ASSESSMENT OF THE EFFECTS OF LAND USE METHODS CONTRIBUTING TO WATERSHED DEGRADATION IN MAKUENI COUNTY

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DECLARATION

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

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Supervisors Approval

We confirm that the work reported in this thesis was carried out by the candidate under our supervision and has been submitted with our approval as university supervisors.

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DEDICATION

I would like to dedicate the research study to my wife, Elizabeth Nthambi and my children Mwanzia, Wambua and Ngina.

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ACRONYMS AND ABBREVIATIONS

AEZ	Agro-Ecological Zones
ALDEV	African Land Development Board
ASAL	Arid and Semi-Arid Land
AMREF	African Medical and Research Foundation
CAAC	Catchment Area Advisory Committee
CFA	Community Forest Association
CSTI	Centre for Science and Technology Information
DANIDA	Danish International Development Agency
DFID	Department for International Development
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organisation
FCA	Forestry Conservancy Area

FFS	Farmer Field Schools
FGD	Focus Group Discussion
FYM	Farm Yard Manure
GAA	German Agro-Action
GIS	Geographic Information System
GOK	Government of Kenya
GPS	Global Positioning System
IGAs	Income Generating Activities
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
KARI	Kenya Agriculture Research Institute
KEFRI	Kenya Forestry Research Institute
KJAS	Kenya Joint Assistance Strategy
KNBS	Kenya National Bureau of statistics
LM	Lower Midland
LUCID	Land Use Change Impacts & Dynamics

MA	Millennium Ecosystems Assessment
MAP	Makueni Agricultural Project
MIDP	Machakos Integrated Development Programme
MOA	Ministry of agriculture
NEMA	National Environment Management Authority
NGOs	Non-Governmental Organizations
NRM	Natural Resources Management
PAFRI	Preserve Africa Initiative
SAPs	Structural Adjustment Programmes
SHG	Self-Help Group
SIDA	Swedish International Development Agency
SL	Sustainable Livelihoods
SPSS	Statistical Package for Social Sciences
SWC	Soil and Water Conservation
SWM	Soil and Water Management
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification

UNCED	United Nations Convention on Environment and Development
UNEP	United Nations Environmental Programme
USAID	United States of Agency for International Development
WCED	World Conference on Environment and Development
WFP	World Food Programme
WRMA	Water Resource Management Authority
WRUA	Water Resources Users Association

ABSTRACT

Land use changes, rapid population growth, poverty, climate change variability and lack of livelihoods diversification aggravate watershed degradation through inappropriate land use methods resulting to water scarcity, land and water pollution, and governance issues. Soil erosion and siltation has led to land denudation, habitat loss and farm lands losing their soil fertility and compromising food security. The main objective of the study was to find out how land use methods influenced the biophysical, socio-economic and institutional conditions to accelerate watershed degradation and their effects on livelihoods. The study examined the livelihood strategies and options of the people as well as the socio-economic conditions contributing to watershed degradation, investigated the land use methods practiced and how they affect the biophysical conditions influencing watershed degradation in Makueni County and determined the institutional conditions influencing watershed degradation. In order to achieve this ultimate objective, the study used a descriptive survey research approach to obtain data on socio-economic characteristics of the study sites as well as historical trends of land use. Systematic sampling along a vertical transect line was used to identify respondents. Structured and semi-structured questionnaires were used to collect data from the community and key informants. The data collected was analysed using Statistical Package for Social Sciences (SPSS) and Microsoft Excel 2010.The study established that Low food production as reported by the farmers (78%) and reduced income and livelihood by (75%), were consequences of watershed degradation in the study area. Landlessness at 39% (S.E=0.311 z= 1.311 sig.0.190), illegal encroachment at 18% (S.E=0.555 z= -0.604 sig.0.546), and laxity in law enforcement at 27% (S.E=0.481 z=0.227 sig. 0.821) were other factors mentioned by the farmers as contributing to watershed degradation. These conditions predisposed farmers to adopt inappropriate farming methods and unsustainable livelihood strategies which compromised the watershed's environmental integrity. The study sought to make recommendation for efficient watershed management.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The African continent is faced with the unprecedented environmental degradation with about 70% of its population being rural, directly depending on land and natural environment for its livelihoods and wellbeing (GOK, 2007). Rapid population growth, poverty and social inequities contribute to watershed degradation (UNEP, 2006). In Kenya, the situation is exacerbated by rapid population growth, high poverty levels, land use changes and poor land use systems, overgrazing and deforestation leading to food crises and watershed degradation (GOK, 2002).

Makueni County is located within Athi River Basin; an arid and semi-arid area. It was previously known as Makueni district which was curved from Machakos district in 1992. The county has experienced watershed degradation due to rapid population growth and land use changes impacting negatively on, biophysical, socio-economic and institutional arrangements of the environment in the county (Tiffen *et al.* 1994; Munyasi *et al.* 2010; GOK, 2012). The declining soil fertility, poverty, deforestation,

diminishing land holdings and erratic rainfall patterns contribute to watersheds degradation (Muriuki *et al.* 2005).

The encroachment of catchment areas and watersheds has invariably led to the loss of ecological functions of watersheds and the increase of floods, sedimentation of riverbeds and siltation of man-made reservoirs and declining river flows (Mungai *et al.* 2004). It has been observed that land quality in man-modified ecosystems (where soil and water conservation is minimal) degrades over time with the need for more farm inputs and increased land under cultivation in order to sustain productivity, which also leads to loss of biodiversity (Tiffen *et al.* 1994; Maitima *et al.* 2004).

Water scarcity, pollution, poverty and water resource conflicts pose the greatest challenge in the study area owing to watershed degradation. Food insecurity, loss of livelihoods and biodiversity is attested by the frequent droughts in the area (Muriuki *et al.* 2005; UN, 2006). Forest cover and vegetation depletion leads to fragile soils becoming vulnerable to rapid destruction by wind and water erosion, decreasing agricultural productivity (GOK, 2002). According to Wamalwa (2009), watershed degradation is influenced by land use methods and modification, high population, increased demand for food and rapid economic growth with negative impacts on biophysical, socio-economic and institutional arrangements conditions.

'No matter where you live, you live in a watershed,'' (EPA 2001). The maxim resonates well with Makueni County which is faced with numerous watershed challenges and degradation. Deliberate environmental conservation efforts together with involvement of local communities in natural resource management strategies offers the best alternative to use technology and enhanced communication to reverse watershed degradation and restore environmental integrity (Emongor *et al.* 2010; Munyasi *et al.* 2010).

The study sought to find out how land use methods have influenced the biophysical, socio-economic and institutional conditions to accelerate watershed degradation and their effects on livelihoods. It also sought to make recommendations for efficient watershed management.

1.2 Statement of the problem

The increase of cultivated land in Makueni County, encroachment of rangelands, watercourse systems and other fragile ecosystems has led to the decline of soil and water conservation efforts. The decline of agricultural extension services, and its inadequate funding threaten, soil fertility and reversing the past recorded agricultural productivity and climate change variability resilience (Tiffen *et al.* 1994; Ifejika *et al.* 2007). Water is unevenly distributed in the area, with high spatial and temporal variability of river water resources. Environmental and ecosystems integrity has been compromised leading to increased watershed health threats that affect water quality through increase and release of chemical pollutants, pathogens and municipal solid

wastes through new economic development activities, over-application of fertilisers and pesticides. Little has been done to reverse the effects of changing land use systems in Makueni County. Watershed degradation occurs amidst lack of concrete integrated watershed management in the area. Rapid population growth, high poverty rates, inappropriate land use methods, and frequent droughts coupled with ineffective social responses contribute to watershed degradation (Ifejika *et al.* 2007).

In Kenya, watersheds management framework is provided in the Water 2002 Act and its subsequent reforms oriented approach (Wamalwa, 2009; GOK, 2012). It has not been optimally applied in the study area with little or non-involvement of local community participation in watershed management. The management of water economies in practice is dogged by inequities and inefficiencies in utilities and distribution (Geiger, 2006). Past studies have been done in the county and their focus has been predominantly on famines and droughts, agricultural production, agro-pastoralism as a means for livelihoods from crop production, marketing, livestock keeping and sale ((Muriuki *et al..,* 2005; Ifejika *et al.* 2007). Unsuitable policies on land and water conservation methods, prescriptive farming and conservation methods, decline of agricultural extension services are some of the identified gaps. Inadequate information dissemination and innovation, low adoption of agricultural technologies and non- responsive institutions (Emongor *et al.* 2010; Munyasi *et al.* 2010) remain an impediment to development and environmental conservation.

1.3 Objectives of the study

The broad objective of the study was to determine how land use methods have influenced watershed degradation in Makueni County and their effects on livelihoods.

The specific objectives were to:-

1. Examine the livelihood strategies and options of the people and the socio-economic conditions contributing to watershed degradation.
2. Investigate the land use methods practiced and how they affect the biophysical conditions influencing watershed degradation.
3. Determine the institutional conditions influencing watershed degradation.

1.4 Research Questions

1. What are the livelihood strategies and options of the people and the socio-economic conditions contributing to watershed degradation?
2. Which are the land use methods practised and how do they affect biophysical conditions influencing watershed degradation?
3. What are the institutional conditions that influence watershed degradation?

1.5 Significance of the study

The study findings will inform on environmental policy making in Makueni County as it will seek to determine and document land use types and their effects on biophysical, socio-economic and institutional conditions which influence watersheds degradation in the county. The study will fill an academic gap and add knowledge and insights on local factors which contribute to the watershed degradation. It will focus on the declining agro-ecosystem and climate change variability resilience, the increasing poverty and inappropriate land uses which force people to engage in unsustainable activities as a form of livelihoods coping mechanisms.

The national and county governments will benefit in understanding the levels of community and stakeholder's involvement in watersheds management as envisaged in the 2002 Water Act and water sector reforms regime for effective water resources management. This will form a basis for developing appropriate course of action by the government, NGOs, and natural resource management practitioners. It will encourage farmers and residents to adopt appropriate agricultural technologies and participate in watershed management programmes. The study will act as a baseline for more detailed studies to come up with comprehensive integrated watershed development programmes to strengthen the existing and additional institutions capacities.

1.6 Limitations of the study

The study faced limitations in a number of ways like the location of respondents covering vast areas. Transport and time management constraints during data collection and interviews were experienced. In some cases especially among focus group discussants, punctuality was not observed by some members. The literacy levels of some respondents and interviewees were expected to be low owing to the study's deliberate sampling of some community respondents aged over 60 years. The study focused on different age groups and discussants in the Focus Group Discussions which mitigated the low literacy levels among some of the interviewees. Participatory approaches (Olson *et al.* 2004a), extrapolated and moderated the effects of the longer period involved in the investigation of land uses change in the study area.

1.7 Assumptions of the study

The study is based on the assumption that; The socio-economic and natural environments in the other 5 sub-watersheds in the county (Table 3.1), are significantly similar to those in Kaiti sub-watershed and any observed effects can be generalised to Makueni drainage area (Lemba, 2009). Farmers in the area faced similar problems and challenges in watershed degradation irrespective of their location within the drainage area. There would be cooperation among various groups and individual respondents to be interviewed. These included the general community members, farmers or group representatives, key informants and stakeholders.

Information obtained from all respondents would be factual and the sample would be representative. It was also assumed that the researcher would be able to access all the sampled respondents in this study.

1.8 Scope of the study

For the purposes of this study Makueni drainage area constitute the present county boundaries and beyond which comprise of several sub-catchment areas spread in the upper hilly areas and the expansive lowlands in relation to the general physical conditions of land and watershed degradation. Watershed delineation boundaries do not necessarily correspond to the political boundary of Makueni County. The drainage area or pattern represents a general geographical unit stretching from mid to upper county boundary (Fig.3.2). Kaiti sub-watershed constituted the study site. It is one of the six sub-catchment areas in Makueni County.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter identifies and analyses previous works done with a view to identify research gaps which the study attempts to fill. In order to situate the topic in a wider perspective, it first seeks to outline general overview of environmental challenges in Makueni drainage area. It then proceeds to look at historical trends of settlements in Makueni County. It further discusses the biophysical conditions, socio-economic dynamics as well as natural resource management institutions.

2.2 Environmental degradation and watershed challenges

Muriuki *et al.* (2005) maintains that water catchment areas are constantly threatened with unsuitable human activities and watershed degradation which have led to adverse environmental changes affecting the riparian ecosystems resulting to sedimentation of riverbeds. Watershed, also known as catchment area or drainage basin is defined as `the land that drains to a single body of water such as a stream, river, lake, wetland or estuary' (EPA, 2001). It can also be draining to an ocean, it may range from a small portion to a mud pond, or as large as a river basin encompassing all land from headwaters to a larger stream or river, a lake or ocean (Shukla, 2013). Watersheds are not only vital for conservation of water resources; they also offer important ecosystem services and goods such as food, wood fuel, carbon sequestration and timber. They provide regulating services like climatic,

water, erosion regulation and cultural services like spiritual values, knowledge systems, recreation and ecotourism. Services like bio-geochemical cycling including soil formation, nutrient and water cycling which are important for plant and animal life sustenance, all of which enhance human wellbeing through the support of economic activities and livelihoods (MA, 2005).

Watershed degradation is evident in the area with the existing environmental conservation measures, lacking integrated approach to tackle the problem. This is especially noticed in agro forestry activities, limited and focused on fruit trees and others priotised for firewood and construction purposes without primarily focusing on soil fertility, regeneration and soil conservation. Soil erosion by water is the predominant form of land degradation in the area (Tiffen *et al.* 1994). Inappropriate land use, deforestation, poor cultivation and grazing practices pose threats to the livelihoods of people in dry lands contributing to soil erosion. Forest cover depletion often leads to fragile soils becoming vulnerable to rapid destruction by wind and water erosion (GOK, 2002; Muia and Ndunda, 2013).

Geiger, (2006) reiterates that land and water pollution is a major challenge in Kenya today, despite the country having good laws on pollution and its prevention. Some industrial and manufacturing plants discharge industrial effluents and wastes in open water bodies. Sanitation and sewerage facilities in urban centres and towns inappropriately discharge untreated municipal wastes in open grounds or in water

bodies which pollute areas located far from these towns. Agricultural chemicals, fertilizers, herbicides, pesticides and insecticides are carried into rivers and streams affecting the quality of water. The importance of watersheds management and ecosystems in the county cannot be ignored in view of the important services they provide for economic and livelihoods sustenance to the populations (Agwata, 2006; Ifejika *et al.* 2007).

The growing population in Africa, with 70% being under the age of 30 years means that the youth are increasingly becoming important in natural resource management in the face of lack of employment and other diversification livelihoods opportunities. The general decline of important sectors like education, health and other capabilities means that their dependence on natural resources will increase with negative environmental impacts and watershed degradation. The scenario affects natural resource base with increased demand for food, water, arable land and other essential materials like fuel wood with the threat to further environmental degradation triggering further social and economic conflicts and hardships (UNEP, 2006; GOK, 2007). Poverty is a big challenge, despite the numbers of poor people living in poverty declining from 58% to 51% between 1990 and 2005 respectively. The Global Monitoring Report (Commission for Africa Report, 2010) indicates that the proportion of people living on less than $ 1.25 will be 38% in 2015 which is still high in a situation where the numbers of the hungry people in sub-Saharan Africa

have remained unchanged with approximately 32% of the population being undernourished.

Although Africa's carbon emission remains insignificant, African countries and economies remain vulnerable to the impacts of climate change as they largely depend on natural resources and the agricultural sector. This will lead to the expansion of deserts with the increasing population exerting pressure on food security and water resources in the continent (Commission for Africa Report, 2010). This will lead to increased floods and droughts, loss of productivity, falling of crop yields and the decrease of arable land for agriculture, causing damage to biodiversity and ecosystems. The overdependence on rain fed agriculture with minimal irrigation and population movement is likely to trigger conflicts over scarce resources (GOK, 2002; Agwata, 2006).

2.3 Historical trends on settlement in Makueni County

There is marked awareness on degradation of watersheds in Kenya today (GOK, 2002). Despite the increased knowledge on watersheds degradation there is tremendous increase in the loss of watersheds and ecological functions associated with the impacts of land use and their socio-economic dimensions (Mungai *et al.* 2004). Over three quarters of Makueni County's total area in the lowlands started as a settlement scheme in 1948 with controlled settlement to be farmed and used according to strict soil and water conservation (SWC) rules which would prevent

degradation under African Land Development Board (ALDEV), (Tiffen *et al.* 1994). The rest of the land on the upper part of Mbooni and Kilungu hills was also subject to strict soil conservation regime initiated by the British colonial government in the larger Machakos district from 1930s and 1940s owing to rapid land degradation noted at the time in the Ukambani districts of Machakos and Kitui. The larger Machakos district benefitted from migration to the new Makueni settlement scheme which eased pressure on land with varying degrees of success in soil and water conservation reversing the effects of severe land degradation in the subsequent years (Tiffen *et al.* 1994).

Tiffen *et al.* (1994) points out that migration to the new settlement scheme continued until 1960 when the scheme was said to be full. The government lost control of the settlement process and the enforcement of the strict land use rules lapsed, funding of the scheme ceased and more unregulated immigrants continued to flow in the settlement scheme and beyond. In the early years of the settlement, SWC was promoted and it became widely accepted even outside the area of the new settlements with many farmers using conservation methods in their farms learnt from the old settlement before their immigration to the new settlement scheme. Rapid population growth of 10-30% recorded in the national population census of 1962-1969 led to the decline of farm sizes in 1980s owing to the fact that there were no more new areas for settlement to absorb the excess population (Tiffen *et al.* 1994; Gichuki, 2000).

The interface of forced conservation, voluntary conservation, government and Non-Governmental Organizations (NGOs) intervention served the county's population well with various success and decline levels in the conservation efforts at different times. However the conservation bore fruits from mid 1960s when terracing and conservation measures resumed on voluntary basis using hired labour or voluntary '*mwethya'* (self-help groups) to work in the farms. New immigrants from the hills brought terracing technology and the concept of the '*mwethya'* groups to the settlement scheme which led to the intensification of soil conservation. Government and donor supported programmes included ALDEV in the early years, Machakos Integrated Development Programme (MIDP) 1978-1988 and Swedish International Development Agency (SIDA) 1978, which supported soil and water conservation, construction of cut off drains and terraces with food for work schemes, which assisted '*mwethya''* groups with tools, voluntary labour, agreed farm plans and technical assistance including extension services (Tiffen *et al.* 1994). Makueni Agricultural Project (MAP) 1995-2004 continued to support soil and water conservation in the former Makueni district (Gichuki, 2000; Lemba, 2009).

The population of Makueni County has increased to 884,253 with average density of 110 persons per square kilometre (GOK, 2013). Land is fragmented into uneconomical parcels, marginal lands are increasingly being cultivated, pastures are being overgrazed and forests encroached upon (Muriuki *et al.* 2005; Ifejika *et al.* 2007). New homesteads and farms are subdivided from the original settlement farms

as sons and daughters get their share from their parents. Water and soil conservation efforts have declined considerably with extension services downscaled due to lack of funding and adequate staff to serve the increasing number of farmers (Ifejika *et al.* 2007; Onyango *et al.* 2013). Frequent droughts and long dry spells impact negatively on water resources with disproportionate engagement in charcoal burning and sand harvesting as livelihoods coping mechanism by some residents (DANIDA, 2003; GOK, 2013). Food insecurity and water scarcity (PAFRI, 2012) is closely linked to watershed degradation as land users in dry- lands seek to maximise agricultural and livestock production even when the land natural production is exceeded, (UNCCD, 2012).

2.4 Biophysical conditions of Makueni County

Watershed degradation as a result of anthropogenic factors like farming in hilly and steep slopes and in riparian systems continues unabated in the county. Soil erosion, sedimentation, drying and pollution of rivers as well as increase in surface run-off and increasing stream flow are some of the biophysical conditions which influence watershed degradation in the area (Muriuki *et al.* 2005; Geiger, 2006; GOK 2013). Deforestation and vegetation clearance for agricultural use, commercial and settlement contribute to watershed degradation and destruction of fragile ecosystems. The growing population and high poverty levels force communities to encroach on riverbanks, cutting indigenous trees and depletion of vegetation cover, planting crops on fragile ecosystems as well as planting tree species which consume a lot of

water hence leading to watershed degradation (Gichuki, 1991; Agwata, 2006; GOK, 2013).

Population growth over the years has invariably led to land use changes, labour relationships, increased demand for food and other goods which combined with increased scarcity of land leading to investments beyond land capacity to improve crop yields (Tiffen *et al.* 1994; Nkonya *et al.* 2011). Fragmentation of land to uneconomical parcels has increased land degradation and destruction of watersheds areas. This is happening despite Tiffen's well known theory that population growth does not necessarily lead to environmental degradation. It is important to appreciate that conditions have changed in the last thirty years such as the economic outlook (low off-farm economic opportunities) and availability of land to absorb excess population which has dramatically changed with new challenges facing the farmers within a situation of diminishing farm sizes. In most cases land users, not satisfied with natural production rate tend to force land more than its natural capacity can allow. Pastoralism and cultivation more than often fail to balance primary productivity and natural supply provided by the ecosystem, leading to adoption of land use systems which exceed renewability of soil resources and vegetation regeneration (Nkonya *et al.* 2011; UNCCD, 2012).

Nkonya (*et al.* 2011) states that land degradation is more than soil erosion; it makes consideration to all interactions on land with users leading to any kind of degradation. The natural processes (biophysical), human activities (socio-economic systems) and the poverty nexus exacerbate watershed degradation. It is caused by both human and natural processes. It is important to make distinction between human induced degradation and those caused by climate change which land users have no control over. It is also important to note that land and watershed degradation is a social problem affecting all the people at all stages of development not only as a causative factor but also as victims of these actions. As poverty increases, people tend to overexploit land resources further increasing degradation (Maitima *et al.* 2004; Nkonya *et al.* 2011). Land use ultimately varies on the type of crops planted, size of plot per land use type, land management and cropping systems. Land quality in man modified ecosystems degrades over time, especially when appropriate SWC are not adequate, affecting the ability of the same ecosystem to deliver the goods and services intended. It also leads to loss of biodiversity and decline in productivity (Maitima *et al.* 2004).

Watershed degradation is on the increase owing to the decline of conservation efforts of the early years and the collapse of conservation programmes like, ALDEV, MIDP and SIDA. Withdrawal of agricultural extension staff supported by the programmes led to decline of soil and water conservation, terracing and agro forestry activities. Neglect of the earlier terracing programmes in individual farms has considerably

increased soil erosion. There is terrace design and construction problems like improper spacing and terraces not laid out along the contour, with insufficient grass cover, weak embankment and highly susceptible to breakage during rainstorms. Intensive terracing remains in the high potential areas especially in the upper hilly lands where cash crops like coffee are grown (Gichuki, 1991; Tiffen *et al.* 1994).

Dry-lands like Makueni County on average receive less annual rainfall with rains of short duration but of high intensity and highly erosive. Torrential rains and floods accelerate soil erosion stripping the top soil, destroying land fertility and its potential to support human and animal populations (GOK, 2002). Overgrazing expose the bare soil to erosion and compaction by raindrops removing humus from the top soil with compaction impending infiltration of rain water and germination or growth of grass and herbs, hence slowing vegetation regeneration. Termites damage shrubs and roots in areas where overgrazing occurs. Runoff start in the foot and stock paths making gullies in the categories of inter-rill or gulley erosion, rill erosion and sheet erosion (Gichuki, 1991; Tiffen *et al.* 1994).

Tiffen *et al.* (1994); Muia and Ndunda (2013) argue that gulley erosion as an advanced form of rill erosion causes water to drain from small catchments leading to waterfall erosion at the gulley head widening the gulley below to form intermittent gullies and streams which denude and damage land forms a common phenomenon

observed in many areas in the county. Clearing of vegetation for cultivation, overgrazing and heavy rainstorms contribute and accelerate the formation of gullies. The soils in such severe erosion become shallow and the nutrient content is low to sustain meaningful crop yields and pastures. The rate of erosion on crop land has, however, been noted to have declined or stabilised while the rate of grazing land erosion has increased, because conservation of cropland has been higher than in rangelands (Tiffen *et al.* 1994)

2.5 Socio-economic dynamics in Makueni County

Land use changes, inappropriate farming methods and improper livelihood choices, complicate in the manifestation of food insecurity, water scarcity, loss of livelihoods, reduced income and increased poverty, exposing the communities into vulnerability to drought and famine, leading to disruption of socio-economic equilibrium with adverse effects on the environment (Ifejika *et al.* 2007). This situation poses new challenges of conflict in water use, and other resources with negative impact on the watersheds, and their ecological and socio-economic functions in environmental conservation and their ability to sustain the needs of the people (GOK, 2012; GOK, 2013).

The expanded unsustainable agricultural activities lead to encroachment into forests and the marginal lands, increasing watershed degradation and other natural resources depletion which impacts negatively on people's lives and particularly to the rural

communities and farmers who are forced to work harder on shrinking and unproductive farms (WCED, 1987). These impacts have different effects on humankind with varied consequences due to power relations and household livelihood systems regulating the access and control of resources and the management responsibilities. Women and youth are often at a disadvantage, as they are forced to depend entirely on the available natural resources for their livelihoods and wellbeing. The overdependence on the natural resources continues to impact negatively on the existing environmental assets (UNEP, 2006).

Whereas equitable, efficient and productive use of natural resources guarantees sustainable livelihoods and poverty reduction (UNEP, 2006), the scenario is different in the area as climate change and variability has significantly contributed to watershed degradation as frequent droughts and long dry spells force people to disproportionally depend on charcoal burning and sand harvesting as a coping mechanism to livelihood alternatives. Sand harvesting has led to water scarcity and conflicts among groups involved in the activity (GOK, 2013). Charcoal burning is indiscriminately practiced with unsustainable harvesting of trees in both private lands, forests and the community land reserves, leading to increased soil erosion, water run-off and change in micro-climate (DANIDA, 2003).

Agro-pastoralism forms the greatest percentage of livelihoods for the majority of the people in the county, supplemented with limited off-farm activities, which are highly dependent on agricultural activities (Tiffen *et al.* 1994; Ifejika *et al.* 2007). The situation has been worsened by the dry crop production environment highly influenced by biophysical and socio-economic conditions, coupled with unreliable rains and inadequate farming technologies and farm implements. Although food production is the main economic mainstay the proceeds are hardly enough to enable farmers to re-invest in their farms in terms of soil and water conservation, soil management, crop pests and disease management. This inadvertently inhibits their ability for economic resilience and sustained livelihoods (Tiffen *2003*; Ifejika *et al.* 2007).

