment for the environmental services and construction of sand dams across seasonal rivers had not been adopted during the wet and dry seasons.

In many instances community based organizations, non-governmental organizations, government departments and even some donor agencies lack policy guidelines in support of water management activities like RWH. Those that have are generally inadequate, and unsuitable to the prevailing local conditions. The Ministry of Water resources in Kenya have no mechanism of approving the construction of a ferrocement tank or water jar since they do not have design standard drawings. The city council by-laws only allow for effective disposal of rainwater from roofs to avoid dumpiness and drainage problems but not to collect for beneficial purposes. There is high potential of rainwater harvesting both in Amalo and Mulot locations due to the rapid population growth and the need for alternative water sources that are simple, effective, low cost and environmentally sound. The current legislative framework and decentralization of governance is creating an enabling environment for collaboration and training in community mobilization and participation. However the new water policy, local council by-laws and various Acts need to be amended to effectively address some of these issues. The community's willingness to participate in RWH is seen as a positive challenge in the development of the water sector policy. Thus with suitable water policy implementation plans and by-laws, RWH can be enhanced and improved to overcome the challenges in supplementing conventional water supply sources (Wanyonyi, 1998b).

4.3.9 The household's characteristics and adoption of sustainable water resource management practices.

To find out the influences of households' characteristics on sustainable water resource management practices, multiple regressions were run. In the regression analysis, enter procedure was used. The advantage of this procedure is that it enters variables into analysis based on their contribution to R square and level of significance. The regression models used was adapted from those used by Nimon *et al*., (2010), Goodenough *et al., (2012)* and Nathans *et al.,* (2012) and modified to suit this study

The multiple regression models were expressed as:

$Y=\beta_0+\beta x_1+\beta x_2+\beta x_3+\beta x_4+\beta x_5+e$

Where:

Y=Adoption of sustainable water resource management practices

β_0=Constant (Regression intercept).

β=Beta regression co-efficient.

X_1=Household size

X_2=Formal education level of household head.

X_3=Household land size

X_4=Household income

X_5=Distance to the water source

X_6=Households level of awareness of conservation activities.

e= Error term.

The results of the multiple regressions are presented by the table 4.13.

Table 4.13: Influences of households characteristics on adoption of sustainable water use in Amalo and Mulot Locations.

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	.847	.410		2.069	.040
Categorized income ('000)	-.059	.071	-.062	-.832	.407
Categorized land size	.139	.100	.093	1.397	.164
Categorized household size	-.064	.113	-.035	-.565	.573
Education level	.022	.077	.019	.283	.777
Distance to main source of water (m)	-.026	.040	-.042	-.662	.509
Awareness level of practices	1.093	.111	.616	9.838	.000

Dependent variable: Adoption of sustainable water management practices. $R^2adj=0.378$ $p<0.05$

Source: Field survey, 2012

The combined effect of the six independent variables on adoption of sustainable water management practices had a coefficient of determination (R^2) of 0.378 which was statistically significant ($P<0.05$). The results show that the households income, household size, land size, level of the education, distance to the water source and households level of awareness of the conservation practices could explain 37.8% of variations in water conservation activities among respondents (Table 4.13). The other 63.2% of the adoption of sustainable water management practices was accounted for by other factors which were not under this study.

According to the results in Regression Analysis as summarized in Table 4.13; there was no significant relationship between household's income of the household in Amalo and Mulot locations and adoption of sustainable water resource management practices. The adoption of sustainable water resource management practices by the households was not influenced by the households income of the household (β=-0.062; $p>0.05$). The households' income had a negative influence on adoption of sustainable water resource management practices which was insignificant. A similar finding was reported by Shiferaw and Holden, (2000) who found a negative relationship between off-farm income and maintenance of implemented conservation structures. They found that, given the higher returns to off-farm labour, households with unconstrained access to nonfarm employment were likely to conserve less land than their counterparts. Reardon and Vosti, (1997) found similar results in their study of adoption of sustainable soil management technologies in Rwanda, Burundi and Burkina Faso. Two reasons were offered in the literature for the negative outcomes. First, under some situations, household workers face higher opportunity costs and prefer to allocate family labour into off-farm activities, where it fetches higher returns than on-farm soil and water conservation. Second, off-farm employment often directly overlaps with slack-season conservation activities and reduces the labour available for adoption and maintenance of conservation practices. In contrast Scherr, (2000) argued that there existed a positive relationship between off-farm employment and adoption of conservation technologies. Some studies reviewing empirical examples across sub-Saharan Africa showed that income from off farm employment under certain enabling conditions could be used to fund essential soil and water conservation investments and contribute to reducing the problem of land degradation. Household's income from off farm employment and migration opportunities may also ease the pressure on land and reduce the intensity of resource use in densely populated areas. Holden *et al.*, (2004) showed that increased availability of opportunities for off-farm employment had a negative tradeoff with reduced soil and water conservation investments. According to Pender *et al.*,(2004), when opportunities for off-farm employment exists, they affect the decision to adopt conservation technologies, the degree of adoption as well as the maintenance of conservation structures once they are in place. The emerging picture from the above discussion is that households' income from off farm employment, should not necessarily be bad for land and water conservation. It would seem that the direction of the effect will depend on the opportunity cost of labour, the policy and institutional environment, and how important agricultural income is for people's livelihoods.

where returns to family labour in agriculture are high due to better market opportunities and supportive policies that encourage farmer conservation, then adoption is likely to be high.

There was no significant relationship between household size in Amalo and Mulot location and adoption of sustainable water resource management practices. The adoption of sustainable water resource management practices by the households was not influenced by the household size (β=-[illegible]5, $p>0.05$) (Table 4.13). This is in contrast with Ersado *et al.,* (2004) findings from a study in Northern Ethiopia found that household size positively affects the adoption of water conservation practices by the household. In addition, Pannell *et al.*, (2006) judged that Demographic variables are important because they influence the goals of the landholder and potentially influence the capacity to adopt an innovation.

There was no significant relationship between land size of the household in Amalo and Mulot location and adoption of sustainable water resource management practices. The adoption of sustainable water resource management practices by the households was not influenced by the land size of the household (β=0.093 $p>0.05$) (Table 4.13). This is in contrast with Ersado *et al.,* (2004) findings who found that land size of the household positively affected the adoption of soil and water conservation practices by the household. However, Pender and Kerr, (1998) found differential effects of farm size on conservation investment across the three villages where they studied in India. Farm size is found to have mixed effects on adoption of soil and water conservation practices. Various studies by Ersado *et al.*, (2004) and Bekele *et al.,* (2003) found positive relationship between adoption of conservation measures and farm size. According to Abadi *et al.,* (2005) property size like the land size is often, but not always, related to innovation adoption. The larger areas tend to increase the overall benefits of adoption of beneficial innovations and so increase the likelihood of adoption. Alternatively, social issues related to adoption may also lead to people having larger properties. In North Central Victoria, the adoption of tree planting was not related to property size. Wilkinson & Cary, (1992) and D'Emden *et al.,* (2005) also found a lack of relationship between farm size and adoption of conservation tillage in Western Australia and hence agreed with this study.

There was no significant relationship between distance to main source of water during dry season of the household in Amalo and Mulot location and adoption of sustainable water resource management practices. The adoption of sustainable water resource management practices by the households was not influenced by the distance to the main source of water (β=-0.042 $p>0.05$) (Table 4.13). This revealed that short or long distance to the water source did not determine the adoption of the sustainable water resource management practices. The quantity of water that households collect and use is primarily dependent on accessibility (as determined by both distance and time). There is some indication that cost and reliability may also influence quantity of water collected, although the available evidence is limited and often contradictory (Thompson *et al.*, 2001).

Most (84%) of the interviewed respondents reported that they previously had problems accessing water during the dry season while 10% didn't have any problem. In Amalo location accessibility was not a problem because 96% did not have any problem while only 4% had accessibility problems. The issues of accessibility had been accelerated by high population of people using the same resource, inadequate water and prolonged drought (*pers obs*, 2013).

The dry season coping strategies which had been adopted by the interviewed respondents in Mulot location included; 57% travelled to far water sources to fetch water, 24% used donkeys to carry water from far sources, 2% dug boreholes, 4% harvested water during the wet season and stored it for use during the dry season, 2% conserved the little amount of water available, 8% bought water for use from far places like springs and 4% treated the polluted water for use. In Mulot location most (84%) of the respondents reported that the water was inadequate during the dry season, 4% was fairly adequate, 7% was adequate and 5% was very adequate. However, in Amalo location which is in the upper catchment water adequacy was not a major problem because there was only a short dry period between January and Mid March.

There was no significant relationship between education level of household heads in Amalo and Mulot location and adoption of sustainable water resource management practices. The adoption of sustainable water resource management practices by the households was not influenced by the education level of household head (β=0.019, p>0.05) (Table 4.13). More than 50% had attained secondary level of education while 48% had attained primary level of education and below. However, this did not relate to the adoption of the sustainable water resource management practices. This was in contrast with Ersado *et al.,* (2004) findings who found that education level of the household head positively affected the adoption of water conservation practices by the household. Several studies cited a positive correlation between level of education and number of sustainable water conservation practices adopted; therefore indicating that formal education is an important variable explaining adoption behavior (Asrat *et al.*, 2004; Tenge *et al.*, 2004; Anley *et al.*, 2007). It is inferred in these studies that higher levels of education facilitate the individual's capacity to learn and to make informed decisions (Anley *et al.*, 2007). Bodnár *et al.* (2006) also found that several steps were essential to learning about and accepting innovations, i.e., awareness of the particular problems, ability to recognize possible solutions, and ability to acquire the skills necessary to implement corrective measures. Bodnár *et al.,* (2006) determined that belief in the potential benefits of sustainable water conservation practices implementation is also a necessary condition.

The household's level of awareness of water conservation activities had a positive and significant influence on the adoption of the sustainable water resource management practices (β=0.616, p<0.05) (Table 4.13). This implied that as the household's level of awareness of water conservation activities increased there was a significant increase on the adoption of the sustainable water resource management practices. A similar finding was reported by Mahboubi, (2005) in a study on factors affecting adoption behavior of water conservation technologies in Gol watershed in Iran.

4.4 Community's institutions and sustainable water resources management practices in Amalo and Mulot locations.

The second objective of this study was to investigate the influences of community institutions on sustainable water resources management practices in Amalo and Mulot locations. The community's institutions used were number of the WRUAs and CBO'S the households were aware of and household's member registered by WRUAS and CBO's.

The major findings of the study were indicated using cross tabulations & Regression Analysis. Regression Analysis showed that membership and registration in WRUAs had a significant influence on adoption of sustainable water resource management practices. Cross tabulations was used to show the distribution of adoption of sustainable water resource use across the numbers of the CBO's including WRUAs, households members registered by the WRUAs and the other CBOs.

4.4.1 Number of WRUAs households is aware of.

Mara River Water Users Associations is one of the Community-based Organizations involved in water conservation; in both Amalo and Mulot locations. This WRUA's represented the Mara catchment for both Amala and Nyangores Rivers (plate 4.2). However, based on the focus group discussions one WRUA for Amalo sub-catchment was awaiting approval by the time of this study. Despite having the one Water River Users Association only 51.6% knew about it and its involvement in water conservation activities while 48.4% did not know about it (Table 4.14).

