

**SOCIO ECOLOGICAL RESILIENCE AND PASTORAL LAND USE
CHANGE IN SEMI-ARID LANDS IN KAJIADO COUNTY KENYA**

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**A THESIS SUBMITTED IN PARTIAL FULFILMENT FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY IN DRYLAND RESOURCE
MANAGEMENT TO THE UNIVERSITY OF NAIROBI**

**DEPARTMENT OF LAND RESOURCE MANAGEMENT AND
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UNIVERSITY OF NAIROBI, KENYA**

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DEDICATION

I dedicate this study to the glory of God and comprehensive family support. The completion of this thesis would not have been achievable if it was not for my beloved children; Lesley, Gillian, Clive, Ian and Angel who constantly encouraged me and were my driving motivation to accomplish. I am indebted to my parents, Mzee Henry Morara who passed on during my course work examinations and my late mum, Wilkister Maturwe, who taught me the value of hard work, honesty and patience. I remember their comforting words when things did not go well or as planned: *“Everything happens for good for those who believe and trust in God”*. *No matter what happens the clock does not stop -- just keep moving even though at a slow pace you will eventually make it”*. To my cherished husband and friend: Fred Makamara, “thank you for constantly being there for me. The many times you drove me to the field during the household survey, especially the rough terrains that made me uncomfortable. You nurtured me through the hard times and reassured me that the process would eventually be over. Your endless love and comfort have been my strength, a sense of inspiration and motivation. I celebrate this achievement with you”.

ACKNOWLEDGEMENT

My special thanks go to my supervisors and mentors Professor Wambui Kogi-Makau and Dr. Laban MacOpiyo for the excellent guidance and support given and the meticulous follow up during proposal development, data collection, comments and criticism that greatly contributed to the quality of this thesis. My sincere thanks go to the local administration especially the Deputy-County Commissioner Kajiado North Sub-County for granting me permission to collect data and connecting me with the entire Sub-County administration network. I thank the people of Kajiado North, especially the village elders who tirelessly guided me at the grass root level and helped when I was recruiting the enumerators for questionnaire administration; specifically elder Stanley ole Karei who was quite instrumental in various facets of my field work. I offer my gratitude to the following field extension officers: Mr John Kimani, Divisional Agriculture Extension Officer (DAEO)-Kitengela, John Thiongo DAEO-Isinya, Margaret Okindo DAEO-Ongata Rongai and Melilau Sein DAEO South Kekonyokie, who was my main interpreter.

I thankfully appreciate Professor Jesse Theuri Njoka, Director, Centre for Sustainable Dryland Ecosystems and Societies for funding my research initially and linking me with Wildebeest Landscapes Programme through his active collaborative educational and research networks. I acknowledge Prof. Njoka for his great role and contribution in the compilation of this thesis. I thank, Professor Randall Boone and Dr. Jeffrey Worden who through Wildebeest Landscapes Program, United States National Science Foundation

(NSF) grant number 0919383, a collaborative project between African Conservation Centre (ACC) and Colorado State University (CSU) for funding my research.

Finally, I offer my gratitude to Professor John Wangai Kimenju, the Dean Faculty of Agriculture and Professor Geoffrey Kironchi, Chairman Department of Land Resource Management and Agricultural Technology (LARMAT), as well as academic and support staff in the Faculty of Agriculture for their great assistance.

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LIST OF ABBREVIATIONS

ACC	African Conservation Centre
AEZ	Agro Ecological Zone
ALMP	Arid Lands Management Programme
ASAL	Arid and Semi-Arid Lands
AWF	African Wildlife Foundation
CBC	Community-Based Conservation
CBNRM	Community-Based Natural Resource Management
CBO	Community Based Organisation
CCAA	Climate Change Adaptation in Africa
CCTV	Close Circuit Television
CLIFS	Crop-Livestock Integrated Farming System
CSDES	Centre for Sustainable Dryland Ecosystems and Societies
CSU	Colorado State University
CWD	Conservation With Development
DAEO	Divisional Agriculture Extension Officer
DPSIR	Drivers-Pressures-States-Impacts-Responses
DM	Decision Maker
WCLP	Wildlife Conservation Lease Programme
ENVI	EXELIS Visual Information Systems
ETM	Enhanced Thematic Mapper
EPZ	Export Processing Zone
FAO	Food and Agriculture Organization of the United Nations

FGD	Focus Group Discussion
GEF	Global Environment Facility
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GWR	Geographically Weighted Regression
HH	Household Head
IDI	In-depth Interview
ICDP	Integrated Conservation and Development
IDRC	International Development Research Centre
ILRI	International Livestock Research Institute
KARLO	Kenya Agricultural and Livestock Research Organization
KII	Key Informant Interview
KLDP	Kenya Livestock Development Project
KWS	Kenya Wildlife Service
LRM	Logistic Regression Model
LUCC	Land Use/Cover Change
LUMP	Land Use Master Plan
MSP	Medium Sized Project
NEMA	National Environment Management Authority
NFSNP	National Food Security and Nutrition Policy
NGO	Non-Governmental Organization
NSF	National Science Foundation of the United States
OLS	Ordinary Least Squares

PES	Payment for Environmental Services
PRA	Participatory Rural Appraisal
PRISE	Pathways of Resilience in Semi-Arid Economies
RCMRD	Regional Centre for Mapping of Resources for Development
SES	Socio Ecological Systems
SPSS	Statistical Package for Social Sciences
TM	Thematic Mapper
TWF	The Wildlife Foundation
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USD	United States Dollar
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WCLP	Wildlife Conservation Lease Programme
WRS	Worldwide Reference System

OPERATIONALIZATION OF WORDS

Adaptive capacity: The capability of a system to change, modify, or fine-tune its characteristics and activities to mitigate potential future damage and to take advantage of any opportunities, so that it can continue to function consistently with its original purpose and/or organisational identity. Examples of adaptive capacity include diversification of livelihoods, adoption of drought resistant seed and upgraded livestock.

Absorptive capacity: A system's ability to address, mitigate or prevent negative impacts, using encoded coping responses for the purpose of preserving and/or restoring critical basic organisational and operational functions. This includes survival strategies utilised during shock epochs. Instances of absorptive capacity include delaying pregnancy in livestock, storing hay, migrating livestock to other areas.

Agricultural production systems: Includes all aspects of both crops and livestock production activities for home consumption and selling. In the study area crops include maize, beans, tomatoes, kales, spinach and indigenous vegetables while livestock includes cows, goats, sheep, poultry, pigs and bees.

Agro-ecological zone: A zone which is defined by its relevant agro-climatic factors (in the Tropics, mainly moisture supply) and differentiated by soil pattern. The aim of zoning is to provide a frame-work for the ecological (natural) land use potential.

Zoning facilitates making of sound decisions in international and long term agricultural policies. To improve provision of advice to farmers in the Sub-County it became necessary to develop a more differentiated system showing yield probabilities as well as associated risks.

Community: A group of people (or animals) in a shared geographical space, linked by social and/or economic ties, shared identity, collective action, and providing a means for a common livelihood; notwithstanding the fact that they may have diverse characteristics and priorities.

Driving forces: These are the underlying currents that compel communities to undertake certain activities, which increase or mitigate pressures on the environment, given prevailing socio-economic and socio-cultural factors. Examples include demands for agricultural land, energy, employment, transport and housing within an urbanising setting.

Fragmentation: Disconnection of areas of landscape resulting in restriction of certain people's and/or animals' access to resources like water and forage. Barriers can be physical like fences or policy like conservation into parks or conversion of land cover/habitat transformation due to residential and urban development.

Food security: A situation where a community of people, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and preferences.

Geographic Information System: It is a configuration of computer hardware, software and personnel designed to efficiently capture, store, update, analyse and display all forms of geographic data in a referenced information structure.

Global Positioning System: Is able to determine the location, speed, direction and time of objects by utilising a collection of at least 24 medium earth orbit satellites that transmit precise microwave signals. It is the only fully functional global navigation satellite system (GNSS).

Group ranch: A livestock rearing farm owned jointly by a group of people, who maintain agreed stocking levels and collectively herd their livestock which they own individually mainly based on kinship and traditional land rights.

Household: A family set up which includes a husband as household head, wives/wife, children and any other dependent family members living in the same compound either partially or permanently if any. While female headed household consists of mother as household head, children and dependent family members if any.

Impacts: Are the final effects of certain interventions (e.g. major projects) on the environment and/or a given community's socio-economic status.

Land: Farmland, wetland, pastures and forest.

Land tenure: The way holding of land is determined/defined in a given society; whether legally or customarily, among people, as individuals or groups. It includes the rules, norms and institutions that govern land use. For example, freehold is a form of tenure by which land is held free of any fees for life and for descendants.

Land tenure system: Protects the rights and obligations on land supported by national laws and regulations – can be formal or informal, statutory or customary, permanent or temporary. It determines who can use which land-based resources, for what purpose, for how long, and under what terms.

Land use pattern: Shows the spatial and temporal extent of human activities on land through occupation, which can be either economic or social in nature.

Land use/cover change: Distinct changes in land cover/use pattern over time due anthropogenic and natural (biotic and abiotic) causes.

Pressures: The enduring strains that human activities place on the environment due exploitation of resources like land, water, minerals.

States: This is the condition of the environment and refers to the quality of the various environmental media (air, soil, water, etc.) due to the pressures and their consequent ability to support the demands placed on them (for example, supporting human and non-human life, supplying resources).

Rangeland: It is land suitable for grazing livestock; in which the natural vegetation is predominantly grasses and shrubs.

Remote sensing: It is the science and art of obtaining information through the analysis of data acquired by devices that are not in physical contact with the objects, areas or phenomena that are under investigation.

Resilience: The capability of societies, communities, households, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces their vulnerability and facilitates inclusive growth.

Responses: Demonstrated actions or efforts by society, either as groups or individuals, to solve the problems arising from impacts of certain interventions or changes caused by external factors to their environmental situation.

Shock: An abrupt occurrence with a significant and often negative impact on the integrity of a system and its parts. Shocks (e.g. droughts, floods, epidemic diseases) represent substantial negative (or positive) impacts on people's livelihoods and on the functioning of society

Sociological resilience: The ability of groups or communities to handle and mitigate disturbances (e.g. social, political and environmental) and the resulting stresses so that their lives continue to be sustained.

Stress: Pressure or distress arising from disruption to groups' or individuals' livelihoods and forced adaptation to the changing physical environment. Such stresses cause steady difficulties in the attempt to reverse decline in human wellbeing; e.g. climate change, soil degradation etc.

Transformative capacity: The ability to re-engineer systems fundamentally such that a given shock will no longer have debilitating impact. Examples of transformative capacity include the introduction of new technology, effective conflict resolution mechanisms, sustainable urban planning measures, easement programmes etc. This is usually necessary when ecological, economic or social structures make the existing system untenable.

Worldwide reference system: It enables a user to inquire about satellite imagery over any portion of the world by specifying a nominal scene centre defined by the PATH and ROW co-ordinates. It is a global indexing scheme designed for the Landsat Program.

ABSTRACT

Since the year 2000, a range of stakeholders and the Kenyan Government have tried to limit the land use/cover change and offer guided development, on the premise that Kajiado North is pastoral and acts as a wildlife dispersal area and migratory corridor for Nairobi National Park. A Wildlife Conservation Lease Programme (WLCP) was started in year 2000 and Kitengela-Isinya-Kipeto land use master plan (LUMP) drafted in 2008 for the period 2008-2028. However not much has been achieved with respect to the objectives.

This study was inspired to find the status of land use master plan and wildlife conservation lease program through the following objectives; Ascertain the extent of land use/cover change in Kajiado North Sub-County for the period 1980-2010, ascertain the socio ecological factors that contribute to and/or impede land use/cover change in Kajiado North Sub-County, establish how the land use/cover change has impacted on ecosystem services and resilient livelihoods in semi-arid lands and analyse the impacts of the household and community resilient pathways on expected outcomes in relation to LUMP and WLCP. The study used the DPSIR framework to analyse the driving forces, pressures, the state, the impacts and the response towards land use cover change in Kajiado North. Landsat imageries were used to analyse land use/ cover change for the period 1980-2010. Household survey questionnaire, key informant interviews (KIIs), focus group discussions (FGDs), and in depth interviews were used to collect primary data at household and community levels. Supervised classification using ENVI 4.7 software of Landsat imageries yielded seven land use/cover classes: rangeland, bare ground, rocky areas, water bodies, built-up areas,

crop land, woodlots and riverine vegetation. Descriptive statistics, Chi-square and regression analysis were applied at 95% confidence levels in describing the trends in land use/ cover changes for the period 1980-2010. Landsat images analysis for years 1984, 2004 and 2010 present the state of the environment whereby significant declining changes ($p < 0.001$) of rangeland 31.42% were observed. While increasing significant ($p < 0.001$) changes were observed in built-up, crop land, woodlots and riverine vegetation. Overall the result indicates an increase in fragmentation due to population increase accompanied with degradation, as 34% of the respondents indicated. The driving forces were the demand for land in the community due population growth and migration to facilitate livelihood activities. The spatial regression analysis using ArcGIS 9.3 software on land use/cover change maps results showed that the urban centres had an influence of up to 93% on the change in land use/cover while roads had up to 33% and rivers up to 22 % by the year 2010.

The stresses on the environment were experienced in form of competition for resources and decrease in mobility/ accessibility to resources. The fast appreciation of land was given as a major challenge since the indigenous people are tempted by speculators who project huge returns with the proposed infrastructures like standard gauge railway and Konza Technocity. There was no good will to enforce LUMP while the incentives for WCLP were not adequate in compensating those who leased the land due to the high value of land and alternative uses. Therefore to stop peri-urban fragmentation of areas at the fringe of national parks it will be appropriate to create buffer zones with compatible land use systems that support/integrate wildlife conservation.

CHAPTER ONE

1.0. INTRODUCTION

1.1. Summary

This chapter provides the context of the study by furnishing general information on the land use changes in semi-arid lands. It captures the extent of land use change in Kajiado North Sub-County as well as the contributing and impeding factors towards it in the area. Moreover, it provides an overview on the impact of Land Use/Cover Change (LUCC) on the ecosystem services and resilient livelihoods in semi-arid lands. Additionally, this chapter provides the scope of the study including an analysis of household and community resilient pathways in relation to LUCC in Kajiado North Sub-county.

1.2 Background

Semi-arid areas are characterised as areas that are unsuitable for cultivation and often experience relatively lower economic growth, high levels of poverty and increasing climate change impacts (FAO, 1987). The semi-arid lands in Kenya make up part of its massive rangelands, which occupy over 80% of the country's total land area (Mwang'ombe, et al., 2011); and is home to millions of pastoralists and agro-pastoralists. Pastoralism is the main user of primary production in these semi-arid rangelands (Nyangito, *et al.*, 2009).

Pastoralism within dry lands all over the world has coexisted with wildlife for years (Berger, 1993) and in Kenya, the Maasai adapted to life in arid and semi-arid rangelands by continuously changing between the wet and dry season grazing areas and maintaining various species of livestock (Seno and Shaw, 2002). This migration of livestock between the wet and dry season foraging zones is done in order to cope with the variability in fodder availability as determined by spatially and temporally variable and unpredictable precipitation patterns and foraging pressure (Oba, *et al.*, 2000). Likewise, wildlife from the neighbouring protected regions use these areas to exploit their forage requirements (Western and Lindsay, 1984).

The semi-arid African rangelands have a preponderance of highly resilient vegetation types that thrive in alternate climatic states (Kinyua, *et al.*, 2010). As people and herd populations in the semi-arid rangelands and the rest of Kenya have increased significantly overtime the pressure on the land has also been intensifying. The high numbers of livestock have resulted in heavy grazing that has altered the vegetation configuration leading to diminished primary productivity (Wessels, *et al.*, 2007).

Communities in these areas have, over the years developed several pathways to resilience in their livestock farming techniques such as; Conversion of pastureland to cropland (Mganga, *et al.*, 2011); The simultaneous and methodical of rearing livestock and cultivation crops on the same farm i.e. agro-pastoralism (Block and Webb, 2001) and cross-breeding to develop more

heat tolerant breeds. Management of resilience and resilience building is essential in creating sustainable development in changing environments. Several programmes have thus been developed with their ultimate aim being to support the emergence of equitable, climate resilient economic development in semi-arid lands through research (IDRC, 2007; Lumosi, 2015) in order to spur climate-resilient development in African semi-arid lands -- two of such include Climate Change Adaptation in Africa (CCAA) and Pathways of Resilience in Semi-Arid Economies (PRISE).

Kenya has undergone a series of fairly quick changes in land tenure policies and regulations which have transformed former pastoral communal lands into various use types. Whereas in the past all land in the area was being used communally, we now generally have three forms of land holding – group ranches, individual ranches and private holdings. These changes have in turn steered to a rise into various land-use systems (Kristjanson, *et al.*, 2002; Mwangi, 2006), mainly commercialisation of the rangelands by privatising land and improving herd management and range production systems particularly due to the structuring of government policies (Graham, 1998).

This accelerating rate of land fragmentation in pastoral regions has led to concerns over the impact of land subdivision and successive land use change on migratory wildlife populations and pastoral herds in ASALs (Boone, *et al.*, 2005). Additionally, the population increase in peri-urban regions generates adjustment and readjustment of human and land use livelihood activities

(Oluseyi, 2006) and, in Kenya, the Wildlife Lease Conservation Program (WCLP) and Land Use Master Plan initiatives were started by stakeholders and the Kenyan Government in a bid to limit the land cover use change.

The increased attacks over the years on Maasai livestock by wildlife and other human wildlife conflicts have made an increasing number of Maasai, especially the younger generations, less tolerant to wildlife. Many Maasai households have barred wildlife on their land through fencing and direct killing of any that prey on their livestock (Matiko, 2014). This is in contravention to the WCLP, which was started with the objective of requiring participants to allow free movement of wildlife on their land while continuing to use this land for grazing of livestock and, protect natural vegetation, and avoid fencing or sub-dividing their land (Republic of Kenya, 2008; Reid, *et al.*, 2008). Under WCLP, participating households are compensated with lease fee of four dollars per year as an incentive to allow wildlife to criss-cross their land; while entry and exit to the program is voluntary (Republic of Kenya, 2008; Reid, *et al.*, 2008).

Similar initiatives have been undertaken in the USA successfully (Knight, 2002; Bernstein and Mitchell, 2005; Ferguson, 2009) to protect natural or cultural resources. The WCLP contributed greatly to the development and adoption of the Land Use Master Plan (LUMP) initiative which aims to control unsustainable land uses in the region and offers a chance for better contribution of local land owners in the administration of their land-based resources, and the

employment of complementary conservation interventions (Matiko, 2014). It only allows land use systems that are well suited with open livestock/ wildlife grazing and sets a minimum tract size of 60 acres in the open foraging lands (Matiko, 2014) thereby trying to discourage land fragmentations that are not ecologically feasible (Republic of Kenya, 2008).

LUMP has been rapidly accepted globally with other successful implementations as a blueprint for the earlier Comprehensive Plan in 2007 for the Boone Town Council, North Carolina, Singapore, Trenton, New Jersey, Cornell University and New York (URA, 2015). Despite the achievements experienced through the implementation of the WCLP and LUMP, a few existing setbacks are proving to be a great detriment to the objectives of conservation and planned development. Rapid urbanisation as well as population growth in Kajiado County has led to an increase in land subdivision and conversion of land use to non-pastoral uses such as crop cultivation and it is expected to continue as Nairobi Metropolis expands into Kajiado. Additionally, the projected plan to construct the southern that crosses the Nairobi National Park has further impeded these initiatives and further accelerated land fragmentation. Finally, the rising land prices, for instance, parts of Athi-Kaputiei Plains have appreciated at over 11% over the last 10 years; reflect the peri-urban and urban potential of the area, meaning that the area will soon not be conducive for wildlife as a type of land use (Norton-Griffiths and Said, 2009).

However, Simon, (2008), holds the view that environment-development issues in peri-urban areas could be handled differently from the current paradigms with better even results. According to Simon peri-urban areas are known or described in several ways as rural-urban fringes or transition zones, or peri-urban zones or areas or interfaces – are the transitional zones between distinctly urban and vaguely rural areas. It is further reiterated that internationally, urban systems are expanding into lands that are valuable for agricultural and forest production and encroaching on the health and resilience of social-ecological systems (SES) (Guzy, *et al.*, 2008). These land-use changes provide current benefits at the cost of disregarding future options for ecosystem goods and services.

Population growth is a major driving factor in the development of urban systems and is a fundamental variable into the input of many land management decisions. Simon, (2008), argues that such matters about the environment and development ideas and procedures are a reflection of the developing constraints of conventional concepts of a basic rural-urban contrast regarding the actual and developing world. Additionally, peri-urban areas are characterised by geographical as well as social and institutional transition (Narain, *et al.*, 2013). Socially, peri-urban regions are naturally dynamic, wherein social forms are continuously initiated, transformed and abandoned (Iaquinta and Drescher, 2000). Based on changes in land use – and the variety of commercial benefits that this generates over time – social groups tend to vary and are in continuous shift (Allen, 2003). Although there have been a growing amount of research on

susceptibility of African municipalities, there hasn't been any major focus on research on the determinants of adaptive and absorptive capacities.

Greater emphasis is, however, now being placed on the part that indigenous responses and underlying socioeconomic settings play in determining susceptibility to climate uncertainty or change. This shift has in turn led to an increase in focus of adaptive and absorptive capacities, to the social perspective in general, and to the precise structural conditions that instigate social and urban vulnerability (Macchi and Maurizio, 2014). Further literature reveals gaps on implications of land use change on agricultural production systems and community gender roles for both indigenous and immigrant populations over time with regard to agricultural production systems adopted to ensure food security in the study area.

Against this background, this study sought to analyse the trends in land cover and land use changes, vis-à-vis human population growth and land price trends; and assess the public perception on environmental easement and zoning with respect to Land Use Master Plan for the area. The study focused on four areas of assessment. First, the study examined the existing gradual changes within the Kajiado North Sub-County area for the period 1980 – 2010 in order to determine the scope of Land Use/Cover change in the region. Second, it assessed the role and contribution of the various actors involved in bringing about the land use changes in the Kajiado North Sub-County area so as to comprehensively ascertain the factors which contributed and/or impeded in the

Land Use/Cover Change in the Kajiado North Sub-County area. Third, it gave a basis to the establishment of the impact the LUCC has on the ecosystem services and resilient livelihoods in semi-arid lands. Lastly, the study analysed the impacts of the household and community resilient pathways on expected outcomes in relation to the LUMP and WLCP through examining all existing perceptions and behavioural changes in the household and the community.

1.3 Statement of the Problem

The proliferation of changes in Kenya's land policies have led to the structural transformation of former pastoral communal lands into an emergence of several land-use systems; namely group ranches, individual ranches and private holdings (Kristjanson, *et al.*, 2002; Mwangi, 2006). There is a range of forces that are driving changes in land use, and these include demographic changes (indigenous population growth and immigration), commercial changes (higher relative earnings to work and land in crop production than in livestock), policies (e.g. land privatization), and improved quality of and access to services and infrastructure (Olson, 2006; Mwangi, 2006).