The inability of indigenous and traditional weather knowledge systems and methods of forecasting rainfall to give correct prediction on dates of the onset, cessation and duration of rains in the face of climate change variability worsen the situation. The abandonment of traditional drought resistant food crops like sorghum and millet in favour of maize and beans growing which are sensitive to drought, has also impacted negatively on food security and the socio-economic wellbeing of the people (CSTI, 2009; Muui *et al.* 2013). Local stakeholder participation considerations and institutional integration to bring together government agencies that implement policies on land, water and other natural resources to harmonise conflicting regulation on the ground can enhance appropriate land use methods and new farming

technologies and knowledge (Lelo *et al.* 2005). The socio-economic dynamics of profitable sustainable farming and irrigation agriculture can rectify the present situation through holistic approach to watershed studies, natural resource mapping, integrated watershed management strategies, adoption of conservation agriculture techniques and application of sound environmental management plans for restoration and conservation of watersheds (Agwata, 2006; GOK, 2013).

2.6 Natural resource management institutional functioning in Makueni County

Government and public institutions are crucial for policy implementation. Studies done in the area (Emongor *et al.* 2010; Munyasi *et al.* 2010), have indicated that institutional gaps exist in natural resource management, where 65% of the stakeholders listed natural resource management as the most pressing training need, with 48% citing livestock production, 40% soil and water management and 33% crop production respectively of pertinent issues requiring attention. It was found that government and public institutions do not fare well in information sharing with stakeholders with only 27% of the respondents who confirmed their commitment in sharing information. This contrasted significantly with 69% of respondents who indicated that private institutions and NGOs were more willing to share information than government agencies with stakeholders. Governance issues and stakeholder inclusion in natural resources management has not been entrenched in planning and implementation of development projects. Despite the existing community inclusion policies, water and natural resource management and development does not

adequately cater for active participation and involvement of the local communities in watershed management (Geiger, 2006).

Tiffen *et al.* (1994) and Muriuki *et al.* (2011) insist that unsustainable land management practises contribute to watershed degradation. Integrated watershed management and strengthening of institutional capacities and local community participation can enhance conservation and restoration of the watershed (Agwata, 2006; Geiger, 2006). Soil and water conservation, Conservation agriculture and livelihoods diversification are some of the feasible improved land use methods which can be used and integrated in institutional strengthening and approaches to reverse the current environmental degradation in Makueni County (Tiffen *et al.* 1994; Gichuki, 2000; Ifejika *et al.* 2007).

Natural resources management knowledge, optimum soil and water conservation methods, appropriate crop production and livestock production skills with modern farming technologies, remain an impediment to farmers ability to sustainably reap maximum benefits in their interaction with the natural environment. Despite the past studies efforts to address some of the issues affecting the watershed, these problems have not been adequately addressed for effective watershed management framework. The study sought to fill in the identified gaps obtaining in the area.

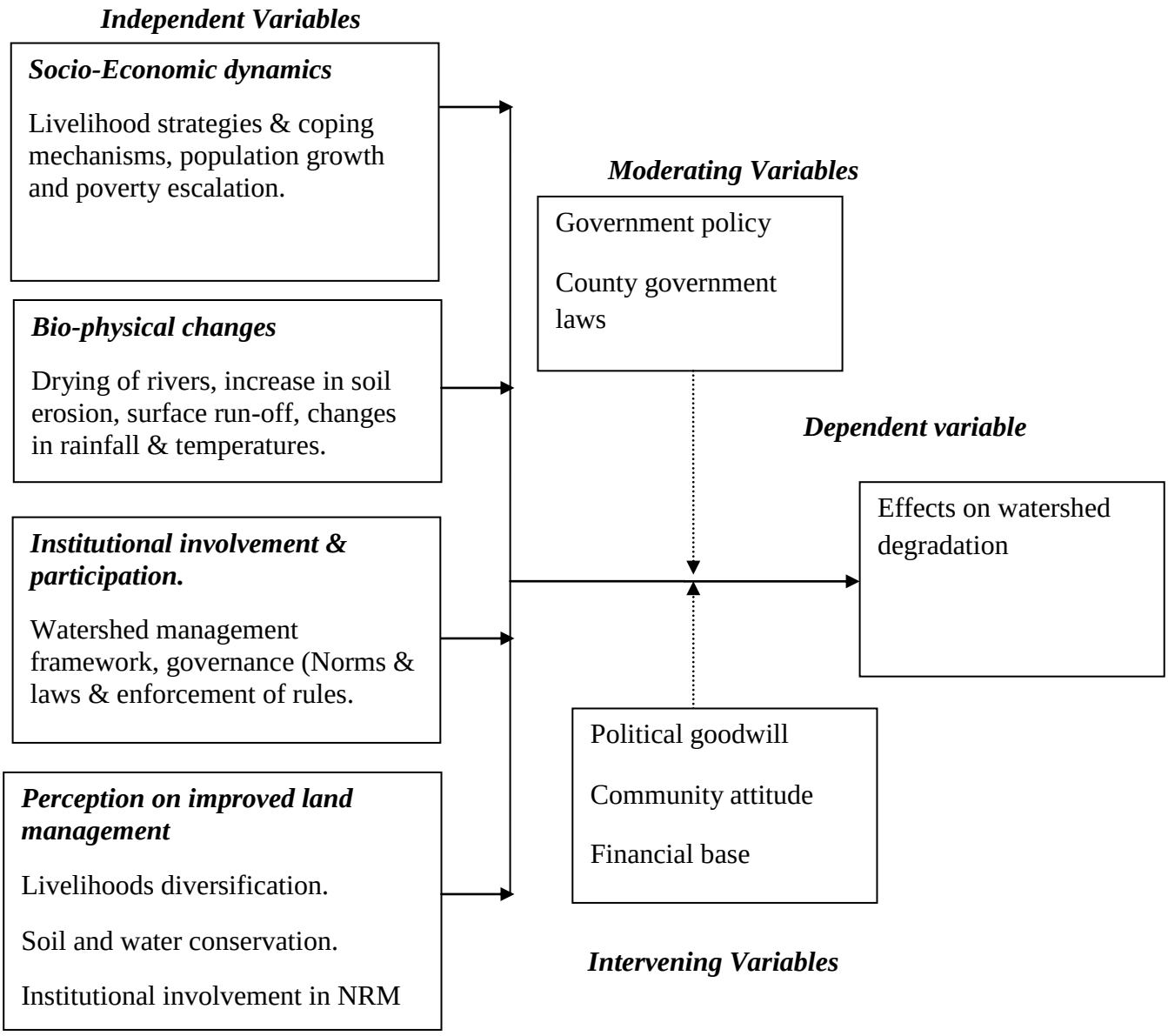

Figure 2.1: Conceptual framework

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter deals with the methods used in undertaking the research. It answers the fundamental question of how the research work proceeded. It therefore, discusses and identifies the study area, research design, sample size and sampling procedures, data collection and data analysis.

3.2 The General Study Area

The following is a brief description of the most salient character of the study area in relation to the study. The general study area lies within Makueni drainage area of the larger Athi water basin.

3.2.1 Athi water basin

Athi water catchment area is one of the six drainage basins in Kenya which include, Ewaso Ngiro North, Lake Victoria South, Lake Victoria North, Rift valley and Tana catchment areas (Fig. 1). It covers an area of 68,900 km^2 of which 5.7 percent or 3954.86 km^2 is under forest cover which is below the national target of 10% forest cover. The basin serves a population of 16.7 million people and the two premier cities of Nairobi and Mombasa among other urban centres. This population is the highest of all the six catchment areas. Athi basin has 356 m^3 per capita which is less

than 1,000m^3 per capita the global benchmark. The implication is that the basin falls in the category of beyond the water barrier since its water availability is less than 500m^3 per capita. There is scarcity of water in some areas of the basin, something which can be improved from ground water abstraction since 80% ground water constitutes the bulk of water resources in the area (GOK, 2012).

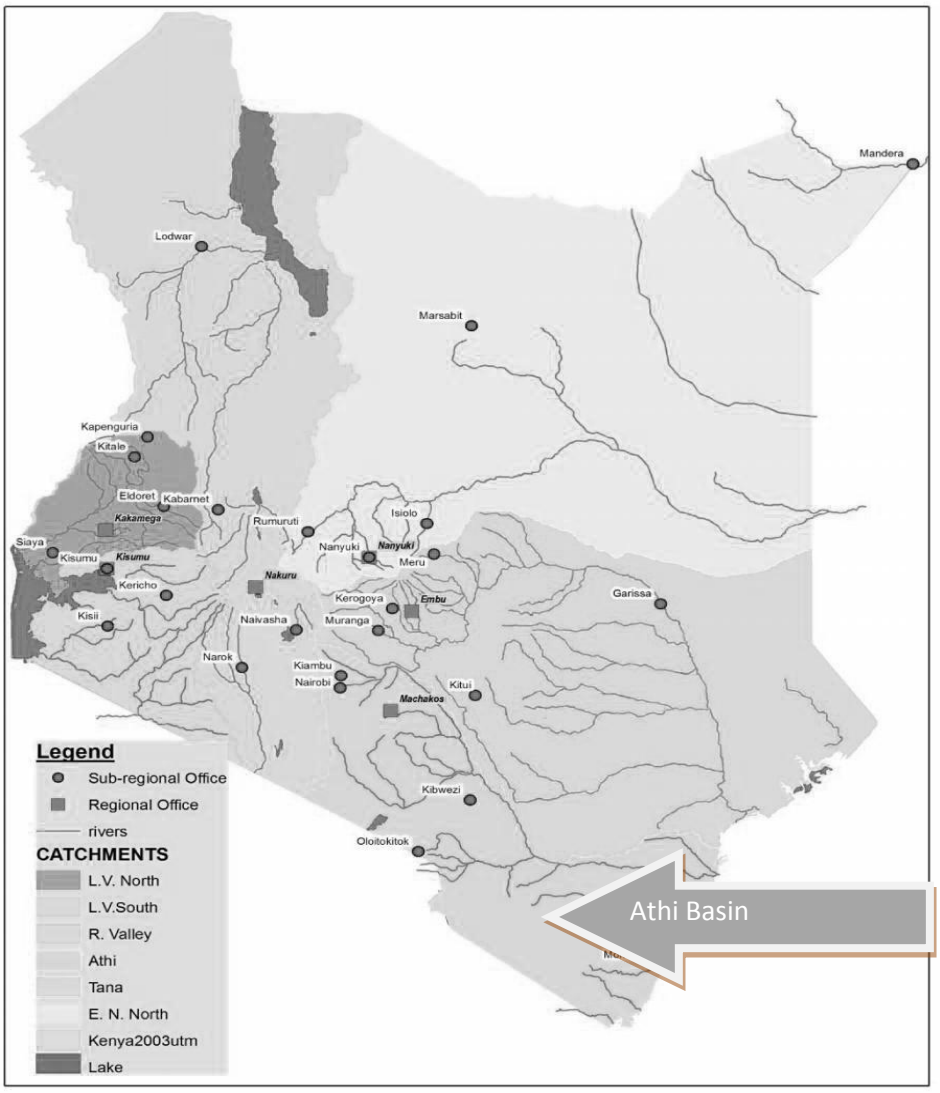

Figure 3.1: The drainage basins of Kenya: Source: GOK, 2013

3.2.2 Makueni drainage Area

Makueni drainage area (Fig. 3.2) (the general study area) falls in the Chyulu-Athi River catchment areas within Athi catchment area in Kenya's water sub-catchment of 3F or drainage area 3 in the Lower Midland (LM) zones extending over elevation of 800-1300m. The annual mean temperatures range from 21 º -24 º Celsius with annual average rainfall of 400-1000mm. LM 4 is a marginal cotton zone with fair to poor conditions for cotton and maize, fair for pigeon peas and good for sisal. LM 5 is lower midland livestock and millet zone with natural pastures able to support low density grazing, (Jaetzold *et al.* 2006). Makueni County falls in the Arid and Semi-Arid Lands, (ASAL) range of 50-85 percent of sub humid to semi-arid conditions typical in arid and semi-arid zones. The main rivers that drain the catchment include Athi, Kiboko, Kibwezi and Masongaleni which are perennial tributaries. The ephemeral tributaries include Thwake, Kaiti, Muooni, Kikuu, Thavu, Kambu and Mtito-Andei rivers. All these rivers traverse the county from West to East and drain into the Athi River which forms the Makueni-Kitui counties boundary in the East. Chyulu range is an important water catchment for both surface and ground water in the area, (Gichuki, 2000; GOK, 2012).

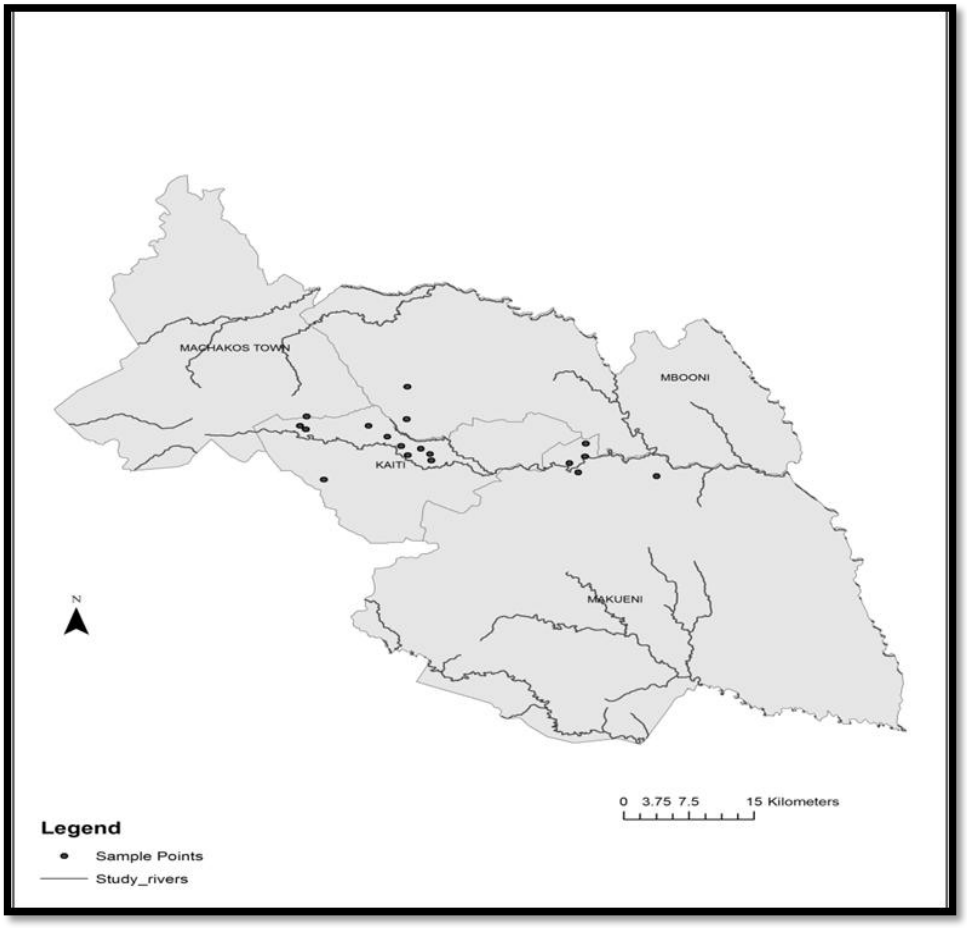

Figure 3.2: Makueni Drainage Area

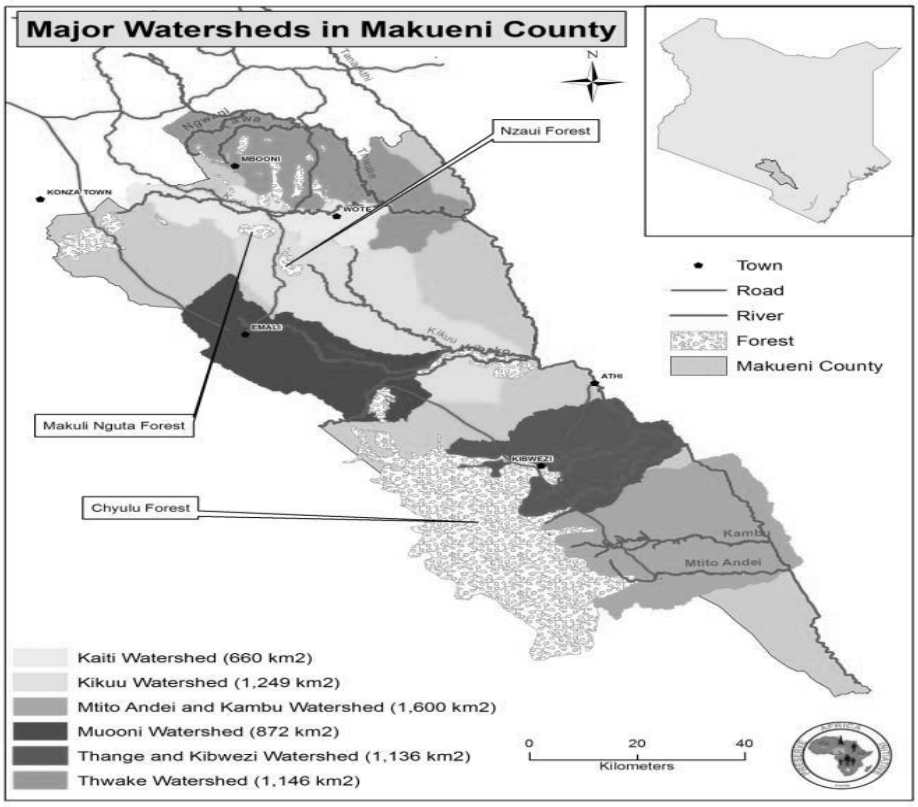

Figure 3.3: Makueni County's sub-watersheds: Source: PAFRI, 2012

3.2.3 The Specific Study Site

The county covers an area of 8,034.7 km^2 it boarders Kajiado, to the West, Taita Taveta to the South, Kitui to the East and Machakos county to the North. The county lies between Latitude 1º 35´ and 3 º 00 South and Longitude 37º10´ and 38º 30´East (GOK, 2013).

The county lies in the arid and semi-arid zone in Eastern Kenya. It consists of hills and small plateaus rising between 600-1900 metres above sea level (masl). The highest point of elevation is 1900m above sea level comprising of Mbooni and Kilungu hills in the upper north west of the county with vast low lying areas in the mid stretching to the southern parts in Tsavo rising to 600m above sea level, and to the volcanic Chyulu hills in the south west boarder of the county, (Muhammad, *et al.* 2010; GOK, 2013). The county is served by river Athi which is the most important perennial river. The river presents high potential for irrigation alongside other natural resources found in Makueni County like land, good soils and suitable climate for agriculture and livestock production and, horticulture (GOK, 2012).

Kaiti sub-watershed is characterised by high population density of 120,116 and 248 persons per square kilometre respectively as compared to the average of 110 persons per square kilometre for the county (GOK, 2013). According to Muriuki *et al.* (2005), high population has a bearing on the state of the watershed due to the increasing human activities and their effects on the wellbeing of the downstream communities in the county. Soil erosion in the sub-watershed is a major problem due to farming on steep slopes with siltation of manmade reservoirs experienced in the downstream of Kaiti River. It covers an area of 660 km^2 and is located between 10º 38 South and 10º 51´ South and 37º14´ East and 37º41´ East. Kaiti sub-watershed (Fig 3.4) shows the specific study site in Makueni County.

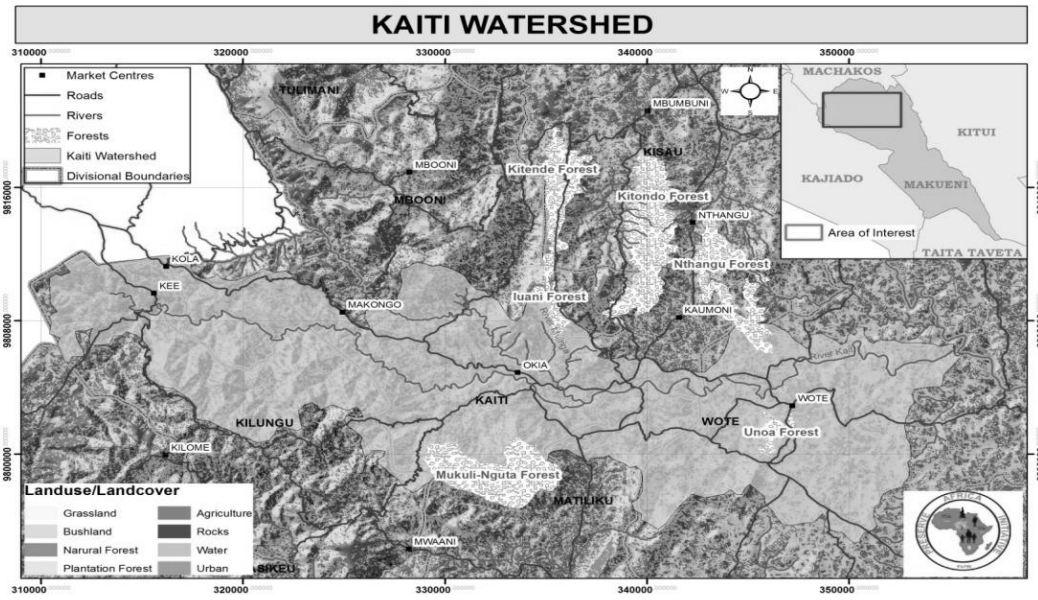

Figure 3.4: Map of Kaiti sub-watershed: Source: PAFRI, 2012

Kaiti sub-watershed lies in the fertile upper parts of the county which experience average rainfall of 800mm-1200mm. It comprises of Kilungu, Kee, Kalama, Kaiti and Wote divisions. The sub-watershed topography is characterized by mountainous terrain including Kilungu and Mbooni hills. Kaiti River and its numerous tributaries originating from the hills serve the watershed which influence surface water sources and ground water recharge capacity (Muriuki *et al.* 2005).

Hilltop forests, stream valleys and agricultural land in the lowlands are some of the watersheds characteristics and natural resource endowment (Fig.3.3). High population and poverty lead to destruction of natural vegetation in the hilltops through charcoal burning, firewood collection, extraction of building poles and

timber, overgrazing and clearance of vegetation for farming. Unsustainable land management practices exert pressure on natural resources leading to increased soil erosion, increased stream flow, riverbanks erosion, decrease of the amount of water and decline of ground water (Muriuki *et al.* 2005; Muia and Ndunda, 2013). Some of the other documented anthropogenic intrusions affecting the hilltops include illegal logging, tree debarking, forest fires and human encroachment (Makau, 2014)

3.2.4 Agro-climatic conditions

The county's rainfall distribution is bimodal received in two rain seasons. The short rain season is between November and December and the long rain season between March and April. The upper hilly parts of Mbooni and Kilungu hills receive an average of 800-1200mm of rainfall per annum; while the drier southern low lying areas receive an average of 300-400mm per annum. The mean rainfall in the two seasons range between 200-350mm (half of the annual precipitation) largely influenced by the altitude among other factors, which is mostly depressed, barely enough to sustain the major staple food crops of maize and beans grown in the county. Temperatures range between 24.6 ^{o}c in the upper hilly areas to 35.5 ^{o}c in the low lying areas. The mean monthly temperatures in the area ranges between 18 ^{o}c to 25 ^{o}c. The months of February and October are the hottest and July being the coolest month. The agro-ecological conditions in the area support agricultural activities predominantly comprised of rain fed agriculture, crop and livestock production which dominates land use and household livelihoods in small-scale subsistence farming (Jaetzold *et al.* 2006; Muhammad *et al.* 2010; GOK, 2013).

3.2.5 Population

The county's population as per the 2009 Kenya National Population and Housing census stood at 884,527 people, (Table 3.1).

Table 3.1: Makueni County demographics

S/N0.	Sub-county	Area	Population	Density km^2	Households	Farm families
1.	Kaiti	422.9 k m^2	120,116	248	20020	19018
2.	Makueni	1546.1 km^2	193,798	125	32301	30685
3.	Kibwezi W	2100.7 km^2	165,929	79	27735	26347
4.	Kibwezi E	2216.5 km^2	132,196	60	21954	20855
5.	Mbooni	949.2 km^2	184,624	195	30772	29234
6.	Kilome	641.3 km^2	87,864	137	14644	13912
7.	Makueni County	8034.7 km^2	884,527	110	32301	30685

Source: GOK 2013 & KNBS-2009

It is projected to reach 961,748 people in 2015 with an annual growth rate of 1.4 %. The majority of people in the labour force age group of between 15-64 years comprise of 51.1% or 471,454 people as per 2012 projections (GOK, 2013). Rapid population growth is exacerbating the existing problems of imbalance between human numbers and the available arable land with deforestation, poor land use systems and inappropriate farming methods leading to food insecurity and land degradation,(GOK, 2002). The rapid population growth, deforestation, diminishing land holdings, erratic rainfall patterns and conflict in water use are among the factors considered to influence watershed degradation in the study area (Gichuki, 2000; Muriuki *et al.* 2005).

3.2.6 Socio-economic dynamics and infrastructural development

According to GOK, (2013) and Ifejika *et al.*, 2007) Agro-pastoralism is the main source of income for households with agriculture accounting for 78%, followed by wage employment at 10 % and rural and urban self-employment at 8% and 4% respectively. The majority of people in Makueni County lack employment and meaningful source of livelihoods. The unemployed rely on agriculture for their livelihoods, a trend which will continue to exist in the county at least in the foreseeable future to the detriment of the county's environmental integrity.

The county has a road network of 3,203 km with only 453.8 km being of bitumen standard, the rest are either gravel or surface roads, which become impassable during rainy seasons. There are 21 post offices in major urban centres in the county. Mobile telecommunication network is fairly developed which majority of the population relies for communication. The county has 982 primary schools, 339 secondary schools, 7 tertiary institutions and 2 satellite university campuses. It has 162 public health facilities. Firewood use 84.8% and charcoal 11.1% are the major sources of cooking fuel in the county. The major sources of energy for lighting comprise paraffin 69%, electricity 5.9% and solar 3.8%, respectively.

The state of underdeveloped infrastructure in the county and limited economic diversification opportunities influences economic activities around exploitation of natural resources and in particular land which impacts negatively on the environment. The urban population projected to be less than 8% in 2015 depicts a situation of overdependence on land and other natural resources by the majority of the people in the county (GOK, 2013).

3.2.7 Livelihood strategies and major land uses

The table below outlines the agro-ecological zones and economic characteristics of Kaiti sub-watershed, which influence the growing of different crops and adoption of varied livelihood strategies in the study area, (Table 3.2).