Table 4.14: Knowledge of WRUAs involved in Water Conservation.

Knowledge of WRUAs	Frequency	Percent
Yes	97	51.6
No	92	48.4
Total	189	100.0
189		

Source: Field survey, 2012

Plate 4.2: Water Resource Users' Association in Mulot location, Mara River Basin, Kenya.

Source: Field survey, 2012

4.4.2 Membership and participation in Water Resource Users Associations (WRUAs)

Most of the respondents (96.3%) were not registered and did not participate in activities of the Mara River Water Users Association while only 3.7% were registered (Table 4.15).

Table 4.15: Households members registered in Water Resource Users' Associations.

Households members in WRUAS	Frequency	Percent
Registered	8	4.2
Not registered	181	95.8
Total	189	100.0

Source: Field survey, 2012

In Mulot location 4.2 % of the respondents were registered in WRUAs while 95.8 % were not registered. In Amalo location 100% of the respondents were not registered in any of the WRUAs (Figure 4.7).

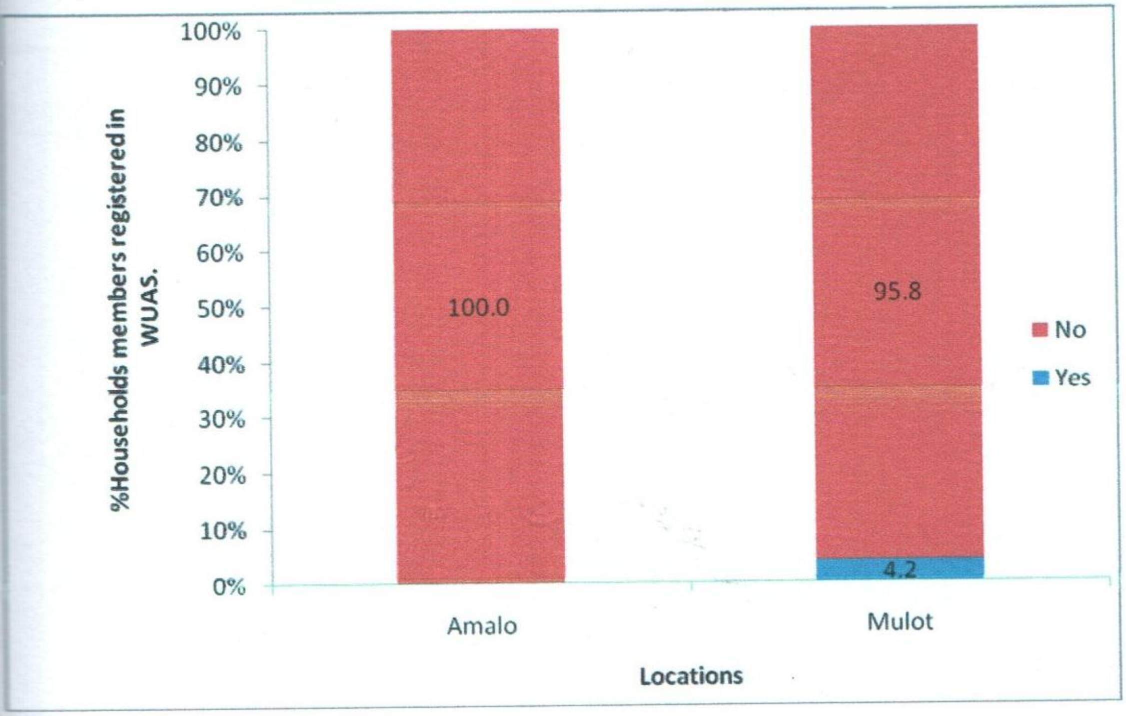


Figure 4.7: Percentage of household members registered in WRUAs in Amalo and Mulot Locations.

Source: Field survey, 2012

4.4.3 Number of Community Based Organizations in the study area.

There were 22 Community Based Organizations involved with water conservation, 21 in Mulot location and 1 in Amalo location (Table 4.16).

Table 4.16: Number of the other Community Based Organizations involved with water conservation that the respondents were aware of.

Location	Community Based Organizations	Respondents Awareness	Percent
Mulot	Implementation youth Group	1	2.2
	Chebinyiny Football Club	1	2.2
	Immanuel Self Help Group	4	8.7
	Salvation Group	1	2.2
	The International Small Group and Tree Planting Program(TIST).	3	6.5
	Faulu Group	1	2.2
	Tuinuane Group	1	2.2
	Saunet Group	1	2.2
	St Mary's Group	3	6.5
	Kelu-emet Group	1	2.2
	Lamayat Women Group	10	21.7
	Mosimowa Group	1	2.2
	Chepoldany Youth Group	1	2.2
	Chepkona Group	1	2.2
	Chemichemi Women Group	1	2.2
	Waves of Light Group	5	10.9
	Sunshine Women Group	2	4.3
	Sessgaa Women Group	2	4.3
	Set Kobor Group	1	2.2
	Oldany Visionary Group	1	2.2
	Water Users Association	97	51.6
Amalo	Implementation Youth Group	1	1.2

Note; the percentages do not add up to 100% because the respondents were aware of more than one Community Based Organizations.

Source: Fieldwork, 2012

Registration and Membership in Community based organizations (CBOs).

Most (79.9%) of the respondents were not registered while only 20.1% were registered (Table 4.17).

Table 4.17: Household and membership in CBO's.

Household members in CBO's	Frequency	Percent
Registered	38	20.1
Not registered	151	79.9
Total	189	100.0

Source: Field survey, 2012

In Mulot location 33% of the respondents were registered in CBO'S while 67% were not registered. In Amalo location 3.6% of the respondents were registered while 96.4% were not (Figure 4.8).

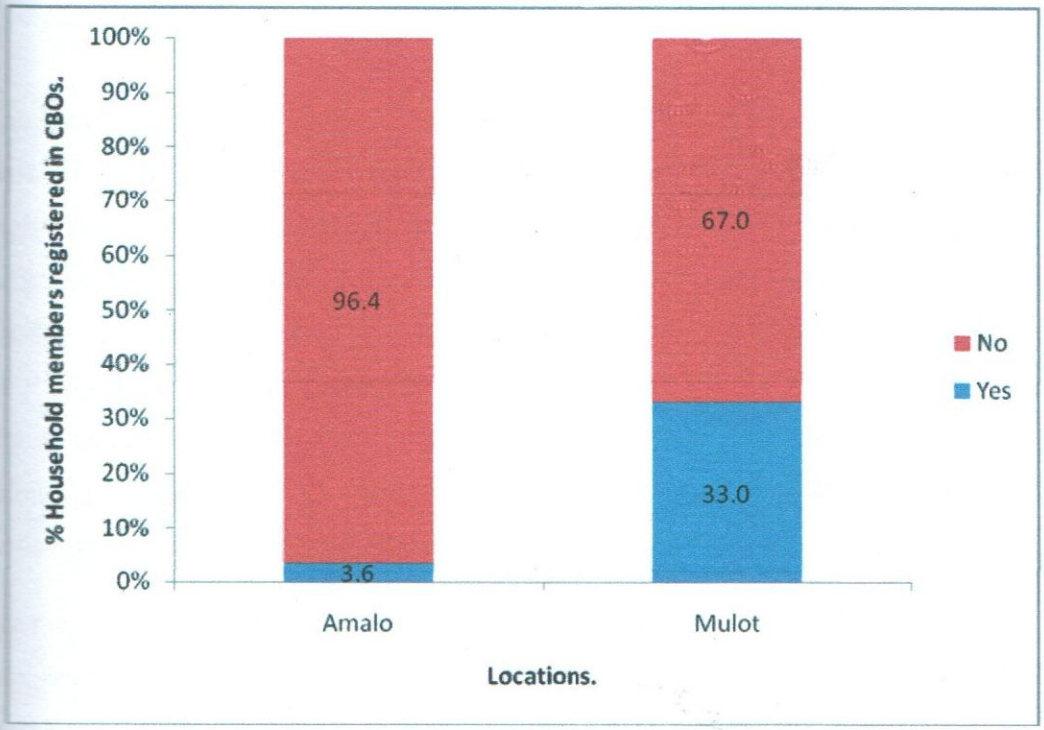


Figure 4.8: Proportion of household members registered in the other CBO's in Amalo and Mulot Locations.

Source: Field survey, 2012

4.4.5 Cross tabulation of community institutions and sustainable water resource management practices.

The study also established the role played by the Mara River Water Resource Users Association on adoption of RWH. A cross tabulation was run between the Mara River Water Resource Users Association and adoption of RWH. Roof top RWH was practiced during the wet season when the water was available for harvesting. This practice had been adopted by all the sampled respondents in Amalo and Mulot locations. Most (50.3%) of those who had adopted RWH were aware of Mara River Water Resource Users' Association (MRWRUAs) and its involvement in Water conservation while 49.7% did not know of it. Despite the respondent's high awareness of the Water Resource Users' Associations only 3.7% of the all the respondents who adopted Rooftop RWH cited that they were registered household members in the WRUAs and actively participated in its activities while 96.3% were not (Table 4.18).

Tree planting had been adopted by all the sampled respondents in Amalo and Mulot locations. Most (50.3%) of those who had adopted tree planting knew of the Mara River Water Resource Users' Association (MRWRUAs) and its involvement in Water conservation while 49.7% did not know of it. All the interviewed respondents in Amalo and Mulot locations had adopted tree planting. Of these 3.7% of the respondents cited that they were registered household members in the WRUAs and actively participated in its activities while 96.3% were not (Table 4.18). This was in contrast with the study conducted by Maarit (2013), across four case study sites in Indonesia. Across the sites trees were planted mainly by the farmers that had more active participation in farmers groups or other social organizations.

The respondents who had adopted water demand management practices were 84.7%. From these respondents who had adopted water demand management practices, 42.5% said that they knew no WRUAs in their community involved with water conservation while 57.5% said that they knew about it. Most (96.3%) of the respondents who had adopted Programmes on Water Demand Management cited that they were not registered household members in WRUAs while 3.8% of the respondents who adopted it cited that they were registered household members in WRUAs and actively participated in its activities in their community (Table 4.18).

The respondents who adopted maintenance of the riparian buffer zones were 58.2 % while those who had not adopted were 41.8 %. From those respondents who adopted, 59.1% said that they knew no WRUAs in their community involved with water conservation while 40.9% said that they knew about them. Most (99.5%) of the respondents who had adopted maintenance of the riparian buffer zones cited that they were not registered household members in WRUAs while 4.5% of the respondents who adopted it cited that they were registered household members in WRUAs and actively participated in its activities in their community (Table 4.18).

More than 50% of the respondents who adopted rooftop rain water harvesting, tree planting and water demand management practices said that they knew of the WRUAs in their community and its involvement in water conservation activities. Only 40.9% of the respondents who had adopted the planting of the riparian buffer zones cited that they knew of the WRUAs in their community and its involvement in water conservation activities.