The WCLP and LUMP initiatives started by stakeholders and the Kenyan Government from year 2000 have tried to limit the land use/cover change and offer guided development (Republic of Kenya, 2008). Their purpose is to effectively eradicate fragmentation of land to small holdings that are not

ecologically sustainable and avoid land uses that are discordant with livestock and wildlife (Republic of Kenya, 2008) as well as be influential to the protection of the remaining wildlife in the Kajiado North Sub-County area. However, after their implementation, it has not yet been ascertained whether they have been successful in controlling the unplanned fragmentation and land use/cover change in Kajiado North Sub-county. This study sought to determine if the two initiatives i.e. the LUMP and WCLP are to the benefit and not the detriment of the residing community in the Kajiado North Sub-County area by affirming whether the LUMP and WCLP are contributing to the area's ecosystem sustainability and pathways to livelihood resilience for semi-arid economies.

1.4. Justification

Kajiado County falls in the classification of arid and semi-arid lands (ASAL) (Jaetzold, *et al.*, 2011). Pastoralism of the semi-nomadic, transhumant variety has been the land use of choice for hundreds of years in the region. Land tenure studies that have been carried out covering the pre-colonial era period before 1900 to date among the Maasai of Kenya and Tanzania affirm this. In summary, these research findings have revealed that major land use changes commenced with change in tenure as communal group ranches were subdivided to individual holdings from 1980, thus making it possible for the indigenous people to subdivide and sell.

It can be surmised, from the introduction, that urban sprawl is the main factor influencing land use choice in peri-urban areas a result of population increase and, with population growth, the demand for land and other natural resources soars while access to various markets improves. This makes certain agricultural activities more profitable, leading to changes in crop intensification based on relative prices. In general, food prices increase as demand rises, primarily being driven by population increase and urbanisation (Boserup, 1965). Kajiado North Sub-county, the study area, has undergone sprawl and experienced numerous land use cover changes as well as changes in land tenure policies due to the government policy organizing for the commercialisation of the rangelands by privatising land and upgrading herd management and range practices (Graham, 1998). This has in turn led to an increasing rate of fragmentation in the County and has created concerns over the effect of land subdivision and sequential land use cover change on wildlife and livestock herds in the area and the possibility of fragmentation posing a threat to pastoral livelihoods and wildlife ventures.

The LUMP and WCLP initiatives implemented in the area sought to effectively discourage land fragmentation to small holdings that are not ecologically viable and prevent land uses that are incompatible with livestock and wildlife (Republic of Kenya, 2008) as well as be a contributor to the conservation of the remaining wildlife in the Kajiado North Sub-County area. Since their effectiveness has not fully been determined in the study area, the findings of

this study seek to fully ascertain that and in turn provide a basis for policy development on issues of land use change and fragmentation of peri-urban ASALs pastoral areas bordering wildlife areas in Kenya with special consideration on the perception at the grassroots level of initiatives against land fragmentation, specifically, the LUMP and WCLP initiatives.

1.5. Objectives

1.5.1 Overall Objective

The overall objective of this study was to ascertain whether the Land Use Master Plan (LUMP) and the Wildlife Conservation Lease Program (WCLP) can control unplanned fragmentation and land use/cover change in the Kajiado North Sub-county area. In addition assess the community's socio-logical resilience towards fragmentation and land use/ cover change.

1.5.2 Specific Objectives

The specific objectives were to:

1. Ascertain the extent of land use/cover change in Kajiado North Sub-County for the period 1980-2010.
2. Ascertain the socio ecological factors that contribute to and/or impede Land Use/cover Change in Kajiado North Sub-County.
3. Establish how the Land Use/cover Change has impacted on ecosystem services and resilient livelihoods in semi-arid lands.
4. Analyse the impacts of the household and community resilient pathways on expected outcomes in relation to LUMP and WLCP.

1.6 Research Questions

The research questions to be answered were as follows:

1. What is the extent of land use/cover change in Kajiado North Sub-County for the period 1980-2010?
2. What are the contributing and impeding socio ecological factors towards LUCC?
3. How have these factors leading to LUCC impacted on ecosystem services and resilient livelihoods in semi-arid lands?
4. How do regulations such as LUMP and WLCP contribute towards controlling LUCC?

1.7 Conceptual Framework

1.7.1 Defining Resilience

Upon review of the literature, several representative definitions of resilience have been presented, some of which include the following:

- Resilience is the shared ability to counter to harsh conditions and adjust to preserve position and functionality. A resilient society can counter a catastrophe such that it strengthens its capacity in preserving/developing society links, means, and the community's ability to persist (Sutter, *et al.*, 2007).
- Resilience is a transformative process of reinforcing the ability of communities to foresee, avert, recover, adapt to and/or overcome shocks, stresses and adverse change (UNDP, 2013).

Although these descriptions differ in their phrasing, they all feature a certain vital component of resilience in that it occurs at various levels i.e. personal, family, community, system, institution society, etc. (Berkes and Folke, 1998; Carpenter, *et al.*, 2001; Gunderson and Folke, 2005) and, all these definitions as well as further literature analysis (Morrow, 2008), surmise that resilience entails:

- Know-how of the hazard
- Precise awareness of the risk
- Knowledge of existing options
- The resources and elasticity to counter effectively

Nevertheless, these aspects are not distributed evenly through all communities or within any group. Their distribution is basically governed by ecological, historical, Socio-economic powers, most of which are mainly outside the management of most of the people.

Resilience can therefore be classified into various types:

1. **Physical Resilience:** This implies the physical power – in condition and numbers – to deal with an impact (Morrow, 2008).
2. **Economic Resilience:** This is the capacity of a community to marshal sufficient resources, in amounts and variety, to surmount a disaster (Morrow, 2008).
3. **Ecological resilience:** The capacity of an ecosystem to withstand disturbance without altering self-organized processes and structures (Gunderson, 2000).

4. **Social Resilience:** The ability within human societies to adjust to change, particularly to absorb recurring disruptions such as famine and floods so as to preserve fundamental organizations and procedures (Adger, *et al.*, 2005).

Presently, assessments of resilience usually focus on household resilience (Frankenberger and Nelson, 2013a) and, most disaster research is focused on individual-level outcomes (Norris, *et al.*, 2008). This tendency to focus on households has left a major gap in the understanding of resilience at higher scales thereby making it difficult to consider resilience across multiple levels. The on-going debate over the definitions of resilience as well as the suitability of outcome versus process indicators and which subsystems and policy areas are the subjects of resilience has hampered action and measurement (Frankenberger, *et al.*, 2013b). Despite the fact that a well-developed body of literature in natural resource economics around collective action exists, a gap between theoretical discussions of resilience and their application among the development community also exists (Cutter, *et al.*, 2008; Cutter, *et al.*, 2010). The transformation of the concept into an operational tool for policy and management purposes has been and still is a major challenge that is yet to be overcome (Klein, *et al.*, 2003). Current efforts made in the application of resilience measurement to development practice include the USAID Feed the Future Learning Agenda Paper on resilience (Frankenberger, *et al.*, 2013b; Frankenberger, *et al.*, 2013c), the Technical Working Group on Resilience Measurement and the Expert Consultation on Resilience Measurement for Food Security.

1.7.2 Defining Community Resilience

Community resilience depends on social capital – i.e. social links and shared action grounded on ties of relationships, reciprocated dependence, trust, and community mores. Social capital backs community resilience by offering a spontaneous cushion to those disturbed by disaster, surmounting challenges to adjustment through organised resident processes and supporting transformative change by strengthening the community's collective voice and action, (Aldrich, 2012).

A working definition of a community can therefore be determined from this; as 'a group of people in a common geographical area, linked by social ties, shared uniqueness, shared exploits, and providing a channel for accessing resources, their assorted characteristics and priorities all the same' (Murphy, 2007). Whereas at the community level, resilience is closely knotted to its economic and political statuses in addition to the strength of its social capital, at a personal or family level, resilience is related with not only economic resources but also cultural resources, such as literacy and education, and social resources, such as kinfolk and associates (Heinz Centre, 2002).

The inkling of community resilience has mainly been established from social resilience. One of the widely accepted descriptions of social resilience is 'the capacity of groups or communities to deal with exogenous stresses and disruptions due to social, political, and environmental change' (Adger, 2000).

Another widely accepted description of social resilience is ‘the necessity of human systems to learn to cope by adjustment and infers that “ambiguity and shock are part of the contest’ (Folke, 2006). From these definitions, a number of chief concepts regarding community resilience have been developed, namely:

- Community resilience can be both preventive and/or facilitate recovery after a traumatic event (Frankenberger, *et al.*, 2013b)
- Community resilience speaks to whether more vulnerable stakeholder groups are capable of recovering from a disturbance without reducing the well-being of any other community-based institutions or individuals (Wilson, 2012)
- Community resilience is the balance between economic productivity, environmental health, and the social needs of communities (Rotmans, *et al.*, 2002)

Resilience is related to sustainability in that it describes a certain feature of maintaining procedures; from the environmental to the quality of life over a particular phase. In a disaster setting, it refers to the capacity of ‘a region to manage and surmount injury, weakened productivity and decreased quality of life caused by a life-threatening occurrence without significant outside help’ (Mileti and Gailus, 2005). Essentially, a disaster is the failure of humanity to adjust to its environment (Oliver-Smith, 1996); it can be concluded that disaster resilience encourages viability (Geis and Kutzmark, 1995). The inequitable distribution of resources of a society brings about the terms

environmental integrity and social integrity which are used by diverse fields to discuss this.

- Environmental integrity targets on the inequities in the physical distribution of hazards and risk; particularly, the evidence supporting the argument that certain communities, (e.g those not well-represented in government/power) are more likely to be exposed to environmental hazards, both natural and scientific (Cutter, 2001). It argues for ‘the significant participation of all people’ in how the environment is used in addition to equal rights to a healthy and secure environment (Dobson, 1999)
- Social justice shares a comparable focus on the dissemination of benefits and problems. It argues in favour of targeting on supporting a good quality of life throughout populations, both for the current and for the future (Dobson, 1999). It encompasses more than environmental issues and argues for the equal rights of all sectors of society to meet their basic needs and advocating for greater socio-economic parity (Foley, 2004)

1.7.3 Vulnerability and Resilience

Vulnerability as defined by Constan and Frankenberger, (2013), refers to the sensitivity of a household or community to a disturbance. ‘The concept of resilience is useful because it provides an overarching organisational scheme within which vulnerability, shocks, and heterogeneity of recovery pathways

may be understood, measured, and modelled' (Constas, *et al.*, 2013). This statement provides a depiction of the relation between vulnerability and brings out resilience to be a concept which helps to explain how vulnerability states shift over time, across contexts, at multiple scales, and in the face of varied shocks and stresses and despite the fact that the two are related, vulnerability is not the inverse of resilience (Constas and Frankenberger, 2013). Pertaining to community resilience, it is important to understand variations in vulnerability to food insecurity associated with risk exposure events (i.e., vulnerability is not a static state – it varies depending on risk exposure); (Summer, 2013) and the role of collective action in aiding communities to reduce vulnerability and to cope and adapt to shocks and stresses (Frankenberger, *et al.*, 2013b).

The contribution of a community resilience framework must be considered in relation to a well-established construct of vulnerability (Constas and Frankenberger, 2013). However, the recognition of community heterogeneity is linked to the view that community resilience is not essentially associated with uniformly resilient individuals/households (Frankenberger, *et al.*, 2013b). On the other hand, a collection of resilient individuals/households does not necessarily imply community resilience (Norris, *et al.*, 2008).

In summary, a community may be resilient overall, given that it has the ability to absorb disturbance and adapt while maintaining its essential functions, structure, and identity (Longstaff, *et al.*, 2010), yet resilience at the individual or household levels within that community may vary extensively. Studies

suggest that households' vulnerability to climate change and variability depends on the availability and diversity of household resources, household characteristics, existing political institutions and social networks as well as environmental setting (Brooks, *et al.*, 2005; Ifejika, *et al.*, 2014). The vulnerability framework is especially used to address climatic disturbances such as drought events as it integrates the livelihood framework with components on risk management and climate change adaptation (Fraser, *et al.*, 2011). Furthermore, it stresses the understanding that adaptive capacity of households and communities responds to disturbances such as drought, floods, disease outbreaks and conflicts, and how such disturbances affect households' exposure to risk, resulting in either increased vulnerability or increased resilience over time (Tschakert and Dietrich, 2010).

1.7.4 Resilience Systems Analysis: The DPSIR Model

A resilience systems analysis provides certain significant players in the field with either one of the following (OECD, 2014):

- A shared opinion of the risk environment encountered by the population
- An understanding of the broader system for people's welfare
- An analysis of how the risk landscape affects the key components of the well-being system, which components are resilient, which are not, and why
- A shared understanding of power dynamics; and how their use or misuse helps or hinders people's access to the assets needed to cope with shocks

The Driver, Pressure, State, Impact, and Response (DPSIR) framework (Driving Forces – Pressures – State – Impacts – Responses) was used in this study as the resilience systems analysis method to describe the interactions between the pastoral community and their environment, particularly the land use cover changes in relation to climate changes and environmental degradation in the study area. Its components are, namely:

- Driving forces – The socio-economic and socio-cultural factors driving human activities, which increase or mitigate pressures on the environment
- Pressures – The stresses that human activities place on the environment
- State, or state of the environment – The condition of the environment
- Impacts – The effects of environmental degradation
- Responses – The answers or reactions by society to the environmental situation

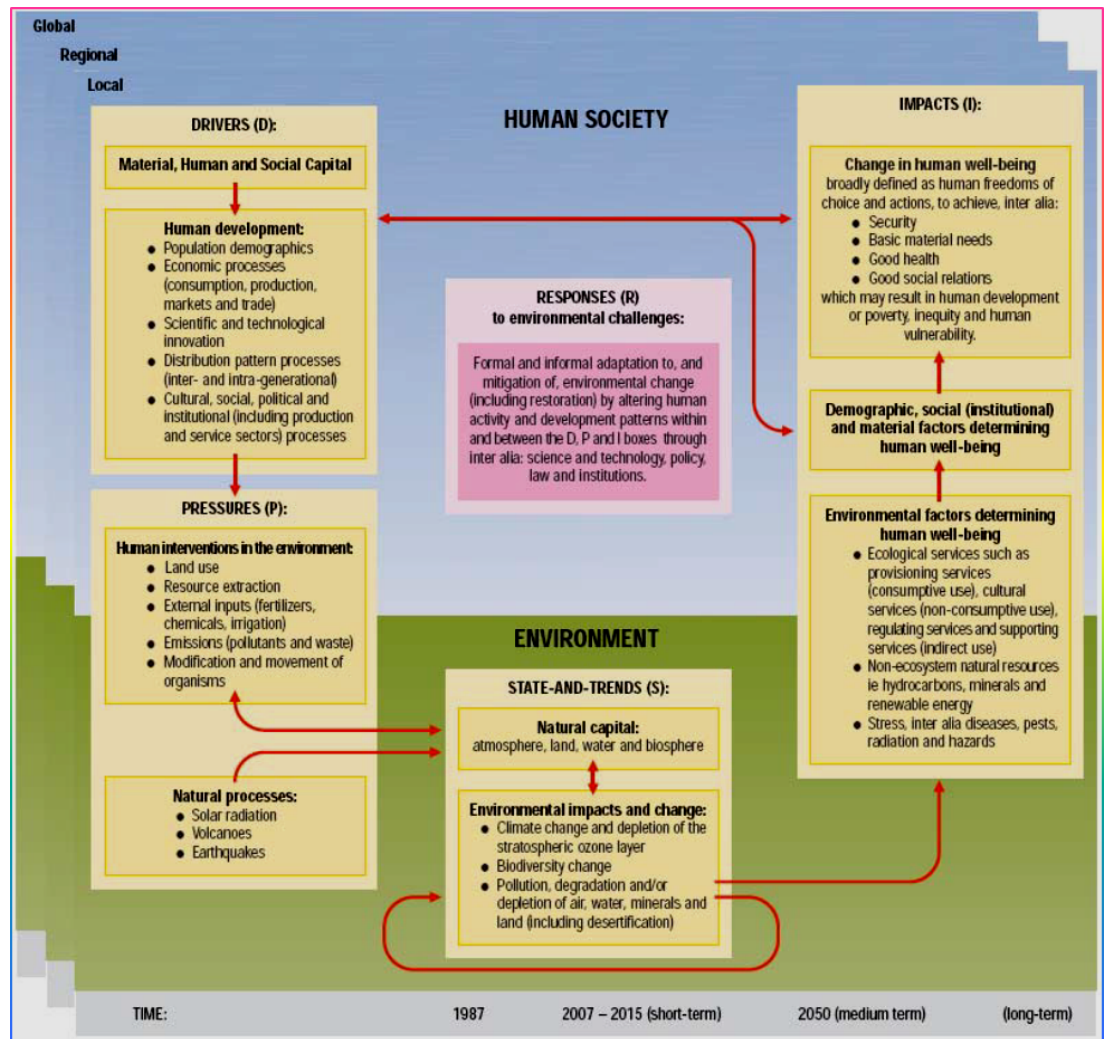


Figure 1.1: The DPSIR Framework

Source: UNEP (2006)

The occurrence of severe droughts has been increasing over the years in Kenya resulting in deaths of large numbers of livestock, resource based conflicts, livestock disease outbreaks and environmental degradation (Nkedianye, et al., 2011). Moreover, the human population pressure and settlements, land use changes and conflict, particularly human-wildlife conflict, limit access of livestock to grazing areas in Kenya’s ASALs and in turn, directly affecting pastoralist communities.

From as far as the 1950s, climate extremes such as droughts have been traced (Hadley, 2012) but, the drought cycle has become more frequent in recent time, giving no time for households to recover from its adverse effects (Huhó and Kosonei, 2014). Pastoral communities in Kenya have been most affected by this drought and have suffered economic, environmental, social and cultural losses. Strategies such as herd mobility to make best use of the heterogeneous landscapes, keeping diverse mix of livestock species, restocking and destocking (Watson and van Binsbergen, 2008) as well as households' diversification to crop-farming, wage labour, reliance on remittances and social networks of support have been put in place by these communities as a means of coping with the harsh conditions. Presently, these strategies have been hampered by the frequent droughts in pastoral lands, rapid social and economic changes and deteriorating climatic trends.

This study used the DPSIR model so as to wholly understand the stresses and shocks that result in pressures on households in pastoral lands as well as linking unplanned land fragmentation and land use/cover change to the response and coping strategies of pastoral communities. It further explores in detail the pre-existing policies employed to combat climate-induced disturbances along with a basis for the development of more effective policies and resilience programs for ASALs.

1.8 Limitations of the Study

The study examined the socio ecological resilience and pastoral land use change in semi-arid lands in Kajiado North Sub-county in Kajiado County Kenya. However, LUCC is influenced by physical location, demographic, cultural and socio-economic factors at the household, community, national and global level; therefore every land use system adopted differs from the rest in the extent to which the driving forces inherent will apply. Furthermore, the driving forces applying in dry lands vary within peri-urban areas in Kenya. Thus the results of this study might only be applicable to areas which have the same climatic and physical location characteristics as those of the study area. Additionally, the factors that influence the choice land use system are highly dynamic and change with changes in political and institutional setup within and beyond the study area. Therefore, the use of these results should be supplemented by additional information on the existing political and institutional frameworks with respect to national and global levels since land choice is affected by forces beyond the community.

1.9 Organization of the Thesis

In this thesis, Chapter One diagnoses the problem and current status. It explores the trends in land use/cover change in Kajiado North Sub-County and their implications and why it is necessary to address the problem. In addition, the chapter states the objectives and research questions and put the issues in perspective into the DPSIR conceptual framework. The second chapter

provides the literature review. The chapter details the state of knowledge socio ecological resilience and pastoral land use change in semi-arid lands. It outlines the existing legislation and regulation that control land fragmentation in the area.

Chapter Three details the research methodology and data analysis used. Chapter Four gives the detailed presentation of the data analysis results for all objectives. Chapter Five discusses the results with reference to other studies carried out in similar scenarios. The thesis concludes with recommendations for adoption, policy implications and further studies where gaps were noted in the field in Chapter Six.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1 Summary

This chapter presents literature on pastoral lifestyles and pastoral household livelihoods with a great focus on land use change and the resilience of these communities at various levels. It begins with a thorough explanation of the transformation of Maasai from a pastoral to transhumance and semi nomadic or sedentary/urbanized lifestyles as seen in the period between the 1800s and today. It also offers a deep understanding on land use change, particularly, the causes of land use change and precipitating factors that lead to it. Furthermore, it provides a deeper understanding of resilience at the household, community and county levels and delves into its three capacities: The Adaptive, Absorptive and Transformative Capacities. Finally, this chapter analyses the LUMP and WCLP initiatives while linking them to the community resilience of semi-arid lands and their effect on that resilience.

2.2 Land Use/Cover Change

Land cover, should not be confused with land use since it is defined as ‘the observed (bio) physical cover on the earth’s surface (FAO, 1999). Land use, on the other hand, is ‘characterised by the organisation, actions and inputs people undertake in a particular land cover type to produce, which can change or sustain it’ (FAO, 1999). From this definition it is obvious that there is a direct connection between land cover and the activities of the people in that particular ecosystem; various classifications thereby arise for land use. Factors that

contribute toward land use change can be related to demographic i.e. local population growth and migration; the economy i.e. higher relative returns to land in crops than livestock and policy i.e. land privatisation, technological, institutional or cultural (Olson, 2006). A distinct understanding of land use and land use change patterns thereby requires the identification and analysis of how the accelerating factors interact in the required context so as to influence decision making in land use.

The directions and speeds of land-use change are frequently determined by the region's political economy, but mainly by the market economy and political influence, crosscut by globalisation (Lambin and Geist, 2001). Land tenure in pastoral and agro pastoral regions is under considerable pressure, originating mainly from changing vegetative cover and demographic ecosystems; whereas other fundamental triggers are social, economic and political transformations. In the recent past, i.e. last two decades, with a national average population growth rate estimated at three per cent per year, both pastoral and agro-pastoral regions have experienced fast population growth, (Lambin, *et al.*, 2003). In turn producing patterns of land-use to change in the ASAL areas; which were primarily used for nomadic pastoralism to sedentary pastoral and agro-pastoral, or purely crop production (Muriuki, *et al.*, 2005). This has negatively impacted on livestock production with huge areas of these lands undergoing some degree of degradation due to unprecedented population growth, undue cropping pressure and overgrazing affecting biodiversity, productivity, carrying capacity and soil potency (Olson, *et al.*, 2004a).

Recent interventions in parts of the ASAL areas such as the Mara, including privatisation and confiscation to form ranching schemes or to provide room to cultivation have occasioned negative rates of return on land, and favoured richer families (McCabe, *et al.*, 2010). These intrusions have nevertheless mostly substituted nomadic pastoralism, which has formerly been a successful adaptation to the reasonably dry and vulnerable environment, (Homewood, *et al.*, 2012).