Table 3.2: Transect spanning altitudinal and Agro- ecological zones in Kaiti sub-watershed

Zone	Altitude	Agro-economic characteristics
Lower zone (Wote)	1069-1158	LM4 marginal cotton zone, with fair to poor conditions for cotton and maize, Fair for pigeon peas, cow peas and good for sisal
Mid zone (Kaiti)	1219-1479	LM3/LM4 cotton zone, with very good conditions for cotton and fair for maize, Fair for beans, cow peas, pigeon peas and green grams.
Upper zone (Kilungu)	1560-2019	Sunflower maize zone, marginal coffee zone, Cabbages and onions

Source (Modified from Jaetzold et.al, 2006)

Rural livelihood strategies have many dimensions. According to Muhammad *et al.* (2010), they may include and not limited to the pursuit of recreation, shelter provision, water and sanitation, health care, transportation, maintenance of productive capacity of the environment and status in the society. All the above factors form part of the basic needs which human beings hope to achieve in their lifetime and in the environment in which they live. Ifejika *et al.* (2007), maintains that Agro- pastoralists in Makueni County primarily derive their livelihoods from crop and livestock production as well as marketing of farm produce and from low-income off-farm and non-farm activities. The upper and the mid stream zones are

favourable for variety of crops growing like maize, beans, vegetables and coffee. The lower zone is a cotton marginal area favourable for cow peas, pigeon peas, sisal and livestock keeping. The study used a comparative analysis of transect line spanning altitudinal and Agro-ecological zones in the watershed to determine livelihood strategies and biophysical conditions in the study area (Maitima *et al.* 2004; Jaetzold *et al.* 2006).

3.3 Research design

The study used a descriptive survey research design (Singh, 2006). Both qualitative and quantitative methods were used to gather and evaluate primary and secondary data from the field and past studies and reports respectively. The study used multiple methods such as household surveys, observations, Focus Group Discussant interviews (FGDs), key informant and experts' interviews, drawn from sampling of households systematically along the vertical and horizontal transect lines (Table 3.3).

It also used triangulation which is a form of cross-checking and the use of multiple methods both qualitative (inquiry) and quantitative (validation) methods in studying the same phenomenon for the purpose of increasing the study credibility (Hussein, 2009). Triangulation of data information sources is highly desirable when examining complex systems like society and environmental interactions leading to land use and management change. This was to ensure that data collection and analysis had several sources or types of information available on a particular topic and objective (Olson *et*

al. 2004a). Reconnaissance and pre-testing of the questionnaires was done and the gradient based transect lines were drawn using Global Positioning System (GPS) to outline and generate a digital map of the study area (Katana *et al.* 2013). Vertical and horizontal transect lines were determined marking the outer boundaries of the watershed, running from the East (Kikumini in the lower zone) to the West (Nunguni in the upper watershed area) and from South (Kyuasini) to the North (Kikima), with their convergence point in Mukuyuni area in the mid-stream watershed.

In the household survey, questionnaires were administered to respondents sampled systematically at random points along the vertical transect line running from East to West direction, traversing the whole watershed along the general flow of Kaiti River. Data was collected on livelihoods strategies crop and livestock production practices, soil and water management practices, land use management, off-farm and livelihood activities, fertiliser and manure application, important food crops, access to agricultural and weather information, market outlets and watershed degradation indicators (Muriuki *et al.* 2005; Ifejika *et al.* 2007; Muia and Ndunda, 2013).

According to Soini, (2006), to obtain representative information various methods have to be used to enrich the scope of findings where reliance of people's memory is involved. To address these challenges the study therefore used these multiple methods to gather data; including household survey with historical perspectives, relying on observations, farmers account and their perceptions on biophysical

changes and socio-economic dynamics. Environmental changes (land use and bio-physical changes) affecting livelihoods were included in the community/farmer questionnaires, based on the interviewee's memory. Transect lines that covered different agro-ecological zones were used in the study as well as triangulation for cross checking and verification of information (Maitima *et al.* 2004; Hussein, 2009).

3.4 Sampling procedure

The study used a line transect with systematic sampling of farmers along a vertical line following the general flow of Kaiti river. Kaiti sub-watershed, (Fig.3.4) was purposively selected for investigation based on its population distribution, density and varied physical characteristics (Muriuki *et al.* 2005; GOK, 2013). The line transect approach (Maitima *et al.* 2004) was used as part of the sampling framework traversing much of the ecological, socio-economic, land uses and environmental variability in the study site. Random point samples along the transect line were used to sample respondents to obtain information.

The sampling was based on spatial organization of interests of the community respondents (Olson *et al.* 2004b). In this case agro- pastoralism as a major economic activity among the community respondents was considered in the sampling of households and focus discussion groups. Gender, age and wealth status among group interviewees were a key consideration to maintain fair representation and participation of the population in focus group interviews. The study survey was

designed to collect views from 51 respondents, drawn from farmers. Three divisions namely Kilungu, Kaiti and Wote, which fall within the general delineated boundaries of Kaiti sub-watershed, were selected for sampling of the respondents. Seventeen (17) farmers interviewed in each of the 3 Divisions.

Kilungu division represented the upstream communities, Kaiti division representing the midstream and Wote the downstream communities of the sub-watershed. In the 3 divisions, 12 farmer's respondents were interviewed. An additional five respondents aged above 60, years were interviewed in each of the three divisions. Thirty respondents (30) for Focus Discussion Groups were interviewed in Kaiti division in the mid stream area of the sub-watershed. The 20 key informant respondents were drawn from among people with technical expertise in the divisions and from the county headquarters.

Table 3.3: Types of information and primary data collection methods

SN	Strategy	Activity & No. of respondents	Methodology
1	Reconnaissance & site selection	Site selection &questionnaire pre-testing	Purposive sampling
2	Household survey	Administration of Household survey-36 farmers & 15 farmers aged over 60 years	Systematic sampling along transect line
3	Focus group Discussion	Group interview guide-30 members	Purposive sampling
4	Key informants	Administration of key informant questionnaire-20 respondents	Purposive sampling
5	Use of GPS	Use of GPS to map the study site	GIS technique

3.5 Data Collection

Data was collected in Kaiti sub-watershed between the months of April-July, 2014 in the household survey, Focus group Discussion and key informant questionnaires. The questionnaires were administered to farmers sampled systematically along a vertical transect line running from East to West direction, traversing the watershed along the general flow of river Kaiti. The study used a variety of methods to gather information. Quantitative methods using a standardised questionnaire with open and closed questions was administered to farmers to obtain information at household level on land uses and farmers perception on land use changes. The Qualitative methods involved Focus groups (Focus Group Discussions), involving both men and women because they have different perceptions on environmental changes, land and watershed degradation and livelihoods strategies (Ovuka, 1999; Muriuki *et al.* 2011, Onyango, *et al.* 2013).

Key informants were also used in the study because of their expert opinion and experience on the ground, to give information on their perception of the watershed degradation in the study area. Stringer and Reid, (2006) argue that using any one of the scientific indicators or methods alone to determine land use changes may have limitations and may not absolutely provide accurate diagnosis or solution, hence the need to use multiple methods or approaches to verify and triangulate information for enhanced accuracy (Hussein, 2009). They point out that the local communities and

experts may highlight important links and points often overlooked in the purely scientific approaches. Ovuka, (2001) and Olson *et al.* (2004b) concur by stating that interpretation of satellite maps or aerial photographs together with field verification, household interviews, observations and ground truthing gives information on environmental changes and their effects on the people. Information from the respondents was gathered on the trends of land use and land cover changes, human activities and their influence on the biophysical, socio-economic and institutional involvement in watershed management, which have had significant impact on Kaiti sub- watershed degradation and environmental integrity.

Soil and water conservation in the form of terraces (Ovuka, 2001), was used to understand farmers perception on land use changes. Fifteen farmers aged above 60 years were purposively sampled to obtain information about their perception on environmental changes and how the changes affect their livelihoods and the general trends on watershed degradation. These farmers were sampled on top of the 36 households interviewed because the scope of the study and the chosen satellite images (Fig.4.10 and Fig.411) were intended to understand changes over a period of 40 years, hence the need to have a sample of elderly respondents.

The study gathered information at household level on community participation and involvement in watershed management. Water resources infrastructure in the form of existing water projects in the watershed, was used to understand local community perception on policies and institutions involved in natural resources management. It also sought to understand the levels of community involvement in development and management of natural resources. Information on their actual involvement in planning, implementation and the levels of their participation were sought. Information on the various agencies operating in the areas was also included. The government line ministries, NGOs and other private actors were some of the development agencies targeted in the questionnaire.

Awareness on various government policies, laws and their impact and influence of watershed degradation was tested among the respondents. Their attitude and perceptions on the extent of degradation and who were responsible for these changes was also sought as well as the challenges of integrated water and natural resources management. Their perception of solution and recommendations were also evaluated.

Information on who was responsible for the changes and the government policies role in affecting the watershed were included in the questionnaire. The key informants were drawn from technical personnel in government line ministries and

NGOs working with various organizations in the area. Past studies/literature review and government official policy papers were reviewed to gather information on institutions involvement in natural resource management in the study area.

The themes discussed in the household and focus groups where land use changes, crop and livestock production, watershed degradation and farmers perceptions on their influences on the environment and rural livelihood strategies. Historical account of soil and water conservation was obtained from farmers, agricultural extension workers and key informants and the effects on the environment and livelihood strategies. The combination of these methods provided a basis to obtain information on the state of terracing e.g. terraced and non-terraced farms in the study area.

3.6 Data analysis

The study adopted the Sustainable Livelihood (SL) Framework developed by DFID, (2001) and descriptive statistics to analyse socio-economic data. Data collected was managed and analysed using Statistical Package for Social Sciences (SPSS), version 19 and Microsoft excel 2010. Descriptive statistical tools like percentages, means and frequencies were used to analyse quantitative data.

Qualitative data was analysed from thematic trends obtained from field discussions. The results were presented in bar graphs and pie charts. The interpretation of the information was done by including views of local experts, preferably technicians working in the area and older farmers with knowledge of the area as well as the local residents and referring to various secondary sources (Olson *et al.* 2004a).

CHAPTER FOUR

RESULTS AND DISSCUSSIONS

4.1 HOUSEHOLD LIVELIHOOD STRATEGIES AND SOCIO-ECONOMIC CONDITIONS INFLUENCING WATERSHED DEGRADATION IN MAKUENI COUNTY

4.1.1 Socio-economic characteristics of selected households in the study area

The most outstanding Socio-Economic characteristics of the study sites revealed by the survey are presented in table 4.1 below. From the sampled 51 households, where semi-structured interview questionnaires were administered 32% of households had no formal education, 35% had primary education. In the study area 67% of the household heads were married, and 33% were widowed. Male headed households comprised of 69% while the female headed households were 31%, respectively. In this study, women respondents 75% were the majority compared to 25% males, because most of the men were out either in employment or doing other off-farm activities like casual labour and other economic activities.

Table 4.1: Selected household characteristics July, 2014 (N=51)

Characteristics	**Lower zone Wote**		**Mid zone Kaiti**		**Upper zone Kilungu**		**Kaiti Sub-watershed**		
	No.	%	No.	%	No.	%	No.	%	Ave.
No. of Households	17	100	17	100	17	100	51	100	
Respondents gender- M	3	24	6	35	3	18	13	25	
F	13	76	11	65	14	82	38	75	
Gender of H/head- M	10	59	14	82	11	65	34	69	
F	7	41	3	18	6	35	17	31	
Marital status-Married	10	59	13	76	11	65	34	67	
Widowed	7	41	4	24	6	35	16	33	
Average age H/H	60	-	55	-	56	-	-	--	57
Household size	6	-	6	-	6	-	-	-	6
HH education-None	5	30	8	41	4	24	17	32	
Primary	7	41	4	24	7	41	18	35	
Secondary	5	29	5	29	5	29	15	29	
Tertiary	2	-	-	-	-	-	2	3	
Occupation- Farming	17	100	17	100	17	100	51	100	
Livestock	3	18	1	6	1	6	5	10	
Ave. in acres	8	-	3	-	2	-	-	-	4.3

The average household's size in the study area was 6 members and the average farm size was 4.3 acres. The majority of households indicated that they relied on family labour, (Fig. 4.1) for crop and livestock production which are the major economic activities in the area. Farming 100% was mentioned by all households; livestock keeping with about 10% came second in terms of major economic activities undertaken by the farmers. Livestock rearing was found to have been higher in Wote division 18% as compared to 6% in Kaiti and Kilungu respectively where average land size per household was smaller. It was clear that crop production was the most commonly mentioned form of economic engagement and source of food by the households. This clearly predisposed watershed degradation due to the choice of livelihood strategies in the study area. Some household heads reported they had no formal education with 30% Wote, 41% Kaiti and 24% in Kilungu division. The average age of the household heads was 60 years in Wote division and 55 and 56 years in Kaiti and Kilungu respectively. These factors influenced watershed degradation in the study area as majority of these farmers relied on traditional farming and livestock rearing methods as opposed to modern agricultural practices, which are known to enhance production and promote soil and water conservation (Ifejika *et al.* 2007; Onyango *et al.* 2013).

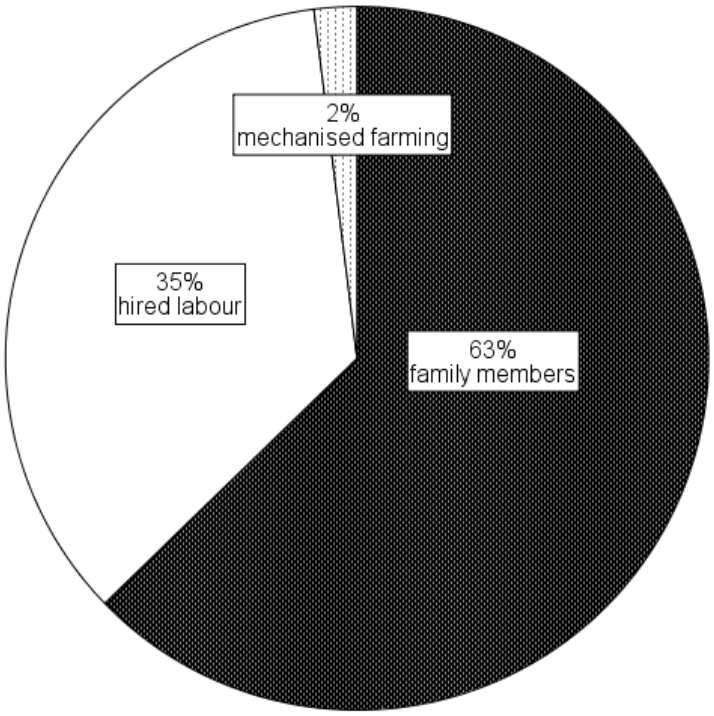

Figure 4.1: The types of labour used in Kaiti sub-watershed

The main source of farm labour was family members (63%) working in their farms (Fig. 4.1). Thirty five percent of the respondents admitted that they occasionally hired labour for their farm work. Family labour however was found to be on the decline due to the schooling of their children as stated by the majority of farmers. Farming activities were generally being left to the elderly who lack formal education, or have low level of education, and might be slow to adopt modern agricultural practices. The youth and the educated people leave the area, and migrate to urban areas and cities in search of employment opportunities. As a consequence, poor farming methods and the decline in farming acreage occurs as most of the farmers

are old and poor and not able to hire labour for their farms (Ifejika *et al.* 2007). This is common in Wote area where the average farm size is bigger than the upper hilly areas of Kaiti and Kilungu. Low literacy levels among farmers, especially household heads, low adoption of appropriate agricultural technologies and modern agricultural practices, could ultimately lead to watershed degradation. The County's illiteracy mean stand at 22.41%. In this study there is higher reflection of respondents 32% of respondents who reported to have had no formal education. This was as a result of deliberate selection of older members in the farmer's sample. They were considered to be important and able to give information over a long period of time, critical for the study's themes of discussion. Their age and long experience in farming was deemed important to capture land use changes spanning a period of more than 40 years.

4.1.2 Household Livelihood Strategies

The current livelihood strategies in the area were found to have negative impact on the watershed health as more people got involved in agricultural activities sometimes cultivating on steep slopes, clearing of forest or vegetation cover along unprotected river banks exposing the soil to water erosion (Muia and Ndunda, 2013). The decline of agricultural extension services and the neglect of terraces in the farms and other soil and conservation (SWC) measures also contribute to watershed degradation. Land use and environmental changes (most of which is caused by anthropogenic

factors) has occurred in the area which include overgrazing, removal of natural forests or scrubs and soil erosion (Tiffen *et al.* 1994; Muia and Ndunda, 2013) all of which impact negatively on livelihood strategies

As in the previous studies, the findings of the study confirmed that crop and livestock production at 100% and 10% respectively (Table 4.2), continue to be the dominant livelihood strategies among the households; providing them with food and their financial needs (Ifejika *et al.* 2007). Livestock keeping though currently reduced in numbers and scope to most of the households continues to be a major economic activity in the area. Despite its decline in the recent years, it plays a significant role; foremost as some kind of insurance against crop failure and a major source of income, especially for education of children. This is happening in the background of considerable reduction of farm sizes and grazing land noted in the study area.

Table 4.2: Livelihoods strategies for Households (N=51)

Livelihood component	**Lower zone Wote**		**Mid zone Kaiti**		**Upper zone Kilungu**		**Kaiti sub watershed**	
	No.	%	No.	%	No.	%	No.	%
1. Crop production	17	100	17	100	17	100	51	100
2. Livestock rearing	3	18	1	6	1	6	5	10
3. Small businesses	3	18	5	30	4	24	12	24
4. Employed (salaried)	2	12	-	-	-	-	2	4
5. Daily labour wage	5	30	3	18	6	35	14	27
6. Firewood/charcoal	5	30	1	6	-	-	6	10
7. Timber harvesting	-	-	1	6	10	59	11	22

Agro-pastoralism continues to be supplemented by other non-farm activities like petty trade, small-scale business enterprises at 24% and unskilled casual labour representing 27% of the respondents. In the majority of the households at least one member was reported to be engaged in other non-farm activities (Tiffen, 2003). These employment options included some people working as artisans or formally employed as teachers and nurses. However the latter comprises a small percentage of

the population at 4%, to have significant impact due to the dwindling formal employment opportunities in the country. Generally off-farm activities were found to be limited with many people lacking opportunities even for casual jobs, a factor documented in past studies (Ifejika *et al.* 2007; GOK, 2013). The findings indicated that both farm and off-farm activities are influenced by the agro-ecological gradient zones in the study area. Small-scale trade opportunities were lower in Wote area at 18%, Kaiti 30% and Kilungu 24%. These off-farm activities largely depend on agriculture based economy, often affected by climate change and the frequent droughts in the area. Their success and intensity differed in the three areas, with the mid and upper zones recording higher livelihood diversification opportunities than the lower watershed area. Although farming was reported to be the most important activity, Livestock production as a major source of family income at 18% in Wote area and 6% in Kaiti and Kilungu respectively signifies that, it was considered more viable in the lower zone as an alternative to crop production. Majority of the households at 45% owned between 2 and 3 heads of cattle in the study area, which signifies a decline of livestock rearing in the study area owing to the diminishing farm sizes (Muriuki *et al.* 2005; Ifejika *et al.* 2007).

Availability of land and favourable climatic conditions influences livelihood choices in the study area. Firewood and charcoal burning was also reported to have been higher at 30% in Wote (lower catchment area), with only one household reported to have engaged in the activity in the midstream watershed, while in the upper stream

none of the households engaged in charcoal burning. Timber harvesting on the other hand was reported by 59 % of respondents in the upper watershed area, 6% in Kaiti and none in Wote area. The climatic conditions and altitude of these areas were more favourable for agro-forestry than in the low lands. Unskilled labour engagement was high in Kilungu and Wote respectively, much of it influenced by small farm acreage in the upper part of the watershed and lack of livelihood diversification opportunities in the lower region.

The majority of those engaged in small scale trade were higher in the mid and upper watershed area. In these areas, vegetables and tuber crops were relatively grown by 41% and 59% of the farmers, which formed the bulk of farm produce goods for growth of small scale businesses commonly owned by women. Majority of them doubled as farmers with small vegetable kiosks near their homes. Availability of ready market for their produce was relatively high compared to the lower part of the watershed. Majority of the households in the upper watershed depended on local markets for their domestic food consumption, because they hardly produced enough food to feed them long during the year.

Crop production remains the main source of income providing food for domestic consumption, employment and other financial and social needs. Majority of the households combined both crop and livestock production for their livelihoods. (Table

4.2) Nonetheless livestock production came second in terms of the major economic activities of the farmers. However it was clear that it remains important to the households as a mitigation measure in case of crop failure due to drought and rainfall variability which are common in the area. It is considered important, because it significantly contributes to household financial needs for education of the children, health and in case of emergencies. It is also practiced as a measure of wealth, social status as well as source of Farm Yard manure (FYM).

In the study area, growing of maize, millet, sorghum, beans, cow peas, pigeon peas and cow peas (Fig.4.2 and Fig. 4.3), represented the biggest type of land use in Kaiti sub-watershed. Tuber crops like cassava and vines together with growing of vegetables constituted to a lesser extent other land uses in the area. These were grown in small quantities compared to the former. Farm plots under cereals and legumes ranged from 1-4 acres. Maize at 92% constituted the largest percentage of land use grown by all the farmers interviewed. In nearly all instances, it was intercropped with pulses which, are seldom planted alone in the area (Table 4.3).

Table 4.3: Acreage under cereals, legumes and cash crop in Kaiti sub-watershed (N=51)

Acreage under crops	**Less than 1 Acre**		**1-2 Acres**		**3-5 Acres**		**Over 6 acres**	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1.Maize	32	62.7	11	21.6	3	5.9	1	2.0
2.Sorgum	3	3.9	-	-	-	-	-	-
3.Millet	1	2.0	-	-	-	-	-	-
4.Beans	28	54.9	1	2.0	2	3.9	-	-
5.Pigeon peas	6	11.8	1	2.0	2	3.9	-	-
6.Cow peas	2	3.9	6	11.8	3	5.9	-	-
7.Green grams	1	2.0	2	3.9	-	-	-	-
8.Coffee	2	3.9	-	-	-	-	-	-
9.Cotton	1	2.0	1	2.0	-	-	-	-
10.Cassava	11	21.5	-	-	-	-	-	-
11.Vines	12	23.5	-	-	-	-	-	-

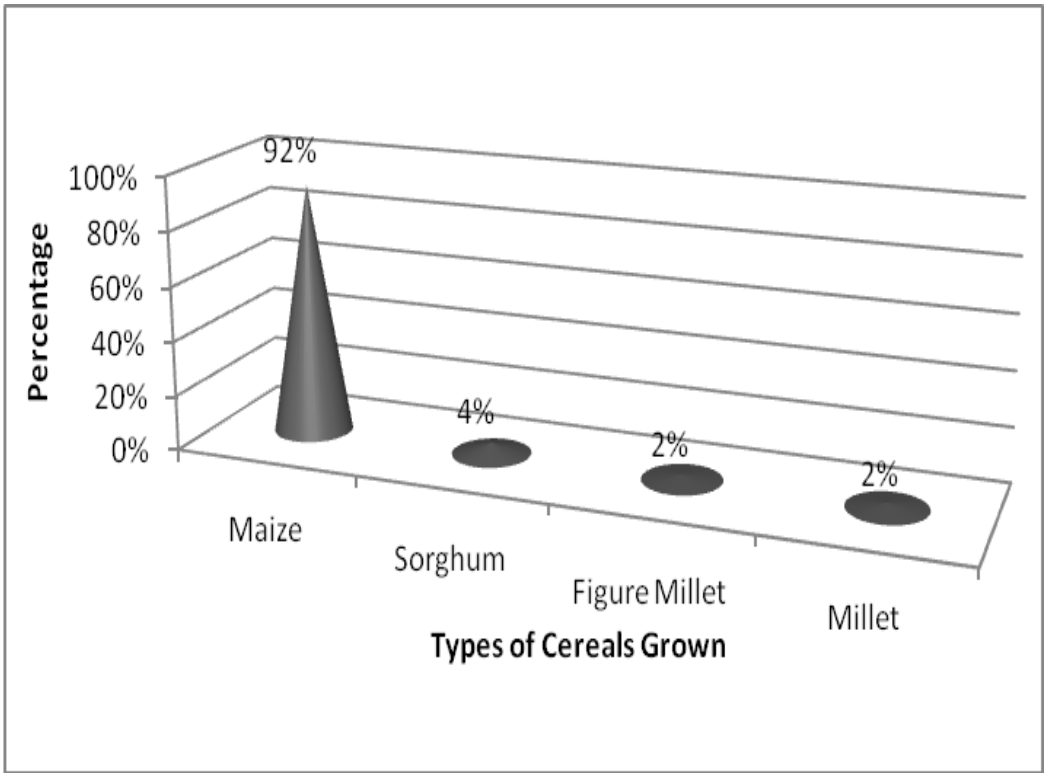

Figure 4.2: Types of cereals grown in Kaiti sub- watershed

In the study area, legumes are important food crops. Farmers indicated at 60%, they grow beans and 18% grow pigeon peas and cow peas respectively. Beans crop was found to be grown in all areas, however its harvest is better in the mid and the upper stream watershed while cow peas do well in the lower watershed area (Fig.4.3 and Table 4.4).