From the results it was clear that 50% of the respondents who adopted most of the water management practices were aware of the Mara River Water Resource Users Associations in their areas. However there was low registration and participation in WRUAs which according to the focus group discussions could have been attributed to the voluntary nature of the associations, lack of awareness on the existence of these CBOs and the legislations guiding local water governance, community participation in water management and use, mandate and membership to WRUA, lack of incentives and huge logistical and financial challenges facing the Water Resource Users Association.

The study further sought to establish the role played by the number of CBO's on adoption of Rain Water Harvesting. A cross tabulation was run between the number of CBO's and RWH. Water harvesting was practiced during the wet season when the water was available for harvesting. RWH had been adopted by all the sampled respondents. Most (74.1%) of those who had adopted RWH did not know of any CBO's in their community involved with water conservation whereas 25.9% knew about them. From all the sampled respondents in Amalo and Mulot Locations who had adopted RWH, 20.1% of them were registered and participated as household members in the CBO's while 79.9% of them were not registered in any CBO's (Table 4.18).

Tree planting had been adopted by all the sampled respondents. Most (74.1%) of those who had adopted tree planting did not know of any CBO's in their community involved with water conservation whereas 25.9% of the respondents who had adopted tree planting knew about them. The respondents who practiced water demand management practices like not misusing water and using water pans for the drinking animals were 84.7%. From these respondents who adopted, 70% said that they did not know of CBO's in their community involved with water conservation activities while 30% said that they knew of CBO's in their community involved with water conservation. From all the sampled respondents in Amalo and Mulot Locations who had adopted tree planting, 20.1% of them were registered and participated as household members in the CBO's while 79.9% of them were not (Table 4.18).

The respondents who practiced maintenance of the riparian buffer zones were 58.2 %. From these respondents who adopted, 77.3% were not aware of CBO's in their community involved with water conservation while 22.7% knew about them. Most (81.8%) of the respondents who had adopted maintenance of the riparian buffer zones cited that they had no registered household members in CBO's while 18.2% of the respondents who adopted it cited that they had registered household members and participated in CBO's in their community . The riparian buffer zones most observed during the interview were grasses. There were no wooded vegetations which were observed along the riverbanks. Indications that there were no riparian trees that were managed as part of the riparian zones. The chiefs and community leaders can form community barazas and meetings and encourage the people in these areas to register in the WRUA's as well as actively participate in its activities. The WRUA's would then be used in creating awareness to the community members who are registered and actively participating in its activities on the benefits of growing the riparian trees and other riparian plants along the river banks (Table 4.18).

Most (76.9%) of the respondents who had adopted Programmes on Water Demand Management cited that they had no registered household members in CBO's and did not participate in its activities while 23.1% of the respondents who adopted it cited that they had registered household members in CBO's and participated its activities in their community (Table 4.18).

There is a clear indication that more than 75% of the respondents who had adopted the water conservation management practices were not registered members and did not participate in the other CBO's in their community. This could have been due to the role and the activities which were carried out by the CBO's.

More than 70% of the respondents who had adopted tree planting, water harvesting, water demand management practices and planting of the riparian buffer zones said that they were not aware of CBO's in their community that were involved with water conservation activities. This was an indication that the number of the CBO's that the respondents were aware of in their community did not influence the adoption of the water conservation activities (Table 4.18). The number of the CBO's in both Amalo and Mulot location that the respondents were aware of are as shown in the Table 4.16. However, this had no influence on adoption of sustainable water resource management practices. According to the Focus Group Discussions the CBO's carried out water conservation activities but their major role was limited to providing subsidiaries and charity work. This was an indication that there was a great need to focus more on building the capacity of the local CBO's so as to promote their other conventional role of carrying out water conservation activities.

Formal and informal women's organizations and networks can play important and stimulating roles in mobilizing resources for sustainable and equitable water and land management projects (FAO, 2008).

Other water management practices which were not adopted by the interviewed respondents were payment for the environmental services and construction of the sand dams across seasonal rivers.

Table 4.18: The role of the community institutions on the adoption of the water management practices in Amalo and Mulot locations.

Community Characteristics		**Adoption of water management practices** Rain Water Harvesting (%)		Tree Planting (%)		Water Demand Management (%)		Maintenance of the Riparian Buffer Zones (%)	
		YES	NO	YES	NO	YES	NO	YES	NO
Number of WRUAs aware of	0	49.7	0	49.7	0	42.5	89.7	59.1	36.7
	1	50.3	0	50.3	0	57.5	10.3	40.9	63.3
TOTAL		**100**	**0**	**100**	**0**	**100**	**100**	**100**	**100**
Registered in WUA,s.	Yes	3.7	0	3.7	0	3.8	3.4	4.5	2.5
	No	96.3	0	96.3	0	96.3	96.6	95.5	97.5
TOTAL		**100**	**0**	**100**	**0**	**100**	**100**	**100**	**100**
Number of other CBO's aware of.	0	74.1	0	74.1	0	70	96.6	77.3	69.6
	<1	25.9	0	25.9	0	30	3.4	22.7	30.4
TOTAL		**100**	**0**	**100**	**0**	**100**	**100**	**100**	**100**
Registered in Other CBO's	Yes	20.1	0	20.1	0	23.1	3.4	18.2	22.8
	No	79.9		79.9	0	76.9	96.6	81.8	77.2
TOTAL		**100**		**100**	**0**	**100**	**100**	**100**	**100**

Source: Field survey, 2013 F= Frequency %= Percent N=189.

4.4.6 Community institutions and adoption of sustainable water resource management practices.

Regression analysis was used to indicate the nature of the relationship and make predictions between community institutions and adoption of sustainable water resources management practices. A two tailed significance test was utilized. The results are summarized in table 4.19 below.

Table 4.19: Influences of community institutions on adoption of sustainable water resource management practices in Amalo and Mulot locations

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
1 (Constant)	3.322	.113		29.357	.000
Number of CBO's aware of	-.025	.195	-.010	-.129	.897
Number of WRUAs aware of	.281	.174	.126	1.610	.109
Household member registered by WRUAs Household member registered by other CBO's	1.259	.429	.214	2.935	.004
	-.412	.371	-.149	-1.111	0.268

Dependent Variable: Adoption of water management practices R^2=0.057. P<0.05 N=189

Source: Field survey, 2012.

The combined effect of the four independent variables on adoption of sustainable water use management practices had a coefficient of determination (R^2) of 0.057 which was statistically significant (P<0.05). Only 5.7% of the adoption of sustainable water resource management practices was accounted for by the number of the CBO's including the WRUAs households were aware of as well as household members that were registered by the WRUAs and CBO's. The other 94.3% of sustainable water resource management practices was accounted for by other factors which are not under this study. This could have been constraints to adoption of the sustainable water resource management practices. The number of WRUAs though not significant (P>0.05) had slightly higher beta (β= 0.126). Household members registered by the WRUAs positively influenced on the adoption of the sustainable water resource management practices (β=0.214, P<0.05) as shown in Table 4.19. This implied that adoption of sustainable water use practices can be improved by increasing the number of people who are registered in the WRUAs.

Number of CBO'S the households are aware of.

The addition of number of CBO's to the regression model given that number of WRUAs and membership in WRUAs and CBO's are already in the model (fixed) did not help to explain the variability in the adoption of the sustainable water resource management practices (t =-0.129, P>0.05). In addition, there was no significant influence of the number of CBO's the households were aware of on adoption of sustainable water resource use practices (β=-0.010, p>0.05) as shown by Table 4.19. This is an indication that adoption of sustainable water resource management practices by the households was not influenced by the number of the CBO's the households were aware of in the study area. This was because the practicing of the water conservation activities was not a major role of these CBO's. The CBO's were very many but they were so much involved in charity work.

Number of WRUAS the households are aware of.

The addition of number of WRUAs to the regression model given that number of the other CBO's and membership in WRUAs and CBO's are already in the model (fixed) did not help to explain the variability in the adoption of the sustainable water resource management practices (t =1.610, P<0.05) (Table 4.19). The number of WRUAs the households were aware of did not have any significant influence on adoption of sustainable water resource management practices (β=0.126 p>0.05) (Table 4.19). This means that an increase or decrease in number of WRUAs the households were aware of would not have any influence in adoption of sustainable water use practices.

Membership in other CBO's

The addition of those households who were members in CBO's and actively participated in its activities to the regression model given that the membership in WRUAs, number of WRUAs and other CBO's the households are aware of in the model (fixed) did not help to explain the variability in the adoption of the sustainable water resource management practices ($t=-1.111$, $p>0.05$) as shown in Table 4.19. In addition, membership in CBO's had negative and non significant influence on the adoption of sustainable water resource use practices ($\beta=-0.149$, $p>0.05$) as shown in Table 4.19. The negative coefficient implies a negative correlation between sustainable water resource management practices adoption and the membership of CBO's as shown in Table 4.19. This implied that, as registration and membership of the households' members in the CBO's increased there was an insignificant decrease in adoption of the sustainable water resource management practices. Respondents who were members of community-based groups or, organizations in the study area were not better placed to adopt sustainable water management practices technologies than those who did not belong to any organization. According to the study conducted by Dikito, (2001) and Coleman, (1998), self-help grouping and formation of cooperatives is a more reliable and pragmatic means of achieving social capital and ensuring dissemination and adoption of innovative technology. In addition, membership to such organizations enables households to attend seminars and workshops at which stakeholders meet and exchange ideas (Alufah *et al.*, 2012).

Membership in WRUAs

The addition of those households who were registered members in WRUAs and actively participated in its activities to the regression model given that the membership in CBO's, and the number of CBO's including WRUAs the households are aware of are already in the model (fixed) helped to explain the variability in the adoption of the sustainable water resource management practices ($t=2.935$, $p<0.05$) as shown in Table 4.19. In addition, registration and membership in WRUAs had a positive and significant influence on the adoption of sustainable water resource use practices ($\beta=0.214$, $p<0.05$) (Table 4.19). In order to explain variations in adoption of sustainable water resource use practices, stepwise linear regression analysis was used.

The results in Table 4.20 showed that the household's members registered by WRUAs could explain 5.2% of variations in adoption of water conservation practices among respondents. The following model could be used to explain respondents' adoption of water conservation practices in the study areas:

$$Y = 1.407X + 3.451.$$

Where Y=Dependent variable representing respondents adoption of water conservation practices and X is the household member registered by WRUA. A unit increase in the membership in WRUA resulted in increase of 1.407 units in adoption of sustainable water resource management practices. This implies that as the registered household members in WRUA increased there was an increase in adoption of sustainable water resource management practices by the households. There was a positive and significant correlation between adoption of sustainable water management practices and the membership to Water Resource User Associations ($\beta=0.239$; $P<0.05$). The positive association implies that households' membership to WRUAs and participation in WRUAs increase the adoption of sustainable water management practices and vice versa among households' in Amalo and Mulot Locations.

Table 4.20: Influences of household's member registered by WRUA's on adoption of water management practices in Amalo and Mulot locations

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	3.451	.080		42.926	.000
Household member registered by WRUAs	1.407	.418	.239	3.368	.001

Dependent variable: Adoption of water management practices. $p<0.05$ $AdjR^2=0.052$

Source: Field survey, 2012

similar study by Kington and Pannell, (2003) showed that membership of organizations such as catchment groups are positively correlated to adoption of sustainable water management practices. The latter findings also concurred with those of Doron *et al.*, (2011), which found out that membership in farmers social networks can facilitate adoption of water conservation activities through information flow and group action (Caviglia, 2003; Bandiera & Rasul, 2006)). WRUA's plays a major role in creating awareness in the need to preserve all the other water sources to prevent the overdependence on one source.