The families that continue to predominantly practise nomadic pastoralism lost key grazing lands, particularly in low-lying plains so as to create room for the production of maize, wheat, barley and other crops; unfortunately naturally increasing the amount of conflicts, due to the less compatible interaction between crops and wildlife than between livestock and wildlife. With the population increasing progressively – and in certain cases rapidly – in the absence of increased livestock production, there is a decrease in the quantity of livestock per an individual, suggesting that the supply of milk and meat is lowered, increasing the necessity to supplement household foods; presenting a period of continued food insecurity; (Nyariki, *et al.*, 2009).

Decreasing livestock production and productivity is expected to have dreadful effects on numerous characteristics of the Maasai lifestyle (Boone, *et al.*, 2005). Other agriculture and livestock policies, as well as wider political structures determining trade and economic growth have significantly

determined the background of land use and livelihoods change (Rutten, 2005). Over the last several decades, agricultural policies tend to support crop instead of livestock production. To make the situation worse, livestock policies have constantly favoured commercial ranching undertakings over indigenous production systems (Mattee and Shem, 2005). It is also noteworthy that quarantine policies continuously undermine indigenous producers in support of the protected and comparatively small export market producers (Scoones and Wolmer, 2006).

The growing emphasis on diversification away from livestock production, partly due to policy and partly due to economic forces, is taking place together with radical changes in land tenure, that is rapidly declining access due to land privatisation, fragmentation, and setting aside of land for conservation (Olson, 2006). Over the last several decades, especially since Kenya's independence, the Maasai people have experienced radical changes arising from the segmentation of previously communal rangelands into individual holdings, their transformation to commercial cultivation or their designation as conservation areas, (Mung'ong'o and Mwamfupe, 2003; Boone, *et al.*, 2005).

The most significant outcomes of fragmentation include the loss of access to crucial resources by people and livestock and escalating restrictions on mobility between, and competition for, those vital resources that remain (Rutten, 1992). Nevertheless, policy objectives are progressively polarised between poverty reduction and wildlife conservation urgencies (Adams and Hulme, 2001), as

both require differing use of the same land. The inevitable outcome is increasingly beginning to appear as a growing inequity between demography and resources, as a result of changing guidelines of access and exclusion, regardless of the unconditional availability of resources (Gausset, *et al.*, 2005). As financial requirements have multiplied to cater for health, education, livestock and crop inputs, and for the purchase of food items, due to lifestyle changes – such as sugar, maize and tea – the need for families to have an enhanced source of continuous, reliable and sustainable income increases by the day (Homewood *et al.*, 2009).

The assortment of income sources and livelihood choices has changed for Maasai people as government policies and the overall socio-economic settings have changed. They have progressively embraced crop production, not so much as a move out of pastoralism, but so as a pathway to the resilience of their pastoral activities (O'Malley, 2003). As with the rest of the Kenyan residents, there has been increased awareness on the importance and benefit of having educated family members with steady jobs as a means of livelihood diversification and enhancement. The escalating population densities and cultural pluralism due to urbanization of areas in and around the Maasai indigenous land has compounded pressure for services and materials (Bryceson and Jamal, 1997). Some households have seized this opportunity to offer casual labour, as well as gathering, value adding and vending of natural resources through such activities as charcoal burning or honey searching, including petty

trading, amongst additional poverty-reduction strategies (Homewood, *et al.*, 2009).

Usually, terms of trade for pastoral products have regularly favoured the producers, given that milk and meat almost always command a greater calorific value than cereal or other agricultural produce in exchange (Dietz, *et al.*, 2001). Though, the comparative terms of trade for livestock and meat products have dropped over the last several decades, because of dumping of subsidized meat and milk powder from Europe and elsewhere on African markets (Sandford, 1994).

The presence of lucrative wildlife resources in and around the Maasai community's native land creates special opportunities for the community. Revenues acquired through such opportunities can have a bearing at the family level through jobs, wages or dividends, e.g. through the Wildlife Lease Conservation Programme. Such revenues can also stream to the community level through development of health, education and infrastructure facilities in the region. Income derived from wildlife is perhaps more significant for households at the fringe of major protected areas, which is the case somewhere else in Maasai land (Bedelian, 2012). Data within other major tourist destination ecosystems, like Amboseli, indicate households located in the outer, drier parts of the system receive minimal tourism returns (Homewood, *et al.*, 2009).

Major funding streams and powerful players that shape policy and practice in Africa often originate from international wildlife conservation interests (Sachedina and Nelson, 2012). As more land is abstracted over by conservation and privatisation or allocation to state enterprises, increasingly less remains for pastoralism and wildlife protection priorities become more strongly polarised.

2.3 Payment for Ecosystem Services

Ecosystem services are defined by the Millennium Ecosystem Assessment as ‘the benefits people get from ecosystems’ (MEA, 2005); however, often there is a lack of consensus on what the benefits really are. This is partly because some of the services, such as regulation and support, do not have an explicit market value and thus the intended “beneficiaries” do not see them as “benefits”. Consequently, a lack of knowledge of the monetary value of some of the ecosystem goods and services ends up leading to resource degradation.

There are many other related factors including existing policies and practices, demand on existing services, and the opportunity costs of conserving services, which make it difficult for an unambiguous understanding and appreciation of the value of these resources. Consequently, there is less investment than desirable in conservation and management which leads to ecosystem deterioration (MEA, 2005). Ultimately, as the demand for ecosystem goods and services grows, arising from an escalating human population and poorly planned infrastructure development, coupled with unsustainable utilisation and

suboptimal investment in conservation, habitat degradation, biodiversity loss, and decreased agricultural productivity become imminent.

Payment for Environmental Services (PES) is an alien concept to many people. However this is a practical tool that can be applied for the benefit of sustainable productivity of environmental resources. PES is a market-based tool that can be integrated into the WCLP approach as a way to create financial incentives for managing natural resources, addressing livelihood issues for the rural poor, and offering viable financing for protected regions. The vital principle is that those who “provide” environmental services by preserving natural ecosystems must be compensated by recipients of the service (WWF, 2006). PES has developed in recent years into a promising tool for attaining ecosystem conservation and improving the livelihoods of ecosystem-service providers and consumers (Robertson and Wunder, 2005).

Maintaining land in its natural state is occasionally a more attractive option than its conversion because recipients are not the service provider (the land owner). (Pittock, *et al.*, 2009). One of the various descriptions of PES is as ‘a voluntary transaction whereby a well-defined ecosystem service (or a land-use likely to secure that service) is being ‘bought’ by a (minimum one) ecosystem service buyer from a (minimum one) ecosystem service provider if and only if the ecosystem service provider secures environmental service endowment’ (Wunder, 2005). PES can therefore be understood as a coupled social-ecological system, composing of the collaboration between providers and

buyers of environmental service on the one hand, and land use and management practices made by providers that influence environmental service endowment (Van de Sand, *et al.*, 2014). This suggests that PES systems are ideally sensitive to climate changes/variability while at the same time being able to influence the environmental service providers to deal with the effects of climate change and variability. Coping with climate change and variability can include enhancing adaptive capacity and implementing measures to minimise the impacts of climatic perils (Adger, *et al.*, 2005; Füssel and Klein, 2006).

An effective implementation of a PES scheme should consist of mechanisms to (Arriagada and Perrings, 2009):

- Value (or at least measure) a service where no measure currently exists
- Identify how additional amounts of that service can be provided most cost-effectively
- Decide which service providers to compensate
- Determine the level of compensation

Majority of the existing PES schemes worldwide do not satisfy these conditions and among their failures, they (Arriagada and Perrings, 2009):

- Fail to yield positive net social benefits
- Fail to gratify an additionality test i.e. pay for adoption of practices that would have been embraced anyway
- Depose environmentally destructive activities to other regions

- Inability to create resources essential to sustain incentives to service providers i.e. are unsustainable

Some of these shortcomings can be linked with defects in the design of PES programmes. Specifically, they arise from (Redford and Adams, 2009):

- The danger of usual economic models that favour human interests being overwritten such that the non-economic justifications for conservation get further relegated arise. There is therefore need for formulation and implementation strategies that respond holistically to identified stakeholder needs from the beginning to enable a scenario where the intrinsic values of nature, which are often easily downplayed, would be taken proper account of
- ‘The conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life’ (Daily, 1997) is just one of the many existing definitions of ecosystem services. Though all these definitions cite positive values for human society, not all ecosystem processes directly sustain and fulfil human life. Processes such as fire, drought, disease, or flood apparently work against this goal, yet they are vital for ecosystem function, structuring landscapes, and providing vital services and regulatory functions to nonhumans. There is a danger that an economically driven focus on those services that are valuable to humans in their nature, scope, and timing may lead to calls to regulate ecosystem services to times and in flows that match

human needs, at the expense of long-term survival of the non-human parts of the ecosystems, and ultimately the entire earthly ecosystem

- Environmental policy founded on the optimization of ecosystem-service values will not certainly lead to the conservation of biodiversity since ecosystem services need not be provided by indigenous species. Many introduced species will do the assignment as well, or perhaps even better. Ecosystems have subsisted in cases where prevailing species are exchanged with exotics
- There exist a diverse variety of problems related with valuation of ecosystem services. Markets only exist for a certain range of ecosystem services, and some services are not capable of pricing or valuation. Markets also change quickly, and where markets do exist, the value of the services from diverse ecosystems will not reflect their diversity, but their desirability to human consumers. For instance, where a valuable service is provided by a biodiverse ecosystem, where that ecosystem is close to a chief consumer, and where organizations exist to enable those consumers to pay for the service they receive, ecosystem services may provide a formidable stimulus for conservation. Somewhere else, can may not
- With ecosystem services becoming increasingly scarce and valuable, people will compete to gain control over flows of services and the ecosystems that provide them and in such a case there will be winners and losers in markets for ecosystem services. For instance, where ecosystem services are private, or privatized, ecosystem payment

arrangements may have welfare associations. Moreover, the ecosystem services that have the highest price may not be those that contribute the greatest wellbeing and as people invade ecosystems and adapt them to maximize income flows, collateral damage to biodiversity may end up being discounted, for example in rigorously managed forests or dam up rivers

The Wildlife Conservation Lease Programme (WCLP) was started in Kajiado North Sub-County as a form of Payment for Ecosystem Service (PES) in the year 2000 (Republic of Kenya, 2008; Reid, *et al.*, 2008) by the clans in collaboration with; the Wildlife Foundation, Friends of Nairobi National Park, African Wildlife Foundation, The Nature Conservancy and the World bank. The the programme entails partakers to permit unrestricted movement of wildlife on their land, protect natural vegetation, and shun fencing or subdividing their land. Those landowners registered in the WCLP, are compensated with a let pay of four dollars (about Ksh.400) annually, while they can join and leave the programme willingly (Republic of Kenya, 2008; Reid, *et al.*, 2008). The enrolled participants permit the passage of wildlife as they graze their livestock on the same pecel of land. The revenues obtained from the programme complements the possible income that would be obtained through the fencing, selling or farming of the land.

Over the years, increased preying on Maasai livestock by wildlife, coupled with other human wildlife conflicts, have made several members of the Maasai community intolerant to wildlife to the level that they have progressively

excluded them from their land through fencing and direct slaying of predators. Urgent and broad mediation actions are needed to tackle these conflicts and alleviate the adverse consequences on wildlife dispersal to protect the future of Nairobi National Park and the sustainability of wildlife in the Athi-Kaputiei environment. (Matiko, 2014). It was in response to this need, that the WCLP, run by The Wildlife Foundation (TWF), a locally incorporated Non-Governmental Organization (NGO), was started with main purpose of ensuring free movement of wildlife between the Nairobi National Park and Kitengela-Athi-Kaputiei Plains in order to inhibit the possible adverse repercussions on the wildlife and ecosystem. It also had two sub-objectives, namely, to:

- Uphold the periodic dispersal zones and migration passageway open to ensure the sustainability of the Nairobi National Park ecosystem and the biodiversity
- Boost the economic security and standards of living local landowner families (ACC, 2005)

The TWF was given a grant by the Global Environment Facility (GEF) in 2008, through the World Bank in the category of a Medium-sized Project (MSP), as a trial in the expansion of the WCLP demonstration project for successful conservation of wildlife on privately owned lands beyond protected regions (Imbahale, *et al.*, 2008). The project has been successful in facilitating to ensure the long term ecological sustainability of Nairobi National Park by upholding the periodic dispersal zones and migration passageway on adjacent privately owned lands, thus demonstrating the application of wildlife

conservation leases as a conservation instrument beyond protected zones (GRM, 2013). Moreover, in addition to the WCLP raising more than US\$500,000 in additional cash and in-kind resources, its achievements have exceeded the initial targets. These include:

- Number of individual adult lions has nearly doubled from a target of a 20% increase
- The area under voluntary enrolment of Wildlife Conservation Leasing has increased to 417 households covering 61,067 acres which is 104% from the initially targeted 400 families and covers 102% from the initially targeted 60,000 acres
- There are on-going negotiations between the Ministry of Lands, Kenya Wildlife Service (KWS) and the local Maasai Community targeting the permanent designation for cattle and wildlife use of a 2,912 acre parcel of land adjacent to Nairobi National Park
- Research conducted in 2010 in the area indicates that 76% of household income in 2008 and 80% in 2009 generated from leasing is spent to pay school fees. The balance of leasing income was spent on human health and livestock production systems
- Field observations indicate that fencing of rangeland has slowed by 13% of the Kitengela rangeland area currently fenced compared to an initial estimated 10%
- An aerial survey carried out in June 2011 by the Department of Remote Sensing and Resource Surveys established that wildlife populations of

Kitengela in the Athi-Kaputiei Plains increased significantly over the wildlife census periods 2007 to 2011 (GRM, 2013)

The WCLP has actually achieved notable successes through the encouragement and assistance of indigenous pastoralists to:

- Maintain possession of their land
- Leave land open, fallow and un-segmented
- Forage livestock sustainable way
- Share range resources like pastures and water among livestock and wildlife
- Permit open passage of livestock and wildlife
- Provision of secondary and university education for their offspring via the disbursement of incentives

Additional positive effects related to the implementation of the WCLP include:

- Provision of continuous cash streams and alleviation of poverty levels: The WCLP disbursed a total of US\$ 837,120 (in US\$ 2005 equivalent) to a total of 417 households for the 12 year between 2000 and 2012 (AWF, 2009). The average income to the participating households ranged from US\$ 248 in 2004 (7% of gross household income) in a period of normal rains to US\$ 345 per year in 2009 (25% of gross household income in a period of severe drought)
- Reducing pastoral vulnerability to drought: The WCLP has provided a consistent and stable income that has worked as a pathway to resilience of drought episodes when pastoralists suffer acute livestock mortalities

- Gender empowerment: The WCLP has considerably contributed towards the empowerment of women via the sharing of revenues allocated to women recipients who previously were without any source of income

Comparable initiatives have been undertaken successfully in USA (Knight, 2002; Bernstein and Mitchell, 2005; Ferguson, 2009) to protect natural or cultural resources. The main opportunity that has resulted from the execution of WCLP is the development and espousal of the Land Use Master Plan (LUMP), which if implemented could help regulator untenable land uses in the area as well as offer room for improved participation of resident land owners in the administration of their resources, and the implementation of complementary conservation mediations (Matiko, 2014).

The implementation of the Wildlife Conservation Lease Programme is, however failing due to the following:

- Rapid urban sprawl: the growth of urban areas leading to the encroachment of rangelands to settlement areas as urban residents purchase land, further increasing land prices, leading to land subdivision, land sales and change of land use to other uses that are not pastoral like crop production. It is an on-going challenge that is expected to continue as Nairobi Metropolis expands into Kajiado as part of the implementation of the Kenya Vision 2030 economic blueprint (Republic of Kenya, 2008).

- Road infrastructure: The projected plan to construct a US\$ 200 million road bypass that crosses the southern section of the Nairobi National Park may impede the land lease programme and further accelerate the fragmentation of the landscape in Athi-Kaputiei Plains
- Population growth: The demography of the Kajiado North has increased immensely within last three decades due to urbanisation, hence creating more pressure on the Athi-Kaputiei Plains ecosystem as well as increased human-wildlife conflicts in the area
- Rising land prices: Many parts of Kajiado land value has appreciated at rate of over 11% per annum in the last two decades, this high land value in addition to the incessant increasing land prices reflects the peri-urban and metropolitan potential of the area land where the future of wildlife is uncertain as it will not be suitable for wildlife as a form of land use (Norton-Griffiths and Said, 2009)

2.4 Maasai Transformation from Pastoral to Sedentary Lifestyles

The Maasai in East Africa appeared to have perfected the art of pastoralism as early as the 16th Century, however due to the expansion and subdivision of The Great Rift Valley they begun to experience some hindrances to their core way of life. Beginning with the Iloikop Wars between Maasai and other directly related pastoralist groups, they however succeeded in securing control of big regions of East Africa and possibly overextended (Waller, 1976). In the 1800s the Maasai clans was dealt an huge blow by viruses affecting their core source of livelihood, livestock; by bovine pleuro-pneumonia in 1883 and the first

incident of Rinderpest appearing in 1891, killing off an approximated 90% of Maasai livestock (Homewood and Rodgers, 1991).

The Maasai faced another setback when they were inhibited from grazing their livestock on lands converted to national game reserves founded during colonial era – the Serengeti Park and Ngorongoro Crater in Tanzania and the Nairobi, Amboseli, Tsavo, Masai Mara, and Samburu National Parks in Kenya thereby narrowing their graze land (Homewood and William, 1991). During post-colonial rule the Maasai encountered competition for land by the bordering Kikuyu and Kamba farmers who relocated off the highlands they formerly occupied as their populations grew (Rutten, 1992). Subsequently in 1962, the Maasai comprised 78% of Kajiado County's population; by 1992 they were fewer than half, as a result of leasing, rent, and sale by Maasai owners, who could no longer be able to graze their animals on their previous lands (Campbell, 1993).

However, over time the group ranch scheme has been subjected to sub-division of land in a move toward individual land ownership in line with Kenyan government policies (Grandin, 1986). These systems initially aimed at privatising rangelands have generated many of tribulations that have surpassed those they tried to solve, causing social imbalance and exploitation, and exclusions of individual households and communities (Rutten, 1992). The Maasai initially accepted the group ranch concept as a means to inhibit continuing crop production encroachment on their land and to obtain legal

tenure, permitting them to qualify for loans and the development of bore holes and cattle dips (Campbell, *et al.*, 2005).

In 1904 and 1911, the Maasai were forced to sign agreements with the British; resulting in the loss of between 50 to 70 per cent of the land they previously utilised (Hughes, 2002; Rutten, 1992). These factors, coupled with the transhumance nature of pastoralism, made them more susceptible to land snatching. However cultivation that has been embraced gives limited earnings besides adding to food security but it is a tenure strategy curtailing land grabbing, Homewood *et al.*, (2012).

The wetter sections of Kajiado have been acquired by agriculturalists, who include resident Maasai, further blocking livestock herders access to sections of higher potential lands (Rutten, 1992). Additionally, upstream water off take for irrigation, especially in newly settled areas of Maasailand such as Kimana, has greatly reduced wetland habitats downstream, depleting grazing lands and drought pastures even further among pastoralists who remain on the rangelands (Western and Manzollilo, 2004). This is in great contrast to an earlier period when, for instance, water development initiatives in the Amboseli region created a scenario where cattle numbers increased from 70,000 in the 1940s to nearly 200,000 by 1960, leaving few regions outside reach of intense dry season foraging.

Cumulatively, all of these contemporary events total up to a major loss of land, thus substantially reducing the indigenous community's resilience to shocks affecting their livestock, and thus increasing their susceptibility to ecological change, particularly drought, (Rutten, 1992). Another inhibiting factor to the Maasai community is population increase, creating a strain on the ecological amenities. Human population continues to progressively increase outstripping that of livestock, as a result, per capita livestock holdings have dropped steadily from 10 in the 1960s to 4 by the 1980s (Western, 1994), these holdings are now under half those necessary for subsistence according to Boone *et al.*, (2005). In recent times Maasai have changed to crop production to complement foods acquired from livestock, which has played an increasingly critical role in subsistence and nutrition, Galvin *et al.*, (2013). In addition Maasai have progressively shifted their livelihood from absolutely subsistence pastoralism to commercial production therefore creating an additional source of income, Kristjanson *et al.*, (2002).

In order to combat these hindering factors, the Maasai community together with the stakeholders, developed pathways to resilience, one of which is the Wildlife Lease Conservation Programme (WLCP) which turns the hindering factor of the sharing of pastoral land with wildlife into one that is beneficial to the Maasai community (Republic of Kenya, 2008). One of the first endeavours to make wildlife an asset to indigenous dwellers through income-division and wildlife exploitation was started in Amboseli National Park, gazetted in 1974. Lessons from the Amboseli experience have since been integrated into national

policy and execution has over time contributed considerably in terms of cash disbursements and improvement of revenue flows through tourism concessions to group ranches (Western, 1994). The Wildlife Foundation, (TWF) entered into lease agreements with private land owners, for a payment of USD 4 per acre per year, who in turn agreed to leave the portion of land under lease open for grazing and free movement of wildlife (GRM, 2013), thus creating another source of income for the Maasai community.

The restructuring of pastoral patterns of range resources administration and the associated institutional setting has been affected by the processes of incorporation and the encroachment of outsiders' concerns. The development problems of pastoral communities have been further compounded by new ideologies that have added further elements that contributed to fuelling vulnerability while their social and ecological resources are increasingly degrading (Nori, 2008).

Given these evolving challenges, the Maasai have been forced to take up several adaptive strategies in response to the changing face of pastoralism. In attempts to confront the various issues arising from loss of grazing land due to emergent factors and political marginalisation, some are seeking non-pastoral livelihoods either by adopting crop cultivation or migrating into urban areas (Kristjanson *et al*, 2002). While others still carry on with livestock keeping, nomadism is slowly diminishing, thus escalating the inclination towards sedentarisation among traditionally nomadic pastoralists, particularly from the

mid 20th Century. Salzman (1980) views the progression of sedentarisation as a reaction to constraints and prospects in the physio-biotic and social cultural ecosystems.

The decline of pastoralism can be attributed to three major factors: Socio-economic, internal forces, socio-economic and political, external forces and ecological forces or resource limitations (Grossman, 1992). The external factors include growth and prosperity among neighbouring societies; encompassing the growth of opportunities in adjacent urban centres. Internal causes viewed as demographic processes, changes in the local economy, ecological changes and social change arising as result of external influences like education and tourism Fratkin (2001).

It is also of significant importance to state that the Maasai land is in itself undergoing fast change due to climate variability in addition to pressures and shocks it experiences; leading to changing land use and livelihoods in order to foster positive outcomes for conservation and development of Maasai land, Olson *et al*, (2004). The residents of Maasai land are still mainly rural and livestock dependent with some clans and families remaining almost entirely livestock oriented, while majority are increasingly diversifying towards agro-pastoralism or away from farming activities to more urban adapted. The developing significance of diversification away from livestock production is taking place alongside radical changes in tenure with rapidly diminishing

access due to land privatisation, fragmentation and preservation of wildlife (Kristjanson *et al*, 2002; Sogoti, 2010).