Table 4.4: Crop harvests in Kaiti sub-watershed (N=51)

Amount of crop harvested	**Less than 1 Bag (90 Kgs)**		**1-3 Bags**		**4-6 bags**		**Over 7 Bags**	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1.Maize	18	35.5	17	33.3	9	17.6	3	3.9
2.Sorghum	2	3.9	1	2.0	-	-	-	-
3.Millet	-	-	1	2.0	-	-	-	-
4.Beans	17	33.3	7	13.7	1	2.0	3	3.9
5.Pigeon peas	1	2.0	6	11.8	2	3.9	-	-
6.Cow peas	2	3.9	4	7.8	3	5.9	-	-
7.Green grams	1	2.0	1	2.0	-	-	-	-

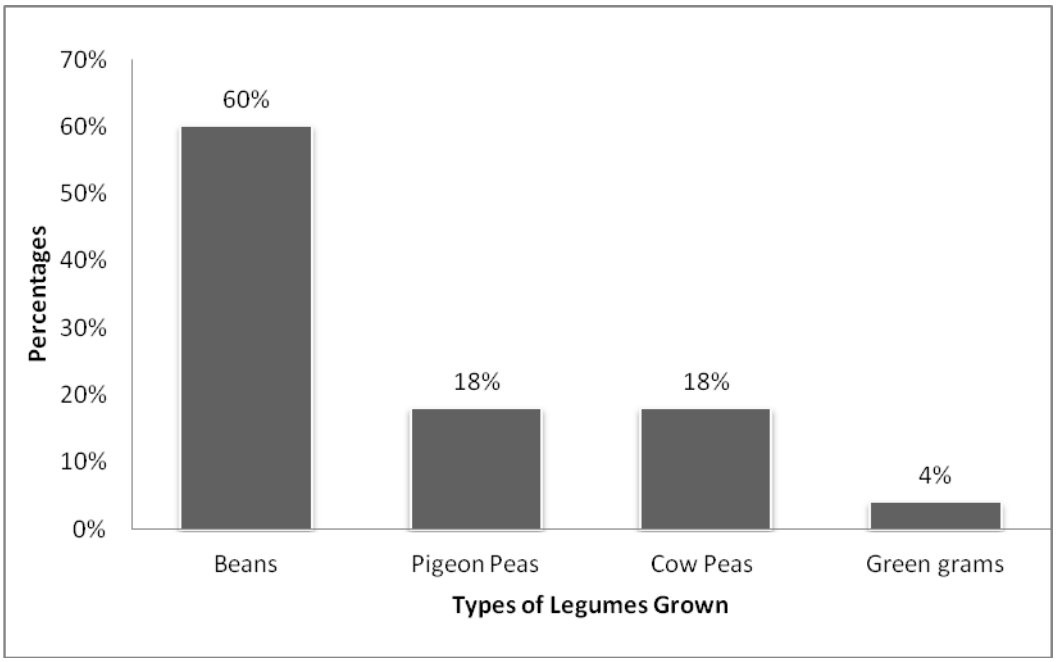

Figure 4.3: Types of legumes grown in Kaiti sub-watershed

Traditional crops like sorghum and millet (Fig 4.2 and Table 4.3), although suitable in the area due to their drought resistance and success in semi-arid conditions, are rarely grown by the farmers. However, in order to address food security they can easily become suitable alternatives to maize which records high crop failure in the county (Muui *et al.* 2013). Farmers should be encouraged to grow them in large quantities to diversify food crop production, increase livelihood strategies and ease pressure on land for cultivation. The adoption of these additional food crops could possibly minimise on watershed degradation as farmers would be guaranteed of harvests and increased income from diversified crop varieties. The choice of crops grown by the farmers influence watershed degradation, especially the observed

overreliance on maize growing, often affected by climate change and frequent droughts in the area. As farmers seek to maximise on maize production continuous planting on the same plots affects soil fertility as well as leading them to encroach on fragile ecosystems as they seek to increase acreage under its cultivation.

Horticulture occupies a significant percentage with mangoes, oranges, avocado and papaws being the preferred fruit trees. Horticultural production has risen in the recent past at the expense of cotton and coffee, the traditional cash crops in the lower and the upper watershed areas respectively (Fig.4.4).

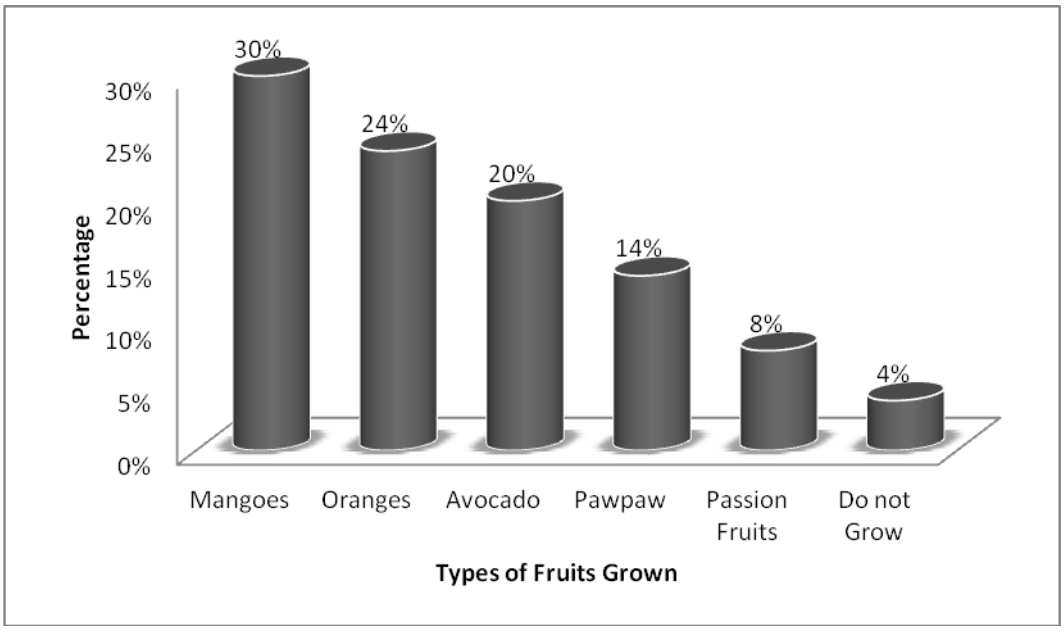

Figure 4.4: Types of fruits grown in Kaiti sub-watershed

Horticulture has gained prominence surpassing the traditional cash crop like cotton with 2% of growing in the lower catchment area of Wote and the mid catchment (Kaiti). Coffee growing which was a major cash crop in the upper catchment has declined considerably with only 2 households in the upper watershed indicated they considered it viable (Table 4.3). Where it was found in the farms, it was ignored and neglected with farmers stating that they no longer tended or cared for their coffee trees. The area under these two cash crops has decreased and the farmers are not keen to grow them. Farmers had abandoned cash crop farming due to marketing constraints. Tuber crops like cassava and vines occupy a small percentage in the area for similar reasons. Climate change and rainfall variability has affected farmers to the level of abandoning arrow root farming and sugarcane planting in the hilly part (upper watershed) due to the drying up of streams and ridge springs where they used to grow them.

Similarly growing of the traditional food crops like finger millet and pumpkins have declined over the years in all the areas, with households reporting increased food insecurity and low food production unlike in the past when they supplemented their food requirements with these traditional food crops (tuber crops) (Ifejika *et al.* 2007). In livestock production, free grazing in the field was practiced in the past (Fig.4.5).

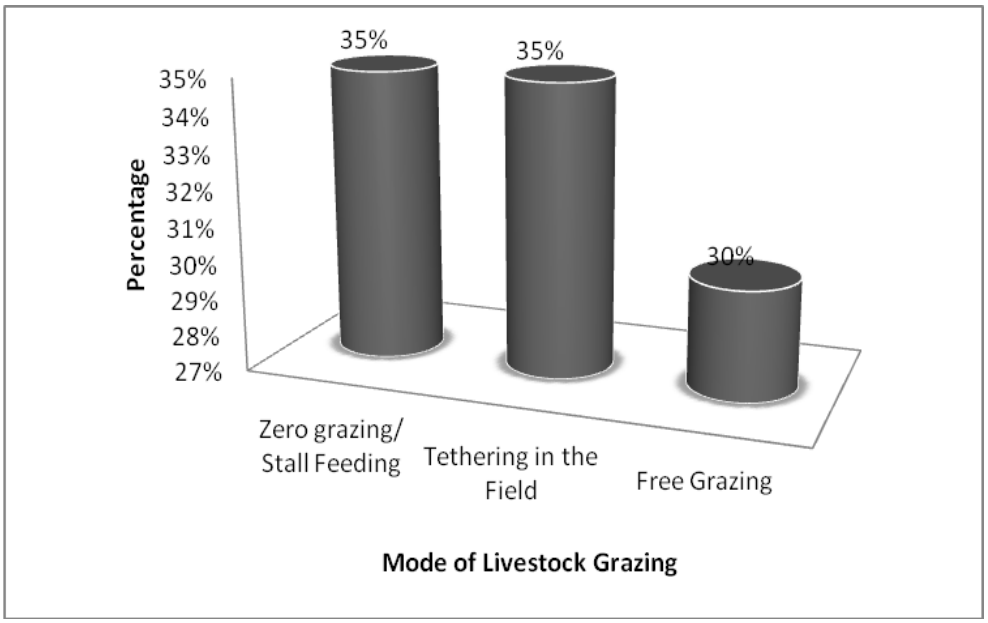

Figure 4.5: Mode of livestock grazing

Currently stall feeding at 35% and tethering 35% respectively of cattle and goats were the commonly practiced livestock rearing methods. Dairy farming is currently limited to a small number of farmers 6% (Table 4.7), despite the fact that the area is suitable for dairy farming. Farmers mentioned the initial dairy farming inputs requirement and lack of structured market for dairy products in the area, as the greatest barrier to adoption of the practice.

Agro-forestry and activities such as planting of *Grevillea robusta* and blue gum trees along farm edges and rivers banks was common with *G. robusta* dominating the mid and the lower catchment, while blue gum and other exotic tree species were common

in the upper hilly parts of the watershed (Muriuki *et al.* 2005). In the three divisions farmers in the recent years have intensified agro-forestry activities with these tree species also being found planted in the farms forest reserves and in institutions like schools and shopping centres.

4.1.3 Land management practices, soil and water conservation measures

Land management practises such as soil and water conservation influences watershed degradation and crop production levels. Gichuki, (2000) and Ovuka, (2001) contends that farmers' choices on SWC practises determine productivity of their farm plots and subsequent crop yields. Fieldwork excursions and farmers account on various land management practices with historical perspectives were used in the survey. The 1990s decades saw the introduction of Structural Adjustment Programmes (SAPs), the government down-scaled agricultural extension services and liberalised the agricultural and marketing services which further affected the farmers (Lemba, 2009). In the 2000 decades human settlement increased as well as institution and infrastructure development in form of roads, schools, sub-surface dams and sand dams and expansion of horticultural farming in form of oranges, mangoes and avocado trees as well as agro-forestry. This tremendous expansion of physical structures and farming activities occurs amidst lack of proper land use management Programmes, decline of conservation efforts, agricultural extension services and enforcement of basic SWM laws.

Farm yard manure (FYM) 63% was applied in the farms with 29% of the farmers who used inorganic fertilisers 8% of them used organic mulching as well as used compost litter especially on their fruit trees and bananas respectively (Fig. 4.6). Maize residue (stalk) was used by some farmers to feed livestock and the remainder was spread in the farms. Fertiliser application was widely used in the upper and the mid catchment and to a lesser degree in the lower catchment (Muriuki *et al.* 2005). However, some farmers reported they used any kind of available inorganic fertiliser, mostly offered in government institutions, regardless of its suitability on their farms.

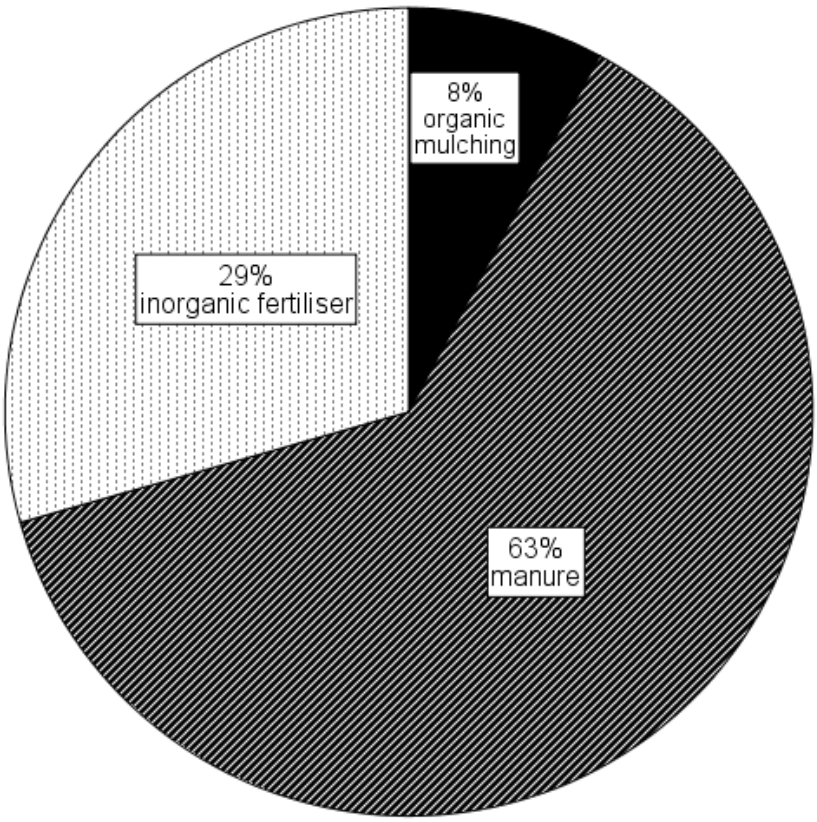

Fig.4.6: Types of fertilisers used by farmers

No soil analysis was reported to have been regularly carried out in the farms to determine the right kind of fertiliser. Majority of them never had their farm soil pH tested. However, there was insufficient application of fertiliser and manure by the farmers due to high cost and unavailability. Many farmers could not afford fertiliser and there was irregular application running into several seasons, because the majority of farmers relied on government fertiliser whose supply is often irregular, sometimes arriving late after the rainy season had started. Maize was continuously

planted in the same plot exposing it to the possibility of various crop diseases that affect the yields.

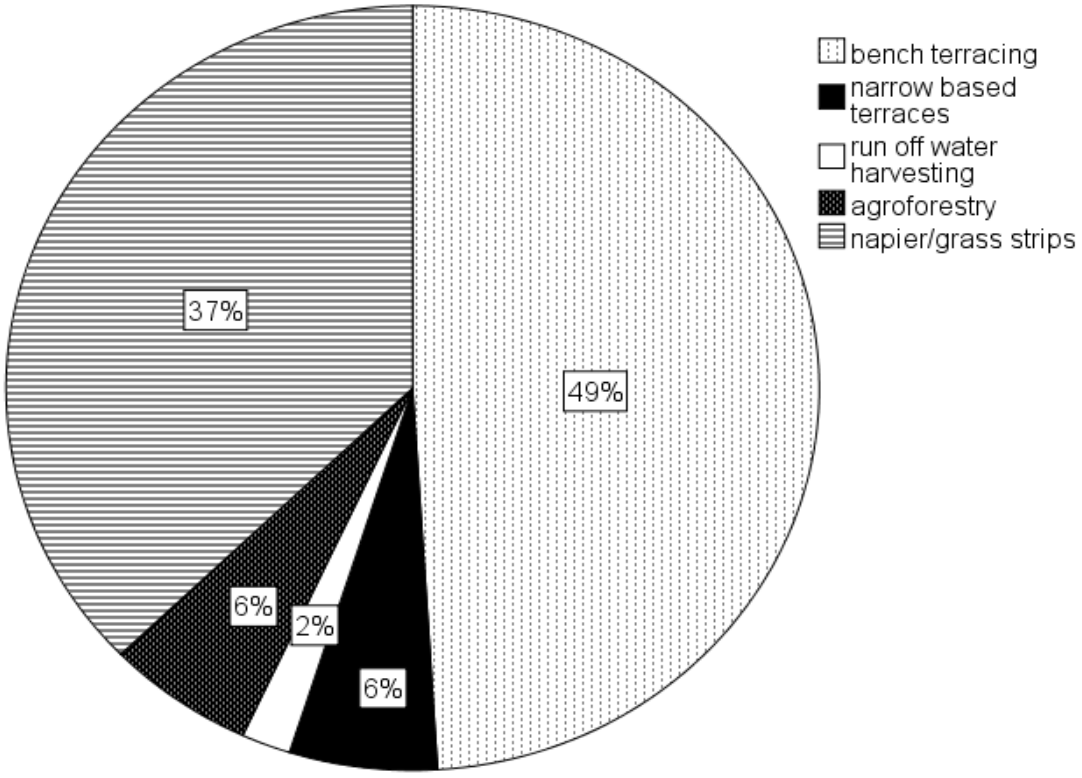

Figure 4.7**: **Percentage of farmers Soil and water conservation methods

The findings of this study concur with previous studies by (Tiffen *et al.* 1994; Gichuki, 2000 (F), Soil and water conservation methods (Fig.4.7) were applied by 49% bench (*Fanya juu)* terraces, 6% used narrow based terraces and 37% napier grass. Agro-forestry and run-off water harvesting was practised by 6% and 2% respectively. In the majority of the farms napier grass was grown on the terraces.

Some farmers had cut off drains to divert water from the roads and pathways into their farms. Some trash lines were observed lined with maize stalks after harvesting although not very common. Some farmers had stone lines especially in the hilly slopes. Planting of *G. robusta* and blue gum crop trees along farm edges were observed in all areas but were highly pronounced in the mid and upper catchment areas. Despite all these conservation measures soil and water erosion along the local roads and river bank erosion was commonly observed in the study area, as shown in the photographs (Plate 4.1).

Soil and water conservation is constrained by neglect of terrace structures in most of the farms, with some not laid along the contour posing danger of increased erosion in the farms, roads and the open fields. Most of the farmers admitted that their terraces were done several years back and were not regularly repaired as required. As a result most of them have weakened and became susceptible to breakage and forming rills, and other erosion trends visible in the farms, the foot and pathways, cattle tracks and on the edges between farm boundaries. The farmers cited poverty and lack of resources as the reasons for non-maintenance of terrace structures regularly. Some farmers said they planted grass on the terraces embankments which provided the much needed livestock feed during drought and times of scarcity, hence the reluctance to disturb the structures in renewing the terraces. Government efforts and involvement in soil and water conservation was found to have declined in the area,

with most of the farmers disregarding, soil and water management (SWM) measures and regulations.

Earlier studies firmly hailed the success of SWC measures in the area, (Tiffen *et al.* 1994). The intensive soil and water conservation practice was happening more than three decades ago existing in a different set of conditions with most of the farmers who made those structures, being beneficiaries of robust government supported conservation Programmes and enhanced agricultural extension services. Crop and livestock production were at their peak with profitable cash crop economy in form of cotton and coffee thriving in the area.

The economic outlook and structures have considerably changed, with crop and livestock production recording unprecedented decline (Ifejika *et al.* 2007; Muia and Ndunda 2013). There has been also an emerging generational change with the majority of farmers not exposed to the earlier government supported and guided soil and water conservation efforts. The agricultural extension services, today do not take the prominence of the peak years of SWM efforts in the area. They exist at most at basic levels to effectively serve the farmers. The discussion with the farmers revealed that they consider most of the conservation efforts to be expensive and beyond their financial ability, considering the declining returns base of farm produce and profitability. Farmers interviewed seemed not to understand the connection

between soil erosion and the decline of soil fertility which in turn leads to low food production (Muriuki *et al.* 2005; CSTI, 2009).

Introduction of exotic trees as cash crop particularly blue gum, planted along farm edges and along river banks especially in the mid and upper watershed area, (some species of eucalyptus) has possibly, resulted to the decline of ground water a factor commonly mentioned by the households in these areas. Soil and water conservation was observed to have been highly practised in the farms as opposed to the open grazing fields, most of which were denuded as a result of past overgrazing or overstocking and general neglect by farmers. Gabion construction, weirs and sand dams were observed across the study area, with most of them undertaken by NGOs and the local communities. Where these structures were constructed, soil and water conservation was evident in the form of regenerative land cover vegetation and retention of sand and water in rivers and streams.

4.1.4 Land management factors influencing watershed degradation

During discussions with farmers and stakeholders and especially the elderly, historical perspectives of the state of environment and water and soil conservation methods (Fig.4.7), came out clearly with the early 1950s and pre-independence years remembered as a period of intensive soil and water conservation period in the area. Land was in abundance in the new Makueni settlement scheme. Bench terracing ``*Fanya juu''*, shifting cultivation and fallow cropping were practiced with intensified agricultural extension services and government support of conservation

efforts (Tiffen *et al.* 1994). As population pressure increased in the 1970s and 1980s amidst diminishing land sizes and unavailability of new land for settlement, Soil and water conservation efforts declined considerably. Government support and agricultural extension services were on the decline. Enforcement of conservation rules had ceased and farmers were increasingly cultivating on steep slopes and along river banks. Soil erosion increased tremendously and soil fertility decline and low food production became common features among the farmers (Tiffen *et al.* 1994; Muriuki et *al.* 2005; Ifejika *et al.* 2007).

They have maintained that during the same decades some of the worst droughts and famine occurred in 1974-1977 ``*Longosa''* and 1984-1985 ``*Nikw'a ngwete''*. Food insecurity and depletion of livestock were the major consequences, a trend which has persistently continued largely due to climate change and inappropriate land use and farming methods. The period saw the decline of the major cash crops in the area with cotton grown in the lower and the mid part of the watershed, being abandoned by the farmers as a result of the collapse of global cotton market and the lapse of Machakos Integrated Development Programme and the collapse of cotton farmers cooperative (Makueni ginnery). Like cotton farming, coffee growing and marketing experienced similar constraints partly due to global decline of coffee prices and economic liberalisation measures in the agricultural sector. Farmers consequently neglected their coffee trees and lost a vital segment of their livelihood strategies in both cash crops.

Cash crop farming in the area has never recovered from that time and today most of the farmers no longer grow them, and are not interested in their revival due to price fluctuation. A good case at hand is the Makueni ginnery now privatised. Cotton growing as a major cash crop in the lower watershed area, has failed to pick again as a crop of choice. This is despite the efforts of the privatised ginnery to win back farmers support. It largely depends on cotton from outside the area for its production, with many farmers opting to practice subsistence farming and planting of horticultural crops like oranges and mangoes whose proceeds are deemed more profitable with good economic returns.

Using the Sustainable Livelihood (SL) framework (DFID, 2001), poverty, drought, famine and low food and livestock production due to climate change, high rainfall variability, inappropriate land use and farming methods and lack of steady markets for farm produce were found to be some of the major factors influencing the vulnerability of the poor people and their livelihood strategies (Table 4.5 and Fig. 4.8) As such, despite their increased farming efforts, they are susceptible to the cyclic shocks and trends of constraints exerted by the external environment beyond their control (Kebe and Muir, 2007).

The findings of this study indicated that population growth influences watershed degradation mentioned by 90% of the households (Table 4.3). High population density influences the continuous farming in the same plots/farms and encroaching

on forests and other fragile ecosystems as well as farming on steep sloped areas causing soil erosion and depletion of soil nutrients (Tiffen *et al.* 1994; Muriuki *et al.* 2005).

Table 4.5: Causes of socio- economic watershed degradation (N=51)

Indicator	**Ecological zone No. and %**							
	Lower zone Wote		**Mid zone Kaiti**		**Upper zone Kilungu**		**Kaiti sub watershed**	
	No.	%	No.	%	No.	%	No.	%
Population growth	17	100	16	94	13	76	46	90
Increase in poverty	12	71	11	70	12	71	35	69
Inappropriate land use/farming methods	14	82	15	88	10	59	39	76
Low food production	15	88	16	94	9	53	40	78
Reduced income/Livelihoods	12	71	11	65	15	88	38	75
Landlessness	1	6	6	36	13	76	20	39
Laxity in law enforcement	9	53	4	24	1	6	14	27
Illegal encroachment (i.e. steep slopes/riverbanks)	2	12	3	18	4	24	9	18

Table 4.6: Logistic regression results for causes of watershed degradation (Parameter estimates)

Parameter	Estimates	Std. Error	z-score	Significance
Age of household head male	-.037	.073	-.512	.609
Age of household head female	.019	.103	.186	.853
Education level of H/ head	.072	.159	.455	.649
Farm acreage	.133	.095	1.395	.163
Population growth	.359	.633	-.568	.570
Poverty	-.221	.362	-.610	.542
Landlessness	.408	.311	1.311	.190
Illegal encroachment	-.335	.555	-.604	.546
Laxity in law enforcement	.109	.481	.227	.821
Inappropriate farming methods	-.259	.362	-.689	.491

Note: Significance level of 10%

The increased farming activities have led to increased run-off and widened rivers and streams increasing soil erosion. Fallow cropping and shifting cultivation which were commonly practiced in the area have been abandoned due to the diminishing land sizes as a result of population growth. Whereas the farms regained their fertility when left fallow, continuous farming has considerably increased the decline of soil

fertility to the detriment of food production which has dropped significantly (Tiffen *et al.* 1994; Muia and Ndunda, 2013).

Population pressure and the fragmentation of land for new settlements have also affected livestock production due to the diminishing grazing land experienced in the area. As a consequence, a key livelihood strategy for the people which acted as a symbol of social status, wealth, prestige and a safety net in case of crop failure has been affected (Ifejika *et al.* 2007). Population growth was a major concern in the mid and the lower watershed area, with Kilungu having a lesser percentage of concern. Probably the longer period of grappling with population pressure and the diminishing land sizes have influenced them to move on, having to do with the small farms they own. In the lower zone which is a recent settlement scheme, people are more concerned about the fast decreasing and diminishing land sizes.

Socio-economic factors were estimated using a regression model with anthropogenic independent variables against watershed degradation (Table 4.6). The results from the survey research showed that age, gender and education levels of the household head were significant at 10% in understanding watershed degradation. Population growth, poverty, landlessness, illegal encroachment, laxity in law enforcement and inappropriate farming methods were all significant at 10% in explaining watershed degradation. The increase of men as household heads increased the chances for better watershed management (S.E=0.073 z=0.-512 sig. =.0.609), while women being household heads were likely to contribute to negative impact on the watershed (S.E=0.103 z= 0.186 sig. =0.853).This could be explained by the fact that men have

better income options and employment opportunities, hence their ability to have soil conservation measures on their farms. The increase of education levels of the household head (S.E=0.159 z=0.455 sig. =0.649) led to better soil and water management while the increase in average farm size for the families (S.E=0.133 z=0.095 z=1.395 sig. 0.163) increased the chances of better management and reduced degradation chances.

Increase in poverty was mentioned by 70% (S.E=0.633 z=0.633 sig. 0.570) of the respondents as another cause of degradation in Kaiti. Livelihood strategies are limited and their ability to sufficiently address the peoples basic needs remain a major concern, largely contributed by inadequate food security and lack of livelihood diversification. People require human and physical capital in order to exploit the natural capital to the maximisation of their livelihood outcomes (DFID, 2001). Majority of the households hardly produce enough food for their domestic consumption and the little surplus and horticultural produce they have is constrained by lack of ready markets. Cash crop farming has been on the decline, now practiced in insignificant levels. Like the concern on population growth 90% (S.E=0.633 z= -0.568 sig. = 0.570), poverty is of major concern in the mid and the lower watershed area due to minimal livelihood diversification and limited off-farm activities. Although cash crop farming of cotton is viable in these areas, farmers have almost abandoned growing it. Droughts and famines have also depleted livestock or forced the farmers to keep a number they can manage. Traditionally livestock used to be a

key source of income especially in the lower area where ranching is favourable (Tiffen *et al.* 1994; Ifejika *et al.* 2007).