Apart from encouraging the formation and membership in WRUA there is need to ensure that users are not only adequately represented but also effectively participate in decision making process as part of increasing the level of local governance in water resource use and management efforts.

Devolved governance system is supposed to provide such opportunity but experience from Uganda shows that users are still left out when it comes to making important decisions (Vanmeerveer & Vliet, 2010). There is also need to review the Water Act 2002 to align it with this devolved system of government that will also enhance effective management and sustainable use of water resources. Privatization of water services has largely been discussed at the national level despite the presence of devolved governance structure. Change in management of water supply and distribution is needed but the government must retain some measure of public investment, water planning and regulation as complete private ownership of water resources is neither likely nor desirable due to equity and strategic national development considerations.

According to World Bank (2004), WRUAs are considered useful alternatives to the poorly functioning centralized approach to water resource management that has contributed to undermining sustainable community practices and traditional knowledge on water management. Local communities are being encouraged to form Water User Associations to help in addressing their water needs. Such associations are often more able to mobilize labor and other resources needed to improve water body management through establishing and enforcing rules of access and duties of the users. They have been formed partly out of the need to complement government efforts in water supply, increase user's participation in water resources management and to establish dialogue between water users due to increasing scarcity. Their involvement in water management is expected to improve access and fair distribution of water among the different users and help in the conservation of catchment areas.

According to World Bank (2004), WRUAs are considered useful alternatives to the poorly functioning centralized approach to water resource management that has contributed to undermining sustainable community practices and traditional knowledge on water management. Rural communities are being encouraged to form Water Resource User Associations to help in addressing their water needs. Such associations are often more able to mobilize labor and other resources needed to improve water body management through establishing and enforcing rules of access and duties of the users. They have been born partly out of the need to complement government efforts in water supply, increase user's participation in water resources management and to establish dialogue between water users due to increasing scarcity. Their involvement in water management is expected to improve access and fair distribution of water among the different users and help in the conservation of catchment areas. Kenya's new Water Policy provides various policies and strategies towards improving river water management. One of the policies is to decentralize decision making to sub-basin and catchment institutions. At the individual river catchment level, one type of institution, namely the River Water Resource Users' Association, can be used as a mechanism of introducing community participation in the management of the river water resources. This would bring the principle stakeholders, who have a vested interest in sustainable management of their river resources, into the process of monitoring, allocating and managing the resource in a way that can complement the official role of the Ministry of Water and Irrigation.

One thing that emerges from this objective is first; there is lack of awareness on the existing legislative and institutional frameworks emanating from the Water Act 2002. Secondly; as a result, there is lack of awareness on the governance structures at a local level as well as capacity, potential benefits to local water users, responsibilities and best practices that need to be embraced to facilitate the process of efficient water management and sustainable use of water resources. With a devolved government, results from this study means that the County government has to develop strategies to promote effective management and sustainable use of water resources if these governments are going to achieve economic growth and ensure there is water for all in desirable quantities and qualities. These will necessitate the development of tools and best practices to guide the implementation of integrated water resource management recognising that water is a finite resource which is very vulnerable, is essential social and economic good, stakeholder participation is key to successful management of water resources and the need to mainstream water management in all sectors of economic growth at all levels.

4.5 Major sources of water for households in Amalo and Mulot locations.

The third objective was to find out the major sources of water for livestock, irrigation and domestic purposes in Amalo and Mulot locations. The major findings of the study were indicated using frequency tables, cross tabulations and chi-squares.

4.5.1 Water source for irrigated crop farming.

Water is a crucial input for boosting agricultural production and improved water management is key to meeting agricultural and food security objectives in SSA (FAO, 2008). The irrigation crop farming during the dry season is an important determinant of household's wellbeing. The irrigation crop farming during the dry season was not practiced in Amalo location this is because there was only one short dry period from Jan to Mid-March which is usually accompanied by strong winds. Most (88%) of the respondents in Mulot location irrigated their crops during the dry season. Some of the irrigated areas and crops are as shown in plates 4.3. The majority of households who irrigated some crops did on vegetables, with tomatoes, cabbages and kales being the leading. Those who did irrigation crop farming were mainly those who were living along and near the Amala River and its tributaries. This is because of the lack of financial resources required to build and acquire irrigation technology for those who were living far away.

Cabbages

Tomatoes

Sukumawiki

Plate 4.3: Some of the irrigated areas and crops in Mulot location Mara River Basin, Kenya.

Source: Field survey, 2012

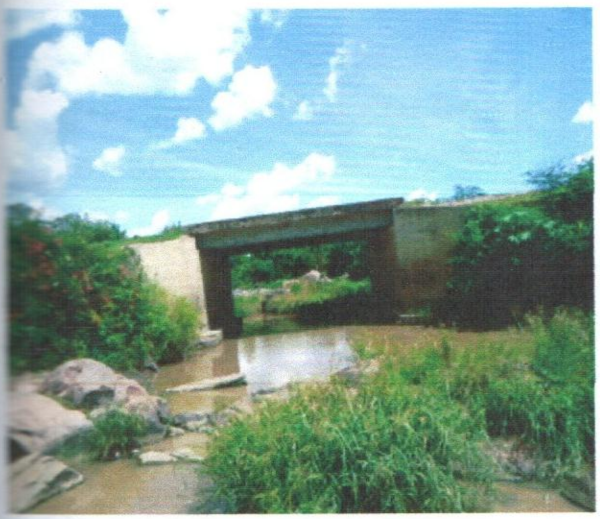
Despite living along the river, each household was asked to report the primary water sources used by households. Some of the water sources that were used by the sampled households were more than one type like in the other developing countries; even though the major source was the Amala River and its tributaries.

The major sources of water for irrigation crop farming during the past dry season are as shown in Table 4.21 and plate 4.4. About 69% depended on Amala River as the major source of the water, with another 11% obtaining it from the Amala river tributary (Ngasiet river). Close to 8% of the respondents obtained their water from the nearby springs, 1% from the roof catchment and 11% from the other sources (Table 4.21).

Table 4.21: Major sources of water for irrigation crop farming during the dry season in Malot Location.

Location	**Source**	**Frequency**	**Percent**
Malot	Amala River	73	69
	Tributary of Amala River	12	11
	Spring	8	8
	Roof catchment	1	1
	Others	12	11
Total		106	100

Source: Field survey, 2012



Amala River in Mulot Location.

Spring in Mulot Location

Tributary of Amala River in Mulot Location.

Plate 4.4: Major sources of water used for irrigation crop farming during the dry season by the households in Mulot Locations, Mara River Basin, Kenya.

Source: Field Survey, 2012.

4.5.2 Major sources of water for irrigation farming and adoption of water management practices

According to the results in Table 4.23, chi-square test value was 32.016 with a significant level of 0.02. The significant level is far below the significant level of 0.05, meaning that there is a significant association between main sources of water used for irrigation purposes during the dry season and adoption of sustainable water management practices. The results further indicated that most (42%) of the respondents who adopted three to four sustainable water resource management practices relied on Main Mara River as major source of water during the dry season. In addition only few (2%) relied on water that was harvested from roof catchment during the rainy season (Table 4.22). This is an indication that despite most of the people harvesting water from the rooftop during the rainy season (Table 4.12) it was inadequate for use during the prolonged dry season.

Table 4.22: Main sources of water for irrigation farming during the dry season and adoption levels of water management practices.

Main source of water for irrigation farming during the dry season		Adoption levels of water resource management practices				
		Non-adoption 0	Low 1-2	Medium 3-4	High 5-7	Total
Main Mara River	Count	1	3	53	16	73
	%	100	30	84	80	78
Tributary Mara River	Count	0	5	7	0	12
	%	0	50	11	0	12
Spring	Count	0	2	2	4	8
	%	0	20	3	20	9
Borehole	Count	0	0	0	0	0
	%	0	0	0	0	0
Tap water	Count	0	0	0	0	0
	%	0	0	0	0	0
Roof catchment	Count	0	0	1	0	1
	%	0	0	2	0	1
Total	Count	1	10	63	20	94
	%	100	100	100	100	100

Source: Field Survey, 2012.

Table 4.23: Chi-square test for major sources of water for irrigation farming and adoption of water management practices.

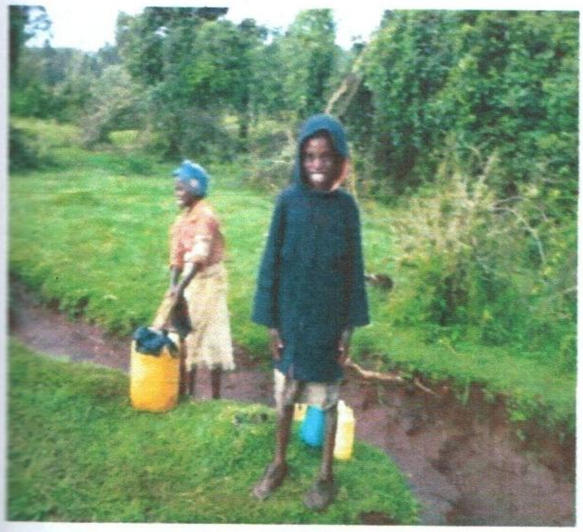
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32.016[a]	18	.022
Likelihood Ratio	30.794	18	.030
N	94		

It is increasingly recognized that productive uses of water have particular value for households and communities and have health and well-being benefits (Thompson *et al.*, 2001). Direct health benefits are derived for example from improved nutrition and food security from gardens crops that have been watered. Indirect health benefits arise from improvements in household wealth from productive activity.

4.5.3 Water used and water source for domestic purposes

The water use for domestic purposes indicator included all water collected by or delivered to the household and used there for drinking, food preparation, bathing, washing clothes, washing dishes, flushing toilets personal and household hygiene and sanitation by the inhabitants of the household. It is assumed that the amount collected is the amount used. A day is a 24-hour period. The respondents were asked how much water they used per day for domestic purposes. The responses were given in numbers of containers rather than liters and therefore the researcher sought to have a series of pictures of the common water containers in that community with the volumes pre-measured (Plate 4.5). All the households used jerry cans to collect water; these cans typically hold 20 liters. Children also used smaller jerry cans, up to 10 liters. Most of the households in Mulot location relied on water systems in which water was collected or delivered in containers from the source and brought to the home and where water was piped directly into the house or compound, these systems were typically not metered either at the source or at the household. The common water containers and means of transport used for carrying water are as shown in the plates 4.5.



Jerricans used in Amalo Location.

Using human power to carry water in Amalo Location.

Using donkey to carry water in Mulot Location.

Jerricans used in Amalo Location.

Plate 4.5: Some of the common water containers used for carrying water in Mulot and Amalo Location, Mara River Basin, Kenya.