The growing influence of politics and nationhood, the advancement of the traditional to a monetary economy, growth in education, population aspects and changes in land tenure have all played a role in determining the current socio-economic state of Maasai in Kenya and Tanzania (McCabe *et al*, 2010; Sogoti, 2010).

2.5 Resilience Capacity

The capacity of resilience of a household, community or county has been seen to appear in three major forms: absorptive, adaptive and transformative capacity. Absorptive capacity refers to the absorption of a shock or stress and coping with its effects is often the first aspect of resilience; it describes the ability to bounce back quickly and not sustain fundamental harm or damage. Absorptive strategies can be an important resilience building process, e.g. when relying on a strong social network, stocking food or financial reserves or investing in a robust, flood resistant house.

Absorptive capacities are based on characteristics such as robustness, resourcefulness and redundancy; however alone they may fail in the light of long-term changes and increased uncertainty, they require to be complemented by adaptive and transformative capacities to sustain functions or even thrive in

anticipation and reaction to changes (Waller, 1976). High absorptive capacities have been seen to facilitate systems to benefit from the beneficial fluctuations they are exposed to as well as to bounce back more successfully from the destructive causes they may be subjected to thus leading to rapid economic growth, better returns on investment, enhanced utilisation of foreign aid, heightened competitiveness and elevated resilience. While with low absorption, studies show that economic growth is stuck, investments are wasted, foreign aid is inefficient or detrimental, innovation is doubtful, and is highly delicate (Gunderson and Holling, 2002).

Adaptive capacity denotes numerous variations that families and clans undergo in order to remain operational with minor qualitative changes in purpose or structural character (IDS, 2012). These rather incremental modifications are long-term oriented, can happen at several measures and regularly occur both in response to known and in expectation of uncertain risks such as lack of revenue or livelihood un-sustainability. Adaptation occurs less often to a particular stressor than to a mixture of many, interconnected risks of swings and shocks, it empowers a community to control possible damages and take advantage of prospects. This entails flexibility, creativity and resourcefulness.

While transformative capacity is most perhaps the most intricate aspect of resilience as it involves fundamental changes that affect basic structures, identities and practises within the community or system, i.e. county or ecological region. Transformation becomes necessary if predefined coping

strategies or incremental adjustments are no longer sufficient for example land tenure policies, carried out by describing the capacity to generate essentially new structure when ecological, economic or social structures make the current structure unsustainable (IDS, 2012). This move can be purposeful but also imposed by social and political, economic or environmental constraints.

Transformative capacities require a combination of self-organisation and robustness that fosters change. In distinction to adaptation, transformative capacities enable a system or community to fundamentally change and shift without long-term negative consequences. The aim of resilience building actions is to heighten absorptive capacity at the clan and family levels in order to moderate disaster risk and absorb the effects of shocks without enduring permanent, undesirable impacts on their longer-period livelihood security (IDS, 2012). Charitable support is destined to best provide the stability needed for enabling and accelerating complementary development exertions at the preliminary stages of post-shock recovery by aiming on reinforcing the adaptive capacity of clans and families by improving their flexibility to respond to longer-term social, economic and environmental change (Hill, 2012). This entails promoting livelihood diversification, supporting asset accumulation, and improving the social and human capital available to vulnerable populations.

Whereas, the transformative capacity of socio-ecological systems is predominantly influenced by the authority and social structures that can enable

a sustainable and system-wide comprehension of resilience, building transformative capacity involves a combination of technological advances, institutional transformations, behaviour changes, and cultural shifts among appropriate stakeholders at the international, regional, national, and sub-national scales (O'Brien, 2011). Enhancing transformational capacity is often not a short-term accomplishment but rather a medium to long-term undertaking which can span several decades. It is therefore obvious that efficient resilience building demands for combined tactics, and continuous commitment to refining all the dimensions of absorptive capacity via well-coordinated disaster risk administration, incremental adaptive capacity through uninterrupted livelihood ventures and transformative capacity through perfected governance and empowerment organizations. (IDS, 2012).

High risk clans like those in ASAL in the developing world are at risk from climate variability and mitigation measures are necessary to ensure resilience (Smit and Wandel, 2006). For generations they have operated a variety of coping strategies to counter to environmental stresses; that have significant cultural and religious aspects and repercussions (Davies and Bennett, 2007) but their applicability and efficacy may continue to be limited because of mores, practises and control relations in a community.

Novelty and innovation as an aspect of adaptive and transformative capacity are expected to assist systems to uphold dynamism and functionality, prohibiting internal botch and/or cross-dysfunction (Gunderson and Holling,

2002). The obligation is to keep prevailing multifaceted systems resilient and to generate novel structures and dynamics each time a system crash, so as to uphold not only running occupations, but also the adaptive capacity of systems and to let complex systems the freedom to ‘discover’ substitute structures and dynamics, to advance (Allen and Holling, 2010).

Common processes seen in arid and semi-arid areas such as invasion, extinction, nomadism, and migration in animal communities reflect high variability and the creation of novelty. Invasive species of plants or animals in ecological systems have subtly or grossly different ways of interacting with their new environments, as compared to native species, and their addition may not alter, but rather reinforce existing ecological organisation (Forys and Allen, 2002) and thus build resilience, or they may be destructive and transformative forces. Global climate change has frequently resulted in rapid transformations in the organisation of the complex systems that we inhabit, we create, and we rely upon, novelty and innovation are key aspects in the process of adaptation to changing environments (UNEP, 2006).

The capability for ecosystem-based adaptation generates a concern in the use of biodiversity and ecosystem services as part of an overall adaptation strategy to the impacts of climate variability and change (SCBD, 2009). One type of ecosystem based adaptation that can offer numerous, socio-cultural, economic, and biodiversity through forage for grazing animals and wildlife habitats gains

is the sustainable administration of pastures and rangelands to boost pastoral livelihoods and the conservation of wildlife habitats (SCBD, 2009).

Another type of ecosystem based adaptation as conservancies embroil the administration of rangelands to boost both wildlife tourism and pastoral livelihoods is the formation of wildlife conservancies, through partnerships between Maasai landowners and commercial tourism initiatives (Osano, 2011, Republic of Kenya, 2013). A number of conservancies and other enterprises backed by governments to support wildlife conservation on private and communal lands comprise a element of direct compensation for biodiversity preservation (Ferraro and Kiss, 2002); such as the LUMP which offers payment of US\$4 annually per acre to families for permitting the free passageway of wildlife by sacrificing the economic advantages of fencing, selling, leasing or cultivation of their land.

Challenges emerge in the endeavour to foster absorptive capacity in vulnerable clans when international development or stabilization resources are channeled to uphold upon a setback that indigenous institutions have been unable to settle and there exists weak communicative facts between the organisation's understanding of how matters should be decided and what is practical and consisten in the local situation (Lamb and Mixon, 2013). These challenges emerge when a declaration of intentions from an international donor conference sets out an elaborate vision for a community's development or post-conflict rebuilding that is admirable as a desire but ineffectual and occasionally

even injurious as a manual to policy. This frequently transpires when a well-intending aid organisation outlines a project aim without actually considering the needs, means, or competences that exist to realize it locally (Lamb and Mixon, 2013).

This was seen in the failed implementation of WLCP to meet desired objectives, due to misguided views and inadequate knowledge of the situation at the ground level, as the potential economic benefits foregone from farming, fencing, leasing or selling of land was not adequately compensated by the \$4 annual compensation given to the households (Flintran, 2008). As well as losses experienced through the destruction of structures, transmission of disease from wildlife to livestock and the killing of livestock by wildlife as no compensation is offered for such damages except in the event of loss of life (Republic of Kenya, 2008).

There have been a series of mismatches between the main objectives of various conservation interventions and the priorities of the local inhabitants, who are the intended beneficiaries of such interventions. For example, the broad objective of the conservationists has been to put aside considerable amount of land for wildlife while on the other hand tries to encourage socio-economic development for local communities mostly through livestock rearing and progressively by way of irrigated crop production. This inconsistency can be likened to an earlier one , where the intentions of the Maasai pastoralists and the FAO/UNDP initiated group ranch development programme in the late

1960s were completely divergent (Rutten, 1992); with the latter choosing to transform the Maasai's livestock economy from milk sustenance to a meat market-orientation, while the former accommodating as they would provide veterinary services and water development, although group ranches would be the real tool to stop individuals both within as well as outside Maasai society from taking over upon their communal grazing lands. This conflict of ideas and objectives was exacerbated by a suspicious relationship between the key stakeholders as a result of a series of past treachery by both the government authorities and conservationists that resulted into the Maasai people losing large tracts of prime grazing land to the colonial settlers and national parks (Rutten, 1992).

In 2009 a group of developing country officials, led by Luis Crouch, drafted an insightful exploration into the causes of absorptive capacity constraints. As experts with experience in interacting with donors and implementing development programmes, they considered a number of theories about the likely cause of limitations of absorptive capacity, mainly at the ministry and inter-ministry levels rather than in the economy as a whole (Lamb and Mixon, 2013). Based on their study findings, they identified a number of likely causes that they suggested for additional research, including the following:

- Knowledge and/or skills shortfalls among ministry staff to effectively meet the requirements for effective handling of the relatively large and complex forms of aid

- Skilled staff shortages, partly worsened by transfers, emigration and donor poaching of government staff
- Low efficacy due to inadequate training, haphazard preparation, lacklustre oversight, and/or feeble intra-governmental collaboration
- The inclination to use blueprints in the implementation of projects, rather than custom-made designs and plans that are applicable to the project area and situations
- Under-coordination or over-coordination by donors
- Impractical objectives set by either donors or recipient-country officials; or by both donors and recipient-country officials

Nevertheless, land use regulations such as WLCP and LUMP turn out to be a great asset to womenfolk of ASAL clans comprising the most economically susceptible and deprived members for example widows; owing to the sharing of income assigned to women recipients who formerly were without any income consequently enhancing standards of living. The percentage of women that were provided by the lease payments between 2000 and 2010 ranged from a low of 18% in 2002 to a high of 39% in 2000 and 2003 respectively (AWF, 2009).

2.6 Household, Community and County Resilience

Resilience may be defined as the capacity of individuals, families, societies, nations, and organizations to address shocks and be able to alleviate, adjust to, and regain from the consequences of the shocks and related stresses.

(Frankenberger, *et al.*, 2013b). In O'Neill's view, the African continent's potential to overcome the effects of climate change will ultimately depend on the resilience and resourcefulness of its people, rather than on external assistance. Partly due to climate change and the increasing pressure on the land resulting from the increasing population and changes in land use, there is bound to be increasing frequency and severity of extreme events such as droughts, floods, and heat waves, along with shifting rainfall patterns predominately in arid and semi-arid areas which threaten to overwhelm the natural resilience of African communities, risking livelihoods and food security (O'Neill, 2012). She also notes that widespread poverty, fragile ecosystems, weak institutions, and fragmented climate information systems amplify Africa's vulnerability to climate change.

Majority of arid and semi-arid inhabitants continually depend on ecosystem services for their livelihoods, through pastoralism and agro-pastoralism. The scarcity of water and natural resources, low agricultural productivity, and minimal livelihood alternatives limit the communities' economic sustainability and are contributing factors to conflicts within and between communities in the region (CDC, 2009). It is however clearly evident there are important economic and ecological assets in the arid and semi-arid areas such as grasslands, forests, drought-tolerant vegetation, precious minerals, and energy reserves that if efficiently managed can contribute to poverty alleviation and economic growth. Nonetheless, national law-makers tend to regard these areas as comparatively less significant in terms of development plans and frequently

overlook the ability of these regions in economic growth plans (UNDP, 2013). Despite the fact that the clans living in arid and semi-arid areas have previously revealed their ability for resilience over several decades, acclimatizing to ecosystem challenges and accruing indispensable intelligence about dry land environments.

Different communities depending upon their location and the shocks and stress they experience will make specific choices to reduce their risks according to capacities they have built, and characteristics they have acquired so far combined with external environment factors (social, political, economic, natural), as well as their national context such as the level of poverty or the access to goods and services, OECD (2014).

Two universal pathways espoused to control the impacts of climate change and variability are acclimatisation and alleviation policies: acclimatisation represents the best coping means against agricultural production decrease and hence leads to enhanced livelihood for smallscale farmers, while mitigation represents the efforts to decrease the outcomes of climate change arising from marvels such as greenhouse gas productions, to improve climate change resurgence, drawing benefits of the carbon storing storage ability of tropical environment and improving progressing ecosystem services of the natural resource (FAO, 2001). It is therefore evident that adaptation is a pathway to resilience applicable in household and community level and mitigation is more

applicable in a county, country and global level through the development of educated policies.

Migration has been identified as one of the chief adaptation approaches with the societies in semi-arid ecosystems (IFPRI, 2010). Failure to properly and meritoriously focus to the ultimate outcomes of climate change and variability might add to social instability and migration, at both intra- and inter-regional levels, through an emergence of ecological immigrants who will trigger a chain of conflicts between communities, thus obscuring the development agenda of several Sub Sahara African countries. Hence there is exigent call for action in reducing the outcomes of climate change now (UNFCCC, 2007).

Key world players are taking into consideration the dire need to develop sustainable resilience against climate change; The African Development Bank (AfDB) has built their Climate Risk Management and Adaptation (CRMA) approach which summaries crucial priority domains of mediation in order to handle the risks brought about by climate change. The aim as specified in the strategy paper is “to ensure growth towards elimination of poverty and contribute to sustainable development in societies’s livelihoods taking into consideration CRMA” (Kimani, *et al.*, 2015). CRMA’s specific objectives are to reduce vulnerability among its Regional Member Countries (RMCs) to the effects of climate variability and improve resilience to climate change outcomes in previous and upcoming Bank-financed growth intercessions, making them more ecologically sustainable. To strengthen this, competence

developing and knowledge establishment within the RMCs will be improved to tackle the issues of climate change and maintain sustainability through policy and governing reorganizations.”

In the pursuit to attain these goals the AfDB contemplated three domains of intervention namely:

- Climate proofing ventures to protect growth exertions from adverse effects of climate change, climate erraticism and drastic weather events
- Give more assistance to the improvement of Policy, Legal and Regulatory Reforms to enable formation of a further facilitating atmosphere for the execution of climate risk administration and adaptation intercessions (Kimani, *et al.*, 2015)
- Supporting Knowledge Generation and Capacity Building for local populations such as agriculturalists, investors, extension service providers, county administrators or policy originators to help mainstream climate variability strategies into their work and thus advance the mitigation of climate risks

There is a wide range of adaptive strategies that small stakeholders use to manage and respond to ecological and socio-economic challenges, including including use of local innovations (Milton and Ochieng, 2007). Interactions of diverse agricultural stakeholders and their combined knowledge types have led to the origination of the innovation system concept in agriculture. (Anandajayasekeram and Gebremedhin, 2009). Both individual and collective

attitudes as well as the environment jointly interact to bring about this hybridisation of knowledge (Callon, 1992); underscoring the fostering of understanding through back and forth flows of knowledge and information amongst stakeholders. Combined with the agri-food systems approach (Ericksen, 2006) they address the food insecurity issues raised in the different project site areas. The unique shocks experienced by individual households, communities or counties elicit unique survival strategies in crises situations (Sutherland, *et al.*, 1999), households will often attempt to improve their livelihoods through informal experimentation activities with indigenous knowledge and skills inherent in different communities mediating all livelihood activities (Milton and Ochieng, 2007).

Research study carried out by Maina and his colleagues (Maina, *et al.*, 2012) by analysing three study sites of Mbeere South sub-county, Nyandarua North sub-county and Kirinyaga West sub-county demonstrated that households engaged in three different types of strategies and innovations: one geared towards enduring exposure to risk, another geared towards risk avoidance and those used to enhance household protection.

Each of the different types of strategies led to various consequential problems and challenges. Strategies geared towards surviving vulnerability were mainly concerned with immediate and short-term consumption needs; with some of those activities being counterproductive and injurious to the natural resource base occasioning loss of household resources and deterioration of household

nutrition. Therefore, revealing that households applying these coping strategies will inevitably require social protection or even aid. Well-planned initiatives, particularly long-term development public sector interventions, coupled with participatory agricultural research were shown to ease food insecurity and extend the livelihood foundation (Sutherland, *et al.*, 1999).

Studies show that inclinations towards building resilience and reducing sensitivity to shocks tend to employ strategies and innovations that are geared towards risk avoidance (Alinovi, *et al.*, 2008), while strategies for enhancing household protection exhibited mechanisms for increasing long-term adaptive capacity. They offered a treasure of prospects for research and development interventions including building capacity for sustainable livelihoods (Sutherland, *et al.*, 1999).

The variety of resilience building activities carried out on a household level include: sale of livestock, provision of casual labour, sale of firewood and charcoal, sale of land, collection and sale of ballast, renting out land and change of food patterns to readily available vegetables among others (Maina, *et al.*, 2012).

2.7 Gaps to be filled by the Study

The literature review reveals various gaps that need to be addressed. First, empirical studies on the socio-economic causes of land use cover change in peri-urban Kajiado County have not been studied since the formulation of LUMP and WCLP. Secondly, there is lack of empirical studies on the evaluation of the ability of stakeholders and Government to effectively implement LUMP and WCLP and projection on the future in terms of two legislations curbing LUCC. Thirdly, there is lack of information on adoptive and absorptive capacities towards resilient livelihoods in the face of declining land holding sizes and climate variability. Finally, further research is needed on the transformative capacity of LUMP and WCLP, especially on the factors that influence effective formulation and implementation of conservation initiatives, as well as location-specific information on the driving forces of LUCC.

CHAPTER THREE

3.0. RESEARCH METHODOLOGY

3.1 Introduction

The section covers the research design, study setting, quality assurance, data collection methodology and analysis used in the study.

3.2 Research Design

Longitudinal survey and cross section designs were used with mixed methods in the study to measure the variables as recommended by Russell, (2006) and Lynn, (2009) for primary research studies. The use of mixed methods addresses the study issues in a simple and factual manner due to the nature of pluralism that results in superior research, Johnson and Onwuegbuzie, (2004). Mixed methods research refers to the use of data collection methods that collect both quantitative and qualitative data in such a way as to bring different perspectives to bear in the inquiry and therefore support triangulation of the findings in answering the research questions, Johnson *et al.*, (2007).

For phase one a longitudinal survey was carried out for the analysis of Landsat imageries to provide the trends in land use/cover change for the period 1984-2010. This involved analysis of Landsat imagery; in reference to ground truthing information acquired in the field with help of hand-held Global Positioning System (GPS) to capture coordinates regarding the location and spatial patterns of current land uses onto Landsat imagery using a geographical information system (GIS). For phase two a cross sectional survey was done to

review the results of the first phase, verify the results obtained, discuss the driving forces, pressures and impacts of the changes and reflect on their future responses to said changes by way of household survey to collect quantitative data, while qualitative data was collected by way of focus group discussions (FGDs), key informant interviews (KIIs), in-depth interviews (IDIs) and unstructured participant observations. Figure 3.1 gives a schematic representation of the research design used.

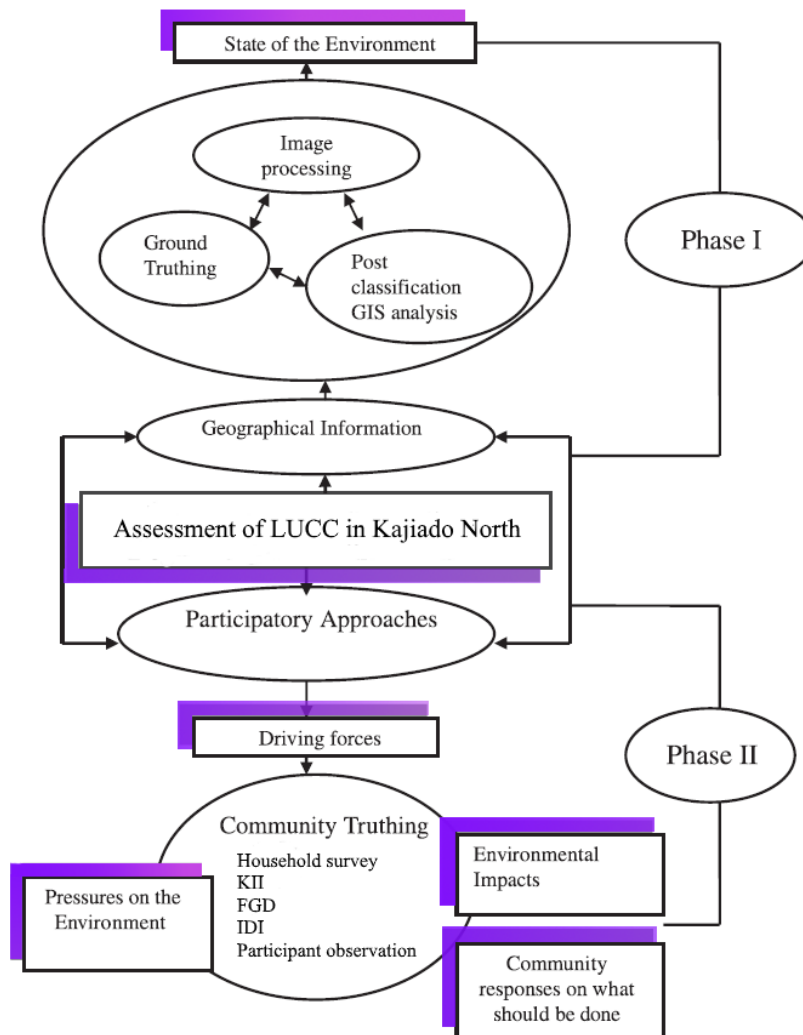


Figure 3.1: Research Design

Source :Author

3.3 Study Setting

The study was carried out in Kajiado North Sub-County of Kajiado County in Kenya. Kajiado North Sub-County is a peri-urban pastoral area bordering Nairobi City and Nairobi National Park with three urban centres within 25-45km from city centre. The study area covers 1631.18 KM² and lies between 36° 37'E to 37° 8'E, and 1° 23'S to 1° 49'S. Administrative boundaries up to locational level were used to map the study area within Kajiado North Sub-County as shown in figure 3.2.