About seventy five percent (S.E=0.376 z=-0689 sig.=0.491) of the respondents in Kaiti sub-watershed felt that inappropriate farming methods like inadequate SWC structures in farms i.e. terraces and encroaching on fragile ecosystems play a major role in watershed degradation (Table 4.5). This situation is confounded by lack of information and the decline of agricultural extension services. Many farmers interviewed expressed the view that they are currently left on their own in soil and water conservation matters as well as obtaining information on appropriate farming methods, except for the emerging trend where the media and in particular the radio is offering most of the information on agriculture and environmental conservation. Agricultural extension services have declined over the years, which has also affected farmer's ability to acquire and use appropriate farming technologies (CSTI, 2009; Onyango *et al.* 2013). Low food production was reported by the farmers (78%) and reduced income and livelihood by 75%, as consequences of watershed degradation in the study area. Landlessness 39% (S.E=0.311 z= 1.311 sig.0.190), illegal encroachment 18% (S.E=0.555 z= -0.604 sig.0.546), and laxity in law enforcement 27% (S.E=0.481 z=0.227 sig. 0.821) were other factors mentioned by the farmers as contributing to watershed degradation.

The low significance in the last two variables among the respondents nevertheless; does not render them redundant. Probably their lack of immediate concern to them is much influenced by inadequate information on their possible impact to the

immediate environment. However laxity in law enforcement was cited by the elderly respondents who recalled the stringent soil and water conservation measures enforced in the pre- independence days by the colonial government with tremendous benefits to the farmers and the overall environment (Tiffen *et al.* 1994).

The decline of soil and water conservation and climate change has negatively impacted on the watershed, which the farmers correctly identified. In some instances they could point out several streams which they used for abstraction of water for their domestic use in the past. Over the years these streams have dried up and they are now forced to cross over several ridges to get water for domestic use. Vegetable growing has also declined, due to the drying of the streams and the decline of ground water levels. This worrying trend although discernable in the area, could also have been influenced by other factors such as climate change, the introduction of exotic trees in the farms and along river banks should be tampered with scientific authentication to advice the farmers on the appropriate tree types and where they should be grown. Agro-forestry as conservation measure as well as a source of livelihoods (Muriuki *et al.* 2005), is highly desirable in the area, provided there is proper guidance and advice to the farmers on the appropriate species to grow.

The upper stream area has widely adopted agro-forestry as a conservation measure and livelihood strategy for timber harvesting (Plate 4.2). This positive development should be encouraged and more efforts concentrated in the furtherance of intensified

tree planting on the eastern side of Kilungu hills, which is parched and highly degraded without much afforestation efforts as witnessed in the upper side particularly around Nunguni area and Ilima locations. Farmers in the area indicated that this renewed efforts on their part is motivated by the realisation that they could derive their livelihood needs from forest products. This is a positive attribute which the county government and the local administrative units in these areas can continue to support and replicate in the other areas of the county.

Plate 4.1: The Eastern side of Kilungu hills with little afforestation

Plate 4.2: Afforestation around Nunguni in the upper watershed area

4.1.5 Constraints to livelihood strategies and mitigation measures

The choice of livelihood strategies and mitigation measures undertaken by farmers, often influence watershed degradation. Using the Sustainable Livelihood (SL) framework (DFID, 2001), the study established that factors beyond farmers control like poverty and climate change affects individual farmers livelihood strategies with varied consequences to their livelihood outcomes and the physical environment on which they depend for their wellbeing. Their land management practices, choice of crop varieties and land use methods has impact on the health of the watershed in terms of its continued productivity and sustainability of the livelihood strategies (Ifejika *et al.* 2007; Muia and Ndunda, 2013). The household respondents indicated

that high cost of agricultural inputs, including labour, draught power and improved drought resistant and quality seeds, formed the bulky of farmer's constraints to adequate crop production.

Table 4.7: Crop production constraints and mitigation (Kaiti sub watershed) (N=51)

Indicator	**% of farmers identifying mitigation factor**	**% of farmers reporting constraint**
Use of family labour	63%	35%
Use of fertiliser or manure	94%	6%
Use of improved planting materials	69%	31%
Cropping systems (intercropping)	94%	Monocropping-6%
Use of recent harvest H/H use	18%-sold	82%
Months harvest lasted	8% >Half year	92% < Half year
Regular selling of far produce	43%	57%
Indigenous cattle ownership	16%	84%
Improved dairy breeds	6%	94%
Place of farm produce sell	Cereal boards-6%	Middle men-35%
	Cooperatives-10%	Local market-10%

To mitigate these problems 35% of the farmers (Table 4.7) used hired labour of people and draught animals to do the tilling and weeding. Although those who opt for such strategies are in the minority they insisted that the initial capital inputs in such measures often exceeded the returns from their crop production, owing to the high rate of crop failure and farm produce marketing limitations.

Ninety four percent of the farmers indicated they used manure or fertiliser in their farms, 69 % used improved planting materials, (drought resistant quality seeds), while 94 % of the farmers revealed that they use intercropping to mitigate the high rate of crop failure due to rainfall variability and frequent droughts in the area. The diminishing farm sizes also influence intercropping to maximise and diversify their crop varieties. These measures however are faced with numerous problems, including unit cost of the inputs which is high to most poor farmers who barely produce enough food for their domestic consumption (Ifejika *et al.* 2007; Onyango *et al.* 2013). Use of fertilisers is pegged on the goodwill of the government supplies which is erratic and irregular. Most of the farmers said that they could not afford it from commercial outlets and when they buy, it is usually in small quantities not adequate for their farms. They do not have any choice other than to use the government provided fertiliser irrespective of its suitability in their farms. Continuous planting of maize on the same plot was noticed in all the areas. It may not auger well for crop production due to the threat of crop diseases and the decline of soil fertility (Muriuki *et al.* 2005).

The entire interviewed households had planted food crops in the last immediate season, October- December 2013 short rains and harvested. A large number of the respondents (82%) reported to have used this harvest in domestic consumption as opposed to only 18 % who got surplus to sell. The rains were erratic, unevenly distributed and short lived which affected crop production to the majority of the farmers. Over 92 % of the respondents revealed that the harvest was projected to last less than six months. It was only 43 % of the farmers who said they regularly sold their food, when they had surplus from their farms depending on availability of adequate rainfall during the planting season. A large proportion (57%) did not have surplus to sell. This trend is collaborated in previous studies (Ifejika *et al.* 2007; Lemba 2009). The majority of those who regularly had surplus (staple food, cereals and legumes) were found to be in the lower and the mid-stream watershed area.

In the upper part of the watershed farmers indicated that season after season they rarely had surplus to sell and their harvests lasts an average of 3 months or less, with the rest of their domestic food requirement being bought from the market. This situation can be explained by the fact that they have relatively small average farm sizes under crop production as compared to the other two areas. Continuous cultivation on the same farm lots over a relatively longer period in the area has taken a toll on soil fertility. Another probable explanation can stem from the fact that inappropriate use of fertilisers over a long period of time regardless, of its suitability could lead to such a scenario. However a combination of factors may have

influenced the situation, but observation showed that most of the farms where maize was grown in the area, the maize stalk were stunted and yellowish insinuating nutrients deficiency.

4.1.5.1 Marketing of food produce

Marketing of farm produce in the study area was faced with numerous challenges. The study revealed that 49 % and 35 % of the respondents (Fig. 4.8) sold their farm produce in the local market centres and to middlemen or brokers respectively. The findings of the study established that most of the farmers felt that they were exploited in these marketing avenues, where the prices were low making them unable to get maximum returns for their farm produce. Low farm produce prices for both cereals and legumes were more pronounced immediately after harvests where the sale prices dropped drastically only to rise after a few months of the farmers disposal of their surplus stocks. Some farmers decried the situation which has been in existence for a long period of time where they sell their farm produce at low prices, only for them to buy the food at significantly high prices later when they went to the shops to buy food for their domestic use (Ifejika *et al.* 2007; Onyango *et al.* 2013).

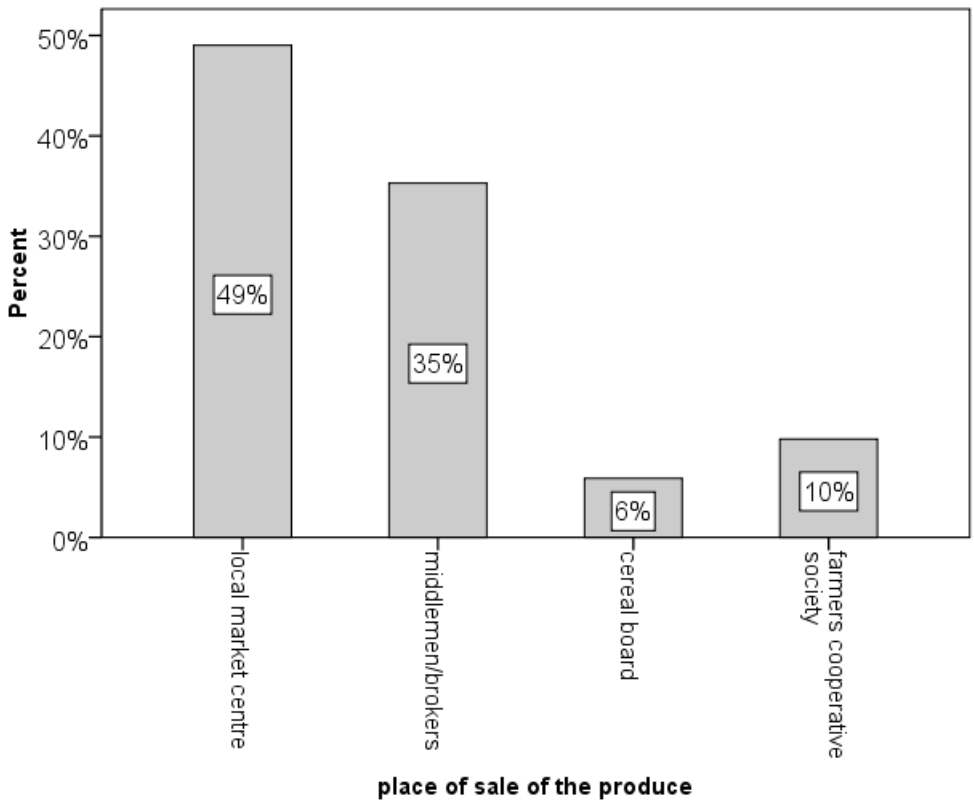

Figure 4.8: Percentage of farmers selling their produce through different outlets

4.1.5.2 Livestock keeping

The study found that 84 % and 16 % respectively of the households kept indigenous and (6%), improved dairy breeds in the area (Table 4.7). The average number of indigenous cattle per farmer has significantly dropped due to diminishing grazing land for majority of the farmers. The number of improved dairy breeds kept is insignificant to make economic sense in an area where livelihood strategies are few and limited. Some farmers were found to lack adequate Soil and Water Management (SWM) especially in range lands where SWC measures were not as intensive as it

was in the farms. This situation impacts negatively on their livelihoods increasing their vulnerability as well as that of the immediate environment upon which they depend to derive their livelihoods. This situation coupled with depression of their economic wellbeing thus predisposes them to inappropriate farming methods and unsustainable livelihood strategies such as charcoal burning, sand harvesting and brick making, commonly found near river banks, and contributing to serious watershed degradation (DANIDA, 2003; GOK, 2013).

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Based on these findings thus, the Sustainable livelihood (SL) analysis points to a situation where the poor farmers are increasingly being exposed to vulnerability despite their efforts to diversify their livelihood strategies. The assets of Sustainable livelihoods, i.e. human, social, natural, physical and financial capital act at different levels of susceptibility which limit their chances to move out of the vicious cycle of poverty (DFID, 2001). The institutional (formal and informal) structures and processes operate at their minimal at both policy and implementation levels, e.g. agricultural extension services have been on the decline, while intensive capacity building and technical expertise are not adequately offered to the farmers, though urgently needed in order to maximise their agricultural production (Emongor *et al.* 2010; Munyasi *et al.* 2010). The external environment, climate change and rainfall variability inhibit their efforts at a level beyond their control (Ifejika *et al.* 2007). It is thus acknowledged that the mitigation measures they undertake fall below the threshold to effectively remedy their problems.

The various mitigation measures by farmers mentioned above are themselves weighed down by problems, which instead of addressing their needs further increases their vulnerability, aggravating their livelihood outcomes (Ifejika *et al.* 2007; Onyango *et al.* 2013). When the farmers are faced with declining family labour, and largely depending on hired labour which the majority cannot afford, they may result to reducing or scaling down their agricultural activities. Likewise when the cost of various agricultural inputs and services are beyond their reach, they resulted to use of low quality seeds, inappropriate choices (e.g. fertilisers) and negligence of SWM practices and existing terrace structures. In deed their convenience measures point towards further reduction of crop and livestock production. It is clear that most of these measures worsen their situation and economic wellbeing. Farmers who used quality improved seeds were about 21% and 15% reported to have planted drought resistant crops with only 14% admitted to have practised crop diversification (Fig. 4.9). This low percentage of adoption of appropriate agricultural technologies and practices affects food production (CSTI, 2009; Onyango *et al.* 2013). It increases food insecurity in an area where rainfall variability is pronounced to the detriment of farmers' choices. This situation further complicates livelihood strategies of the farmer's who in their majority largely rely on agriculture as their main economic activity.

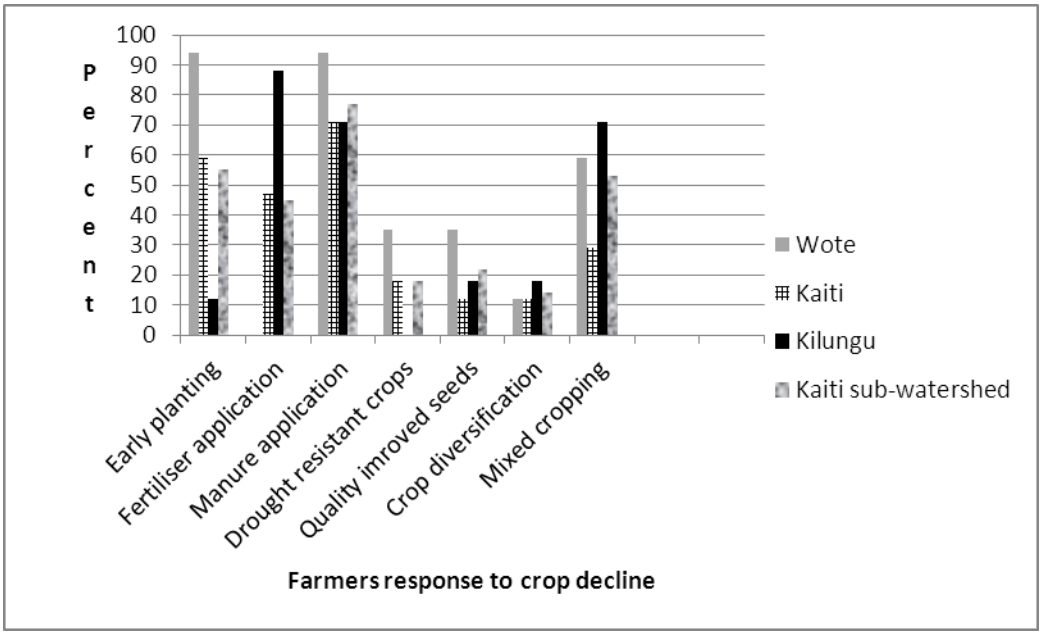

Figure 4.9: Farmers response to declining crop productivity

4.2 BIOPHYSICAL CONDITIONS AND LAND USE METHODS CONTRIBUTING TO WATERSHED DEGRADATION IN MAKUENI COUNTY

4.2.1 Bio-physical conditions and watershed degradation

Biophysical conditions and land use methods influence watershed degradation owing to both natural and anthropogenic factors (Maitima *et al.* 2004), as people continue to interact with the environment for their livelihood strategies. The study established that bio-physical changes have occurred in Kaiti sub-watershed watershed (Muriuki *et al.* 2005). The respondents indicated that, decline of ground water, increase in soil erosion, reduction of forest/vegetation cover, changes in temperature and rainfall and decline in soil fertility, as some of the most discernable factors which have contributed to watershed degradation (Table 4.8).

Table 4.8: Bio-physical changes in Kaiti sub-watershed watershed (N=51)

Bio-physical changes	**Ecological zone No. and %**							
	Lower zone Wote		**Mid zone Kaiti**		**Upper zone Kilungu**		**Kaiti sub watershed**	
	No.	%	No.	%	No.	%	No.	%
Decline of ground water	13	76	16	95	17	100	46	90
Increase in surface run off	17	100	3	18	8	47	28	55
Sedimentation of rivers and water pans	5	29	2	12	-	-	7	14
Increase in soil erosion	15	88	14	82	15	88	44	86
Pollution of rivers	5	29	2	12	-	-	7	14
Drying of rivers	9	53	4	24	6	35	19	37
Changes in rainfall/temperatures	10	59	12	71	16	94	38	75
Decline in soil fertility	14	82	7	41	15	88	36	70
Reduction of forest /vegetation cover	15	88	14	82	13	76	42	82

Table 4.9: Logistic regression results for Land use effects and Biophysical changes (parameter estimates)

Parameter	**Estimates**	**Std. Error**	**z-score**	**Significance**
Age of household head male	-.025	.076	-.336	.737
Age of household head female	.018	.104	.169	.866
Education level of household head	.060	.174	.347	.728
	.-.437	..602	-.725	.468
Decline of ground water	.124	.314	.394	.693
Increase in surface run-off	.006	.575	-.010	.992
Sedimentation of rivers	-1.238	.660	-1.875	.061
Increase in soil erosion	-.761	.491	-1.548	.122
Pollution of rivers	.693	.398	1.739	.082
Drying of rivers	-.204	.374	-547	.585
Changes in rainfall and Temps.	-.495	.362	-1.370	.171
Decline in soil fertility				

Note: Significance level of 10%

The study' showed that the age, gender and education levels of the household heads were critical in understanding and explaining the biophysical conditions in Kaiti sub-watershed and their influence on watershed degradation (Table 4.9).Increase in men as household heads (S.E=0.076 z= -1.013 sig.=0.737) indicated, that they had better knowledge and awareness on the biophysical conditions than women (S.E=0.104 z=0.169 sig. 0.866).The more years the household head had in education (S.E=0.174 z=0.347 sig. 0.183),the more they understood the biophysical changes happening in Kaiti sub-watershed.

Farmers were able to identify decline of ground water 90% (S.E= 0.602 z=-0.725 sig. 0.468), increase in surface run-off 55% (S.E= 0.314 z= 0.394 sig. = 0.693), increase in soil erosion 86% (S.E= 0.660 z= -1.875 sig. 0.061), Changes in rainfall and temperatures 75% (S.E=0.374 z= -0.547 sig.= 0.585), decline in soil fertility 70% (S.E= 0.362 z= -1.370 sig.= 0.171) and drying of rivers 37% (S.E=0.398 z= 1.739 sig.=0.082), which were significant at 10%.

These factors were deemed to cause biophysical changes, which contribute to watershed degradation in the area. It was clear that reduction of forest and vegetation cover due to farming and grazing activities has led to increase in soil erosion and reduction of soil fertility (Muia and Ndunda, 2013), which has impacted negatively on crop and livestock production, and the livelihood strategies (Ifejika *et al.* 2007). This was more pronounced in Wote and Kaiti divisions which have less afforestation efforts as compared to Kilungu in the upper watershed. Degradation and depletion of riparian vegetation and ecosystem has contributed to adverse changes with riverbeds

becoming drier leading to loss of important biodiversity like *Phragmites* plant species and animal/bird habitats, (Makau, 2014) a trend fairly observed in all the rivers/streams in the study area.

The decline of ground water and drying up of rivers and streams were mentioned in the mid and the upper watershed area. Water scarcity is more pronounced now in Kilungu were respondents reported streams and springs to have dried up forcing them to trek long distances in search of water. This contrasted with the past where they confirmed water was found to be plenty and common in the streams and ridges. Everything has changed to the worse, because, where as they were using the water to plant vegetables and arrow roots in the past, they have completely abandoned growing of some of these food crops. This can be attributed to climate change effects and rainfall variability, noted in the last couple of decades (Ifejika *et al.* 2007; Onyango *et al.* 2013). The entire watershed faced similar problems as most of the respondents could identify water scarcity as a problem on the increase. This state of events then explains why despite farmer's willingness to use irrigation farming, only 4% of the respondents in the watershed reported to have been currently involved in micro-irrigation farming. The decline of ground water and fast drying of riverbeds were mentioned as the greatest impediment to sustainable agriculture and addressing of the perennial food insecurity in the area.

These findings support previous work done by (Muia and Ndunda, 2013); land uses and human (anthropogenic) factors highly influence watershed degradation in the study area, because the majority of the people directly depend on the environment for their livelihood outcomes and survival (Ifejika *et al.* 2007). Unsustainable utilisation and extraction of natural resources were identified in the form of unsuitable livelihood strategies like charcoal burning, timber harvesting and sand harvesting in the absence of robust livelihood opportunities and diversification options for the communities (Ifejika *et al.* 2007; GOK, 2013). Farmers account and key informants indicated that the local community contributes to watershed degradation e.g. (poor quality terraces and non-maintenance). The other factors include non- adherence to land use management policies in relation to implementation of various development programmes, which also contributes to the problems of degradation in the watershed.

The widespread watershed degradation owing to biophysical changes is attested in the rills, gullies, sedimentation in rivers, particularly in the mid and downstream area. There are barren and bare grounds, soil deposits in gentle slopes, vegetation change, accumulation of soil deposit around vegetation clusters and increased run-off (Tiffen *et al.* 1994; Muia and Ndunda 2013). The scenario signifies increased watershed degradation, depletion of soil nutrients (Muriuki *et al.* 2005) whose ramifications can only lead to decline of food production yields, loss of flexibility in land management as large swathes of land become unproductive and possible diversion of resources to expensive rehabilitation efforts, in any already cost laden

agricultural sector (GOK, 2013). Reduction of forest and vegetation cover exposes soils to water erosion (Muia and Ndunda 2013), leading to the decline of soil fertility and loss of arable land, a trend with connections of the bio-physical conditions obtaining in the watershed. This can largely be attributed to both natural causes and human activities. However anthropogenic factors outweigh the former, due to increased agricultural activities in the watershed.

4.2.2 Land use and watershed degradation

The study revealed that land use changes have occurred in the study area, with rapid changes as a result of farming and development activities (Tiffen *et al.* 1994). The main land use changes identified included subsistence crops (croplands and grazing lands), human settlements, institutions, infrastructure development such as roads and water masses (earth dams) and forests. Soil and water conservation in form of terraces were also examined in the watershed area. Terracing structures in the area was revealed to be widespread by use of satellite images. Historical perspectives on SWC approaches, farmers and agricultural extension workers account was also used to understand the extent of adoption of terracing technologies in the study area.

In the 1950s and 1960s decades, farmers testified that land was plenty as there were still new areas where people could migrate and ease pressure on land. Shifting cultivation, crop rotation, fallow cropping and intensive soil and water conservation

were commonly practiced due to availability of land and the farmers' perceived profitability in crop production and livestock production. Population pressure and unavailability of more new settlement areas, farm sizes decreased considerably with fragmentation of the farms increasing at higher rates to absolve the growing population (Tiffen *2003*; Muriuki *et al.* 2005; Ifejika *et al.* 2007) (section 2.2).

This led to more land being used for settlement and establishment of homesteads. Agricultural land expansion accelerated, encroaching to fragile ecosystems, clearing of forests and vegetation cover to increase food production (Muriuki *et al.*, 2005). The decline of SWM conservation measures led to increased soil erosion and soil fertility decline. The sustained practices of overgrazing in the low lands over the decades also increased land and watershed degradation as attested in the cattle paths along road reserves and farm demarcation paths. Rills and gullies are commonly evident in many areas (Muia and Ndunda, 2013). Farmers have also contributed to this problem by fencing off and encroaching on road and pathway reserves. In some instances such roads and pathways have been completely eroded to be unmotorable.

The main land use categories identified were comprised of built up areas, homesteads, schools, road infrastructure and shopping and market centres and urban areas. Herbaceous crops, tree or shrub crop were another land use category identified in the study (Fig.4.10 and Fig. 4.11). Forests were other kind of land use classes

identified. Some physical structures like homesteads, schools road infrastructure, shopping centres and other institutions were easily identified from the satellite images and were easy to locate and determine. Changes in land forms and depletion of riverine vegetation were commonly observed in the study area. However rills, erosion trends in the farms as well as differentiation between indigenous and exotic forests were difficult to make in the farm lots along the farm edges and boundaries. This is happening, despite the fact that there are notable increased agro- forestry activities in individual farms, across the watershed (Plate 4.3).

Plate 4.3: Agro-forestry activities in Nunguni area

These land use changes observed in satellite images (Fig. 4.10 and Fig. 4.11) and photography were collaborated by the farmers account on the discernable land use changes and their perceptions, on their effects on their livelihood strategies and the environment.

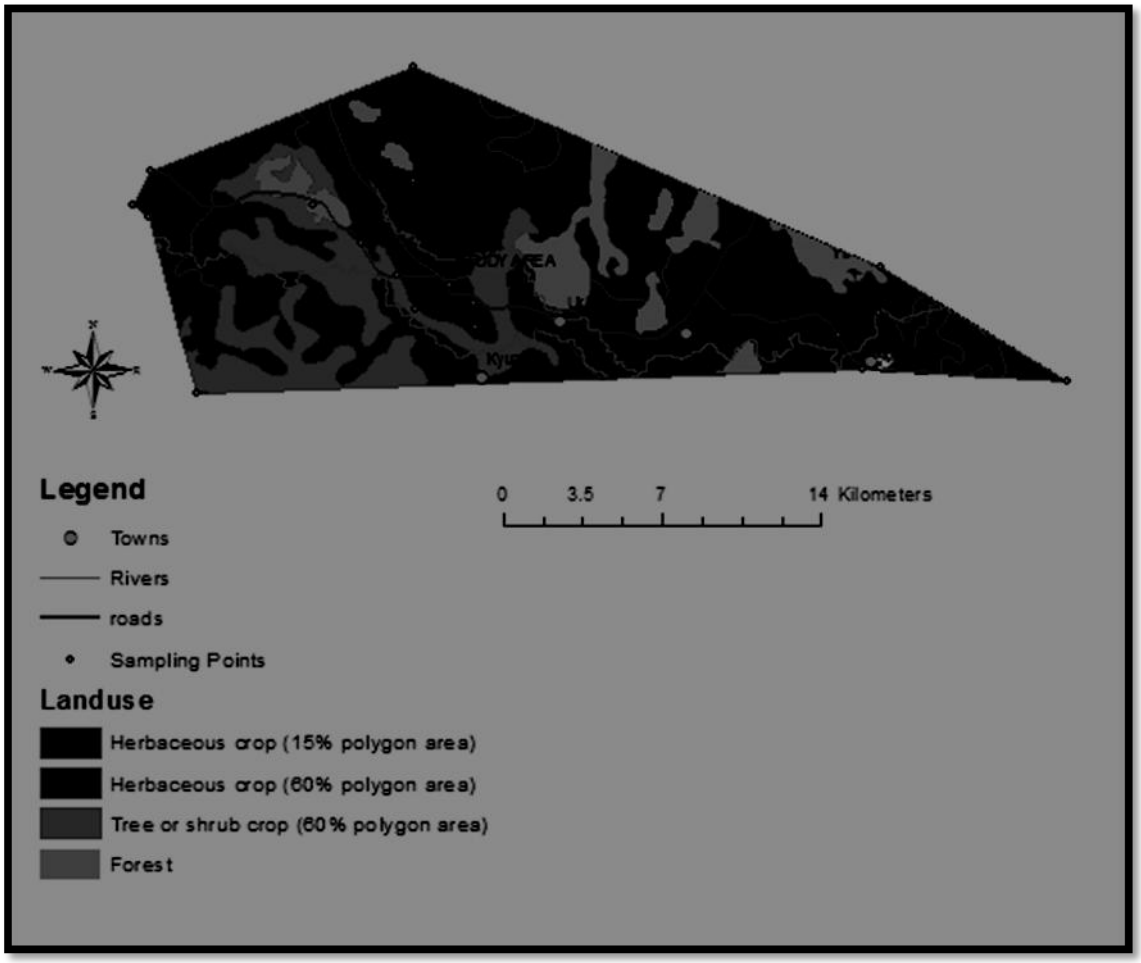

Figure 4.10 Land use categories

Infrastructure development (Plate 4.4), i.e. roads, schools and earth dams has also contributed to land degradation in the watershed. Infrastructure development has considerably increased in the recent years in form of roads, schools and earth dams (Onyango *et al.* 2013; GOK, 2013). There is neglect of maintenance of the rural roads which influence formation of gullies, crossing over to grazing land and ridges in the upper hilly areas causing large tracts of land to be denuded. In some cases soil and water erosion action happens in far places from the roads infrastructure sites. This has impacted negatively on farms and grazing lands as well as increasing sedimentation in rivers downstream.