Source: Field survey, 2012

The respondents were also asked for the main sources of water for domestic purposes during the dry season. The responses in Mulot and Amalo location were as shown in Figure 4.9. The presented results in figure 4.9 is in agreement with Ministry of Planning and National Development (2008) findings that surface water (dug wells, dam and river) is the main source of water for domestic use in Mulot and Olenguruone divisions. The main source of water is Amala River. Kenya National Bureau of Statistics (2010) also reported that more than one-third of Kenyan households collect water for domestic use mainly from surface waters like lakes, streams and rivers.

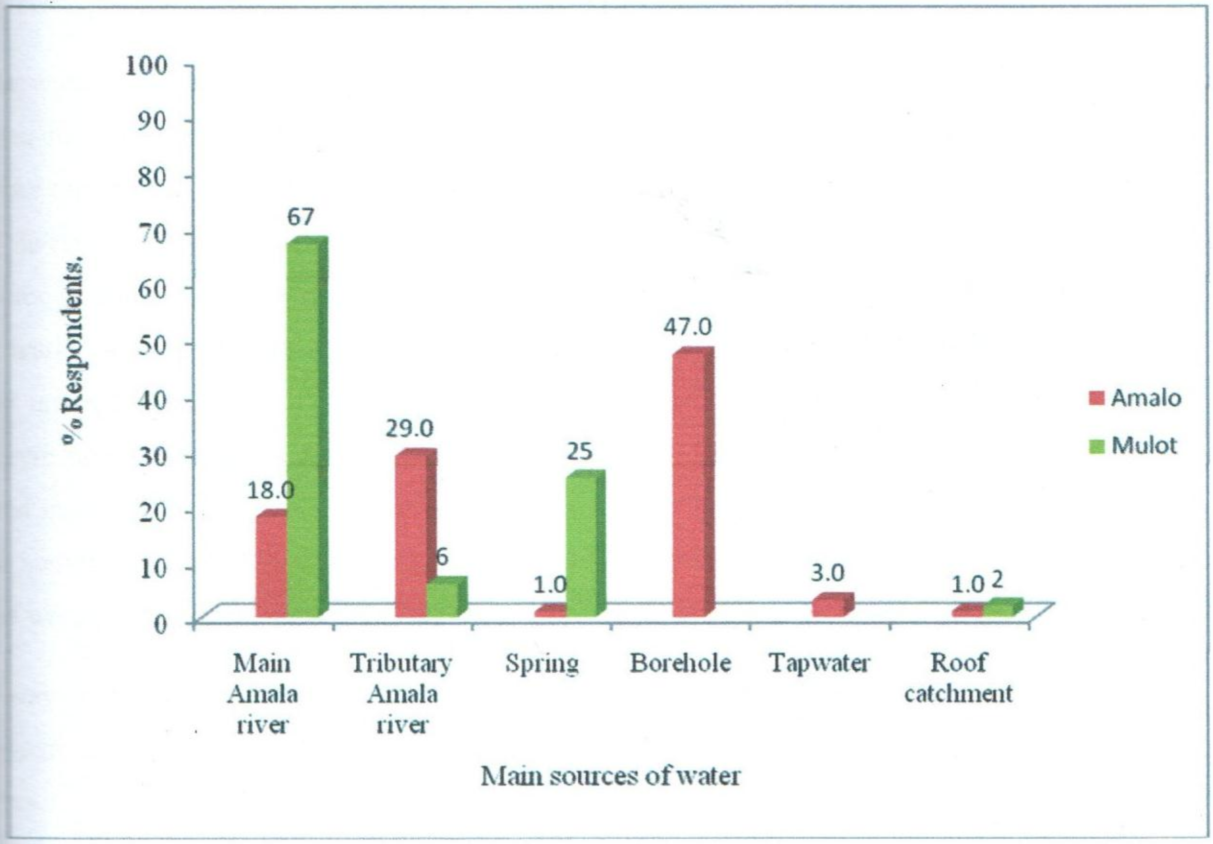


Figure 4.9: Major sources of water for domestic purposes in Amalo and Mulot locations, Mara River Basin, Kenya.

Source: Field survey, 2012

4.5.4 Major sources of water used for domestic purposes and adoption of water management practices

The study further sought to find out how the major sources of water for domestic purposes influenced the adoption of the sustainable water resource management practices.

According to the results in Table 4.25, chi-square test value was 73.127 with a significant level of 0.002. The significant level was far below the significant level of 0.05, meaning that there was a significant association between main sources of water used for domestic purposes during the dry season and adoption of sustainable water management practices.

The water source for domestic purposes is very important. The water source should provide water that meets WHO guidelines. The water resources should also be adequate for current and future domestic use, reliable through the years and the community should own them. Most (42%) of the respondents who adopted 3-4 water management practices relied on Amala River as major source of water. Only a few (2%) relied on water that was harvested from rooftops. This was an indication that despite all of the respondents adopting water harvesting during the wet season it was unsustainable (Table 4.24). The water harvested during the wet season was not enough to sustain people during the dry season. During the Focus Group Discussions some of the reasons cited included lack of funds to purchase large capacity tanks and hence the water harvested by the households was little. The water harvested was considered insufficient to water the seedlings that were planted during the wet seasons.

It was therefore important that the community was involved in water management and the springs and rivers were effectively monitored so as to know how much water was available and when.

The average household's needs is estimated at 20-50 litres of water per person per day, depending on various assumptions and practices (Gleick, 1996). Water quantity monitoring is an important part of sustainability for domestic water supply. However, rainwater harvesting is one of the most sustainable sources of water supply. This is because of its inherent barriers to the risk of over-exploitation which is found in surface water sources, and directly provides drinking water quality if well maintained (WHO & UNICEF, 2010).

Table 4.24: Main sources of water during the dry season and adoption levels of water management practices.

Main source of water for domestic purposes during the dry season.		Adoption levels of sustainable water resource management practices				
		No-adoption 0	Low 1-2	Medium 3-4	High 5-7	Total
Main Mara River	Count	1	12	55	16	85
	%	50.0	38	42	76	45.6
Tributary Mara River	Count	1	10	19	0	30
	%	50.0	31	14	0	15.6
Spring	Count	0	7	19	5	30
	%	0	22	14	24	15.0
Borehole	Count	0	3	34	0	37
	%	0	9	26	0	20.0
Tap water	Count	0	0	2	0	2
	%	0	0	2	0	1.1
Roof catchment	Count	0	0	3	0	3
	%	0	0	2	0	1.7
Others	Count	0	0	0	0	2
	%	0	0	0	0	1.1
Total	Count	2	32	132	2	189
	%	100	100	100	21	100

Source: Field Survey, 2012. %=Percent.

Table 4.25:Chi-square test for the major sources of water for domestic purposes and adoption of water management practices.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	73.127[a]	42	.002
Likelihood Ratio	68.864	42	.006
N	189		

4.5.5 Quantity of water used per capita per day

The quantity of water used per capita per day by all the households in the sample was calculated as follows:-

$$\text{Volume of water used per capita per day} = \frac{\text{Volume of water (in litres) collected for domestic use per day by all households in the sample}}{\text{Total number of the households in the sample}}$$

Calculations for individual households were done and results are summarized in Table 4.26 below. 15.3% persons in the sample used between fifteen and twenty liters per day while 26.5% used 30 litres and above per day. Most persons (87%) used 19 liters and above per day (Table 4.26). This figure is significantly higher than the WHO guidelines, which state that the per capita water consumption should be at least 20 liters per day (Mengesha *et al.*, 2003; Collick, 2008).

Table 4.26: Amount of water per capita per day used by households for domestic use during the dry season.

Amount of water in l/c/d	Frequency	Percent
>=10	7	3.7
10-15	9	4.7
15-20	29	15.3
20-25	40	21.2
25-30	54	28.6
>30	50	26.5
Total	189	100.0

Source: Field survey, 2012

In Amalo location the minimum amount of water per capita per day was 7.5 and a maximum of 59.8 with a mean of 20 while in Mulot location the minimum was 6.20 and a maximum of 32 with a mean of 19 (Table 4.27). This was an indication that basic access of water had already been achieved in Amalo location.

The WHO/UNICEF Joint Monitoring Programme, which produces the Global Assessment of Water Supply and Sanitation data, describe reasonable access as being 'the availability of at least 20 litres per person per day from a source within one kilometre of the users dwelling' (WHO and UNICEF, 2000). In their guidance manual prepared for the Department for International Development (UK), WELL (1998) suggested that a minimum criterion for water supply should be 20 litres per capita per day, whilst noting the importance of reducing distance . Gleick (1996) suggested that the international community adopt a figure of 50 litres per capita per day as a basic water requirement for domestic water supply.

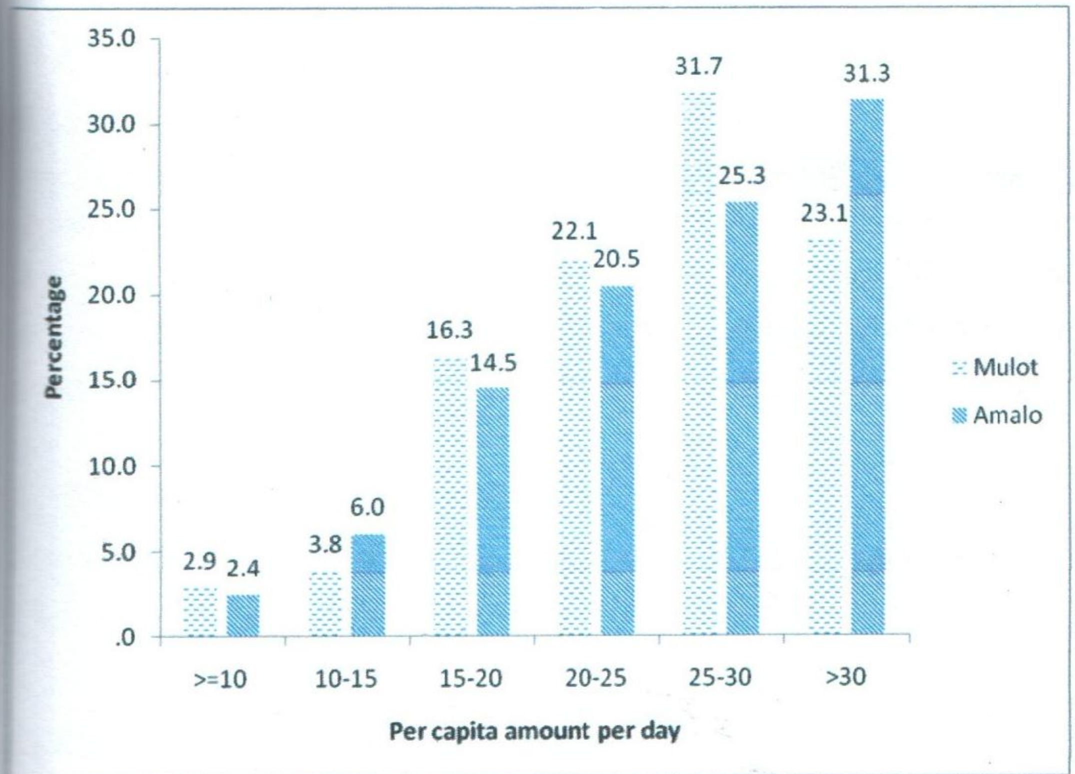


Figure 4.10: Per capita amount per day for water use for domestic purposes

Source: Field survey, 2012.