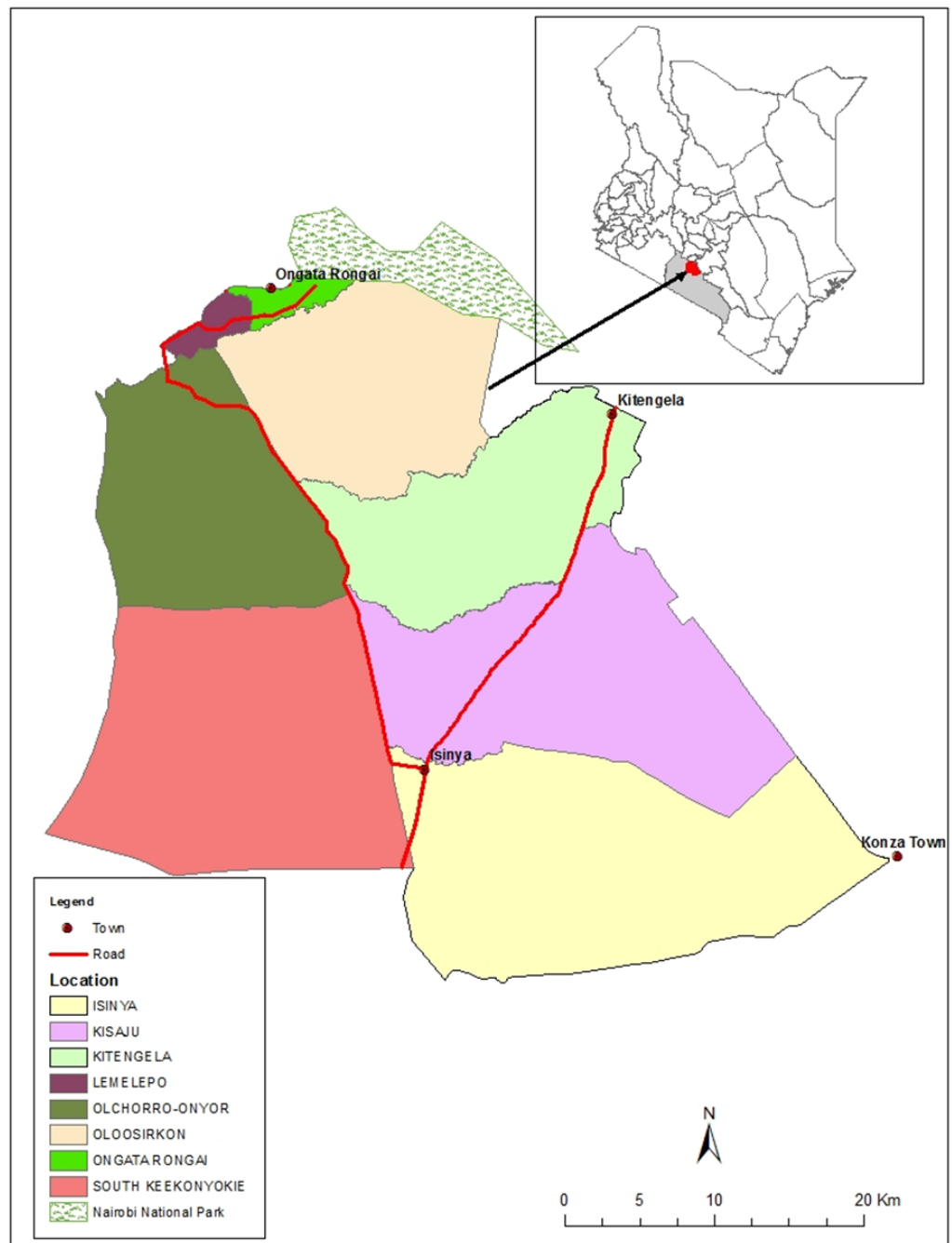


Figure 3.2: Study area map

Source: KNBS, 2009

The Maasai form the predominant indigenous pastoral households undergoing transition while the Kikuyus, Kambas, Kisiis are the immigrants in the area. In

the 2009 census by the Kenya National Bureau of Statistics (KNBS) estimated the study area poverty index at 40% and literacy level of 71.8%. Throughout the Sub-County, rapid population increase has led to more settlements, which, in this area, brought more fencing and many of the new residents are non-Maasai farmers and town people who practise diversified agriculture intensification activities, Reid *et al.*, (2008). The Sub-County has many land use systems in place, some that have remained in their original uses while others as a result of single to multiple changes over time through activities like sub-division, sales, quarrying and diversification (Kristjanson, *et al.*, 2002). The area receives a bimodal regime of rainfall, short rains in October–December and long rains in March–May. The annual average rainfall is between 300 and 1300mm, but it is mostly unevenly distributed and unreliable. Temperature varies between 13 and 25⁰C throughout the year. The Sub-County is largely semi–arid and lies in agro-climatic zones UM 4 to 6 with zones UM5 and 6 being the most predominant, Jaetzold *et al.*, (2011). This means that the area is mainly suited for ranching activities and early maturing crop varieties as the soils are too stony to retain moisture and the rainfall amounts only support crop production if distributed well.

Human population increase in the Sub-County was steady and strongly related to time (Table 3.1). Although human population grew during the three time census periods, a sudden increase occurred between 1999 and 2009 compared to all other time epochs. Throughout the study period, the population of male was higher than that of females. Generally, the study area had a population

growth rate of 4.3% per year between 1989 and 1999 while the rate grew to 12.5% per annum for the period 1999 to 2009 with a population density of 111.6 persons per Km² in 2009 from 23.3 persons per Km² in 1989 (Republic of Kenya, 2009).

Table 3.1: Population Statistics for years 1989, 1999 and 2009

	1989	1999	2009	1989-1999 % increase	1999-2009 % increase
Male	22949	33448	81272	45.7	143.0
Female	19136	30284	78106	58.3	158.0
Population density	23.3	35.3	111.6	51.5	216.4
Number of Households	9907	16739	46981	69.0	180.6
Total	42085	63732	159378	51.4	150.1

Source: Kenya National Bureau of Statistics, 1989, 1999 and 2009

3.4 Quality Assurance

Quality assurance was an on-going process throughout preparation, sampling, data collection and data analysis. In every data collection initiative, the quality depends on survey tools and diagnostic techniques. The quality of survey outcomes relies mainly on execution of survey, comprehensive sampling procedures and appropriate administration of questionnaire.

Pre-testing of data collection instruments was done as follows; for household survey 32 respondents from two locations (one rural and one urban) to pre-test the questionnaire. According to Czaja, (1998) at least 30 completed interviews are adequate in identifying errors in wording, ambiguity, question ordering and layout. Two FGDs and one KII were done with the question guides to test whether the two could capture the issues under study. On reliability the

researcher informed participants of the purpose of the research, the applications of the gathered data and the way in which participants could help in the research. This was also to sensitize the interviewees on the importance of providing the researcher with responses that were as objective as possible.

Data validation was done during FGDs and KIIs based on responses to research questions during household interviews. The validation process involved data cleaning, mining, identification of visual/numeric relationships and the use of descriptive statistics to understand the basic data.

3.5 Data Collection Methodology and Analysis

3.5.1 Secondary data; Landsat Imagery and rainfall

LANDSAT imageries for years 2004 and 2010 were downloaded from <http://glovis.usgs.gov>. The 1984 image that was not downloadable was obtained from the Regional Centre for Mapping of Resources for Development (RCMRD). The imageries for 1984, 2004 and 2010 acquired were for same time periods in terms of rain season August-October. This minimises seasonal climatic variations with respect to cloud cover and vegetative ground cover. Unsupervised classification (Lillesand *et al.*, 2008) aided in acquisition of GPS coordinates of key indicators of current land uses during household survey questionnaire administration.

This study required long term rainfall data which was acquired from the Kenya Meteorological Services (KMS) for the study period 1980-2010.

3.5.2 Quantitative Data

The household survey was conducted with a sample of randomly selected respondents with the pre-tested questionnaire (Appendix1V). The interviews were done by trained enumerators under the supervision of the principal researcher. The parameters covered all factors addressed in the four objectives. The household was the sampling unit.

3.5.3 Household survey sampling procedure

The sampling frame was developed with the help of the local sub-chiefs and village elders of administrative areas from the households within the eight locations in the Sub-County. The formula by Kothari, (2006) was used to calculate the study sample size n :

$$n = \frac{z^2(1-p)p}{e^2}$$

Where n is the sample size, Z is the desired Z-value yielding the desired degree of Confidence, p is an estimate of the population proportion, and e is the absolute size of the error in estimating p that the researcher was willing to permit. In this study a p-value of 0.5 was used. When the percentage estimate of land that has undergone land use/land cover change is unknown and an assumption of 50% is recommended for representative sampling, (Wayne, 2010). The study used 95% level of confidence ($Z= 1.96$ for a two tailed test),

with an allowable error of 0.05. The sample size was calculated as shown in the equation below:

$$n = \frac{1.96^2 (1 - 0.5)0.5}{0.05^2} = 384$$

Add 10% attrition = 38, gives sample size of 422

A sample size of 422 respondents was randomly drawn from the study area for household interviews as follows; 53 households from each location within the study area (Appendix-11) to yield a sample size 419 households while factoring the attrition. The study used a table of random numbers to sample from the sampling frame developed with the assistance of village elders who identified the households in each location (Appendix I). With the objective of assessing the socio ecological resilience and pastoral land use change in semi-arid lands in addition to the community perceptions on LUMP and WCLP in controlling fragmentation and land use/cover, for each family both husband and wife were interviewed. Households selected included both immigrant and indigenous populations. In polygamous cases, the resident wife in the household was chosen for interview. Interviews were also carried out with female headed households.

3.5.4 Qualitative data collection

Qualitative data collection by way of FGDs, KIIs and IDIs were conducted through use of questions guides developed and refined during pre-testing

(Appendix V). Thirty two FGDs were carried out to validate the household survey findings. This number is adequate as recommended by Carlsen and Glenton, (2011). Sampling of informants was done purposively to include community members who had the desired characteristics; retired civil servants, religious leaders, immigrants who had residents for at least two decades, opinion leaders, chairpersons of youth groups and chairpersons of women groups, with the help local administrators and agricultural officers from the sixteen sub-locations.

Two FGDs per sub-location for each gender were carried out separately to allow for community social-cultural issues due to the fact that women do not express themselves freely in the presence of men as found out in the first two mixed pre-test interviews and as also observed in other pastoralist communities (Maranga, 2002; Heffernan, *et al.*, 2003). Sampling ensured that the participants did not know each other as familiarity could hinder disclosures and based on selection criteria given they knew the area well and were competent in issues under discussion. The sessions had eight to thirteen participants of one gender separately as outlined by Kumar, (1987).

Proportional piling was used in resources and attributes ranking. Catley *et al.*, (2013), acknowledges that the method is applicable in obtaining data in percentages as opposed to absolute numbers where a community is not comfortable to provide such. The ranking on a scale of one to a hundred was used and according to Chambers, (2010) results can be presented using a pie or

bar chart with the scores converted into proportions (percentages) to provide statistics to work with. This method does not ask informants to physically count out the number of counters for each item, (Catley, *et al.*, 2013; Harding, *et al.*, 2014), but more to distribute the counters to show a visual pattern that illustrates the relative importance of each item.

The questions were carried out until the selected parameters were exhausted as illustrated in Figure 3.3.

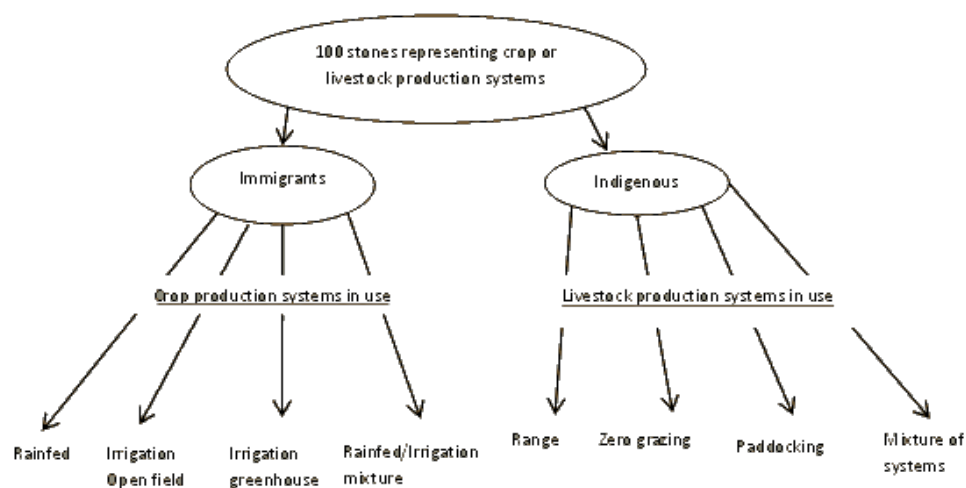


Figure 3.3: Diagrammatic representation of the proportional piling method

Sixteen KIIs were carried out with respondents who were selected purposively. Mason (2010) acknowledges that a number of issues can affect sample size in qualitative research; however this number is adequate in mixed methods interviews due to data saturation concept. According to the guideline by Kumar, (1989), KIIs encompass interrogating a chosen cluster of persons who are expected to give desired data, notions, and insights on a specific topic.

The informants are selected because they have first-hand comprehension about their community, its residents, and issues or problems under examination. The air in these interviews is relaxed, like a conversation among friends. The interviewer delicately questions informants to produce more information and abstracts detailed notes, which are processed later, (Mason, 2002). KIIs are suitable for producing information and ideas in numerous situations, especially when understanding of the fundamental motivations and attitudes of a particular population is needed. Notes were taken to capture the interview process as most informants were not comfortable with recording. The key draft questions were printed leaving space between each question to manually write the informants' comments.

Twelve IDIs were carried out in the study area with purposively selected respondents who were regarded to have the desired information. Guest *et al.*, (2006), acknowledges that this number is sufficient in collection of desired information. Respondents included those who had either been affected by land use change negatively or positively; they were mainly identified by area chiefs, agricultural extension officers, retired civil servants, community opinion leaders and church elders at the divisional level. Baker and Edwards, (2012) assesses the question of 'how many' from majority of the contributors is 'it depends'. In considering what 'it depends upon' nevertheless, the responses provide direction on the epistemological, methodological and practical matters

to consider while undertaking research assignments particularly in mixed methods.

Boyce and Neale, (2006), recommend the use of IDIs as a qualitative research method which entails conducting rigorous personal interviews with a small number of respondents to investigate their viewpoints on a certain ideas, programmes, or conditions. IDIs are valuable when you want comprehensive facts about an individual's opinions and manners or want to investigate subjects in depth in case studies (Moriarty, 2011). The main objective is to obtain the respondent's viewpoint on his /her experiences which in turn delivers a more comprehensive illustration of what transpired in the circumstances and why. IDIs are used instead of FGDs when the would-be participants cannot be involved or at ease speaking freely in a group, or when you want to differentiate individual (as opposed to group) sentiments about the condition.

3.6 Observations

Unstructured participant observation took place during household survey in the field. According to Taylor-Powell and Steele, (1996); Russell, (2006) unstructured participant observation was applied particularly since it allowed the researcher as an insider to be precise as to when and where to observe, what particular attributes of the setting or manners to observe, and how to capture and document the observations. Digital photos were taken of main pointers of tendencies in land cover land use change.

3.7 Data Analysis

3.7.1 Landsat Images

Multi-temporal LANDSAT images (1984, 2000 and 2010) together with physical and socio-economic data were used in a post-classification analysis with GPS coordinates to map land use distribution and to analyse trends in land use/land cover changes in Kajiado North Sub-County, (Lillesand, *et al.*, 2008). Arc view version 3.3 was used to convert the coordinates to shape files, while ENVI 4.7 and ArcGIS version 9.3 was used in classification and analysis. Image processing, land cover classification and change detection was done as shown Figure 3.4.

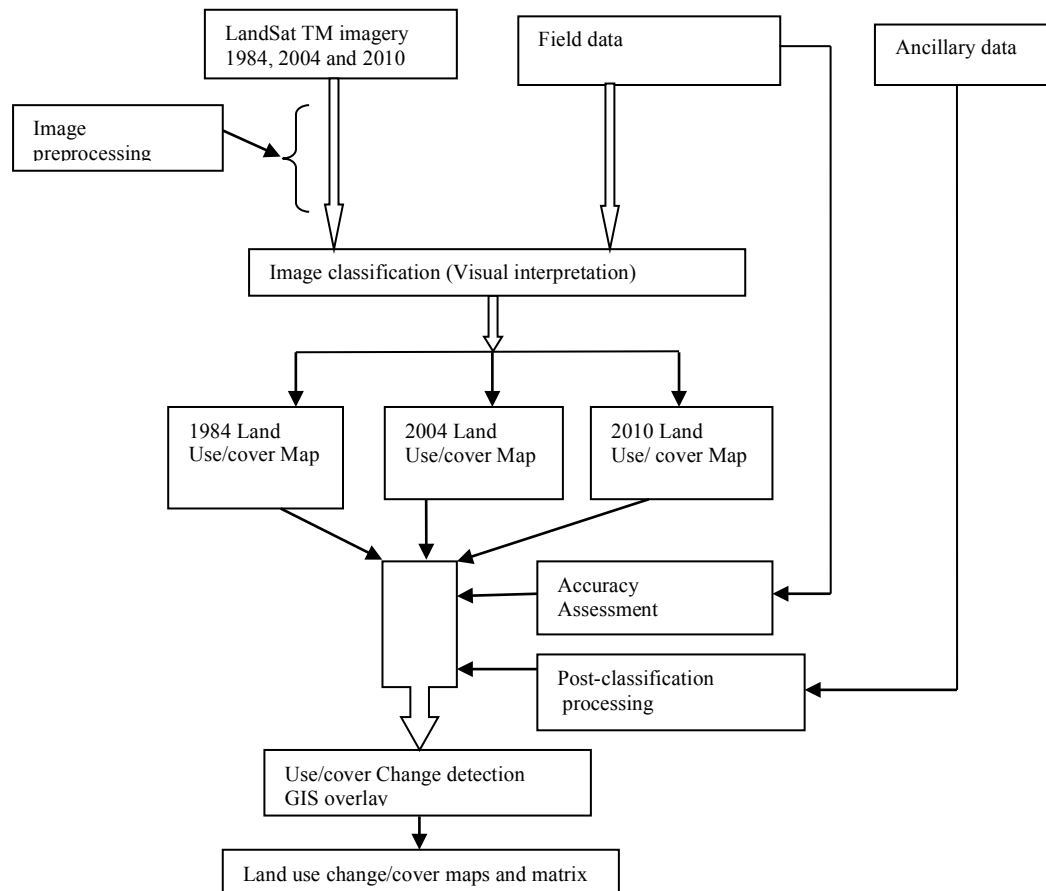


Figure 3.4: Schematic representation of image processing, land use/cover classification and change detection

3.7.2 Image classification

Through defining spectral classes by clustering image data and assigning pixels into classes, land use and land cover maps were developed from the satellite images. Multi-temporal Landsat data processing was prepared using ENVI 4.7 software (ESRI, 2009). Regions of Interest (ROI) were demarcated to extract statistics for classification. Supervised classification was applied with false colour composite bands (4, 3, and 2) to cluster pixels in a dataset into classes matching to the designated ROI. Supervised classification methods used to classify the images included minimum distance and maximum likelihood (ESRI, 2009). Seven land use and land cover types were categorised concurring to Andersen, (1998) guidelines as; range land, bare ground, water body, rocky areas, built-up, crop land, riverine vegetation and woodlots.

3.7.3 Change detection

Change detection was done for the categorized land use and land cover types. ENVI EX Software (ESRI, 2009) was used for thematic change detection by comparing two images of distinct time periods (1984 and 2004 images, 2004 and 2010 images) and general change between 1984 and 2010.

3.7.4 Quantitative analysis

The quantitative data collected from household survey was analysed using Statistical Package for Social Sciences (SPSS version 16), the focus being on parameters that influenced land use choice to generate means, frequencies and graphs to describe current status and trends on land ownership and changes in

use over the years. To determine factors that influence land use choices; physical location, distance to urban centres, distance to basic facilities like tarmac road and rivers, unstructured participant observation of the various parameters were used.

A logistic regression model (LRM) was performed to determine the determinants of each respondent household's decision to change or uphold the existing land use. This regression analysis was based on the maximization of the fundamental utility function that is presumed to be reliable with individual household behaviour. The model characterizing readiness to change land use is stated as:

$$Y \text{ Logit } (p) = \log \left(\frac{P_i}{1-P_i} \right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_{ki}$$

To evaluate the factors that influence land use change = Y, 0 and 1 as the dummy variables.

1= presence of the variable, 0 absence of the factor.

$$Y = \alpha + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + E,$$

$$Y = \log_e \left(\frac{P}{1-P} \right) = \text{logit}(P)$$

$$P = E(Y) \frac{e^{b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + \dots + b_n x_n}}{1 + e^{b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + \dots + b_n x_n}} \quad (3)$$

Where α is the intercept (constant)

Y= is the response, and $b_1 X_1 \dots b_n X_n$ are the influencing factors.

In this study, the dependent variable Y is a binary presence or absence of event, where 1 = land use change and 0 = no change in land use, for the period 1980 to 2010, (Millington, *et al.*, 2007; Huang, *et al.*, 2009). The logistic function provides the likelihood of land use change as a function of the explanatory variables. In other words, the likelihood of land use change for each respondent is a function of the values that the other variables have for the same respondent. While, b_1 , b_2 , b_3 , b_4 and b_5 are the resultant changes in Y with respect to independent variables X_1 , X_2 , X_3 , X_4 , and X_5 ceteris paribus. Regression model coefficients sign-/+ and magnitude reflect each explanatory variable's relationship to the dependent variable.

b_0 = intercept and E = error which accounts for other unobserved factors.

For these independent variables, an omnibus model was run for the following factors in the questionnaire to determine which among them had influence in land use/cover change on the respondent household; Origin indigenous or immigrant, owning of another land in other locations, resource use conflict, current land holding size supported adequate family livelihood, wife can make decision on income generating activity, wife's name was included in the household title deed.

Elimination was done based on the P values, the lower the P value the stronger the effect; $P > 0.05$ has no effect while $P < 0.05$ has effect. A backward

elimination procedure was carried out whereby all P values included in the equation were less than 0.05.

3.7.5 Spatial analysis

The land use change results from analysis of Landsat imageries were used in geographically weighted regression (GWR) analysis using ArcGIS version 9.3. Regression analysis is a set of statistical technique that allows us to examine, model and explore data relationship and spatial data relationship. It was used to better understand why some regions are prone to land use change than others. If we can come up with a model that effectively predicts land use change using explanatory variables like rivers, distance to roads, distance to urban set ups; we will be in a better position to make decisions about land resources management. These decisions can help us maintain the health of our range lands while avoiding loss of livelihoods. ArcGIS 9.3 use ordinary least squares (OLS) regression and geographically weighted regression (GWR) tools to quantify spatial patterns (Rosenhein, 2006). Using the hot spot analysis tool we question where in pastoral peri-urban area you are likely to experience LUCC.

The roads, urban and river areas buffer zones were selected and GWR tools applied for each year to each data set to build a local regression equation for each feature in modelling within the selected buffer zones accordingly as shown in Figure 3.5. Once we know the physical location results of LUCC our next logical question is why. What are the factors that contribute to high LUCC?