Plate 4.4: Gulley formation from soil and water erosion emanating from road infrastructure in Nunguni

The trend has increased mudflows and the widening of rivers and streams channels destroying riverbank forests and vegetation cover including adjacent farms during heavy rainstorms (Muia and Ndunda, 2013). Road construction has significantly contributed to degradation with severe impact in the hilly areas of the catchment area, leading to increased soil erosion. Water from the draining culverts collects in the ridges and run off increase leading to the watershed degradation observed in the area. Mining of soils for brick making was noticed in various areas along river banks

common in the lower and mid-stream area and past and present pottery activities in the upper watershed area has also influenced soil erosion and development of rills and gullies. There is also mining of soils in 3 areas in the upper watershed (Kilungu) which is transported to Athi River and Nairobi for chalk manufacturing. This is a serious form of land degradation witnessed in some hills around Nunguni area.

The other major land uses changes noticed to have occurred in the study area was the expansion of cultivation from the higher elevation to the mid and in the lower elevation zones. This trend intensified from the opening of Makueni settlement scheme in 1948 onwards (Tiffen *et al.* 1994; Jaetzold *et al.* 2006) which was basically a low lying and densely vegetated grassland. The newly introduced farming activities, included crop and livestock production, where food crops like maize, beans, cow peas, pigeon peas and green grams occupy the greatest percentage of crop production. These crops are grown by nearly all farmers with the intensity of legumes preference depending on the ecological zone, and mostly concentrated in the mid and upper watershed areas.

Terracing activities in the watershed were used in this study to understand the bio-physical changes in Kaiti sub-watershed. In 1985 an agricultural technical report indicated that 54% of the farms in the lower undulating landscapes were terraced, with fairly maintained terraces structures (Tiffen *et al.* 1994). Farmers acknowledged

that most of them were done by individual farmers themselves using hired labour and ``*mwethya''* groups in their farms. There was constant government and NGOs conservation measures in the area involved in promotion of conservation, afforestation, gulley control and water supply and promotion of better farming methods among other conservation issues in the area. Agricultural extension services were effectively supported by the government and the technical staff was in contact with farmers' right in their farms.

Farmers interviewed acknowledged that at the start of the 1980s decades such government and NGOs, supported conservation efforts were on the decline, together with agricultural extension services. This meant that the terraces constructed during this time to the present day are largely done on individual efforts without external support, with subsequent decline of organisations involved in SWC (Tiffen *et al.* 1994); Lemba, 2009).

Plate 4.5: A farmer in his farm with roadside run-off water harvesting, bench terracing with napier grass on the embankment

Generally from field verification, observation, satellite images and account of agricultural extension personnel in the area, terracing structures in the area remain intact as depicted in (Plate 4.5 and Fig.4.11). However, most of them are in a state of disrepair, generally neglected and not regularly maintained as required. In the absence of adequate agricultural extension services in the last 3 decades, some of the recent constructed terraces are not laid along the contour; aggravating soil and water erosion in Kaiti sub-watershed.

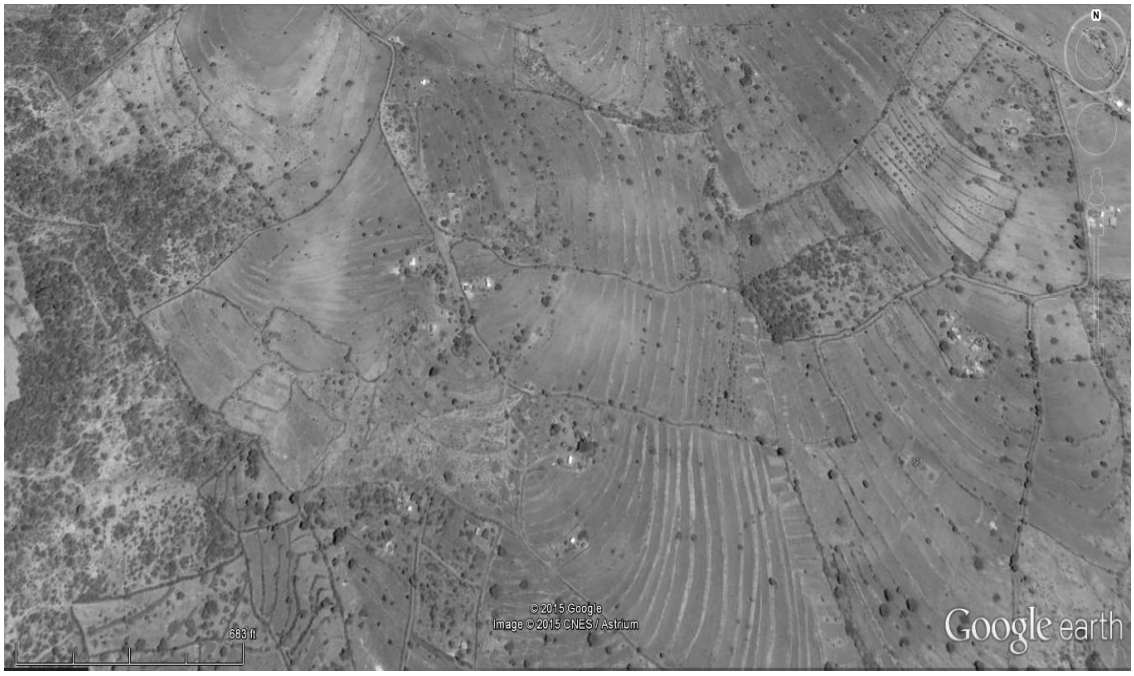

Fig 4.11: Terracing structures in the study area as depicted by Google earth Satellite image January, 2015

They were in agreement that cultivation on steep areas is on the increase without appropriate conservation measures in the majority of the farms. They noted that there is a generational change with majority of young farmers increasingly using inappropriate farming methods in the area. Majority of them lack knowledge on improved farming technologies and cannot afford the required agricultural technologies for effective terrace construction (CSTI, 2009; Onyango *et al.* 2013). They don't consult extension workers and experts before embarking on farming activities. These services and staff have drastically reduced and the few who exist are located in far areas beyond the reach of the majority of farmers

The findings of this study are in agreement with previous studies by (Tiffen *et al.* 1994; Ifejika *et al.* 2007; Onyango *et al.* 2013) on the importance of self help groups in conservation (terracing) work in the Past. However, currently the ``*mwethya*'' group activities (Fig. 4.12) of SWC has declined in the area with intermittent revival by NGOs supporting food for work programmes like German Agro- Action (GAA) and World vision. Their efforts in terracing have considerably declined because the NGOs operate in limited areas to have watershed wide impact.

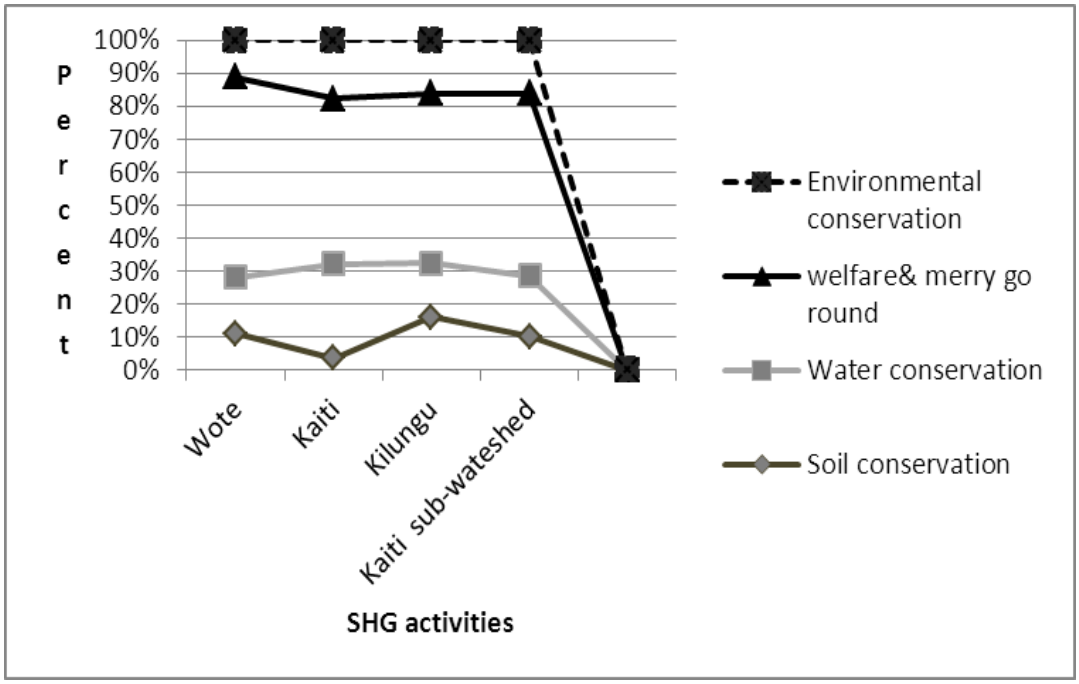

Figure 4.12*: Activities of ``mwethya'' groups (self Help Groups) in the study area*

Seventy five percent of the respondents indicated that welfare and merry go round activities at were the primary purposes and activities of the current ``*Mwethya*''

groups. Environmental conservation was practiced by 27%, soil conservation by 22% and water conservation by 14% of these groups. However they depended much on NGOs activities and presence, with most of the activities concentrated in welfare, tree nursery establishment for environmental conservation (Onyango *et al. 2013)*. Most of these NGOs implemented short term programmes to enable sustained action in watershed management, and widespread soil and water conservation in individual farms.

Farmers mentioned the high cost of agricultural inputs, farm implements and high cost of hired labour to construct and regularly maintain the terrace structures as an obstacle to effective SWC in the area. The high poverty in the area thus, prevents the majority of the farmers to adopt effective terracing. It was noted that SWC measures were only being undertaken, effectively by the well-off farmers who can afford hired labour for terrace construction and maintenance. In the farms where high value cropping like growing of oranges, mangoes, avocado and vegetables existed, the terraces were fairly in good conditions and there was evidence of regular maintenance of terrace structures. Therefore in the absence of proper maintenance of terrace structures, sheet and rill erosion in terraced farms has developed and is visible in the farms with neglected conservation structures. Gully formation is common along the edges of farm boundaries, cattle tracks and Pathways and roads in the area (Muia and Ndunda 2013). This has considerably increased land and water degradation in the watershed with bare land and gullies seen in open grazing lands in the lower watershed area and the parched and bare or scanty vegetated landscapes

common in the eastern parts of Kilungu hills in the upper catchment area. Lack of proper terraces is thus a further threat to the bio-physical conditions of the watershed as depicted by the decline of the quality of terraces.

In Kenya agro-forestry is acknowledged to be part of SWC and it has consistently been promoted since the advent of soil and water conservation methods in the country (Ovuka, 2001). In the area, therefore agro-forestry has grown in tandem with the other conservation measures, particularly bench terracing (Tiffen *et al.* 1994, Muriuki *et al.* 2005). There are 5 gazzetted government forests in the county, majority of them are found in the upper hilly parts of the county (GOK, 2013).The past agro-forestry efforts were predominantly insisting on local tree species, but the introduction of exotic tree species, around the time cash crop was introduced in area, has gained favour among the farmers.

Satellite images, farmers account and field observation indicated that planting of the exotic trees has been adopted in the watershed due to their fast maturing rates with, *Grevillea robusta, Eucalyptus Spp* and *Senna siamea* being the commonly planted exotic species. The former are commonly found to be grown along farm edges to demarcate farm lot boundaries and river banks. In the homesteads, school compounds and shopping centres, however, *G. robusta* and *S. siamea* were the common planted exotic species. Agro-forestry has been combined with bench

terracing with the embankment planted with nappier grass in the area (Muriuki *et al.* 2005). Agro-forestry in the upper watershed area in the recent years has gained prominence with farmers acknowledging that they plant trees for timber products, firewood fuels and foremost as a conservation measure in their farms. In the mid and the lower areas agro-forestry has also been widely adopted by farmers. However, these trees are commonly found in homesteads and schools.

4.2.3 Farmer's perceptions on land use and Environmental changes

The study attempted to understand farmers' perception on land use and environmental changes which have occurred in the watershed as a result of bio-physical changes and land use methods (Table 4.8). Farmer's perception in land uses and environmental change indicated that the farmers considered cultivation in fragile ecosystems, introduction of cash crops and exotic trees as some of the important land use changes in the watershed (Muriuki *et al.* 2005). The other factors mentioned were decline of SWC measures, climate change and rainfall variability deemed to have contributed to watershed degradation. Land use and biophysical changes in the watershed were found to have occurred with negative influence, variously affecting agricultural activities. Crop and livestock production were found to be on the decline in the area. Land sizes have decreased, soil erosion has increased and natural soil fertility is declining owing to these changes (Tiffen *et al.* 1994; Muia and Ndunda,

2013). They have led to the decline of land productivity, with majority of farmers acknowledging the increasing food insecurity threats in the watershed.

It was established that, introduction of cash crop farming, coffee and cotton constituted a major land use change in the area, with the farmers acknowledging of increased farming activities around these two crops (Table 4.3). During their peak time, several decades ago terracing in farms increased due to their perceived importance and profitability of the cash crops. Farmers could also relate on how the use of agro-chemicals and fertilisers increased, with these cash crops. The increase had adverse effects on the environment in the long term. Today they have to depend on agro-chemicals to realise high crop yields and harvest in many types of crop, some of which did not require agro- chemicals in the past, Pigeon peas and cow peas were mentioned as some crops which now require pesticides spraying. They could also relate to the improvement of peoples livelihoods from cash crop farming before it declined in the 1980s decades owing to marketing constraints and global decline of coffee and cotton prices (Tiffen *et al.* 1994; Lemba, 2009).

High value fruit crops like mangoes, citrus, avocado and vegetable growing are also considered as a major land use change (Onyango *et al.* 2013; GOK, 2013) in the area, with many farmers now embracing their growing, with different levels of success. The farmers indicated that fruit tree farming gives them incentive for soil

erosion conservation in form of terracing to increase water retention for their fruit tree management (Tiffen *et al.* 1994; Ovuka, 2001).

The introduction of exotic tree species like *Grevillea robusta* and *Eucalyptus Spp*. Were mentioned by farmers as another major land use change with evidence of these trees grown along farm edges and in the homesteads and public places like schools and other government/community institutions (Muriuki *et al.* 2005). Their preference however has continuously replaced the natural vegetation and tree species. In some cases, these trees are planted along riverbanks which may consequently lead to environmental changes with increased cases of drying up of rivers in the area. The farmers were aware of the negative effects but they preferred them due to their fast rate of maturity, timber products and as a major source of fuel woods in the face of depleted natural shrubs/vegetation which used to be an important fuel woods energy sources in the past.

Past studies done in the watershed Ifejika *et al.* (2007) and (Muhammad *et al.* 2010) concur that agriculture intensification adopted by farmers in the area, as a mitigation measure, constraints the farmers in form of high cost of agricultural inputs and scarcity of family labour. Farmers in their endeavors to increase crop and livestock production therefore are forced to adopt these costly measures. Since majority of them cannot easily afford them and improved agricultural technologies are

predisposed to use inappropriate land use methods and adoption of unsustainable livelihood strategies like charcoal burning and sand harvesting. They encroach to fragile ecosystems and neglect terrace structures which further leads to bio-physical changes.

Lack of markets for crop produce and the fruits also, makes agriculture to lose appeal among the young and the educated. Lack of employment opportunities and diversification of livelihoods, has had negative impact on the watershed, with more and more people depending on land for natural resources exploitation to anchor their livelihoods outcomes. Farmers were aware of the limited livelihoods opportunities and the dangers of the ever increasing cultivation activities in the backdrop of unsustainable fragmentation of land in some instances into uneconomically viable farm plots, now common in the watershed.

This situation is apparent in the mid and the upper stream areas, but it is also catching up in the rest of the watershed. The frequent droughts and famines according to the farmers has on various occasions decimated livestock, decreasing the numbers, hence exposing the farmers into financial vulnerability and minimising their resilience in case of crop failure. The elderly farmers indicated that the trend has affected terracing and other conservation measures, as profitable crop and livestock production enabled them to intensify terracing in their farms. The

decreasing profitability of farming activities leads to negligence of terracing in the farms and grazing lands where rill erosion is currently on the increase.

Downscaling of agricultural extension services and staff by the government is also acknowledged as a factor affecting sustainable agriculture. The failure to enforce the basic conservation laws and prudent use of natural resources, were recognized as key drivers of watershed degradation in the study area (Tiffen *et al.* 1994). Generally the farmers' awareness on SWC was found to be high and well regarded. They recounted the past conservation efforts and the immediate success, it brought to them when they adopted terracing measures on their farms. Some said that the technology spread fast in the low lands, brought by immigrants from the hilly upper areas of the county and beyond. Several generations of people, this far appreciates terracing technology learnt from their fathers and still considered viable and effective SWC measures in the area.

4.3 INSTITUTIONAL INVOLVEMENT AND FRAMEWORK FOR WATERSHED MANAGEMENT IN MAKUENI COUNTY

4.3.1 Watershed Management framework in Makueni County

Land, water and forests, are the main kinds of natural resources in the watershed mentioned by both the community and key informants. The current watershed NRM framework in the watershed focuses on specific resources management (Geiger, 2006; Munyasi *et al.* 2010). Its approach is disjointed and sectoral as opposed to integrated approach on all natural resources in the watershed which are interrelated and interdependent. The situation thus compromises environmental integrity and sustainability in natural resources management. These conditions are worsened by population growth which contributes to influx of more people moving into arid and semi-arid land (ASAL) (GOK, 2002).

Land is fragmented into uneconomical parcels, marginal lands are increasingly being cultivated, pastures are being overgrazed and forests encroached upon (Muia and Ndunda, 2013). The watershed management framework and NRM policies partly influence the unsustainable utilisation of natural resources a fact well corroborated by community respondents and key informants. They recognised government's failure to sustain adequate agricultural extension services, concrete enforcement of

basic conservation laws and land use management framework to be among issues that accelerate watershed degradation in the study area (Onyango *et al.* 2013).

Like in previous studies these findings confirm that, poverty predisposes people to adopt unsustainable livelihood strategies (DANIDA, 2003; Muhammad *et al.* 2010; Muia and Ndunda, 2013) contributing to Land degradation in Makueni watershed. Farmers and key informants indicated that there is degradation in the area which affects the various natural resources and the community. The NRM policies do not effectively address watershed management issues which continue to threaten the watershed with degradation owing to natural resources exploitation and utilisation. The respondents were in agreement that land use methods, livelihood strategies and the current NRM framework impact negatively in natural resources exploitation and utilisation. They indicated that the local community at 92% has been responsible for these changes, depicting high levels of awareness of the extent of watershed degradation in the study area (Fig 4.13.)

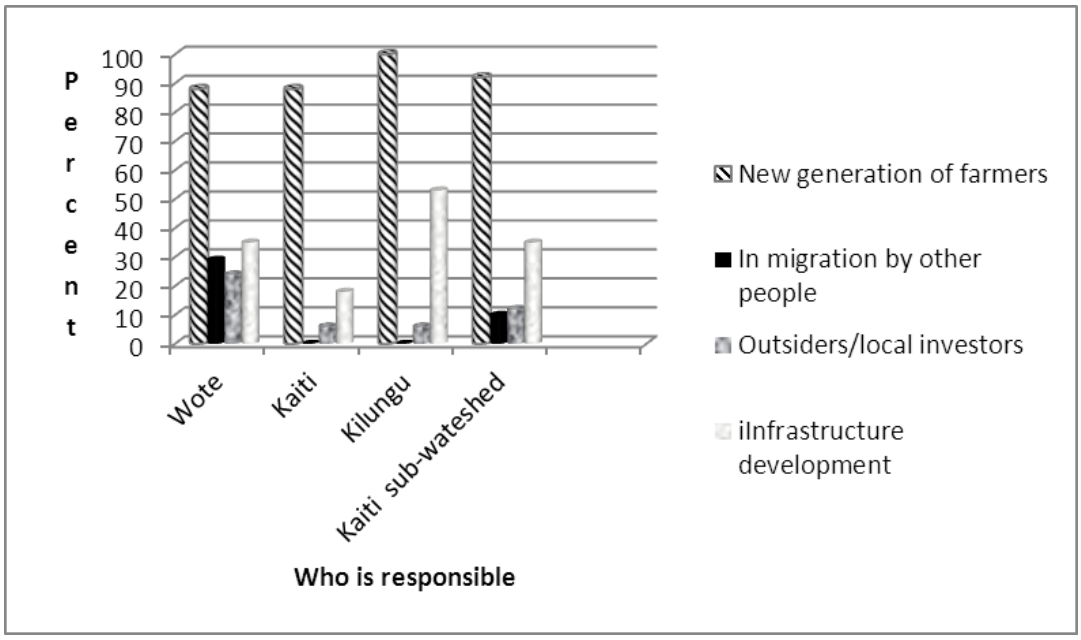

Figure 4.13: Factors or people responsible for land use changes

Reduction of forest and vegetation cover and increase in soil erosion were mentioned by 82% of the respondents as the most conspicuous indicators of degradation. Diminishing farm sizes and diminishing grazing lands were other notable indicators in the watershed, reported by 75% and 37% of the farmers respectively. Changes from seasonal crops to horticulture and from crops to grazing were also mentioned by some farmers (Table 4.10).

Table 4.10: Watershed degradation indicators affecting Makueni watershed

Watershed degradation indicators (Land use changes)								
	Lower zone Wote		**Mid zone Kaiti**		**Upper zone Kilungu**		**Kaiti sub watershed**	
	No.	%	No.	%	No.	%	No.	%
Diminishing farm sizes	13	76	10	59	15	88	38	75
Diminishing Grazing lands	13	76	2	12	4	24	19	37
Increase in soil erosion	15	88	14	82	13	76	42	82
Water scarcity	13	76	4	24	15	88	32	63
Reduction of forest cover	15	88	14	82	13	76	42	82
Grazing to crops	4	24	1	6	2	12	7	14
Seasonal crops to horticulture	5	29	2	12	2	12	9	18

Ninety percent of respondents at recognised drought and famine times as when these changes occurred rapidly. Elnino rainfall intensification and land sub-division were the other factors accelerating watershed degradation in the area, reported by 73% and 39% of the respondents (Fig.4.14).