Table 4.27: Minimum, maximum and mean amount of water per capita per day

Location	N	Min.	Max.	Mean	Std. Deviation
Mulot	105	7.50	59.80	19.96	6.87
Amalo	83	6.20	31.90	19.29	5.77

Source: Field survey, 2012

However safe water for domestic use is one of the basic human rights & it's the responsibility of every government to ensure that this basic right is adequately available to all citizens for the purpose of healthy & productive nation .The world Health organization (WHO) has set standards for the minimum quantity of water per person per day for a healthy life. The standards are a range of 20-40 litres of water per day per person as the minimum requirement for drinking & sanitation uses; and overall basic requirement of 50 litres of water per person per day as minimum standards to meet four basic needs of drinking, sanitation, bathing and cooking. Because basic access to improved water supply has been achieved in Amalo location which is around 20 liters per capita per day, then it is the effective use of the available water that is of principal importance. These standards underscore the importance of supplying safe water to poor communities who are denied their rights to enjoy adequate quantity & quality of water especially in rural areas

4.5.6 Water sources for livestock farming.

The respondents were asked whether they kept livestock during the current dry season. Those who kept livestock were 94.7% while 5.3% did not keep (Table 4.28).

Table 4.28: The respondents who kept livestock during the dry season.

Keep livestock during the dry season	Frequency	Percent
Yes	178	94.7
No	11	5.3
Total	189	100.0

Source: Field survey, 2012.

The respondents were asked to give their main source of water for livestock during the past dry and wet seasons. During the dry season most (55.7%) of the respondents relied on Amala River as compared to 44.8% during the wet season. In contrast boreholes were relied upon by most (33.7%) of the respondents during the wet season as compared to 18% during the dry season (Figure 4.11).

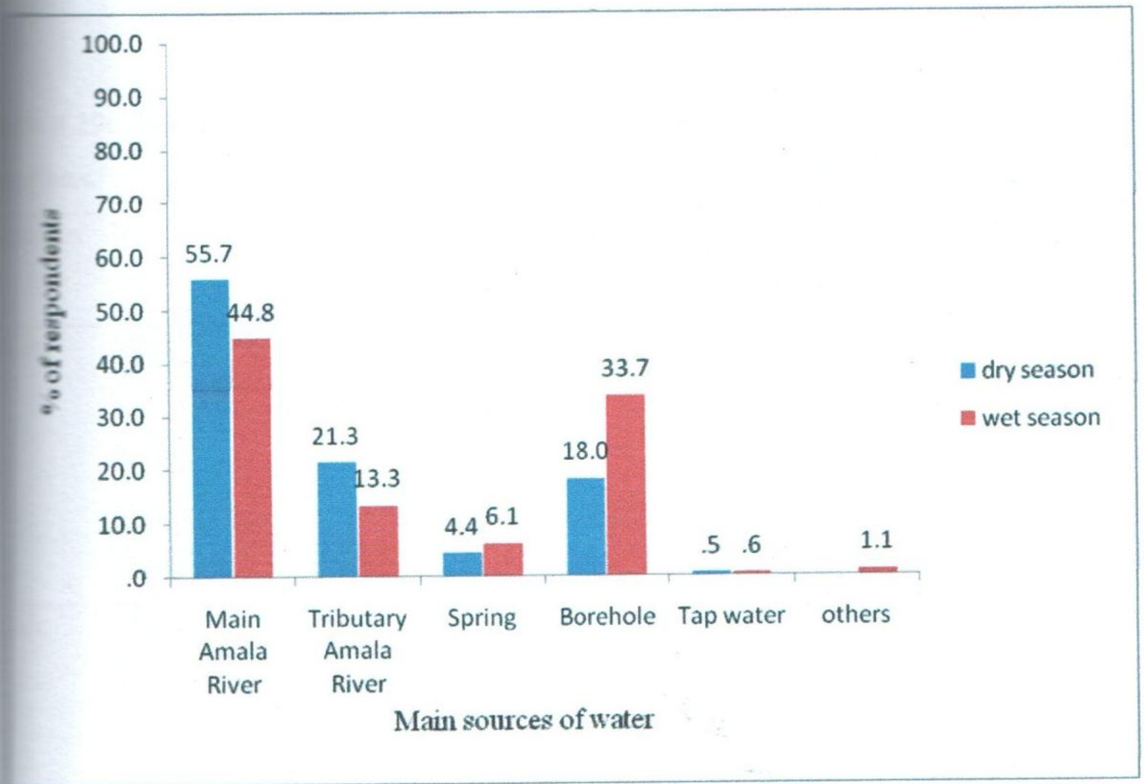


Figure 4.11: Main sources of water for Livestock farming in Amalo and Mulot locations.

Source: Field survey, 2012

During the dry season 84% of the respondents in Mulot location depended on the Main Amala River, 6.6% on the tributary Amala River and 9.4% on the spring while in Amalo location those who depended on Main Amala River were 18%, tributary Amala River was 41%, borehole 39.8% and tap water was 1.2 % (Table 4.29).

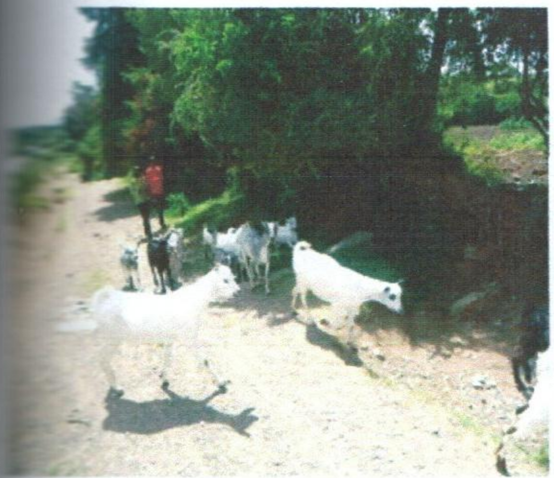
During the wet season in Mulot location the Main Amala River remained to be the major source of water (76.8%), followed by the tributary Amala River (Ngasiet) (11.1%) and spring (11.1%). In Amalo location 73.5% of the respondents highly depended on private boreholes as the major source of water, 15.7% on tributary Amala River, 6 % on Main Amala River, 2.4 % on roof top catchment and 2.4% on tap water (Table 4.29).

Table 4.29: Major sources of water used for livestock purposes in Amalo and Mulot Locations.

Locations	Main source of water	Dry season		Wet Season	
		Frequency	Percent	Frequency	Percent
Mulot.	Main Amala River	89	84.0	79	76.8
	Tributary Amala River	7	6.6	13	11.1
	Spring	10	9.4	12	11.1
	Others	0	0	2	1.0
	Total	106	100	106	100
Amalo.	Main Amala River	15	18.0	5	6.0
	Tributary Amala River	34	41.0	13	15.7
	Borehole	33	39.8	61	73.5
	Tap water	1	1.2	2	2.4
	Roof catchment	0	0	2	2.4
	Total	83	100.0	83	100.0

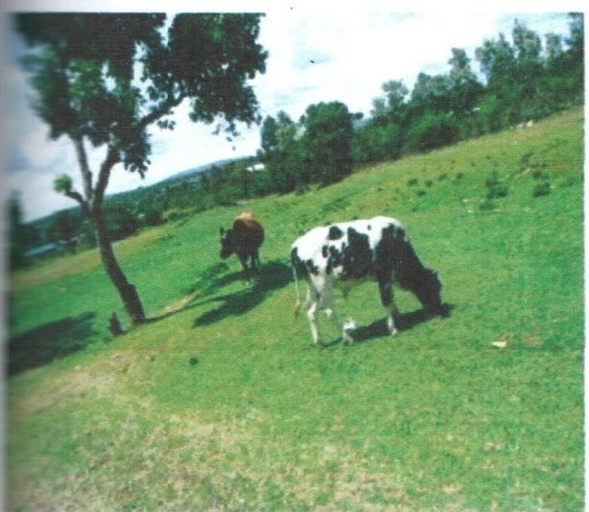
Source: Field survey, 2012.

Some of the animals kept by the respondents in Amalo and Mulot location are as shown in the plates 4.6 ..



Goats kept in Mulot Location.

Cows kept in Amalo Location.



Cows kept in Mulot Location.

Cows and heifers kept in Amalo Location.

Plate 4.6: Animals kept by the respondents in Amalo and Mulot locations.
Source: Field survey, 2012

4.5.7 Major sources of water for livestock purposes and adoption of water management activities.

According to the results in Table 4.31, chi-square test value was 63.119 with a significant level of 0.00. The significant level is far below the significant level of 0.05, meaning that there is a significant association between main sources of water used for domestic purposes during the dry season and adoption of sustainable water management practices.

The study indicated that most of the respondents adopted 3 to 4 water management practices (Table 4.30). For instance 54% relied on Amala River; 22% tributary Amala River; 0.5% spring; 2% borehole; 0.5% tap water and 0% roof catchment as major sources of water during the dry season. Nobody relied on water stored after rain water harvesting. This was an indication that despite most of the people harvesting water from the rooftop during the rainy season (Table 4.12) it was inadequate for use during the prolonged dry season. According to WREM (2008), and the Focus Group Discussions, this situation was a result of lack of enough water storage facilities at the household level for most of the population (LVBC & WWF-ESARPO, 2010a; 2010b).

Table 4.30: Cross tabulations for the major sources of water for livestock and adoption levels of the sustainable water resource management.

Main source of water for livestock farming during the dry season		Adoption levels of sustainable water resource management practices				
		Non-Adoption 0	Low 1-2	Medium 3-4	High 5-7	Total
Main Amala River	Count	1	12	74	18	105
	%	50	44	54	78	56
Tributary Amala River	Count	1	10	30	0	41
	%	50	37	22	0	22
Spring	Count	0	3	1	5	9
	%	0	11	0.5	22	5
Borehole	Count	0	2	31	0	33
	%	0	8	23	0	17
Tap water	Count	0	0	1	0	1
	%	0	0	0.5	0	0
Roof catchment	Count	0	0	0	0	0
	%	0	0	0	0	0
Total	Count	2	27	137	23	189
	%	100	100	100	100	100

Source: Field survey, 2012.

Table 4.31: Chi square tests for the major sources of water for livestock farming and adoption of water management practices.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	63.119[a]	28	.000
Likelihood Ratio	62.711	28	.000
N	189		

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The purpose of this study was to assess the factors influencing sustainable water resource management practices in Amalo and Mulot locations, Mara River Basin, Kenya. This chapter therefore, presents the conclusions drawn from the findings and the recommendations to the sustainable water resource management practices.

Deterioration in water quantity in the Mara River during the prolonged dry spells affects the human and ecosystem wellbeing. The analysis of sustainable water resource management practices showed that rooftop rainwater harvesting, tree planting, and water demand management practices like not misusing water and using water pans while watering animals as well as planting of the riparian buffer zones were practiced. The adoption of these water conservation activities was still there but not sustainable. Paying attention to factors which determine sustainable adoption is a priority. These findings provided basis for the following key findings, conclusions and recommendations.