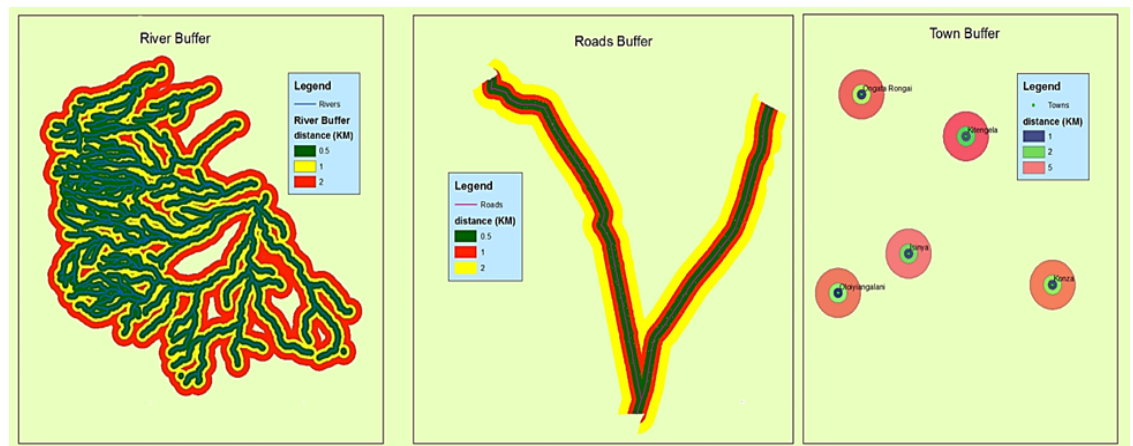


Figure 3.5: River, roads and towns buffer maps for spatial analysis

3.7.6 Regression analysis concepts

$$Y = \alpha + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + E,$$

Where;

Dependent variable **Y**= what I am trying to model or predict; land use change

Explanatory Variables **X**; variables I believe cause or explain the dependent

variable **Y** e.g. roads, urban centres, rivers among others. Coefficients **b**,

Values computed by the regression tool reflecting the relationship explanatory

variables and dependent variables. Residuals=**E**, the portion of the dependent

variable that is not explained by the model; the model under and over

predictions.

R-Squared is a measure of goodness of fit. Its value spans from 0.0 to 1.0, with

greater values being better and it is interpreted as the proportion of dependent

variable discrepancy associated with the regression example (Scott and Janikas,

2008). So in simple words an R-Squared value of 0.72 says that the model

(explanatory variables modelled using multiple linear regression) is explaining approximately 72% of the variation in the dependent variable.

3.7.7 Qualitative Data

Qualitative data was generated from FGDs, KIIs, and IDIs, while the analysis focused on thematic and content analysis that involved coding of raw data.

3.7.8 Thematic and content analysis

Qualitative data analysis involves focusing on a review of all information to gain a sense of the whole data (Mason, 2002). Miles and Huberman, (1994) similarly reckon that qualitative data analysis entails activities such as data reducing, presentation, inference deriving and validation. According to Miles and Huberman, (1994) data examination comprises coming up with a comprehensive story per case and positioning the case within its circumstance. In data handling, Blaxter *et al.*, (2006) proposes that data examination comprises two closely associated methods, both of which they consider as crucial to research:

- Handling collected data by reducing their magnitude and range, so that you can describe upon them satisfactorily and cautiously
- Examining the handled set of data, by unearthing from it and eliciting interest to what the researcher feels is of precise consequence or significance

3.7.9 Thematic and content development

My research trailed the philosophies of thematic analysis (Braun and Clarke, 2006). According to Braun and Clarke, (2006), ‘it is a technique for identifying, investigating and recording patterns (themes) in the data. Furthermore, thematic analysis permits interpretative approach orientation that permits social and human activity in script. For instance, human action can be perceived as an assortment of symbols communicating several meanings.

Thematic investigation is not based in any specific theoretical and epistemological outline and thus can, be used across a wide selection of qualitative study approaches flexibly. Through its theoretical freedom, thematic and content investigation gives a flexible and useful research instrument, which can possibly supply abundant and comprehensive data and can be applied across diverse approaches (Braun and Clarke, 2006).

Content analysis permits the researcher to investigate and deduce narrative data that leads to accomodation of supplements to individual assessment (Taylor-Powell and Renner, 2003). In addition, (Berg, 2000; Russell, 2006), emphasize that ‘thematic analysis seem to reveal the themes salient in a manuscript at diverse stages, and thematic nets target to enable the shaping and representation of these themes. The nature of its manipulability made thematic and content analysis a method of choice for analysis of qualitative aspects of my research.

In carrying out thematic and content analysis, the study followed recommended techniques outlined by (Braun and Clarke, 2006; Lacey and Luff, 2007) to guarantee thoroughness in data scrutiny which is clustered in six stages as presented in Table 3.2. The qualitative attributes of this study embraced all of the six stages of thematic analysis. I transliterated the data, maintaining the original verbatim quotations from participants while re-examining and noting the preliminary notions and assigning inaugural codes using highlighting pens to record remarks.

Table 3.2: Phases of thematic analysis

Phase	Description of the process
1. Familiarizing yourself with data	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes (Level 1)	Checking if themes work in relation to coded extracts and the entire data set (Level 2), generating a thematic ‘map’ of the analysis.
5. Defining and naming the themes	On-going analysis to refine the specifics of each theme, and overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report	The final opportunity for analysis. Selection of vivid, extract examples, final analysis of selected extracts, relating back the analysis to the research question and literature, producing a scholarly report of the analysis

Source: Braun and Clarke, (2006), p.87

3.7.10 Coding

The development of codes took into consideration the definition given by Saldana, (2009), whereby a code in qualitative enquiry is mostly a word or small idiom that emblematically allocates a summative, striking, essence-capturing and or reminiscent aspect of a language or visual data. Lacey and Luff, (2007,) refers to coding as a procedure of determining how to abstractly segregate unprocessed qualitative data. Segments of manuscript records, for example, may be marked by the researcher in various ways (highlighting marker pen, number reference, or bracketed with a textual code at the edge). These segments comprise of data which the investigator is interested in surveying and examining more.

Using a qualitative research approach, the researcher conducted interviews with: 32 FGDs on socio ecological resilience and pastoral land use change in semi-arid lands and the community perceptions on LUMP and WCLP in controlling fragmentation and land use/cover change. In addition the researcher conducted in-depth face to face interviews with 12 respondents who had been either affected positively or negatively with land use change through sale. With the use of thematic analysis, (Harding, *et al.*, 2014), the data generated two themes of where land use change was either associated with sale or natural causes. Under sale theme ten sub-themes were identified and three sub-themes under natural causes as listed in Table 3.3.

Table 3.3: Hand coded transcripts

Transcript	Sub-themes	Codes
Theme 1: Change related to land sale		
Household sells to avoid misuse by children once he is gone	Age of household head	HHAG
Male household head makes all decision on property	Gender/property ownership awareness	GEPO/ GPOA
I wanted to drive/own good house like my age mates	Peer pressure	PEPR
Sold to use proceeds to restock/I had to sell to meet family obligation since I had no other source of livelihood	Household head socialization/ economic status	HHSO/HHES
Uneducated youth do not know value of land in the future especially after the old hh passes on	Level of education of household head	HHED/ HHAG
The land was too big I could still live comfortably after selling	Size owned	SIOW
Drought, loss of all animals, sold to diversify to other income generating activities/buy more land in less congested cheap areas/Sold to treat family member or raise university fees for children.	Livelihood challenges/coping strategies	LCCS
Putting land to the use they planned for / preventing trespass to one's property	Intended use by buyer/ securing with natural fence	BIUS/SENF
Business opportunity-good returns unlike other businesses	Commodisation of land	COLA
Infrastructure/appreciation influenced selling. Electricity, schools, water, hospitals and access roads lead to improved communication and appreciation of land	Infrastructure improvement/ appreciation	INIMP/APPREC
Land use activities that degrade the environment like mining, quarrying, water pans/dams	Land use practises of buyers/leasers	LUC ACTI
Theme 2: Change related to natural causes		
Subdivision to heirs	Population increase	POPIN
Climate variability <ul style="list-style-type: none"> • Variable and unreliable weather patterns • Crop production to supplement family 	Climate change/ Diversification of livelihoods to cope with vagaries of nature	CC/DLCN
The trees adapted to riverine colonised dry river beds/ invasive species used for fencing became un-manageable	Natural succession of trees/ colonisation of invasive species used for fencing	NASC/ CISPP

Having coded the transcripts, the themes and sub-themes were picked out in the procedure of examination and interpretation (applying the six stages of thematic analysis on Table 3.1) as shown in the extracts on Table 3.4.

Table 3.4: Data extracts with codes

Data extracts	Codes for themes/ sub-themes
The youth want to belong, live in good houses, drive big cars and afford the good things that money can buy	Peer pressure, Age issue
Witnessing what happened to age-mates' land after passing on, influenced selling so that they can enjoy before dying	Age of household head, age issue
The women have no role in decision making when it comes to issues of land, livestock. My husband sold 350 acres, and by the time he passed on we had only 50 acres left to share with my six sons	Gender/property ownership rights and awareness
When my son became sick, it was during the drought period, I had no other source of money to take him to hospital	Livelihood challenges/coping strategies
With the improved infrastructure; electricity and access roads brokers kept on enticing me with improved land prices until I gave in	Infrastructure improvement/appreciation /brokers
When I got the 400acres after ranch sub-division, it seemed so big and my children were small. I thought selling just ten acres was not a big deal. However, I continued selling and now left with only 10 acres	Size owned, wealth management
I subdivided to my children when they became of age and they in turn started their livelihoods	Population increase
When my new neighbours came in, I saw like they coped well during drought as they had diversified to crop production	Copying from others

Data extracts	Codes for themes/ sub-themes
<p>The institution had expansion plans and we were able to get a big flat area for expansion.</p> <p>We wanted to buy homes and our workplace Sacco bought 20 acres for subdivision to members at a cheap price compared to other areas.</p> <p>X flower farm bought 50 acres initially but with expansion plans they bought all surrounding neighbours to amalgamate to 600 acres currently.</p>	Intended use by buyer
<p>After buying land the area was so windy I decided to plant trees as wind break at the same time put up a fence to secure my property.</p>	Securing property with natural fence
<p>Due to attack from wild animals we surrounded our home with the thorny cactus but it spread to unmanageable levels</p>	Colonisation by invasive species used for fencing
<p>The acacia species <i>A.kirkii</i> and <i>A.elatior</i> (<i>Olerai</i> –local Maasai name) established itself along dry river beds as it is well adapted and over the years it spread</p>	Natural succession of trees
<p>Sold to put up commercial place to generate income and surplus bought land in other location.</p> <p>Sold to enable me put up borehole to sell water.</p> <p>Started crop production since I had water</p>	Coping strategy/copying from others

CHAPTER FOUR

4.0. RESULTS

4.1 Introduction

The results of the research are given in four subchapters 4.2 to 4.5. In sub-chapter 4.2 the extents of land use/cover change in Kajiado North Sub-County for the period 1980-2010 results presents the state of the land. Sub-chapter 4.3 the factors which contribute or impede in land use/cover change in Kajiado North Sub-County presents the driving forces. Sub-chapter 4.4 presents how the land use/cover change has impacted on ecosystem services and resilient livelihoods in semi-arid lands. Sub-chapter 4.5 presents the community responses to impacts of LUCC on household and community resilient pathways and expected outcomes in relation to LUMP and WLCP.

The application of the DPSIR component within the socio-political context to analyse the changes in land use/cover and respective status, impacts and responses is shown in Figure 4.1. Peri-urban Kajiado North land has been affected by major driving forces including: Sprawl, population growth, climate variability, quarrying and mining activities, agricultural intensification, diversification of income generating activities and land tenure policies as well as immigrants influence.

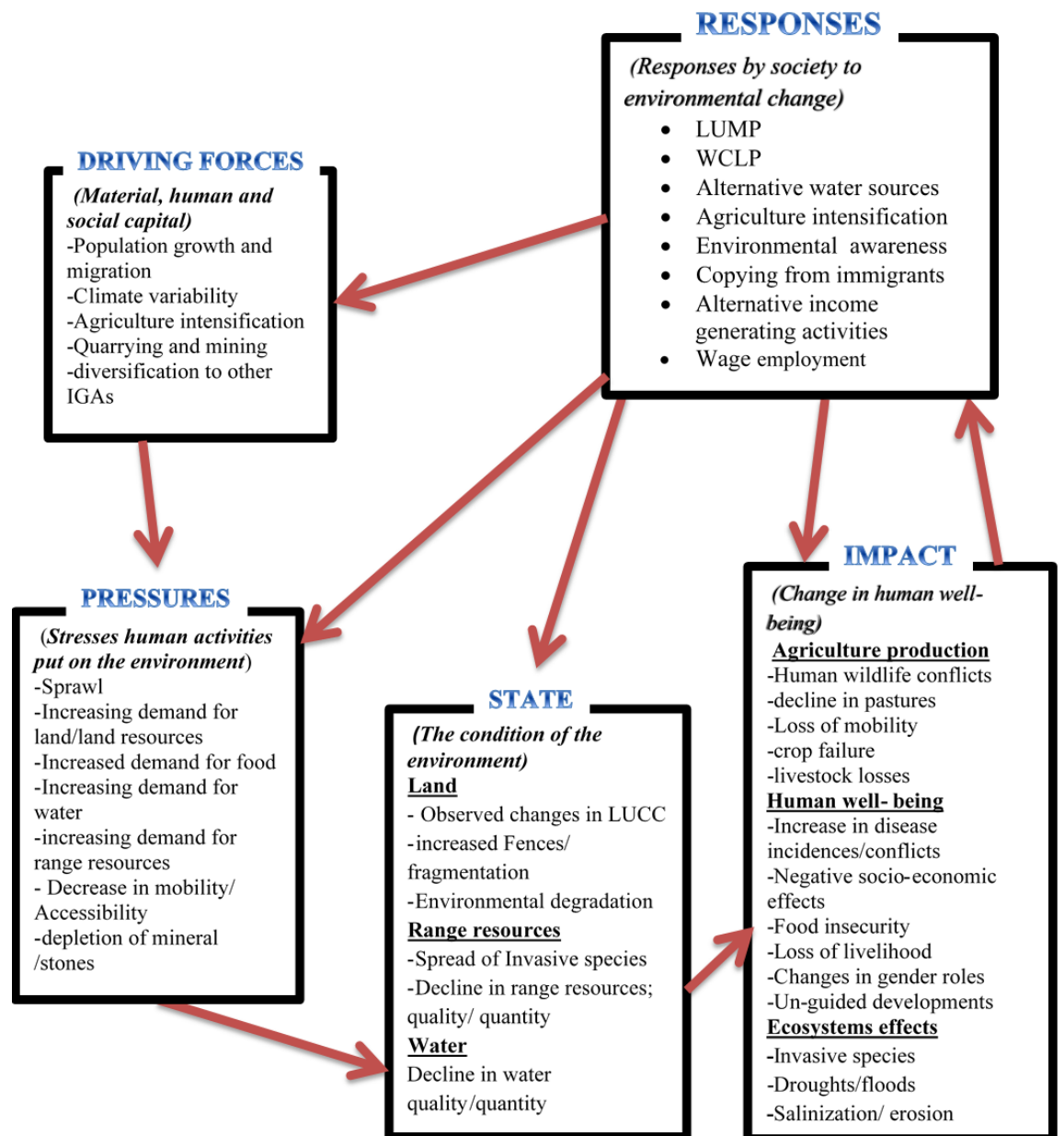


Figure 4.1: A generic DPSIR framework for LUCC in Kajiado North
Source: Author

These drivers have placed a remarkable pressure on the land and water resources. The demand for land has increased due to rapid population growth and this affects the pastoral livestock production and wildlife dispersal activities as range resources decline. The declining land holding size in Kajiado North and fences due to fragmentation and resultant change in use/cover

necessitated the development of LUMP and WCLP as response to conserve the ecosystem and offer guided development. The rapid population growth and developments have brought changes in land use/cover but they have caused environmental degradation and decline in range resources in most sub-locations in Kajiado North. In this section, the results on the DPSIR framework are presented and analysed.

4.2 The Extent of Land Use/Cover Change in Kajiado North Sub-County for the Period 1980-2010

4.2.1 Land use and land cover changes analysis

The satellite images were analysed in conjunction with ground truthing observations as recommended by, (Thomas and Ayuk, 2010; Kumar, et al., 2014). In the ground truthing exercise, a hand-held Global Positioning System (GPS) was used to ensure that structures on ground were in their precise planimetric location on the images. Seven land use classes were delineated as the main land use cover types; namely, range land, bare ground, water body, rocky areas, built-up, crop land, riverine vegetation and woodlots. Given that it is change in locations over a period of time that we should quantify and since analyses fundamentally determine the impact of human settlement by quantifying the change, Weeks, (2003), proposes the use of at least two time-period data collections to notice changes in land use and land cover through developments such as urban sprawl. In this study three time period Landsat images, that is, one Thematic Mapper (5TM), and two Enhanced Thematic Mapper plus (7 ETM+), for the study area for the years 1984, 2004 and 2010 respectively were analysed.

Following the downloading of the images from USGS Global Visualization Viewer (GLOVIS, URL: <http://glovis.usgs.gov>), the choice was founded on the acquirement season, availability, spatial resolution; amount of cloud cover as well as the consumer need and scale of the researcher zone. A total of 21 spectral bands were downloaded and stacked according to construct 7 band

Land Sat TM images for each date (27/8/1984, 23/9/2004 and 19/8/2010). I ensured all images coincided with dry season before the start of short rains in October to evade uncertainties.

Household survey was conducted for 10 months (from June 2012- March 2013), with the aim of collecting data of the different land uses in Kajiado North Sub-County. During household survey, unstructured participant observation was used in the field. According to, (Taylor-Powell and Steele, 1996; Russell, 2006) unstructured participant observation is desirable in particular circumstances because it permits the investigator as an insider to be precise as to when and where to observe, what particular features of the situation or conduct to observe, and how to assemble and document observations. During the household survey, parameters considered included current uses, holding sizes, levels and types of fragmentation and infrastructure. A total of 419 questionnaires administered (Appendix 1), geographic details recorded on each questionnaire, field observation book and hand-held GPS receiver. Digital photographs and GPS coordinates of key features were taken for ground truthing and association with the image characteristics for validation with the land cover maps generated from the satellite imagery.

4.2.2 Land use and cover changes between 1984 and 2010

The Land sat images for years 1984, 2004 and 2010 were classified and catalogued to seven wide kinds of land use and land cover categories according

to (FAO, 2011); range land, bare ground, water body, rocky areas, built-up, crop land, riverine vegetation and woodlots as described in Table 4.1.

Table 4.1: Adopted land cover classification scheme

Land Cover Types	Brief Description
Range land	Zones characterized by Grasslands/Herbaceous and Shrub land; not more than 5 meters tall with shrub canopy usually greater than 20% of entire vegetation. This class comprises of true shrubs, young trees in an early successional phase or trees undersized by ecosystem challenges.
Bare ground	Regions typified by bare soil/gravel pits with no vegetation cover.
Rocky areas	Zones typified by bare rock/quarries
Built-up	Zones typified by constructed materials
Crop land	Areas characterized by herbaceous vegetation that has been planted or is intensively managed for the production of food and feed
Riverine vegetation and woodlots	Areas covered by natural and planted woody vegetation
Water body	All zones of visible water

Source: Adapted from (NLCD, 1992) Land Cover Class Definitions

The land use/cover maps results are illustrated in Figure 4.2

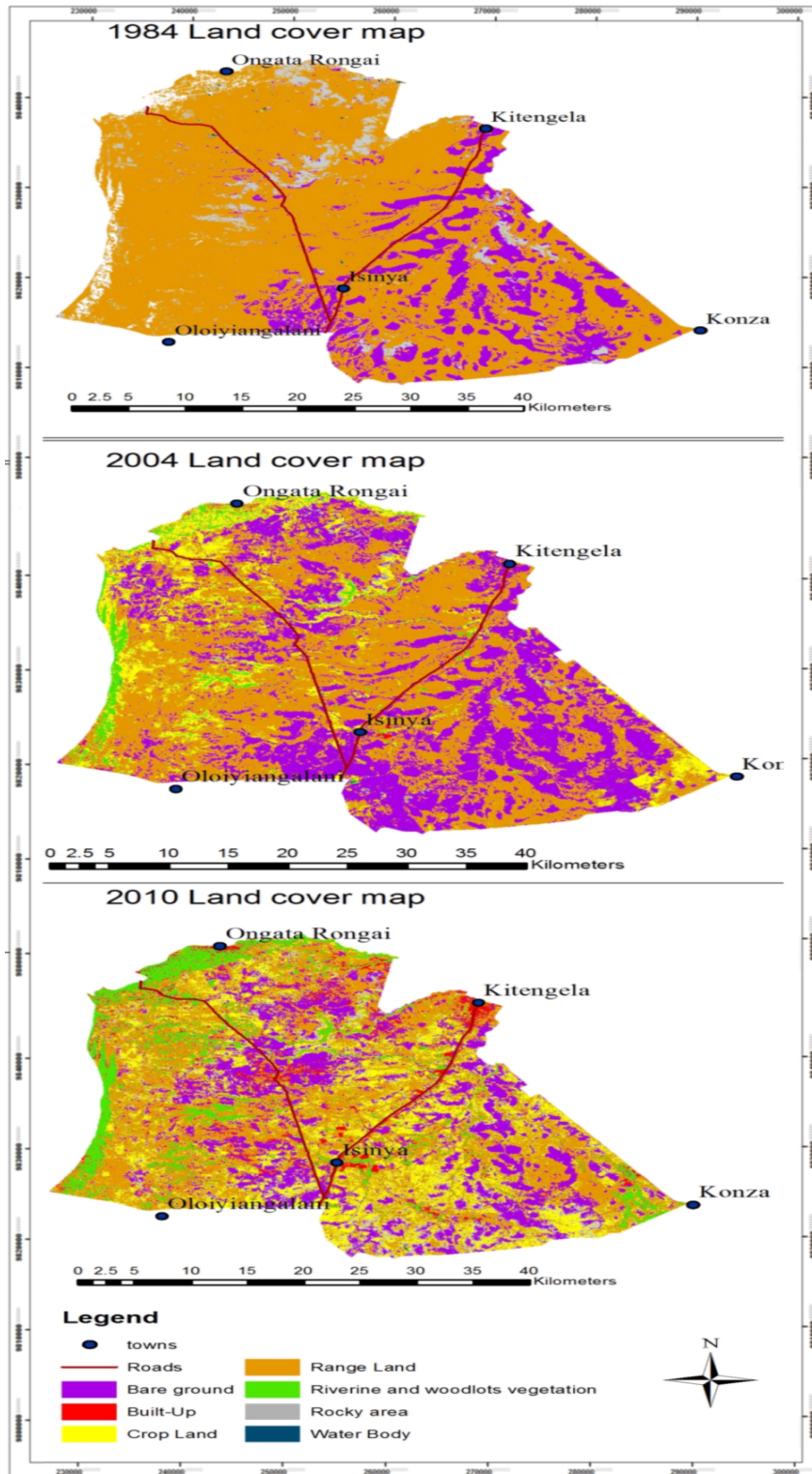


Figure 4.2: Land use/cover classification results

There was a general trend in increase of crop land, built-up, woodlots and riverine vegetation, meanwhile the rangelands, water bodies, rocky areas and bare ground decreased over the years as presented in Figure 4.3.