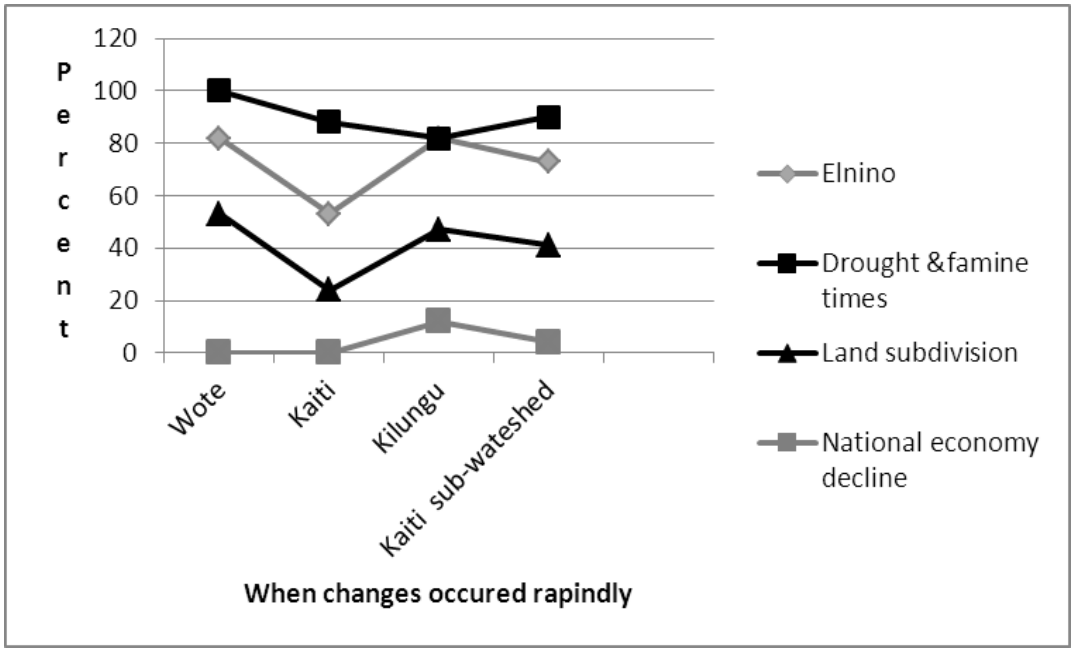

Figure 4.14: When changes occurred rapidly

From the findings of this study 75% the farmers indicated that they were aware of the benefits of a well-managed watershed with availability of water resources and 82% of them mentioned, improved food production and 63% reduced poverty and improved income mentioned as some of the benefits farmers would expect to get in a well managed watershed (Fig.4.15)

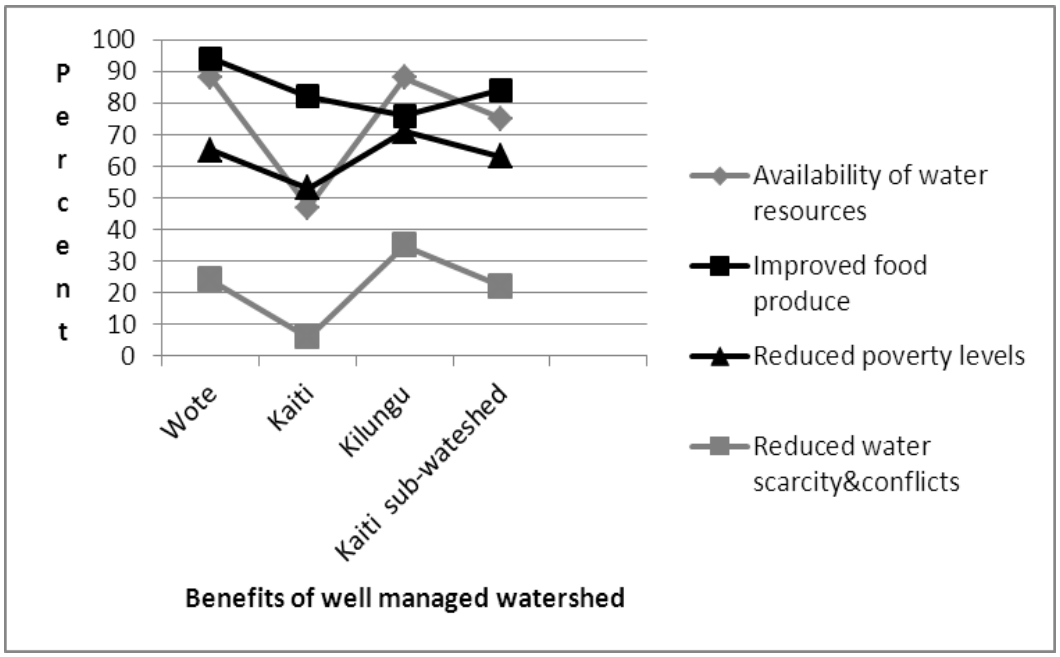

Figure 4.15: Benefits of well managed watershed

It is therefore clear that watershed degradation has reached critical levels 88% as a major concern to warrant urgent attention for the government to regulate the use of natural resources in the watershed. It also indicated that the current NRM framework is inadequate and lacks mechanisms to entrench sustainable natural resource management (Munyasi *et al.* 2010). There is lack of coordination among the various NRM actors and institutions. There is no framework to enforce basic conservation laws to prevent rampant encroachment to fragile ecosystems by agro-pastoralists. Cultivation along riverbanks and sloppy or hilly areas beyond 35 degrees has been on the increase with disregard of basic conservation laws by farmers.

Soil and water conservation measures in cultivated and grazing lands, has been on the decline with agricultural extension services operating at the minimum to the detriment of the watersheds environmental integrity (Tiffen, *et.al,* 1994; Muriuki *et al.* 2005). The national and county governments lack mechanisms for rehabilitation of degraded lands and prevention of further watershed degradation to safeguard the natural resource base in the county. Soil and water erosion control, protection of river banks, water catchment areas (springs and wetlands) as well as enforcing mandatory vegetation cover on all kinds of land uses is not effectively practiced (Muia and Ndunda, 2013). These strategies were reported by some respondents to have been used in the past with success particularly in the early years of Makueni settlement scheme.

During this period agricultural extension services were widely available to farmers, there was strong soil and water conservation measures and funding by the government and NGOs. The national and county government watershed management framework and NRM policies if well formulated and applied could be used and enforced as measures to address soil erosion and watershed degradation (Tiffen *et al.* 1994; GOK, 2013). Control of pollution and implementation of integrated natural resource management framework as well as increased funding for watershed management could be adopted in the watershed (Wamalwa, 2009). The current disjointed sectoral approach in Natural Resource Management work against

sustainable management of natural resources because it largely contributes to degradation and unsustainable natural resources exploitation and utilisation.

4.3.2 Institutions involved in watershed management, NRM and Community Participation

The study established that currently, there are numerous institutions involved in natural resources management in Kaiti sub- watershed (Table 4.11). Government line ministries and departments, such as ministry of water, Ministry of Agriculture, Livestock& Food Security Ministry of Lands Urban planning Environment Management and forestry department have technical staff on the ground among others (Emongor *et al.* 2010; Munyasi *et al.* 2010). Various government parastatals like National Environment Management Authority (NEMA) and Athi Basin water boards, Water Resources Management Authority (WRMA) also operate in the watershed. There are also NGOs among them PAFRI, World Vision and various United Nations agencies such as WFP and FAO, who have a variety of activities in natural resource management. Other organizations working in the area included USAID, AMREF and Action Aid as well as the private sector.

Table 4.11: Institutions and organisations involved in Kaiti sub-watershed and their roles in NRM

Name of institution/organization	Roles in NRM
1. Ministry of Lands Urban planning	Land management and planning
2. Ministry of Agriculture, Livestock&	Agriculture &livestock devt., SWC
3. Ministry of Water	Water resources development
4. NEMA	Environmental impact assessment
5. WRMA & WRUAs	Water resources management
6. Athi Water Board	Water resources development
7. KFS & CFAs	Forestry resources management
8. USAID	WASH and livelihood programmes
9. FAO	Food security and Agriculture
10. WFP	Livelihoods and Environmental
11. AMREF	Water, Sanitation and livelihoods
12. PAFRI	Kaiti sub- watershed management
13. World Vision	Water, Sanitation and livelihoods
14. Action Aid	Water resources and livelihoods
15. Utooni Community Programme	Water and Livelihood programmes
16. KEFRI	Forestry resource development
17. ICRISAT	Agricultural research and extension
18. World neighbours	Water and Livelihood programmes

Key informants drawn from government line ministries and departments and NGOs indicated that they dealt with different issues in the watershed, such as agriculture and crop production, soil and water conservation, agro-forestry, drought mitigation and environmental conservation. Nearly all of them maintained that they work closely with local communities and they have put structures for stakeholder and community participation in planning and decisions making, as per their individual departments and organisations policies (Emongor *et al.* 2010). They also confirmed that they incorporated local community knowledge in their decision making and implementation of their programmes.

However farmer respondents gave a different perspective of the existing NRM policies and different institutions and their involvement in watershed management. Thirty one percent of them indicated that they were involved in some kind of participation in implementation of watershed development programmes. This is despite the question being specific on water projects, a crucial component in watershed management (Geiger, 2006; Wamalwa, 2009). The majority of the respondents (67%) maintained that these institutions never involved them in decision making and implementation of projects. Where involvement and participation was declared they agreed that it was passive in form of consultative meetings, with most of the decisions largely remaining with the implementing agencies and their staff (Fig.4.16).

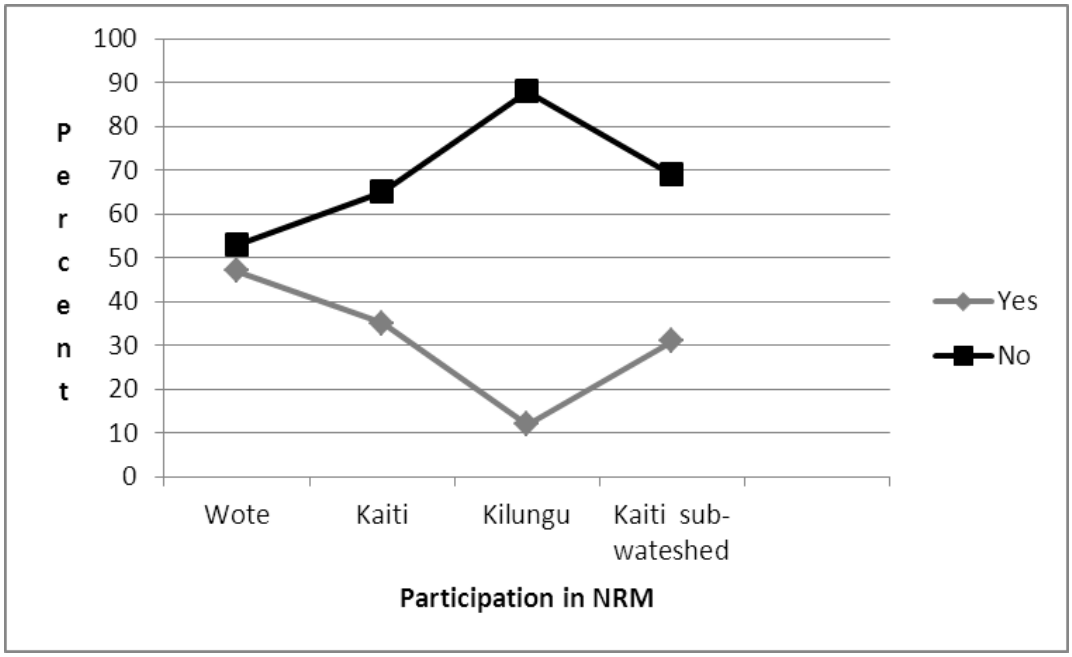

Figure 4.16: Community participation in water and natural resources management

Forty seven percent of those who admitted to have participated in projects implementation were found in Wote and 37% in Kaiti divisions respectively where there was strong presence of NGOs such as PAFRI and World neighbours currently implementing watershed protection programmes in these areas. Ministries of agriculture and forestry departments were commonly mentioned to have had their presence felt in the three areas providing trainings on soil and water conservation and agro-forestry development.

The overall involvement and participation across the organisations was found to have been minimal, at most being involved in consultative forums and meetings. The power of decision making rested with the implementation agencies and the technical staff as stipulated in their individual organisations policies (Geiger, 2006). The element of integration and complimentary roles in addressing watershed management is currently missing in the institutional framework operating in the study area (Munyasi *et al.* 2010). Community respondents indicated that some decisions such as location of projects and priotisation were among issues they have no control over. Political considerations and preference of local leaders often prevailed against their wishes. Some projects were sometimes priotised to the disenfranchisement of the actual beneficiaries and in some cases where external interests were vested; the projects either had taken long time to complete or had stalled all-together.

The government line ministries and parastatals were equally bound by national policies which hinter meaningful community involvement and participation, a factor the key informants were aware and pointed out (Emongor *et al.* 2010; Munyasi *et al.* 2010). They indicated that some policies although good on paper, they are not effectively implemented due to financial constraints and inadequate personnel. Farmers likewise were aware of the limitations inherent in the implementation of environmental policies in the watershed with majority stating that environmental policy is not effectively implemented in the watershed, a trend which aggravates

watershed degradation (Muriuki *et al.* 2005; Muia and Ndunda, 2013). The findings indicated that the various institutions involved in development programmes in the watershed pursued sectoral approaches instead of multi-sectoral approach which has the ability to identify and anchor sustainable implementation strategies.

Lack of community participation and top down approaches (Fig. 4.17) in decision making takes precedence and professional inclinations in the various departments and agencies constrain effective watershed management (Emongor *et al.* 2010; Munyasi *et al.* 2010). There were too many professionals from the natural sciences involved in management issues as compared to other disciplines which are equally important and recognized as citadels for effective watershed management. The government line ministries and NGOs were staffed with professionals with key competencies in sector specific aspects of their projects and sector specialisation. This happens despite the fact that the departments have cross-cutting issues, not adequately addressed in the current human resources policies and inclination. An effective framework would require multi-disciplinary approach (Wamalwa, 2009) to ensure that all the actors and stakeholders are effectively involved and engaged. Various disciplines such as hydrology, economics, law, engineering and sociology/anthropology among others are important and crucial in watershed management.

The complex environmental interconnectedness and interdependence require an integrated approach and involvement of the local community and other stakeholders to appreciate and be engaged in all the issues pertaining to watershed management (Bach *et al.* 2011). Sectoral and disjointed approaches currently employed in Makueni watershed management are bound to fail and miss out some important aspects which eventually compromise the state of the watershed as degradation continues despite the various development strategies undertaken in the area.

Farmers and key informants demonstrated awareness on some of these shortcomings and were willing to work towards sustainable management of the watershed resources. The current conservation laws and policies pose challenges in implementation, with various conflicting mandates expressed by the key informants. Examples are NEMA and WRMA, where conflicting mandate of implementation overlap leaving room for failure in execution of the mandate by these agencies. In most of these policies there are no mechanisms to address localised issues as most of them are designed for application at national level (Wamalwa, 2009).

There is also bureaucracy and vesting of power to the minister to appoint members of various boards and approval of members at the lower segments. In the water Act, 2002 Catchment Areas Advisory Committees (CAACs), members are appointed by water boards and WRMA, with approval from the minister. Majority of the local residents were not aware of these structures and the roles they have to play in water

resources management currently touted as one of the most reformed implementation strategy. Coordination of watershed management activities in the area presented another challenge, because the line ministries, various NGOs and the private sector work independent of each other with duplication of roles and duties as well as use of scarce resources in an unsustainable manner (Munyasi *et al.* 2010). Individual organisations policies and laws provide guidelines to the various actors on how they should approach watershed management which leads to wastage of meager resources in implementing disjointed non-sustainable projects.

The local communities' involvement and participation in such a situation becomes difficulty to entrench because each of these organisations relies on its technical staff for projects implementation at the expense of community needs, priotisation and implementation. This explains clearly why the local communities perceive the institutions involved in natural resources management to have been working in isolation with them. The projects and programmes undertaken in the watershed lacked meaningful involvement and participation of the local communities (Emongor *et al.* 2010; Munyasi *et al.* 2010). This trend impacts negatively on the watershed as the local communities are left out, yet it is their individual actions which significantly contribute to watershed degradation. The sense of ownership and involvement among the local residents in these projects is lacking, further confounding the governments and other organisations efforts in watershed management.

4.3.3 Challenges in the current watershed management framework and NRM policies in addressing watershed degradation

Watersheds, the world over face a range of degradation challenges among them pollution, deforestation, changes in sedimentation (Bach *et al.* 2011; Muia and Ndunda, 2013). Human activities and natural resources extraction fragment and destroy natural habitats, with forest and wetland resource losses, impacting on many plant and animal species in both aquatic and terrestrial habitats. The loss leads to increase in overland flow and significant reduction of filtration of sediments and pollutants which consequently find their way into streams, rivers and estuaries contributing to water pollution. Individual human activities have smaller and predictable impacts whose cumulative effects together with habitat modification have profound and detrimental impact to the environment, (Gichuki, 2000; EPA, 2001). There are numerous institutional capacity challenges in addressing watershed degradation as attested by the analysis of this study (Fig. 4.17).

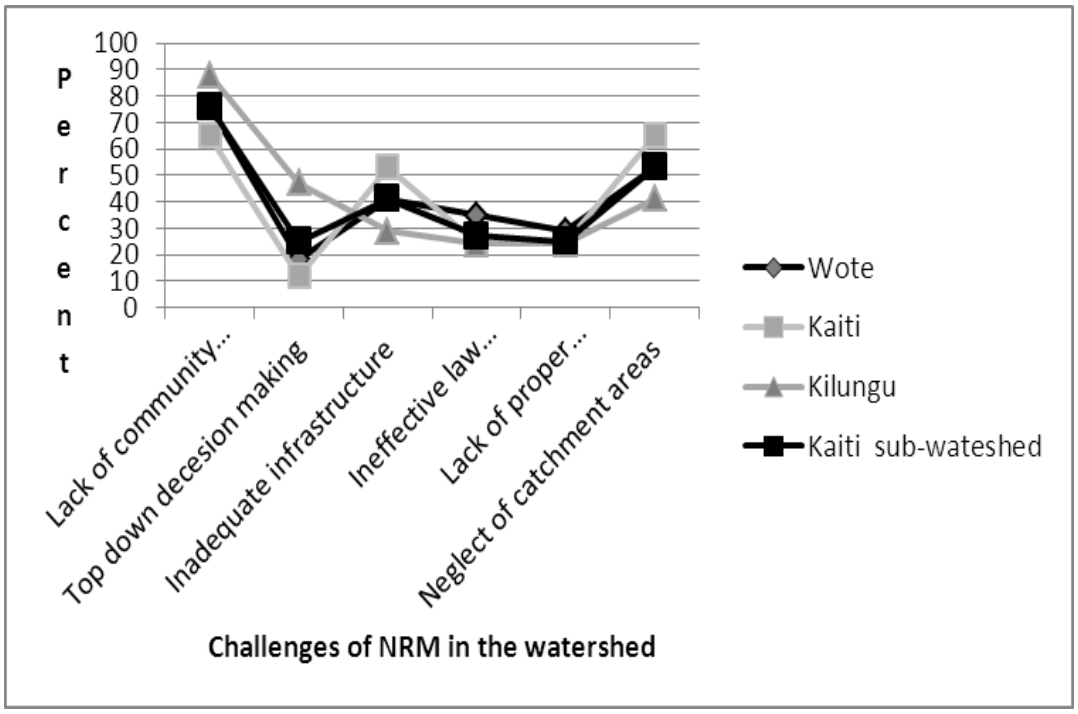

Figure 4.17**: **Challenges in integrated natural resources management

Seventy six percent of the farmers mentioned lack of community involvement, top down decision making 28%, inadequate infrastructure 41%, neglect of catchment areas and inadequate communication as some of the challenges affecting implementation of integrated watershed management in Kaiti sub-watershed. The high levels of farmer's knowledge and understanding of these challenges indicates that they were aware of the gaps in the current watershed management framework in Kaiti.

These challenges posed various watershed degradation problems in implementation of natural resources management programmes in the study area. The government and other development partners have not applied holistic strategies to address watershed degradation problems mostly adopting sectoral approaches (Geiger, 2006; Wamalwa, 2009; Munyasi *et al.* 2010). The local communities and stakeholders participation in natural resources management in the area is lacking and communities' involvement is at most relegated to the periphery with occasional passive consultative meetings. Watershed wide natural resources management framework is lacking, with the sectoral and disjointed approaches taking precedence to the detriment of the watersheds environmental health and integrity (Emongor, *et al.* 2010; Munyasi *et al.* 2010).

There is general failure of NRM framework in recognising that natural resources are interrelated and interdependent in the complex ecosystem found in the watershed. The management structures inherently focus on specific resources (sector based approach) as opposed to focusing the watershed wide management of all the natural resources (Wamalwa, 2009). Lack of local community's involvement and participation negate the issues of sustainability making it difficult to address watershed degradation and increasing the overall environmental integrity of the watershed. For example the study revealed that water scarcity mentioned by 63% of the respondents (Table 4.10) in particular is a major problem in the watershed which is caused by the growing competing water demand in uses like domestic, irrigation,

commercial activities amidst surface and ground water decline in terms of quantity (Gichuki, 2000; Geiger, 2006).

NRM policies and institutional capacity to address water scarcity and water infrastructure development is wanting in an area classified as water scarce (WRMA, 2006: GOK, 2012). Majority of the respondents confirmed that water infrastructure was underdeveloped in the area as depicted by their low participation levels in water resources management. Where there was notable community participation it was due to their proximity to a functioning water project like a borehole, sand dam or sub-surface earth dam. These projects were few and far apart, with a number of incomplete and abandoned water projects due to breakdowns and mismanagement or lack of adequate funding (Plate 4.6). Institutional capacity and NRM policies have a bearing in water scarcity or its availability. Water scarcity is also aggravated by the fact that the county water infrastructure management and distribution is underdeveloped with low piped water connection in both urban and rural populations in the watershed (Geiger, 2006; WRMA, 2006; GOK, 2013).

Plate 4.6: An incomplete water project near Nduu primary school in Kilungu division

Soil erosion, sedimentation and high evaporation rates affect earth dams and water pans with their insufficient holding capacity increasing by the day to the detriment of the residents and livestock (Gichuki, 2000). Most of them are not regularly desilted and properly maintained. Frequent droughts and long dry spells impact negatively on water resources with disproportionate engagement in unsustainable livelihoods strategies like sand harvesting and brick making along river banks (Ifejika *et al.* 2007; Muia and Ndunda, 2013). These activities worsen run off, drying of riverbeds, siltation and sedimentation of water reservoirs. This impact negatively in the overall

availability of water resources in the watershed dotted with large swathes of barren and denuded land cover ground, where infiltration decreases causing most of the water run-off into collection ditches where stream channel erosion occurs. Reduced infiltration may result in less recharge of the ground water stored in aquifers (Muriuki *et al.* 2005; Shukla, 2013) which together with surface water availability are important in watersheds in order for them to effectively provide the various environmental goods and services.

The findings of this study as well as farmers account testified to the fact that springs, wetlands and rivers beds have dried up posing negative challenges to the community, faced with water scarcity. The NRM policies have not been effectively used to protect such fragile ecosystems. Generally water catchment areas are neglected without proper delineation and protection of such water catchment citadels. There is hardly any visible land earmarked for that purpose and properly protected as water catchment areas with the exception of the few government forest land in the watershed. The forest land is not immune to human activities either, springs and wetlands have been interfered with farming and grazing activities witnessed in such areas (Makau, 2014).

Their conservation and protection is inadequate as well of that of river line ecosystems throughout the watershed. Micro-irrigation has declined considerably in the mid and upper catchment areas increasing food insecurity and affecting livelihood strategies of the people (Muriuki *et al.* 2005). In the lower catchment area the respondents mentioned the long distances they travel to get water and drying up of rivers and streams as a major challenge. Sedimentation and siltation of earth dams exposed them to water scarcity and declined water quality (Onyango *et al.* 2013). The scenario confirms the national and county government's policies face implementation bottlenecks on the ground owing to ineffective NRM policies (Munyasi *et al.* 2010), inadequate funding and failure to enforce basic conservation laws together with insufficient agricultural extension services and farm outreach services (Onyango *et al.* 2013).

4.3.4 Institutional policy reforms in Water Act, 2002 and Forestry Act, 2005 and their impact on watershed management

The importance of watersheds management and ecosystems in the country cannot be ignored in the view of the important services they provide for economic and livelihoods sustenance to the populations (Gichuki, 1991; Wamalwa, 2009).The government of Kenya through parliament legislation unveiled institutional policy reforms in water Act 2002 and Forestry Act 2005, to help the country in management of its natural resources. The previous water management systems were sectoral, technical driven and centralised which proved to be inadequate. However the water sector reforms oriented Water Act, 2002, revised in 2012 Cap 372 provides for

integrated water resources management, use, development, conservation, protection and control of water resources within each catchment area (GOK, 2002; Wamalwa, 2009). The new constitutional dispensation anticipates community participation in decision making processes (G.O.K, 2010).

The Act also provides for the establishment of local Catchment Area Advisory Committees (CAACs) with the mandate to advice and coordinate protection and conservation of catchment areas. It also advocates for provision of mechanism and facilitation for enabling the public and communities to participate in management of water resources within each catchment area (Wamalwa, 2009). The Forest Act 2005 also revised in 2012 advocates for establishment of Forest Conservancy Areas (FCAs) and Community Forest Associations (CFAs) committees to enhance catchment areas and forests protection and conservation. Despite the existence of these progressive laws majority of the community respondents, testified that they were not aware of their existence. The key informants were aware of them and admitted that they are not effectively applied in watershed management in the study area.

These two reformist approaches in NRM come close to meaningful local community involvement in watershed management, hence their adoption in this study to understand institutions involvement and community participation in Kaiti sub-

watershed. Their existence, however remain removed from the local communities as the study findings indicated that majority of the respondents were not aware of them or their involvement and participation in watershed management programmes was minimal (Fig. 4.17). The Key informants also hailed them as important laws but admitted that, they are largely on paper to have any meaningful impact to the local communities.

Too much control is vested with the minister and the various localised boards whose appointees are not necessary from the local communities, and who are externally appointed. The water Act, 2002 is narrowly focused on water resource management to the exclusion of other natural resources such as land, forests and wildlife and their interdependence (Wamalwa, 2009). Local community participation is consigned to passive involvement in decision making. It vests coordination to WRMA an entity far removed from the local community as opposed to the CAACs and Water Resources Use Associations) (WRUAs) at lower levels, whose composition is also not truly representative to the local community interests and knowledge (GOK, 2002).

Community awareness strategies and publicity is not clearly spelt in the Act. It has conflicting coordination and implementation mandate with NEMA and there is no mechanism for funding of watershed management activities which are costly and

require massive financial resources to actualise sustainable management. The policy for funding is not explicitly spelt out, meaning that most of the activities rely on donor funds and external funding sources, depending on availability and willing donors. It lacks clear cut administrative structures and participatory monitoring and evaluation strategies to ensure that watershed management activities are implemented and sustainability guaranteed (Wamalwa, 2009).

The forest Act 2005 provides for community participation in forests management, through CFAs with membership drawn from among the people living near forests and who are interested in forest conservation. However like the water Act 2002, the top down approaches and legislation on national scale inhibits its success. The Act in some instances leaves out the ministry of agriculture as a key stakeholder at policy level (GOK, 2005), yet at the lower levels its personnel are actively engaged in agro-forestry activities. Its staff is fairly well distributed in the rural areas where they interact with local communities. The M.O.A staffs in the study area were the most acknowledged by the respondents to have been involved in soil and conservation measures.

At the policy level it is actively involved in conservation work and enforcement of laws and determining the fragile ecosystems not to cultivate in hilly areas where most of the established forests are found. It is ironical that at the local level their

involvement is not provided for which negates sustainability of the implementation strategies. Whereas the local communities can be interested in conservation matters consent must be sought from the director of forestry. Bureaucracy and elitist decision making organs are far removed from the local communities and they don't auger well for effective local community involvement and participation (GOK, 2005; Wamalwa, 2009).This clearly shows that these reformist laws are inadequate for effective integrated management of natural resources in the watershed. The policies sectoral approaches and lack of their full implementation by the national/county governments renders them ineffective in addressing the current watershed challenges in the study area.

The study found out that institutional capacity and framework for Natural Resource management in Kaiti sub-watershed watershed exists in form of government line ministries, NGOs and other actors in the private sector. They manage the various natural resources in the watershed, most of which are threatened with unsustainable exploitation and utilisation in the face of population pressure and high poverty levels in the area (Muriuki *et al.* 2005; Muia and Ndunda, 2013). The current management structures, policies and laws are inadequate to effectively entrench sustainable management of the natural resources in the watershed. The various actors act separately in disjointed and sectoral approaches, each bound by their individual agencies or organizations policies (Emongor *et al.* 2010; Munyasi *et al.* 2010). Community participation is generally relegated to passive involvement in

consultative meetings, with the power relations to make decisions resting with these organizations and their technical staff.