5.2 Key Findings and Conclusions

The key findings of the study were:

i. The household's socio-economic characteristic did not significantly influence the sustainable water resource management practices. But the households level of awareness of the water conservation activities had a positive significant influence on the adoption of water management practices ($\beta=0.616$ $p<0.05$).

ii. The membership, registration and participation of household members in Water Resource Users' Associations had a positive and significant influence on the adoption of sustainable water resource management practices ($\beta= 0.239$, $p<0.05$); there were no significant influence of the number of CBO's ($\beta=-0.010$, $p>0.05$) households were aware of on sustainable water resource management practices.

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iii. The major sources of water used for irrigation crop farming (χ^2=32.016; $p<0.05$); livestock farming (χ^2=63.119; $p<0.05$) and domestic purposes (χ^2=73.127; $p<0.05$) during the dry season had significant association with adoption of sustainable water resource management practices.

From the findings of the study, it can be concluded that:

i. It is clear that different socio-economic factors determine the adoption of water conservation practices in different parts of the world or even in different locations within a given country due to differences in agro-ecological as well as socio-economic setting of the households. Awareness of sustainable water conservation activities should be enhanced among households so as to ensure more of its adoption.

ii. Formation and membership of household and community members in Water User Associations and ensuring that they are all adequately represented and effectively participate in decision making is likely to promote adoption of sustainable water resource management practices. There is also need to empower the community members to unite and register in the already formed associations. Such associations can be able to source funds for development through the financial institutions and organizations. These WRUA's helps to implement and monitor sustainable water resource management practices at local level.

iii. Water managers can use public education to persuade and create more awareness to individuals on water conservation. This can be conducted through various multi-media formats (TV, radio, news papers, internet etc). Education programmes at schools can also be used to persuade young people to conserve water resources.

5.3 Policy Recommendations

i. Significant public and private sector investments in research, development and dissemination of information, including operational guidelines, and promotion of education for water users as well as implementation of sustainable water resource management practices are needed so as to realize the full potential of water-demand management policies

ii. There is need for county government to support and finance water-users groups to optimize local water resources management; develop new, promote and fully enforce the existing national water management policies and legislations like national water harvesting and storage policy. In addition the water demand should be managed better with appropriate existing strategies like strategic plan for WRMA 2012-2017, national water quality management strategy and water sector strategic plans. This can improve the existing supply-demand balance in water-stressed regions and offer multiple benefits to all stakeholder groups.

iii. The Ministry of Water resources and Irrigation should promote other sustainable water sources and practices like rain water harvesting. There should be vigorous awareness raising campaigns of rainwater harvesting as a by-law in the building guidelines and any new development should be encouraged to explore and apply the rainwater harvesting technologies. Rainwater harvesting should not be taken as a 'free for all' resource but should be included in water policies in Kenya. Water management has been only based on renewable water, which is surface and groundwater with little consideration of rainwater. In addition, the communities through the community institutions should be encouraged to build large ferrocement capacity tanks that can store more litres of water for long-term use.

iv. There is also need for synergy between water sector legislations and policies with other related policies such as environmental (e.g. EMCA, Environmental Policy), Agriculture (Agricultural Act, Agricultural Policy), Forestry (Forest Act 2005, Forestry Policy), Fisheries (Fisheries Act), Livestock Act and Policy, Soil and Water Conservation Strategy, Wildlife (Wildlife Management and Conservation Act, Wildlife Policy), and Development (domestication of MDGs, pursuit of Vision 2030).

v. The Ministry of Water resources and irrigation in Kenya should have mechanisms of approving the construction of a ferrocement tank or large water capacity jars by having good design standard drawings. The existing ones are inadequate and unsuitable to the prevailing local conditions.

5.4 Other recommendations

i. People should be encouraged to adopt tree planting along the riparian zones as a water management strategy.

ii. Economic incentive schemes seek to change behavior by including environmental costs and benefits into economic institutions (e.g., taxing polluters for the damages caused or rewarding providers of environmental Services with payments. Payments for the environmental services that rural communities can provide through the adoption of Sustainable Water Resource Management Practices thus seem to be a promising approach. PES programs can in fact provide incentives to land managers to adopt Sustainable Water Resource Management Practices (e.g., increase downstream water quality, quantity and flows).

iii. County government should organize and finance multi-communities groups and programs and the fund may be partly revolving, using repayment or earlier loans.

iv. The communities must differentiate between source of water for domestic purposes and for non-domestic purposes (irrigation and livestock). This would assist in proper management of the existing major sources of water.

v. There is need for the multi-stakeholder engagement especially cross-sectoral. For example Ministry of Agriculture, Livestock and Fisheries working with Ministry of water and the Ministry of Environment. These synergies will optimize water efficient water resource use and management.

5.5 Recommendations for Further Research

i. Since adoption of rain water harvesting, tree planting, water demand management practices and the planting of the riparian buffer zones is still there in many areas, paying attention to the other household's characteristics and community institutions which determine their sustainable adoption is a priority. The additional research should be multidisciplinary, with research teams made up of hydrologists, engineers, environmentalists, ecologists, demographers, and other social scientists.

ii. Further research should be done on the locally available methods that can be used to create more awareness on tree planting, water harvesting, water demand management practices and planting of the riparian buffer zones.

iii. Further study should be done on other rain water harvesting systems and approaches e.g. by using collecting area/catchment area which may be in various forms (e. g galvanized sheets, butyl rubber, concrete, polythene vinyl, asphalt, heavy weight roof paper). Also land mapping should be carried out so as to identify other appropriate rain water harvesting techniques.

iv. Household's and community constraints to sustainable adoption of water resource management practices should be further investigated.

v. The influences of large scale irrigation farming on the Mara River flows during the prolonged dry season should be investigated.

vi. Further research is required on the development of new and alternative sustainable sources of water-supply.

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APPENDIX ONE

SURVEY QUESTIONNAIRE

It is a pleasure to notify you that you have been selected as one of the interviews. The study is intended to assess the factors influencing household water management and their influences on household's wellbeing in Amalo and Mulot locations. Your contribution is vital for the success of this study. The responses will be kept strictly confidential. Please answer the questions asked as honestly as possible.

SECTION A: HOUSEHOLDS INFORMATION AND SOCIO-ECONOMIC CHARACTERISTICS.

Case number: ____________ Date: ____________________Time:____________________

1. Name of head of household (Optional). ____
2. Gender of household head: Male **[1]** Female **[2]**
3. Village: ____
4. Sub-location: ____
5. Location: ____

Household composition and characteristics

6. **Respondent name** ____
7. **Relation to household head**

Head=1 Wife/Husband=2 Son/daughter=3 Son-in-law/Daughter in law=4 Grandchild=5 Parent=6 Brother/Sister=7 Brother/sister in law=8 Others (Specify)____

8. **Sex** Male-1 Female-2
9. **Age** ________________________
10. **Education level** Never gone to school=1 **P**rimary=2 Secondary=3 Tertiary training=4 University degree=5
    Others (specify)________________________
11. **Marital status** Married=1 Single=2 Separated/Divorced=3 Windowed=4
12. **Occupation** Farmer=1 Herder=2 Skilled laborer=3 Non-skilled laborer =4 Large business/medium to large shop owner=5 Self employed professional=6 Truck driver/cleaners=7 Housewife=8 Student=9 Unemployed=10
    Others (Specify) ____________________________

13. **House hold size** ____________

14. Households Income

1. What are your sources of household's income on daily basis?

Sources of income	**Total amount**	
Income from agriculture and farm activities	Per month	Per year
Income from crop produce		
Income from animal and animal produce		
Income from other farm activities (Specify)		
Income from off-farm employment.		
Income from business/ Charcoal Trade etc.		
Income from pension schemes		
Remittances from household members		
Wage income on number of days worked per month.		
Income from animal labor (Donkey).		
Other off-farm employments (Specify).		

2. What is your annual expenditure on the following?

	Total amount	
	Per month	Per Year
Business Investments.		
Health expenses.		
Cloth expenses.		
Education expenses.		
Livestock health expenses.		
Other expenses (Specify)		

13. **House hold size** _____________

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Sources of income	**Total amount**	
Income from agriculture and farm activities	Per month	Per year
Income from crop produce		
Income from animal and animal produce		
Income from other farm activities (Specify)		
Income from off-farm employment.		
Income from business/ Charcoal Trade etc.		
Income from pension schemes		
Remittances from household members		
Wage income on number of days worked per month.		
Income from animal labor (Donkey).		
Other off-farm employments (Specify).		

2. What is your annual expenditure on the following?

	Total amount	
	Per month	Per Year
Business Investments.		
Health expenses.		
Cloth expenses.		
Education expenses.		
Livestock health expenses.		
Other expenses (Specify)		

SECTION B: SUSTAINABLE WATER RESOURCE MANAGEMENT PRACTICES

a) **Sustainable water resource management practices.**

13. Are you aware of any of these water resource management practices? Yes/No_______

14. If yes, which ones are you aware of? (Use codes)_______________________

1=Water harvesting 2=Tree planting

3=Programmes on water demand management. E.g. Growing less water demanding crops

4=Maintaining riparian buffer zones

5=Construction of farm filtration ponds 6=Payment for Environmental Services

7=Construction of sand dams across seasonal river beds 8=Others (Specify) ___________

15. Of the water resources management practices

a. Which one do you carry out during the dry season? (Use codes). ______________

b. Which one do you carry out during the wet season? (Use codes). ______________

SECTION C: HOUSEHOLDS CHARACTERISTICS

c) Land size and land tenure

1. What is the size of your land in ha? ______________________
2. What is the status of the land tenure or land ownership?

With title deed [1] Without title deed [2] Squatter [3]

Leased/Rented [4] Squatters in government land [5]

Communal land [6]

Free hold [7] Others (specify)______________________

3. How did you acquire the land?

Bought [1] Inherited [2] Gift [3] Others(Specify)______________________

e) Distance to the water source

4. What was the main source of water in your farm during the past dry season? ___________

SOURCE	DISTANCE (Km)
Main Amala River [1]	
Tributary of Amala River [2]	

Spring [3]	
Bore-hole [4]	
Tap water [5]	
Roof catchment [6]	
Others(Specify) ____________	

5. What were the other sources of water used by your household during the past dry season? (Same options as above) ____

6. How adequate was your water resource during the prolonged dry season?

   Not adequate [1]   Fairly adequate [2]   Adequate [3]

   Very adequate [4]   Very much adequate [5]

7. If not adequate, what did you do about it?

   Conserved the little amount of water available (WDM) [1]

   Walked for long distances to look for water [2]   Buy [3]

   Others (Specify)________________________________

SECTION D: COMMUNITY INSTITUTIONS.

a) Community Based Organizations.

8. Do you know of any Community Based organizations involved with water conservation activities in your community during the dry season? Yes [1]   No [2]

9. **If yes,** list them and indicate the water conservation activities they carry out.

   ....

   ....

   ....

   ....

   ....

10. Is anybody in the household a registered member in any of these Community Based Organizations?(Tick the appropriate one)

    Yes [1]   No [2]

11. **If yes**, what benefits do you derive from membership in these Community Based Organizations?

....