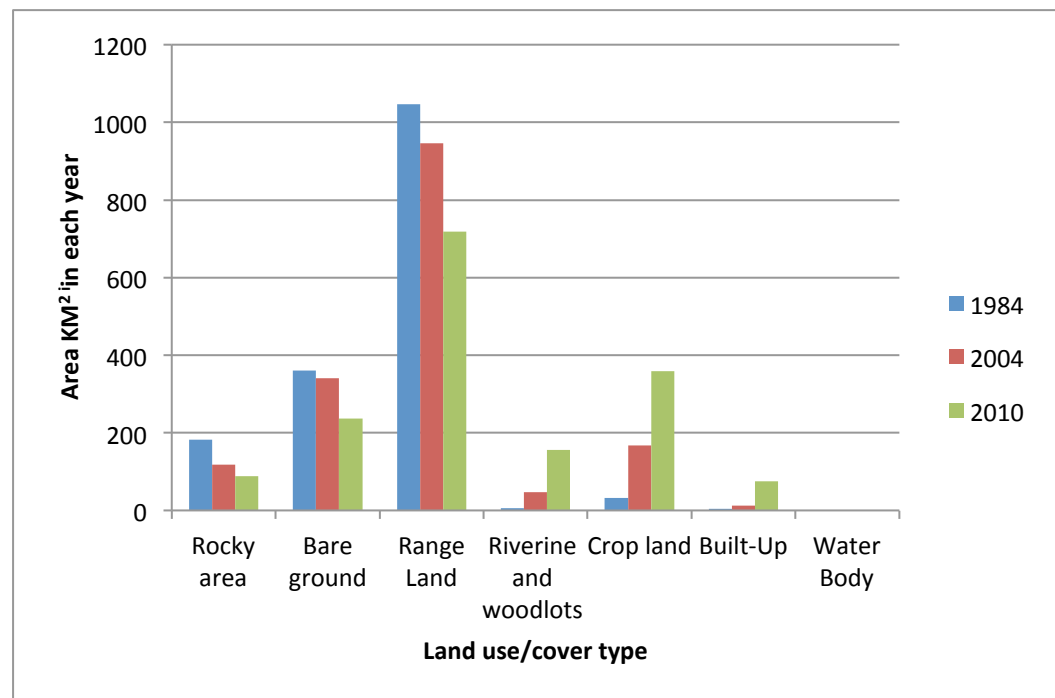


Figure 4.3: Bar chart illustration of land cover/use trends for years 1984, 2004 and 2010

4.2.3 Change in land use /cover and significance

The spatial extents of each category of land use/cover and their percentage changes for years 1984, 2004 and 2010 are presented in Table 4.2 together with the Chi-Square goodness of fit test to demonstrate whether the changes were significant for each kind.

Table 4.2: Extent and proportions of different land use/cover types for the period 1984-2010 and the chi-square goodness of fit

Class Name	1984 Area (Ha)	1984 % area cover	1984-2004 % change	2004 Area (Ha)	2004 % area cover	2004-2010 % change	2010 Area (Ha)	2010 % area cover	1984-2010 % change	X²	df	P
Rocky area	18203.96	11.16	-35.34	11771.28	7.21	-25.24	8799.6	5.39	-51.66	36.38	2	<0.001
Bare ground	36040.1	22.09	-5.24	34150.8	20.92	-30.68	23674.7	14.51	-34.31	28.47	2	<0.001
Range Land	104740	64.18	-9.74	94540.1	57.93	-24.02	71828.1	44.02	-31.42	62.73	2	<0.001
Riverine and woodlots	507.25	0.31	820.29	4668.21	2.86	232.57	15525.1	9.51	2960.62	172.54	2	<0.001
Crop land	3187.28	1.95	427.07	16799.2	10.29	113.36	35842.6	21.96	1024.55	289.64	2	<0.001
Built-Up	457.80	0.28	168.09	1227.32	0.75	508.65	7470.04	4.58	1531.72	94.71	2	<0.001
Water Body	50.34	0.03	-40.79	29.80	0.018	56.15	46.54	0.029	-7.55	0	2	1

The analysis indicated a decline in rangeland, rocky and bare ground while crop land, built-up, woodlots and riverine vegetation increased during the study period. By 1984, the built up area was limited to a small radius within urban centres but by 2010 it had spread extensively along the road network near urban centres, with some urban centres virtually merging in the process. The most drastic expansion occurred between 2004 and 2010 with more than 500% increase meanwhile for the entire study period built up increased by 1,531.72%; with a concomitant decreases in range, rocky and bare ground.

The area under crop increased steadily over the 1984-2010 period by a cumulative 1,024%. For the period 1984-2004, there were major declines principally in rocky, rangeland and bare ground areas. Cropland increased by about 1,025% from 3,187 ha in 1984 to 35,843 ha in 2010, mainly due to activities from the surging number of immigrants and the indigenous who had increasingly adopted crop production over the years. At a variation of only 31.42%, rangeland showed the least overall changes over the study period, compared to all the other land use and land cover types. The second least overall changes were experienced by bare land which showed a decrease of 34.31%. Bare ground and range land combined covered a total area of 95,503 ha equivalent to 58% cover of the area by 2010; this means that pastoralism was still the main activity in the area given that the bare lands turn to grass lands during the rainy seasons.

Rangeland, which consists of forage shrubs and grass, decreased throughout the period of the study by 31.45%; this change was significant ($p < 0.001$) given that the area is pastoral but overall it covers the largest area in the study location, 44% equivalent to 71,828ha (Table 4.2). The overall change in riverine vegetation and woodlots between the three time periods was 2,960% increase – this was probably due to immigrants planting trees around their compounds and establishing woodlots of eucalyptus in addition to the spread of the riverine vegetation along the seasonal rivers. The change in woodlots and riverine vegetation was impressive given their contribution to the environment was significant at ($p < 0.001$). The water bodies had no significant change ($p > 0.05$).

4.2.4 Types of changes between 1984 and 2010

The post-classification change detection procedure, which was used in this research is effective in detecting the type, speed and place of changes, and has been effectively used in many studies of urban sprawl (Hardin, et al., 2007). An overlay technique using ArcGIS 9.3 was applied in order to find the spatial changes in LULC throughout three intervals; 1984–2004, 2004–2010 and 1984–2010.

When this technique was applied, a two-way cross-matrix, was achieved explaining the major kinds of change in the research zone. Cross tabulation investigation on a pixel-by-pixel basis enabled the findings of the amount of conversions from a specific land cover category to other land use classes and

their respective area over the study period. A new thematic layer comprising diverse mixtures of “from-to” change categories was also generated for each of the three seven-class maps as summarized in Table 4.3.

Table 4.3: Major land use/cover conversions from 1984 - 2004 and 2004 - 2010

From class	To class	1984-2004 area in KM ²	2004-2010 area in KM ²
Rocky area	Riverine and woodlots	0.56	1.36
	Built-up	0.3	0.4
	Bare ground	15.75	2.33
	Crop Land	14.39	7.6
	Range land	3.2	10.9
Range land	Riverine and woodlots	17.36	39.19
	Built-up	2.18	15.37
	Bare ground	237.75	85.65
	Crop Land	123.57	127.92
	Rocky area	9.63	58.64
Bare ground	Riverine and woodlots	2.36	4.64
	Built-up	0.79	14.09
	Rangeland	58.92	136.95
	Crop Land	24.72	84.47
	Rocky area	5.86	100.4

As indicated, the majority of range, rocky and bare lands were converted to crop land, riverine and woodlots vegetation and built-up. Conversions to rocky land indicate a lot of human activities at stone quarries and gypsum mines meanwhile bare ground is due to extreme weather conditions at the time of taking the satellite image. This suggests the existence of intensified burden on

ecosystem resources in Kajiado North Sub-County to meet the growing requirements on land for diverse livelihood activities.

4.3 Socio-logical factors which contribute to or impede land use/cover change in Kajiado North Sub-County

4.3.1. Logistic regression analysis

A binary logistic regression investigation was used to recognise the determinants of each respondent household's choice to change or continue with the existing land use. The regression investigation was based on the maximization of the fundamental utility function that is assumed to be consistent with individual household behaviour.

The logistic regression analysis results of factors influencing land use change are presented in Table 4.4. Of the seven independent variables hypothesized to influence land use/cover change only five had a positive effect; the land was more likely to undergo change in use if the household head and wife perceived that the parcel of land they own was adequate in supporting their household livelihood which meant that they could spare some, if wives could make decision on income generating activities, if a household owned land in other locations and if current owner was immigrant. While the following factors had no effect on land use change; existence of resource uses conflict and wife's name on title deed.

Table 4.4: Logistic regression analysis results for factors influencing land use change

Variables in the Equation								
	B	S.E.	Wald	Df	p-value	exp (B)	95% C.I. for exp(B)	
							Lower	Upper
HH-Land size support livelihood - X_1	0.645	.305	3.237	1	.048	1.728	.898	3.497
Wife-Land size support livelihood- X_2	0.629	.285	4.967	1	.025	.987	.389	.909
Wife can make Decision on Income generating activity - X_3	1.312	.293	16.724	1	.001	1.104	2.569	5.278
Origin- X_4	0.247	.316	.467	1	0.047	0.723	.539	1.352
Land owned in other locations - X_5	0.130	.302	0.159	1	.05	.856	.637	1.435
Wife name on title deed - X_6	-0.052	.703	.028	1	.854	.721	.315	3.067
Resource use conflict - X_7	-0.156	.229	.456	1	.573	.823	.517	1.478
Constant- α	0.164	.182	.353	1	.714	1.134		

Therefore the variables that have P value ≤ 0.05 influencing land/cover use change form the:

Model equation

$$Y=0.164+0.645* X_1 +0.929* X_2+1.312* X_3 +0.247*X_4+0.130*X_5$$

4.3.2. Spatial regression analysis

The effect of urban centres, roads and rivers was analysed using GWR; the results are presented in Table 4.5.

Table 4.5: Urban centres regression results as an influence on LUCC for years 1984, 2004 and 2010

VARIABLE NAME	Urban centres Variables								
	Isinya			Kitengela			Ongata Rongai		
	1984	2004	2010	1984	2004	2010	1984	2004	2010
Bandwidth	0.67	0.01	910.01	0.01	0.02	1229	0.01	0.02	1193
Residual Squares	37.88	20.94	6.91	9.32	4.69	3.24	18.63	30.07	10.27
Effective Number	2	6.53	7.69	6.13	8.3	6.39	5.56	3.34	6.6
Sigma	1.86	1.3	0.75	0.93	0.7	0.55	1.14	1.3	0.91
AICc	59.47	76.07	60.07	57.82	55.89	40.88	71.35	76.93	64
R ²	0.08	0.37	0.68	0.81	0.91	0.93	0.69	0.75	0.81
Dependent field definition	Distance								
Explanatory field definition	Area								

For the urban centres the regression shows that in Kitengela town in 1984 the urban centre influenced land use change by 81%, in 2004 by 91% and 93% by 2010, the types of land use change were mainly being an increase on built-up and crop production with an associated decrease on rangelands. In Ongata Rongai the urban centres influence was 69% in 1984 and 75% by 2004 and 81% by 2010, the types of land use change being an increase on built-up, crop land, riverine and woodlot vegetation and a decrease on range lands and bare ground. In Isinya, which is far from Nairobi, the urban influence was only 8% in 1984 while it increased to 37% in 2004 finally to 68% in 2010, the types of land use change being in built-up and crop production with an associated

decrease on rangelands. The effect of roads and rivers on land use cover/change was analysed using GWR and the results are shown in Table 4.6.

Table 4.6: Roads and rivers regression results as an influence on LUCC for years 1984, 2004 and 2010

VARIABLE NAME	Roads variables			Rivers variables		
	1984	2004	2010	1984	2004	2010
Bandwidth	289739	240392	13678	371780	282403	14625
Residual Squares	323.5	224.5	151	7.96	7.77	6.37
Effective Number	3.01	3.01	3.01	2	2	3.44
Sigma	64.23	56.78	32.21	0.65	0.64	0.6
AICc	119.8	107.33	99.73	46.64	46.13	44.64
R2	0.03	0.15	0.33	0.01	0.05	0.22
Dependent field definition	Distance					
Explanatory fields definition	1.Grid code 2.Area					

The roads had more influence than rivers even though more change was observed in the field at the roads that were near rivers due to cultivation under irrigation. Roads had an influence on land use change of 3% in 1984, 15% in 2004 and 33% by 2010 which could be attributed to built-up and crop production this is because people built in areas where there is infrastructure. The rivers had 1% in 1984, 5% in 2004 and 22% in 2010 which was associated to riverine vegetation.

4.3.3. Factors influencing land use change as perceived by the community

The narratives by the respondents revealed conflicting roles played in land use change/choice by each gender depending on origin, level of education, family size and composition during the study period. Land use/cover changes due to

selling, natural causes and livelihood activities were the general themes that materialized from the data and were arranged in accordance to the interview questions. The issue of land use change associated with sale is quite sensitive and the respondents handle the issue differently either with remorse or bitterness as reckoned by (Carcary, 2009), while conducting IDIs as opposed to FGDs and KIIs.

4.4. Factors Influencing Selling of Land

A number of factors influenced a household to sell land resulting in change as narrated by the respondents;

4.4.1. Size of land owned

In one rural FGD a respondent revealed that; “owning of large farms influenced indigenous people to sell”. After subdivision of the ranches the land owned used to look very big. Initially selling was done without involvement of qualified surveyors. Measurements were done visually and with negotiations. “Sometimes men were bought liquors while pledging land as collateral”. This was quite common in the rural sub-locations. “Over time some of those verbal transactions have been revoked when the next of kin, especially sons became of age”. One destitute IDI respondent said, “The land was too big I thought I could still live comfortably after selling but once the sale proceeds were over I kept on selling until I only have three acres with ten dependants, I really regret”.

4.4.2. Fast land appreciation rate

A KII respondent from the urban area had this to say: “The infrastructure has improved so much that all areas located near roads and electricity are bound to change in the next five years. This is because these areas have been sold and fenced off for development – a situation confirmed during household survey. “Temptations to sell from brokers are real because the price appreciates fast and they keep on visiting owners near good infrastructure with upward price revisions”.

The urban areas experienced the highest price increase per acre during the period 1980-1990 of 190% per year while the rural areas experienced highest price increase during the period 1990-2000 of 90% per year. The respondents gave the average price of land per acre with respect to physical location as tabulated in Table 4.7.

Table 4.7: Trends in land prices for the period 1980-2010

PHYSICAL LOCATION	LAND PRICES IN KSH/ACRE ('000')AND PERCENT ANNUAL CHANGE						
	1980 Average Price / acre	1990 Average Price/Acre	1980-90 annual % price Increase	2000 Average Price/Acre	1990-2000 annual % price increase	2010 Average Price/Acre	2000-2010 annual % price increase
Urban	10	200	190	1,000	40	15,000	140
Rural	3	10	23	100	90	600	50

4.4.3. Ownership with respect to origin

Meanwhile all land with individual ownership was subject to household/owner decision making. Immigrants do more crop production than indigenous owners. While doing proportional piling, the respondents said; “currently in a scale of 1-10, eight immigrants do crop production while for the indigenous it is 3 out of 10 but before 1980 the indigenous did no crop production”.

KIIs and FGDs revealed that intended use of the buyer was implemented according to plan with regard to property developers. “Land bought by institutions mainly colleges and universities is completely fenced and areas demarcated for development accordingly. The institutions of higher learning also influence land selling around them within distances of 3 to 5Km; as property developers target building of students’ residential halls that are deemed to be lucrative”. Estate development companies have developed several housing units which are coming up as estates e.g. Jamii Bora trust in Kisaju area of Isinya, which proceeded “despite objections from stakeholders.” “While individuals who have bought land for home development start almost immediately funds are available.

KIIs from Oloosirkon and Kitengela locations said that; “Picnic sites and holiday resorts have been developed there overlooking the Nairobi National Park while areas near the road have come up with meat eating and drinking joints that are popular to both international and local visitors”. “When the ostrich farm was started the indigenous people sold the land at a paltry, Ksh

3,000 per acre but now due to the resort the land around has appreciated to Ksh 5 million per acre within a span of 20 years”.

KIIs revealed that several Sacco’s have bought land on behalf of members and possible sale to increase developments. There were several sign posts advertising land for sale from 1/8 acre to 50 acres in the study area. Figure 4.4 shows common adverts in the field.



Figure 4.4: Sign posts at a junction displaying land selling/development activities in Kisaju location

Nine flower farms in the study areas have slowly increased their acreage over the years leading to expansive areas under green houses. Industrial parks have come up extending from the export processing zones (EPZ) in neighbouring

Athi River -- this leads to increase in demand for housing and water. Speculative land buying due to the Konza techno city about 40 km away and possible up-scaling of the area to metropolis adjoining Nairobi city have increased the land buying activities as revealed by KIIs. Improved infrastructure and basic amenities; access roads electricity, schools, water, banks and hospitals have attracted many middle income earners to the area given that the land is quite cheap compared to Nairobi city.

4.4.4. Basic facilities and infrastructure

Urban FGDs identified the main attraction for immigrants and working class from Nairobi to the area to include:

“Basic facilities like schools, hospitals, water, electricity, access roads, jobs within proximity like EPZ and flower farms, distance to Nairobi /industrial area influence immigrants while the indigenous Maasai do not like living in congested areas with a lot of noise. They dispose of land near roads and those with potential to attract high population due to availability of basic amenities”.

4.4.5 .Peer pressure and competition

FGDs revealed that “The young men mostly copy each other in selling land to buy cars, built good houses, drill boreholes, buy gadgets to reflect change of lifestyle/current status, waste on drinking and partying. This has also started with old men from 2005, after witnessing careless use of land sale proceeds from young people”. In one IDI a respondent said; “after witnessing what

happened after the death of his age mate, he decided to subdivide his land to all his heirs and the rest he sold to eat before dying like the neighbour”.

The culture of easy fast money has taken root as reiterated by one IDI from Ololoitikoishi; “The youth are not working hard, they know the value of land in the area and are just waiting to inherit their portion, sell and buy big cars. The youth cannot do labour intensive chores; there are many immigrants to be hired for such. They have grown up seeing their fathers survive on the proceeds from land sale. Since they have no other livelihood skills and opportunities they will also sell land”.

In another IDI a respondent said “when he was sick and wanted his livestock sold to offset his medical expenses, he overheard his sons saying that there was no need. The old man had outlived his time and he was using their stock of oxygen. He should rest so that they can enjoy life”. “The old man decided to subdivide to all his heirs when he became well and decided to sell his share at least to use before he dies”.

KII from all divisions acknowledged that; “acquisition of off-road drive vehicles is common. Results from FGDs proportional piling revealed that 50-60% of land sale proceeds are used to buy vehicles. Field observation in Kitengela sub-location revealed that 5 out of the 27 households interviewed during household survey had CCTV cameras installed even though they were living in a house constructed with iron sheets”. “Need for money to facilitate

acquisition of pleasure or non-essential services like; graduation party, celebration of Christmas, marriage ceremony and associated functions necessitated land sales

4.4.6. Social cultural issues

This impacted on the way wives participated in land selling deals in the community. The household head is the sole decision maker for the indigenous and some immigrants as far as main assets are concerned. The indigenous wife is only allowed to make decisions for chicken, milk, kitchen gardening and manure. Women do not participate in major family decisions. In one FGD one man said “women are a man’s property and land is a man’s property, how can property participate in decisions about property?” Further an IDI respondent from Kisaju revealed that to them; “Men are the household heads, village elders, sub-chiefs, chiefs, land board members, lands officers, advocates and magistrates. They meet at social places and strike deals. If a wife had land issues it will almost be impossible to succeed. The un-educated indigenous wife lacks the courage to face them and explain her situation. She does not know where to start from. The village elders may not give her a hearing, same for others along the administration hierarchy. The constitution is just a paper that is not implementable to many indigenous women even though there is requirement for family members’ consent before the contract is sealed”.

A KII from South Kekonyokie division said; “Most wives who are illiterate do not know about the consent requirement. For those who know, the household

head coarsen them to sign the consent form otherwise they experience domestic violence leading to separation and eventual divorce”. “Alternatively they take advantage during the period of separation to complete the process when the wife comes back it is no longer family land but a new owner’s”.

In a male FGD from Kitengela division a respondent said; “that with the realization that they need the wife’s consent, the process of strategizing and negotiation starts long before going to the land board. They entice their wife with goodies like permanent house, water, furniture and sending children to school. With the wife not conversant with the transaction figures he may say like we are selling 2 acres while in reality it is 2 hectares. Once he receives the proceeds, he does all that he promised but they may consume less than 10% of the total proceeds because during negotiation he is quite careful not to go into the nit gritty of the house construction, furniture and other items. To impress the wife he goes further and buys her several “Shukas” and Sandak shoes. This is to ensure that next time he wants consent to sell he will not be denied on the basis of failing in his promises”.

Respondents from Illipolasat women FGD said “married men between 45 and 25 years have developed a culture of meeting at social places to strategize how to sell family land without their wives consent. All they do is squander the sale proceeds like there is no more tomorrow. They wished they can agree to participate in joint livelihood trainings to improve the financial literacy levels”.

A KII from Kisaju said “When men transact in land selling negotiations majority of women are sketchily involved”. “There was a case whereby the household head took advantage of a desperate situation of meeting urgent medical costs to convince the wife to sign the consent forms claiming he was leasing for five years and not selling”.

In the rural areas of Oloiyangalani men felt that women were like part of their property while some instances they are likened to children. In one IDI interview in Sholinke a respondent said; “she tried to stop her husband from selling their land before subdividing to the sons. In an arbitration meeting with community elders, she was asked “when did children manage property? Do they know the value? Since when did property manage other property?” In a men FGD a respondent from Kisaju said; “when a woman is married she does not come with property; how then can she just come to control the way you manage your resources? These will extend to her controlling you from becoming polygamous”.

4.4.7. Lack of alternative livelihood coping strategy

Selling of land is a common practice of meeting family obligations; One IDI from Kisaju Said; “I had to sell my land to meet medical costs for my family and later to pay university fee for my children. After the 1985 drought I had to sell my land to restock as I had lost all my animals”.

4.4.8. Peace/security in the area and speculative buying

Five KIIs while confirming why immigrants prefer Kajiado North Sub-County said “if you compare other dormitory areas to the study area, peace and stability is high due to the cosmopolitan nature of residents. There are no incidences of vigilant groups who are common in Kiambu and other areas surrounding Nairobi common in Kiambu and other areas surrounding Nairobi.

4.5. Natural Causes Influencing Land Use Change

4.5.1. Population increase

In Kisaju FGD a respondent said that “in 1989 there was only one shop in Kisaju shopping centre and by then the population was low. Now the centre has several shops with different types of businesses and the turnover is good. In addition there are motor bikes operators who have made the place quite busy”.

KIIs revealed that “most household heads who received land from group ranches in the 1980s have grown-up sons and grand children who need their own homes. Naturally they receive their inheritance and thus are free to make independent decisions like selling.” “Even the immigrants who bought large pieces have subdivided to their heirs as they become of age”.