The policy reforms in water Act 2002 and forestry Act, 2005, presents an opportunity in addressing some of these challenges, as vibrant local community involvement and local knowledge integration in management of natural resources is strongly advocated and recommended (Wamalwa, 2009). However, despite the existence of these reformed laws, the watershed continues to face difficulties in watershed management due to lack of national and county government's mechanisms to entrench them in their implementation strategies. It is important to note that these two Acts are sectoral oriented and limited in scope to fully address watershed wide natural resources management. Further reformist policies anchored on multi-sectoral approaches could entrench integrated watershed natural resources management to capture all the natural resources found in the area and other key factors that enhance integrated management approaches (Agwata, 2006; Bach *et al.* 2011). Proper coordination strategies and mechanisms of active involvement of communities are desirable for sustainability. It is imperative to note that strengthened capacity building to the communities to create awareness on the importance of sustainable resources and watershed management could ensure that the watersheds environmental integrity is ultimately guaranteed.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study established that population growth, increase in poverty, climate change and rainfall variability and socio-economic dynamics influences watershed degradation in Kaiti sub-watershed. Crop and livestock production was the main economic activities. Farmers relied on family labour for their farm work and subsistence farming in form of growing maize and beans which was the major type of land use. These factors, predisposes farmers to adopt unsustainable land management practices and livelihood strategies such as cultivation in fragile ecosystems along river banks and on hilly and sloppy areas, charcoal burning, sand harvesting and soil mining.

These activities increase soil erosion, affecting soil fertility, compromising land productivity leading to low food production and the increase of food insecurity. Cash crop farming, SWC measures and agricultural extension services were on the decline. Farmers have adopted inappropriate farming methods like continuous planting of maize in the same plots and planting of uncertified seeds due to high cost of agricultural inputs and low adoption of appropriate agriculture technologies. Economic opportunities and Livelihood diversification strategies were limited and

constrained to the detriment of the local community and the watersheds environmental integrity.

The findings indicated that as population growth and poverty increases, it influences land use changes and biophysical changes which have contributed to watershed degradation in the study area. There has been increased cultivation on fragile ecosystems, riverbanks, hilly and sloping areas as well as overgrazing and illegal encroachment in forest land clearing forests and vegetation cover. These activities have led to increased soil erosion, siltation and sedimentation of rivers and man-made water reservoirs, leading to low food production and scarcity and low quality or quantity of water resources for domestic consumption and micro-irrigation. Land use in subsistence crop production, settlement and infrastructure development expands in the absence of robust SWC measures and agricultural extension services. Land use policy and management practices were not effectively applied in the watershed. Some farms and grazing lands lacked appropriate SWC measures and structures such as terraces. Terracing has declined in the last few decades with some structures in a state of disrepair and neglect due to lack of regular maintenance leading to watershed degradation.

The study established that anthropogenic factors and natural processes influence biophysical changes such as decline of ground water, increase in soil erosion; soil fertility decline and decline of forest and vegetation cover which influences watershed degradation. Introduction of cash crops, exotic trees, increasing low soil fertility, increased chemical fertiliser use; limited livelihood strategies, climate change and rainfall variability were mentioned by the farmers as some of the changes to have occurred in the study area with both positive and negative impacts which continue to influence land use and livelihood strategies in the watershed.

The current institutional involvement and NRM policy in watershed management is inadequate further influencing watershed degradation. The management framework is sectoral based with disjointed strategies, by different actors in government line ministries, NGOs and the private sector each working separately and driven by their individual organizations guidelines and policies. The institutional involvement and the current implementation strategy is limited by implementation challenges such as lack of community involvement and participation, top down decision making, inadequate infrastructure and to some extent lack of adequate personnel. Ineffective law enforcement, inadequate communication strategies and neglect of water catchment areas, are other notable problems.

These issues are further complicated by the inherent watershed challenges existing in the watershed which included poor land use methods, water scarcity, forests and vegetation cover clearance, ineffective land policies and enforcement of basic conservation laws and land and water pollution. The institutional involvement faced

with those challenges could not be said to be robust enough to address watershed degradation issues, especially when hinged on sectoral approaches prodding for execution of management of certain resources (i.e. water) at the exclusion of the other natural resources in the study area.

The study found that, despite the existence of reforms oriented water act 2002 and forestry act 2005 both reviewed in 2012. The NRM framework in the watershed continues to eschew sectoral approaches. This largely excludes the local communities in watershed management programmes, which is detrimental to the environmental integrity of the watershed. The local communities and key informants were inclined to policy paradigm shift to enjoin the local knowledge in planning and implementation of watershed programmes. There perception and understanding of the problems entirely hinged on the experiences, qualifies them to be key partners in these programmes. This understanding and resilience points to a situation which could be improved if watershed wide thought NRM framework is explored and articulated to all the actors including the local communities.

Past experiences with SWC measures, the success of programmes and new ventures like cash crop farming, exotic tree and fruit farming indicate that the local communities are interested in sustainable approaches to natural resources exploitation and watershed management. New knowledge and success models with proven success obviously hold key to solving some of the watershed degradation problems in the area. The renewed individual and community interests in realising sustainable livelihood strategies and increased profitability from agro-pastoralism is

evident in individual farmer's efforts to increase SWC measures in their farms. This happens, despite the challenges of high cost of agricultural inputs and appropriate technologies. Communication channels, mass media (Radio), now plays a key role in farmer education. It affords them avenues for marketing of farm produce, weather forecast and linkage with alternative farming opportunities. This evolution gives hope that incorporation of information communication technology (ICT) has the potential to unlock opportunities and empower the communities to be in the forefront to maximise their livelihood outcomes as well as safeguard the environment.

5.2 Recommendations

From the analysis of this results therefore the study recommends, adoption of integrated watershed management approach in favour of the current management which has sectoral approach to natural resources management. The current practice largely focuses on single types of natural resources leaving out the rest. Integrated watershed management with multi-sectoral interdisciplinary approach, (both natural sciences and social sciences) will seal the loopholes inherent in sectoral oriented management framework. This is because it incorporates local knowledge, culture and belief systems in the NRM policies. Such an approach should be people centred with the local community and stakeholders fully involved in watershed management decisions.

The county and the national government should be working closely with complimentary roles in natural resources management in terms of policy guidelines development and support. It should ensure that regulation framework for natural resources utilisation and exploitation is in place. It should also review the current institutional framework and establish proper management structures with well-defined roles, coordination and implementation mandate. The current bottlenecks in coordination and conflicting mandate should be eliminated in integrated watershed management where watershed natural resources are managed in totality not just focusing on one or a few of natural resources for sustainability. The county government should initiate a process of mapping all the natural resources in the watershed to determine their locality of existence, abundance or scarcity and delineate all the fragile ecosystems with the aim of developing strategies and policies for sustainable management, utilisation, rehabilitation and conservation of such resources.

Those benefiting from such proceeds whether in the local community or business communities should be made to pay for the services and initiate further conservation projects to conserve the environment. The county government and NEMA should make it mandatory for all development projects within the watershed to undergo EIA and EMPs executed on them before approval. There should be regular inspection and monitoring of such projects to ensure that environmental policies and laws are adhered to. Restoration of environmental integrity by proposers of development

projects should be effectively monitored and enforced to ensure that they restore the environment where their activities have interfered with.

The county and national governments should promote and support SWC measures with such appropriate structures as required being mandatory in all types of land uses. Strengthening of agricultural extension services and enforcement of SWC laws should be a priority to address the current watershed degradation challenges. Increasing the personnel, conservation funding and devolving of extension services to the lowest administrative levels will enable these officers closely work with farmers. Their constant monitoring and evaluation of SWC trends will ensure that timely reports on degradation threats in different areas are identified and acted upon immediately to remedy on the nascent threats. Appropriate basic conservation laws and rules should be formulated based on the local conditions in the watershed. They should be applied and enforced at all times with promotion of sustainable agriculture and training of farmers. This should include; - SWC measures, importance of FYM, proper choice and use of chemical fertilisers and pesticides, agro-forestry and appropriate tree species, slope protection and sedimentation control, crop and livestock disease control, value addition, cooperative societies and commodity based association among others.

Livelihood diversification options for creation of off-farm activities are required in the watershed for economic engagement and employment opportunities through value addition of farm produce and establishment of agro-processing industries which can employ the people. Support of Income Generation Activities in different segments of the rural economy, can increase farmers' resilience and enhance livelihood diversification. Alternative rural energy technologies, promotion of trade and small medium business enterprise are other strategies which can be strengthened. Development of micro-finance for small-scale business start-ups will definitely widen the scope for local residents to diversify their livelihood strategies. Provision of education in both formal and informal sectors to increase technical expertise and life skills will also prepare them for better livelihood outcomes and choices. Strengthening of cooperative societies and commodity based farmer associations for farm produce marketing will improve on crop and livestock production. These strategies will increase livelihood diversification options to the local communities and free many people from dominantly relying on the environment for their livelihood outcomes.

The county government should promote and support afforestation programmes in the watershed with mandatory requirement for all land users to maintain sufficient vegetation cover in their farms and grazing lands. These should also extend to public institutions like schools promoting the green schools conservation concept. Other institutions like churches, administrative centres and shopping centres should be

encouraged to plant and maintain forest cover in their compounds. The county government can target 10% forest cover in both individual farms, community and government forest reserves through promotion of agro-forestry activities using appropriate tree species.

Cultivation on hilly sloppy areas beyond 35 degrees should be discouraged and such areas should be declared as forest reserves. Farmers in the private farms in such areas should be supported and educated to establish forests. The rest of the land should be in community and government forest reserves. For effective forestry conservation in the hilly upper watershed areas where illegal encroachment to government forest land such land should be repossessed by the government for better forest management and rehabilitation of the hilltops. The national and county government should speed up the process of land surveying in the hilltops were farmers indicated that they have not been issued with title deeds owing to the disputed government forest land and private land boundaries. Uprooting of inappropriate exotic tree species along river banks should be adopted to prevent the rivers and streams from drying up.

The county government, NGOs and other development partners as well as the local community should participate in rehabilitation of gullies and the denuded parched hilltops in the upper watershed area and the degraded grazing lands in the lower catchment area. The degraded riparian ecosystem should be restored with appropriate

riverbank protection and vegetation cover. The riparian zone distance concept of no human activities should be enforced with natural forests and vegetation in such areas being retained. Farmer education and awareness campaigns should be stepped up on the importance of preservation of such indigenous forests and vegetation cover.

The county government should ensure infrastructure development is intensified in the watershed with particular focus on neglected rural roads which contribute to watershed degradation through enhanced soil and water erosion. Gullies have developed on the sides of these roads denudating farms and grazing lands. Rehabilitation of earth dams, construction of new ones, sand dams, gabions and weirs are important for water for domestic consumption and micro-irrigation. These structures also act as soil and water erosion control measures. Such water structures along river channels holds sand raising the water table and increasing availability of water resources. Where they exist river banks protection is enhanced and soil fertility improves in the adjoining farms.

The study suggests community involvement and participation which should be guaranteed in a sustainable integrated natural resources management framework. Funding of watershed programmes, implementation mandate, coordination and channels for local community involvement should be clarified. Mechanisms for monitoring and evaluation should also be included. The legislation, planning and implementation of all development programmes should embrace the spirit of the new

(2010) constitution which affirms the rights of citizens' participation in all decisions affecting them. The national and county governments should ensure that its agents, development partners and staff adhere to this requirement for sustainable development of programmes.

Public awareness campaigns and sensitisation forums will enhance the crafting of practicable and reliable local laws to stem watershed degradation. Genuine participation entails the balance of power relations in decision making. This is by giving the local communities a bigger say to decide what can work well for them with authentic conceptualisation and implementation of their suggestions. If proper local community participation is initiated, integrated watershed management approach can easily succeed in restoration of Makueni county watersheds environmental integrity.

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APPENDICES

APPENDIX ONE: COMMUNITY QUESTIONNAIRE

ASSESSMENT OF THE EFFECTS OF LAND USE METHODS AND WATERSHED DEGRADATION IN MAKUENI COUNTY

The Information Collected from this Survey is strictly Confidential and is to be used for Academic Purposes Only.

Informed Consent Statement

This questionnaire seeks to gather information that will facilitate in evaluation of land use methods and their effects on Biophysical, Socio-economic and Institutional conditions in Makueni watershed. You have been identified as a key stakeholder in this research and therefore a respondent to a few questions. The information you provide will be treated with confidentiality and will be used for academic purposes only.

COMMUNITY QUESTIONNAIRE

SECTION A: HOUSEHOLD IDENTIFICATION

DATE OF INTERVIEW	Day:	Month:	Year:
NAME AND GENDER OF HOUSEHOLD HEAD	Name:		Gender:
NAME OF RESPONDENT/RELATION WITH HHD	Name:	Relation:	Gender
QUESTIONNAIRE SERIAL NO.			

SECTION B: HOUSEHOLD GENERAL INFORMATION

B1. Age of Household Head Husband:_____Wife:_ _____

B2. Level of education of household head _____

B3. Marital status 1. Single_____2._____

Married____3.Windowed____

B4. Household size _____

B5. Farm Acreage _____

B6. Location _____

B7. Kindly fill in the following information

Other Family members/resident	Gender	Relation	Age	Education level	Occupation
1. 2. 3. 4. 5. 6. 7. 8. 9. 10.					

SECTION C. LAND USE TYPES

C1.

No.	Land use	Acreage
1.	Crop production	
2.	Livestock production	
3.	Dairy farming	
4.	Forestry/vegetation	
5.	Horticulture	
6	Others(specify)	

C2. What is the main occupation of the Household head?

1. Farmer/own labour(subsistence)
2. Livestock rearing
3. Small business/Petty trade
4. Employed (salaried)
5. Daily labour/wage labour
6. Firewood/charcoal
7. Timber harvesting
8. Other (specify)

C3. Did you plant crops during the most recent planting season?

1. Yes 2.No (if no skip)

C4.How did you water your crops?

1. Rain fed only
2. Irrigated (riverine, Pool, shallow well, run-off harvesting)

C5.Type of crop

Type of crop	How much in acres did you plant for each crop?	How much did you harvest in Kgs or bags?	How did the harvest compare to the previous season?(Same, More ,Less)	What was the main cause of change?1.More/less rainfall 2.More/less/quality seeds 3.More/ less cultivated land 4.Draught power 5.Drought tolerant seed variety
Cereals				
Maize				
Sorghum				
Millet				
Finger millet				
Legumes				
Beans				
Pigeon peas				
Cow peas				
Green grams				
Fruits				
Oranges				
Paw paw				
Mangoes				
Avocado				

Passion fruits				
Vegetables				
Kales				
Cabbage				
Tomatoes				
Cash crops				
Coffee				
Cotton				
Maize				
Sorghum				
Green grams				
Tuber crops				
Cassava				
vines				
Yams				
Others				

C6. How many months does your harvest last for household consumption? _____

C7. How did you use your most recent harvest?

1. Household consumption_____2.Sold_____3.Spoilt/Unusable (afflatoxin/ Pests____4. Other____

C8. Do you regularly sell your farm produce?

1. Yes_____ 2. No_____

C9. Where is the produce sold?

1. Local market centre_____ 2. Middlemen/brokers_____3. Cereal board_____ 4.Farmers cooperative society_____5. Others (specify_____

C10. Types of labour used in the farm

1. Family members_____ 2. Hired labour_____ 3. Mechanised farming_____ 4. Others (specify_____

C11 .Soil and water conservation activities in the farm

1. Bench terracing 2.Narrow based terraces 3.Run off water harvesting 4.Roof water harvesting 5.Agroforestry 6. Napier/Grass strips 7. Others (specify) _____

C12. Do you use fertilizer or manure for planting?

1. Yes_____ 2. No_____

C13. (If yes) What kind of fertilizer?

1. Organic mulching 2. Manure 3.Inorganic fertiliser 4. Others (Specify)

C14. Do you use improved planting materials (seeds)?

1. Yes_____ 2. No_____

C15. (If yes) which crops and source?

_____

_____

C16. What cropping system do you use in your farm?

1. Monoculture 2.Intercropping 3. Rotational 4. Others (Specify) _____

Livestock ownership.

C17. Does the Household currently own livestock? (Indigenous stock)

1. Yes_____2.No_____

C18. How many livestock does the household own?

1. Cattle_____
2. Goats_____
3. Sheep_____
4. Chicken_____
5. Rabbits_____
6. Donkeys_____

C19. Does the Household own Dairy cattle?

1. Yes_____2.No_____(if no skip the next question)

C20.How Many dairy cows and goats?

1. Cattle_____2. Goats_____

C21. What is the mode of livestock grazing?

1. Zero grazing/stall feeding

2. Tethering in the field

3. Free grazing in the fields

4. Other (specify)

C22.Where do you get information about improved farming technologies?

1. Agricultural extension officers_____ 2.Neighbours_____ 3.Media/advertisement_____ 4. Farmer field schools_____ 5.Others (Specify___

C23. From where do you get information on weather forecast?

1. Traditional weather forecasters 2. Agricultural extension officers 3.radio 4. Newspapers 5.Television

C24. Do you belong to any farmers SHG (*mwethya*) group?

1. Yes_____ 2. No_____

C25. (If yes) what is the composition of group members?

1. All men_____2. All women_____3.Both men and women_____4. Others (specify_____

C26.What activities does the group undertake.

1. Soil conservation/terracing
2. Water conservation/Harvesting
3. Environmental conservation
4. Marketing
5. Others (Specify_____

C27. What other physical/Natural resources exist in your area

1. Rivers/streams 2. Forests 3.Wildlife 4.Others (Specify)

SCTION D:BIOPHYSICAL AND SOCIO-ECONOMIC CONDITIONS

D1.What are the main land uses in Makueni watershed

1. Farming/Crop production

2. Grazing/Livestock production

3. Settlement

4. Horticulture

5. Others (Specify) _____

D2. Have you noticed any land use changes which have occurred over the years?

1. Yes_____2.No_____

D3. (If yes) which ones?

1. Diminishing farm sizes
2. Diminishing grazing lands
3. Reduction of forests/vegetation cover
4. Increased erosion and river banks erosion
5. Grazing to crops
6. Seasonal crops to horticulture
7. Others (Specify)

D4.Who is responsible for those changes?

1. New generation of local people (farmers)

2. In migration by other people

3. Outsiders/local investors

4. Infrastructure development (roads, Dams, schools)

D5. When did these changes occur rapidly?

1. Intensified rain seasons (Elnino)

2. Drought and famine times

3. Land sub-division (son's farms)

4. National economy decline

5. Others (specify) _____

D6. In your view do you think Makueni watershed is being degraded?

1. Yes_____2.No_____

D7. (If yes) what are the causes?

1. Poverty

2. Population growth

3. Landlessness

4. Inappropriate farming methods

5. Illegal encroachment

6. Laxity in law enforcement

7. Others (Specify) _____

D8. What is your rating of the problem?

1. Degradation has reached critical levels and needs urgent attention

2. It is critical but does not need urgent attention
3. It is not critical there are no significant land use changes
4. It is not a major problem in the area.

D9 Does land use change affect water resources and soil productivity?

1. 1. Yes_____2.No_____

D10 (If yes) what are the effects?

1. Decline of ground water
2. Increase in surface run off
3. Sedimentation of rivers and water pans
4. Increase in soil erosion
5. Pollution of rivers
6. Drying of rivers
7. Changes in rainfall and temperatures
8. Decline in soil fertility
9. Others (Specify)___

D11.Are you affected by watershed/land degradation?

1. 1. Yes_____2.No_____

D12. (If yes) how are you affected?

1. Reduced income from farm activities
2. Low food production
3. Water scarcity

4. Poverty increase
5. Conflicts due to water scarcity
6. Waterborne diseases
7. Siltation of dams and water pans
8. Decrease of pasture
9. Others (Specify)_____

D13.What benefits do you get from a well managed watershed with better soils, water and other natural resources?

1. Availability of water resources
2. Improved food production
3. Reduced poverty levels
4. Reduced water scarcity conflicts
5. Others (Specify)_____

D14.What land management practices in the area appear to prevent soil degradation?

1. Terracing 2. Agro forestry 3.Nappier/ grass strip 4.Run-off harvesting 5. Zero grazing 6. Others (Specify) _____

D15.As a farmer, how do you respond to declining productivity?

1. Early planting

2. Fertiliser application

3. Manure application

4. Drought tolerant seed varieties

5. Quality improved seeds

6. Crop diversification

7. Mixed cropping

8. Others (Specify_____

D16.What do you think can be done to address Makueni watershed problems?

1. Adoption of appropriate farming methods
2. Afforestation programmes
3. Intensification of conservation agriculture
4. Community/stakeholders participation forums.
5. Improved communication and awareness strategies
6. Others (Specify)_____

SECTION E: INSTITUTIONAL SUPPORT

E1.Do you think Environmental policies are adequately implemented?

1. 1. Yes_____2.No_____

E2. (If yes) mention the departments involved

1. National Environment Management Authority
2. Water resource Management Authority
3. Ministry of Agriculture
4. Forest department
5. Non Government Organisations (NGO)
6. Others (Specify)_____

E3. In the case of NGOs mention their name and acivities_____

_____

E4.What has been the role of the national government in affecting land use?

1. Land tenure (adjudication, Subdivision)

2. Infrastructure development

3. Infrastructure deterioration (roads dams)

4. Agricultural extension services (Increase, Decline)

5. Land use rules enforcement (Increase, Decline)

E5.Do you have local water user associations in your area?

1. Yes_____2.No_____

E6. (If yes) what are roles do they play in the watershed?

1. Management and protection of water catchment

2. Water conservation and control
3. Regulation and protection of water quality
4. Water resource management and conflict resolution
5. Monitoring and assessment of water resources

E7. Do you participate in water/natural resource management?

1. Yes_____2.No_____

E8. (If yes) what is your participation?

1. Identification of community needs and local projects
2. Water catchment protection
3. Management and conservation of water resources
4. Water resource monitoring
5. Others (Specify)_____

E9. Do you think locally initiated management and community participation in water/natural resource management can help in addressing Makueni watershed problems?

1. Yes_____2.No_____

E10. If yes how?

1. Enhanced water catchment protection
2. Improved water resource management
3. Equitable sharing of water resources

4. Water resource conflict resolution
5. Enhanced community conservation initiatives
6. Improved agriculture/ farming methods
7. Water conservation and soil erosion control
8. Increased community awareness

E13.What are the challenges of integrated management of water/natural resources management

1. Lack of community involvement and participation
2. Top down/Prescriptive implementation strategies
3. Inadequate infrastructure/Inefficiencies
4. Ineffective law enforcement
5. Lack of proper communication
6. Neglect of catchment areas and river protection
7. Others (Specify)_____

E14.What recommendations do you suggest for sustainable water/Natural resource management?_____

_____

_____

_____

_____

APPENDIX TWO: KEY INFORMANTS-CATEGORY

ASSESSMENT OF THE EFFECTS OF LAND USE METHODS AND WATERSHED DEGRADATION IN MAKUENI COUNTY

The Information Collected from this Survey is strictly Confidential and is to be used for Academic Purposes Only.

Informed Consent Statement

This questionnaire seeks to gather information that will facilitate in evaluation of land use methods and their effects on Bio-physical, Socio-economic and Institutional conditions in Makueni watershed. You have been identified as a key stakeholder in this research and therefore a respondent to a few questions. The information you provide will be treated with confidentiality and will be used for academic purposes only.

KEY INFORMANTS-CATEGORY

Respondent's name:

.....

Name of Organization/Department:

……

Designation: .....

Age: .....

Gender: .....

Level of education: .....

Years of service: .....

1. What are the core functions and priorities of your organization?.....

   .....

   .....

2. Do you have community/stakeholders participation policy in your organization? Please state what it entails.....

   .....

   .....

3. Does your organization include local community/stakeholders knowledge in management decisions regarding development initiatives?.....

   .....

4. What Strategies/mechanisms do you use to incorporate the local knowledge in planning and implementation of projects?

   .....

   .....

5. Who are the main stakeholders in your organisation?

   .....

6. Have you noticed evidence of watershed/land degradation in the area?.....
   .....
7. What land degradation indicators have you noticed?.....
   ....
8. Where did the changes occur most and why in those particular places?.....
   .....
9. Who has been responsible for those changes?.....
   ....
10. What are the main reasons for these changes in land use?.....
    .....
    .....
    .....
11. What is the poverty/land degradation relationship in the area?.....
    .....
    .....
    .....

12. How do farmers in the area respond to declining crop productivity?.....

    .....

    .....

    .....

13. What management practices appear to prevent soil degradation?

    .....

    .....

    .....

    .....

14. What has been the role of the national government in affecting land use?

    .....

    .....

    .....

15. What has been the role of community and NGOs in soil and water conservation?

    .....

    .....

16. In your opinion is integrated watershed management entrenched in the case of Makueni watershed…....Please give reasons for your answer.

    .....

.....

.....

17. Does the organization/department have a policy on integrated activities in Environmental management?.....Please indicate how it Works.....

.....

18. 10. Does your organization support integration of development activities in Makueni watersheds.....? State the activities.....

....

19. In your views does the government have adequate policy on environmental management to support effective integrated watershed management?……..Please state and give reasons for your answer.....

..... …….....

20. What are the challenges for integrated watershed management in Makueni watershed?

……

21. What recommendations can you give for improved watershed management?

……

APPENDIX THREE: GROUP INTERVIEW GUIDE AND OLDER RESPONDENTS

ASSESSMENT OF THE EFFECTS OF LAND USE METHODS AND WATERSHED DEGRADATION IN MAKUENI COUNTY

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Informed Consent Statement

This questionnaire seeks to gather information that will facilitate in evaluation of land use methods and their effects on Bio-physical, Socio-economic and Institutional conditions in Makueni watershed. You have been identified as a key stakeholder in this research and therefore a respondent to a few questions. The information you provide will be treated with confidentiality and will be used for academic purposes only.

GROUP INTERVIEW GUIDE AND OLDER RESPONDENTS

1. What are the major land use changes that have occurred since 1960s in this area?
2. Where did the changes occur mostly?
3. Why have they occurred in those places?
4. When did the changes occur and why?
5. Who is responsible for the changes?

6. What are the reasons or causes for land use change?

7. What land/soil degradation indicators have you noticed?

8. Who has been responsible for those changes?

9. How do farmers in the area respond to declining crop productivity?

10. What management practices appear to prevent soil degradation?

11. What has been the role of the national government in affecting land use?

12. What has been the role of community and NGOs in water and soil conservation?

13. What are the forces affecting future land use?

14. What will this area look in 20 years?

APPENDIX FOUR: PRIOR INFORMED CONSENT FORM

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Informed Consent Statement

This questionnaire seeks to gather information that will facilitate in evaluation of land use methods and their effects on Biophysical, Socio-economic and Institutional conditions in Makueni watershed. You have been identified as a key stakeholder in this research and therefore a respondent to a few questions. The information you provide will be treated with confidentiality and will be used for academic purposes only.