....

....

....

12. Have the Community Based Organizations assisted you in adopting the sustainable water resource management activities? Yes [1] No [2]

13. **If yes**, list them and indicate how they have assisted? (Use codes).

....

....

....

....

b) Water Resource Users' Associations

14. Do you know of any Water Resource Users' Associations involved with water conservation activities in your community during the dry season? Yes [1] No [2]

15. **If yes**, list them and indicate the water conservation activities they carry out.

....

....

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....

16. Is anybody in the household a registered member in any of these Water Resource Users' Associations? (Tick the appropriate one)

Yes [1] No [2]

17. **If yes**, what benefits do you derive from membership in these Water Resource Users' Associations?

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18. Have the Water Resource Users' Associations assisted you in adopting any of the sustainable water resource management activities? Yes [1] No [2]

19. **If yes**, list them and indicate how they have assisted you? (Use codes).

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SECTION E: MAJOR SOURCES OF WATER FOR IRRIGATION, LIVESTOCK FARMING AND DOMESTIC PURPOSES

(a) Crop irrigation farming

20. How many acres of land are you cultivating? _____________ acres

21. Do you do irrigation farming during the dry season? Yes[1] No [2]

22. **If yes**, indicate the **main** crops grown under irrigation, acreage of each crop and income

Crop	**Area** (Ha)	**Use of crop** 1= Consumption; 2=Sale; 3=Both	**Annual income**

23. **If yes**, how often do you irrigate? Very often [1] Often [2] Not often [3] Rarely [4] Very rarely [5]

24. What was the main source of water for crop irrigation during the past dry seasons? _______ Main Amala River [1] Tributary of Amala River [2] Spring [3] Bore-hole [3] Tap water [4] Roof catchment [5] Others (Specify) ______________________

25. What were the other alternative sources of water used by your household for crop irrigation during the past dry season? (Same options as above) ______________________________

(b) Water used for livestock farming

26. Did you keep any livestock during the current past dry season? Yes[1] No[2]

27. **If yes**, please fill in the table below for the livestock and livestock produce produced.

Livestock	**No. kept**	**Management practices**	**Use** 1= Consumption; 2=Sale 3=Both	**Income per year**
Sheep				
Goats				
Poultry				
Rabbits				
Donkeys				
Cattle				
Poultry				
Bee hives				
Others animal sales (specify)				

Codes for animal management practices
Tethering=1 Free range =2 Zero grazing=3 Improved hive=4 Traditional hives =5 Pad docking =6 Semi zero-grazing=7 Others (specify) =8

28. Indicate how the product was used, amount of produce and money earned from produce.

Product	Use of product 1= Consumption; 2=Sale; 3=Both	Amount	Income (Ksh)
Milk		____**litres / month**	
Honey		____**kg / year**	
Hides and skins.		____**No. / year**	
Other animal produce (Specify) ____ ________			
Total			

29. What is the main source of water for your animals during the dry season?

The Main Amala River [1] Tributary Amala River [2] Spring [3] Bore-hole [4]

Tap water [5] Roof catchment [6] Others (Specify) ____________________

30. Where do you take your animals to water during the wet season? (Same options as above)

____

31. What is the alternative source of water for animals during the dry season? (Same options as above)____

32. Do you have problems accessing (reaching) water:

During the Dry season Yes/No

During the Wet season Yes/No.

33. **If yes**, what are causes of inaccessibility:

During the dry season____________________________

During the wet season____________________________

34. If water is inaccessible, what do you about it:

During the dry season____________________________

During the wet season____________________________

35. How would you rate your access to (reaching) water during the dry season for the following purposes?

	Excellent	Very good	Good	Poor	Very poor
Crop farming					
Livestock farming					
Domestic purposes					

36. How would you rate your access to water during the wet season for the following purposes?

	Excellent	Very good	Good	Poor	Very poor
Crop farming					
Livestock farming					
Domestic purposes					

37. Have the water been always available

During the dry season Yes/No

During the wet season Yes/No

38. **If No**, what causes this water unavailable

During the dry season______________________________

During the wet season______________________________

39. If water is unavailable, what do you about it

During the dry season______________________________

During the wet season______________________________

40. How would you rate your water availability during the dry season for the following purposes?

	Excellent	Very good	Good	Poor	Very poor
Crop farming					
Livestock farming					
Domestic purposes					

41. How would you rate your water availability during the wet season for the following purposes?

	Excellent	Very good	Good	Poor	Very poor
Crop farming					
Livestock farming					
Domestic purposes					

42. Do you have problems in having enough and clean safe water for use (water adequacy).......

During the Dry season Yes/No

During the Wet season Yes/No.

43. **If yes,** what causes this water inadequacy

During the dry season____

During the wet season____

44. If water is inadequate, what do you about it

During the dry season____

During the wet season____

45. How would you rate water adequacy/sufficiency during the dry season for the following purposes?

	Excellent	Very good	Good	Poor	Very poor
Crop farming					
Livestock farming					
Domestic purposes					

46. How would you rate your water adequacy during the wet season for the following purposes?

	Excellent	Very good	Good	Poor	Very poor
Crop farming					
Livestock farming					
Domestic purposes					

(c)Water used for domestic purposes

47. What is the main source of water for domestic purposes during wet season? The Main
    Amala River [1] Tributary Amala River [2] Spring [3] Bore-hole [4]
    Tap water [5] Roof catchment [6] Others (Specify)____________________
48. What is the main source of water for domestic purposes during dry season? (Same options as above) ____________________
49. What are the alternative sources of water for domestic purposes during dry season? (Same options as above) ____________________

Please indicate the amount of water you use for the following purposes during the dry season?

Purpose	Amount of water used per day	Price		
		Day	**Month**	**Year**
Drinking				
Food preparation				
Bathing				
Washing clothes				
Washing dishes				
Flushing toilets				
Others (specify)				
Total				

APPENDIX TWO

INTERVIEWS FOR KEY INFORMANTS.

I am a student from Egerton University (Department of Natural Resources) conducting a research on factors influencing sustainable water resource management practices in Amalo and Mulot Locations, Mara River Basin, Kenya. These questions will be for interview purposes only. The information you will provide will be treated with outmost confidentiality. Your assistance in answering the questions truthfully and accurately will be highly appreciated. Thank you.

GENERAL INFORMATION.

1.1 Name of the Interviewer	
1.2 Date of the Interview	
1.3 Time of the interview	
1.4 Name of the Respondent.	
1.5 Respondents Telephone contacts	
1.6 Area of Residence (tick as appropriate)	1.Amalo location [ ] 2.Mulot location [ ]
1.7 Place of Interview.	
1.8 Respondents Occupation	
1.9 Respondents Age	
2.0 Respondents Education level	

1. What do you think are the major factors affecting the adoption of sustainable water resource management practices on water management among the households? (Briefly explain).

2. What water resource management practices have been adopted by residents in this area?(Briefly state)
3. Have it been of any benefit to them?
4. How do you think the households make decisions regarding the adoption of sustainable water resource management practices? (Briefly explain).
5. In your opinion do you think there are water shortages in this area during the prolonged dry season?
6. If there is, what do you think needs to be done to curb the issue of water shortages in this area during the prolonged dry spells?
7. Have the following factors influenced on the adoption of sustainable water resource management practices among the households? (Briefly explain).
   Number of Water Resource Users' Associations active in water conservation the households are aware of Yes [ ] No [ ]
   Membership in Water Resource Users' Associations. Yes [ ] No [ ]
   Number of Community Based Organizations active in water conservation the households are aware of Yes [ ] No [ ]
   Membership in Community Based Organizations'. Yes [ ] No [ ]
8. What role/s does your organization/Institution/Ministry play in terms of enhancing sustainable water resources management practices (Briefly state).
9. Does your organization/Institution/Ministry have any programs on sustainable water resource management practices during the prolonged dry seasons?
10. Have these programs been conducted (Explain when, where and the target groups)
11. How are these programs conducted?
12. Are the programs effective (briefly explain)?
13. In your opinion are the implemented sustainable water resource management practices among the households effective in controlling water shortages during the prolonged dry season? (Each practice at a time).
14. How could they be enhanced? (Each practice at a time).
15. What is the main source of water among the households living in this area?

16. What are the major uses of this source of water in this area?

17. Have the use of water from this source contributed to household's wellbeing (food security, income and health) in this area? Yes [ ]   No [ ]

18. If yes, how have it contributed negatively and positively to the following :-
    - Food security
    - Household's income.
    - Household's health.

19. If no, why?

20. What are you doing currently to ensure that maximum benefits will be got from this main source of water by the residents in this area?

21. What is the total population of households living along the river?

Thank You for Your Cooperation.

APPENDIX THREE.

FOCUS GROUP DISCUSSIONS.

1. What are the most sustainable water resource management practices adopted by residents in this area during the dry season?

2. In your opinion are the sustainable water resource management practices used effectively in controlling water shortages during the dry season in the location?

3. Of the water resource management practices which ones do you think are the most effective methods during the dry season?

4. Which methods would you prefer to implement during the dry season? Briefly explain.

5. Where do you get advice on sustainable water resource management practices? Briefly list

6. How do the households make decisions regarding the adoption of sustainable water resource management practices? (Briefly explain).

7. What factors exert influence on the adoption of the sustainable water resource management practices? (Briefly explain and rank).

8. Number of water conservation projects.

9. Number of springs in Mulot location and their areas of siting /location

10. In your opinion, do you think that the water used for domestic use (i.e. drinking, washing) livestock farming/use and crop farming/irrigation from the Mara River during the

prolonged dry season have got any impact on your income, food supply in the house and occurrences of diseases in the house? (List each with its impact).

WATER USE	NEGATIVE IMPACTS
For domestic purposes	
For crop farming/irrigation	
For livestock farming	

11. If there are negative impacts, what do you think can be done to the water in the mare river to improve the situation?

12. Have there been occurrences of these diseases in this region during the prolonged dry season?
    - Typhoid –
    - Dysentery-
    - Malaria-
    - Common cold-

13. In your own opinion, what do you think needs to be done to ensure that most of the community based organizations emphasize more on sustainable water resource management practices like water harvesting and tree planting?

14. How many community based organizations are you aware of?

15. Have you benefitted from these communities based organizations especially in water conservation activities? Yes.

16. If Yes, list how the community have benefitted from this community based organizations.(list each CBO with its benefits.

17. Are many people/households registered in these community based organizations? Yes.

18. If no, what do you think needs to be done to improve membership in these CBO's?

APPENDIX FOUR

RESEARCH PERMIT

PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Jane Gachambi Mwangi
of (Address) Egerton University
P.O.Box 536, Njoro.
has been permitted to conduct research in

	Location
Molo and Narok	Districts
Rift Valley	Province

on the topic: Factors influencing hopusehold water use and impact of household wellbeing in Amalo and Mulot location, Mara River Basin, Kenya.

for a period ending: 31st August, 2012.

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Research Permit No. *NCST/RCD/9/012/08*
Date of issue *6th July, 2012*
Fee received *KSH. 1,000*

Applicant's Signature

Secretary
National Council for Science &Technology

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed with-out prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

GPK6055t3mt10/2011

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

(CONDITIONS-see back page)