4.5.2. Increase in vegetation and invasive species

Proportional piling during all FGDs revealed that; “95% of immigrants plant trees and live fences around their homesteads a practice that 10% of the

indigenous have been influenced to adopt. From 1990s some homesteads have established Eucalyptus woodlots”.

A KII from Illipolasat said that; “many households used *Opuntia* species as a fence around the homesteads, it turned invasive and they had to abandon their homes completely since they did not know how to control it”. “The riverine vegetation has slowly increased along the seasonal rivers, while the Ipomea weed has invaded the grasses destroying grazing areas”.

4.5.3. Climate variability

The weather patterns have become unpredictable. One KII said “in the 1970s you could predict the onset of both short and long rains, but now they either come very early or delay varying in amounts and erratic distribution”. “Almost every year people and livestock lose lives as they are swept by flooding seasonal rivers”. The heavy rains cause erosion and destroy roads hindering movement”.

4.6. Livelihood Activities

Livelihood activities were influenced by physical location, owner origin and intended use of land.

4.6.1. Physical location

Interior places (rural) are still owned by the indigenous people who have not yet diversified uses. But in/near urban centres use depends with location; urban

is built- up, near roads we have flower farms and chicken breeders. A KII said “in 1970 when he migrated to area, the whole area was range land; no fences could be seen as wildlife mingled freely with livestock. The tall grass and shrubs during the short rains were quite good scenery”. Current situation “almost like Nairobi in the 1960 meaning twenty years from now the whole area will turn into urban; with slums, residential areas, industrial areas and central business district at the urban areas. This is because the urban areas have expanded so fast within the last ten years, while Jamii Bora Trust has built a congested residential area with residents from Kibera”.

4.6.2. Diversification to continuous income generating activities

A KII from Kitengela said the indigenous learned from those who bought land earlier, he said; “Initially an immigrant who closely associated with the indigenous in the 1960s was allocated about 800acres near the road around Kitengela town during group ranch subdivision. He sold and used the proceeds to develop properties where he was earning a lot of income”.

To diversify; in the urban areas FGDs respondents said; “if you have one acre you are rich since you can sell 1/8 acre use the money to develop the remaining to be an income generating source e.g. rental units since the approximate price of urban areas is 30-40 million/acre currently”.

4.6.3. Land use practices

Land use activities that degrade the environment have led to land use change/cover in several areas; KIIs from Kitengela and Ilipolosat said;

“Quarrying activities at land leased out has degraded the environment. Gypsum mining has left a lot waste inert soil and deadly water ponds which trap livestock that accidentally slip while trying to drink water. Run off from greenhouses causes’ soil erosion creating huge gullies”.

FGDs from Olturuto, Olooloitikoishi and Enkirigiri complained of land degradation when livestock access water from water pans. “They noted that the situation is so bad such that when the Ministry of agriculture staff went round identifying willing households to construct dams/water pans for communal use none accepted. They said that the government should buy the entire catchment area because herds of livestock cause degradation through animal traction”. “In addition, the value of land is high; it will be a great loss for one household to avail land freely like in the 1980s”.

A KII from Kisaju said that crop production activities have contributed to the observed land use/cover change;

“Areas with crop failures remain bare once the rains are inadequate”.

“Immigrants may harvest a good crop under rain fed agriculture once in five years but they cultivate every year in anticipation of good rains”.

KII revealed that “returns from crop production were perceived to be higher when compared to pastoral livestock production and in fact for commercial purposes, if one targets high returns a greenhouse for horticulture is beneficial”, this holds true for those with small holdings”.

4.7. Factors That Impede Land Use Change

Some factors that impede land use change were those associated with not selling and looking for alternative sources of livelihood.

4.7.1. Ownership

A KII revealed that in Oloseos; “approximately 600 acres community land is in the original state. The land is in the original form mainly used for grazing, collecting forest products like honey, firewood and hay since individuals do not have a right of changing ownership through sale transactions”.

4.7.2. Size of land owned and physical location

KII revealed that “Those in the rural locations who practice pastoralism were unlikely to sell. Some had registered in WCLP hence they could not subdivide nor change use as required.

4.7.3. Age and education level of owner

All FGDs and KIIs said that “75% of those below 45 years old who have received their share of inheritance were likely to sell due to peer influence to

acquire assets like vehicles and built good homes. Where ownership is still with the household head (above 45 years) who is informed e.g. retired teacher, chief or civil servant selling was unlikely unless it was to sort out a financial issue like; university fees, restocking, medical expenses or major income generating activity like borehole or commercial building”.

Three KII respondents said “Ignorance due to illiteracy contributes to selling without proper planning for proceeds. In cases where current inheritors are below 45 years and with low education status they tend to uncontrolled selling and hence land use change. When they receive their share, these immature people normally see the amount of land to be expansive; for example, since they cannot see 200 acres’ physical boundaries; they embark on continued selling until they realise they have less than 10 acres.”

4.7.4. Ability to get alternative source of livelihood

KII from Kisaju said “Some HH became watchmen during severe drought to enable them put food on the table until the situation changes instead of selling land”. While others were formally employed or engage in petty trade and menial activities in addition to selling livestock.

4.7.5. Awareness of the constitution and exposure to immigrants

The role of men as the sole decision makers with regard to property and major assets is slowly changing in the urban sub-locations due to exposure from immigrants and the Constitution 2010. KIIs from Isinya and Kitengela

Divisions said; “With the women becoming aware of their rights especially the granting of consent to sell, they normally put caution on their land at the board. But men are not happy about this”. “Initially women used to run away either back to their home or to the man’s relative. This was followed by a sitting by the elders to discuss the issue. If they got convinced that the proceeds will be used for a noble activity the man will be allowed to sell. But if they thought that he was going to misuse the proceeds he was denied permission to sell”.

Exposure to other communities on the role of women with regard to family property has changed as an IDI with a respondent from Sholinke said “If it were not for my neighbour from Kiambu who enlightened me, we could not be having any land left for use. I opened up to her on my worries as the household head kept on selling and she advised me on several approaches and I chose one that was applicable in my situation”.

4.8 How the Land Use/Cover Change Has Impacted On Resilient Livelihoods and Ecosystem Services in Semi-Arid Land Kajiado North Sub-County

4.8.1. The impacts of land/use cover change on resilient livelihoods in semi-arid land Kajiado North Sub-County

Using the DPSIR framework analysis was carried to assess the impacts of land use/cover change on resilience livelihoods covering the following components or assets; *Natural capital* with respect to the ability of the environment e.g. land, water, soils to produce goods for consumption and sale; *human capital*

with respect to the ability of residents to make a living through skills, education and knowledge; **Physical capital**, the infrastructure and basic amenities like houses, schools, clinics, roads, electricity that facilitate accessibility in the community; **Financial capital** sources of income, assets which can be traded or sold, to raise cash for example livestock, crops, land, water; and finally **Social capital**- family links, groups, support networks, leadership, influences over political decisions, conflict-for community cohesion and well-being.

In the analysis, physical location was categorized to; urban which refers to sub-locations within 1-4 km radius from town or commercial setups, rural at least 5 km from urban set-ups and urban/rural sub-locations that stretch from the urban to the rural. Figure 4.5 gives the breakdown as to how the questionnaire was administered with respect to physical location.

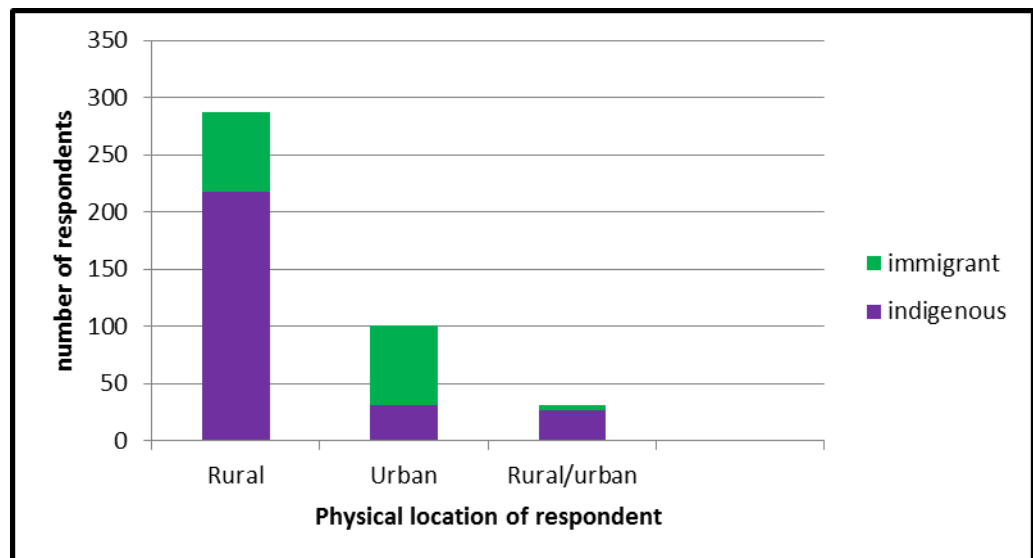


Figure 4.5: Distribution of sampled households by physical local and origin in the survey

(i) Land

The distribution of land as natural capital depended on the origin of the owner whereby the indigenous had large sizes compared to the immigrants. The average land size owned by each ethnic group with respect to each physical location is given in Table 4.8.

Table 4.8: Ethnic group and acres owned in each location type

Physical location	Ethnic group/average acres owned									
	Indigenous		Immigrants							
	Maasai		Kikuyu		Kisii		Kamba		Others	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Urban	188	58.99	5.5	1.65	0.4	0.06	0.25	0	4.3	1.35
Urban/ rural	145	45.97	41.6	13.57	0.1	0	-		-	
Rural	185	57.67	12	3.83	0.9	0.22	0.35	0	17.1	5.59

The indigenous still own fairly large pieces of land on the average 144-188 acres though the range was from less than 10-400 acres while the immigrants own from less than one acre to forty one acres. This necessitates gradual changes from pastoralism to agro-pastoralism whereby livestock and crop production systems tend towards diversification and intensification through adoption of improved breeds and technology as outlined below.

(ii) Livestock production systems

The size of land owned and origin of respondent influences livestock production system adopted. Pastoralism of the semi-nomadic, transhumant type with predetermined patterns of mobility is a major livestock production system

in practice as shown in figures 4.6 and 4.7. This system is practised by 65.9% for cows, goats 63.8% and sheep 67.3% of the respondents. With regard to land size owned, the system was practised by about 95% of those with large sizes (>140 acres) of land with no fences mainly located in the rural areas, while those with less than 20 acres have fenced the land and use mixed methods. Mixed methods were used by approximately 12.4% of the respondents depending on season and availability of labour.

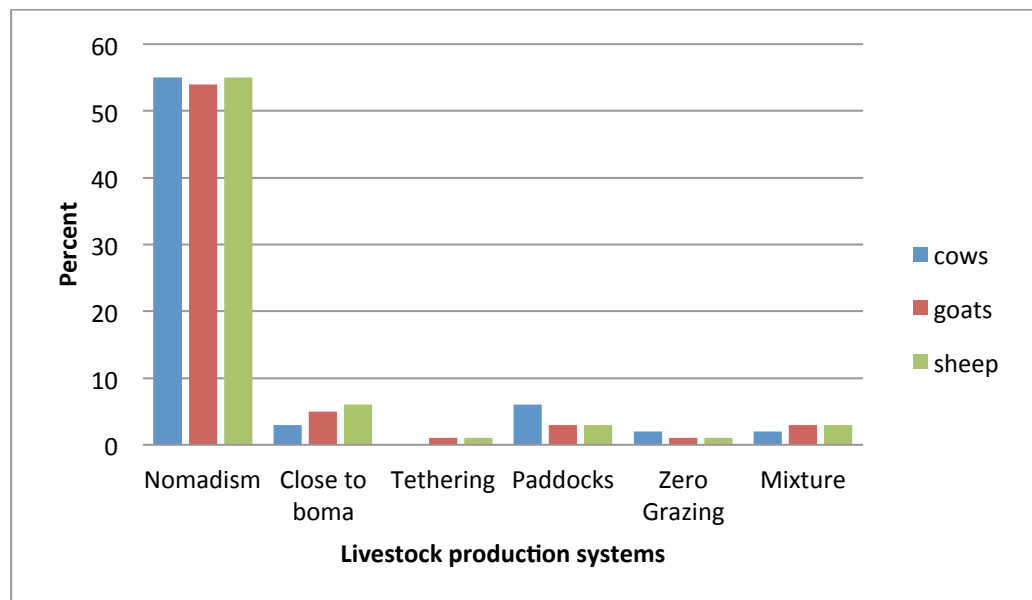


Figure 4.6: Current indigenous livestock rearing systems

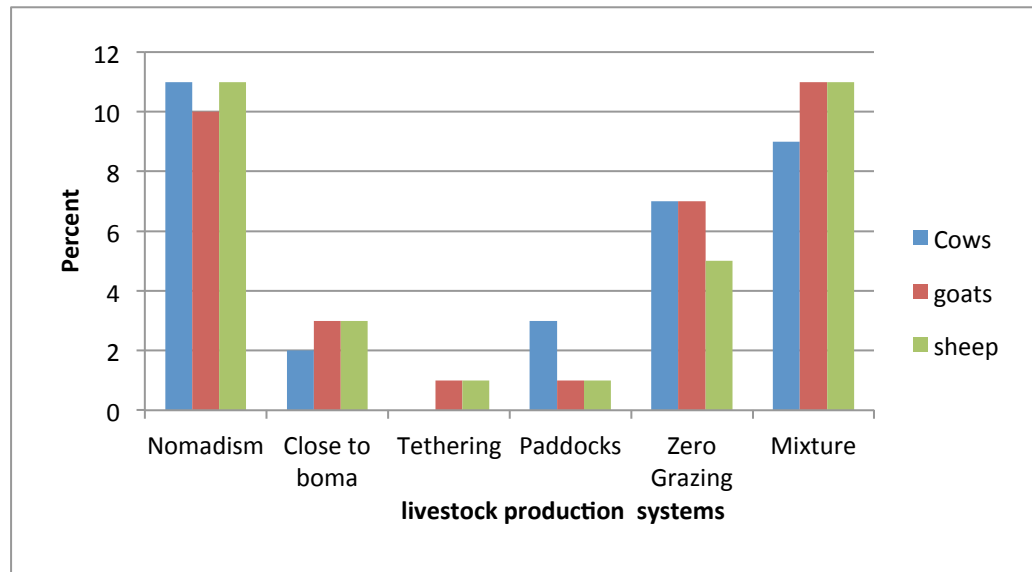


Figure 4.7: Current immigrant livestock rearing systems

In the rural/urban to urban areas livestock production is practised in a transitory manner, few about 7% do pure transhumant nomadism for cows and 8% for sheep while others have their land divided into paddocks for efficient utilisation of pastures with little or no trespass. Tethering of livestock is practiced by few farmers 3.5%, while cows’ zero grazing is practised by immigrants in urban areas at 6.5%. Accumulative total of 19.2% immigrants practise zero grazing system for all livestock of as opposed to indigenous who do only 4% total.

Use of veterinary drugs is practised by 64.4% of the households currently; this contributes to protection against diseases hence livelihoods can be sustained by intensification returns without keeping large herds as opposed to only 5% in the 1980s. FGD proportional piling results revealed that for the indigenous “To reap the benefits of intensification, approximately 70% use veterinary drugs

currently as opposed to only 10% in 1980. They sometimes used herbs for some diseases as approximately 40% use a combination of herbs and veterinary drugs. They believe that herbs are still potent; the only disadvantage being extinction of medicinal plants due to encroachment of the forests as a result of human activities”.

Several farmers had done herd improvement changes over the years and results are presented in Figure 4.8.

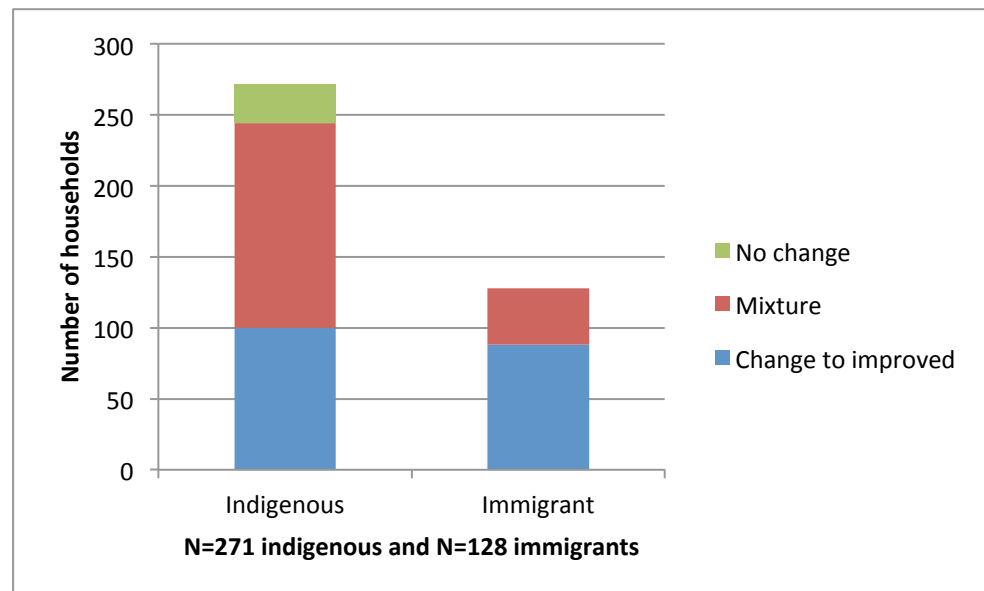


Figure 4.8: Livestock improvement changes with respect to origin

The current results indicate that most immigrants keep improved 69% while 31% keep a mixture of breeds. Majority of the indigenous farmers indigenous 144 equivalent to 53% keep mixed breeds and only 27 equivalent 10% keep indigenous livestock. In addition to dairy, poultry and pigs were kept on commercial basis by 5% of urban immigrant farmers.

Livestock production systems have changed to cope with household declining land size. FGDs from Isinya and Kitengela divisions said “Before 1986, most farmers had the red Maasai sheep after which the residents adopted dorpers. Sahiwal and Simmental dual purpose cows were introduced in 1986 for breeding in collaboration with Kenya Agricultural and Livestock Research Organization (KARLO) Naivasha and Kenya Livestock Development Project (KLDP) that promoted the use of improved cattle breeds by providing bulls (mainly Sahiwal) either free or at subsidized prices to provide better yields of both meat and milk as opposed to Zebu. “Sahiwal skin colour is referred to as “rangi ya pesa;” (meaning the colour of money when it comes to household herds). This implies that whoever has the Sahiwal herd has breeds of high value compared to others. “There was realisation that one can achieve returns from one Sahiwal bull equivalent to 3-4 local bulls, in turn use less space and feeds”.

The breed improvement adoption was true for sheep, dorpers are good grazers, achieve faster growth and have more weight for same size, and hence they achieve more returns as opposed to local breeds, have high fertility rate, good mothering ability and long breeding season, hardy and resistant to worms and local diseases. They adapt quickly to environmental changes and are non-selective grazers hence making maximum use of pastures as opposed to goats”. “These attributes makes them more marketable”. “A breeding centre for dorpers was established at Maasai Technical Institute in 1985 which made

accessibility easy while Naivasha shoats breeding centre was an alternative source for quality dorpers for farmers”.

FGDs in Kitengela and Ongata Rongai division said that; “In the Kajiado North Sub-County peri-urban area households that had smaller land holdings earned more income per acre from farming and livestock than the more traditional pastoral households, suggesting a move towards more intensive crop and livestock production with shrinking landholdings for some households”. KIIs from Kitengela and Sholinke said that “Immigrants on small acreage 1-10 do mixed commercial farming; keep dairy animals, pigs, fish ponds, rabbits, have green houses and open field irrigation”. KIIs from Kitengela and Ongata Rongai divisions said that production that requires minimal space has been adopted by immigrants in some enterprises; “High returns from quail farming have attracted many farmers who have acquired permits from Kenya Wildlife Service”.

KIIs from all divisions noted that cross breeding as an adaptation to declining land size was evident for cows and sheep; “that majority of farmers had done cross breeding to improve adaptation to harsh climatic changes at the same time achieve higher yields per unit area”.

(iii) Crop production systems

Analysis was done to establish the current crop producers by origin and physical location and the results are as presented in Figure 4.9.

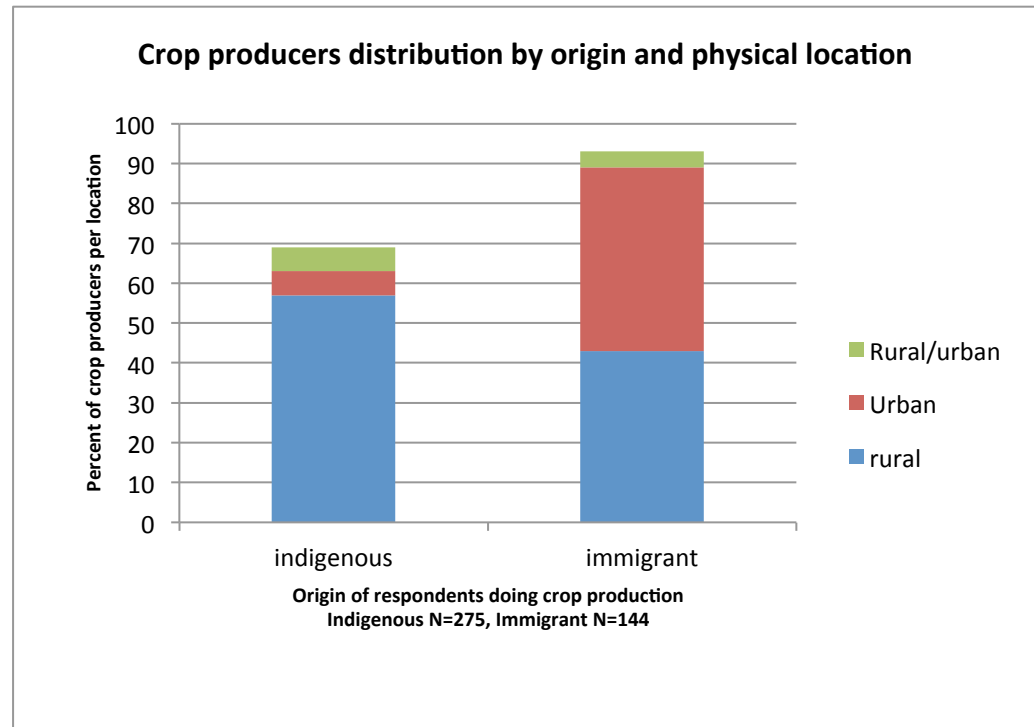


Figure 4.9: Crop producers' distribution by origin and physical location

Most crop producers are immigrants as 92.4% participate while only 69.1% of the indigenous do crop production. Majority of indigenous crop producers reside in the rural sub-locations while the immigrants are mainly located in the rural and urban areas. The rural- urban locations had the least number of crop producers.

Figure 4.10 shows how crop production is carried out in relation to water availability and technology.

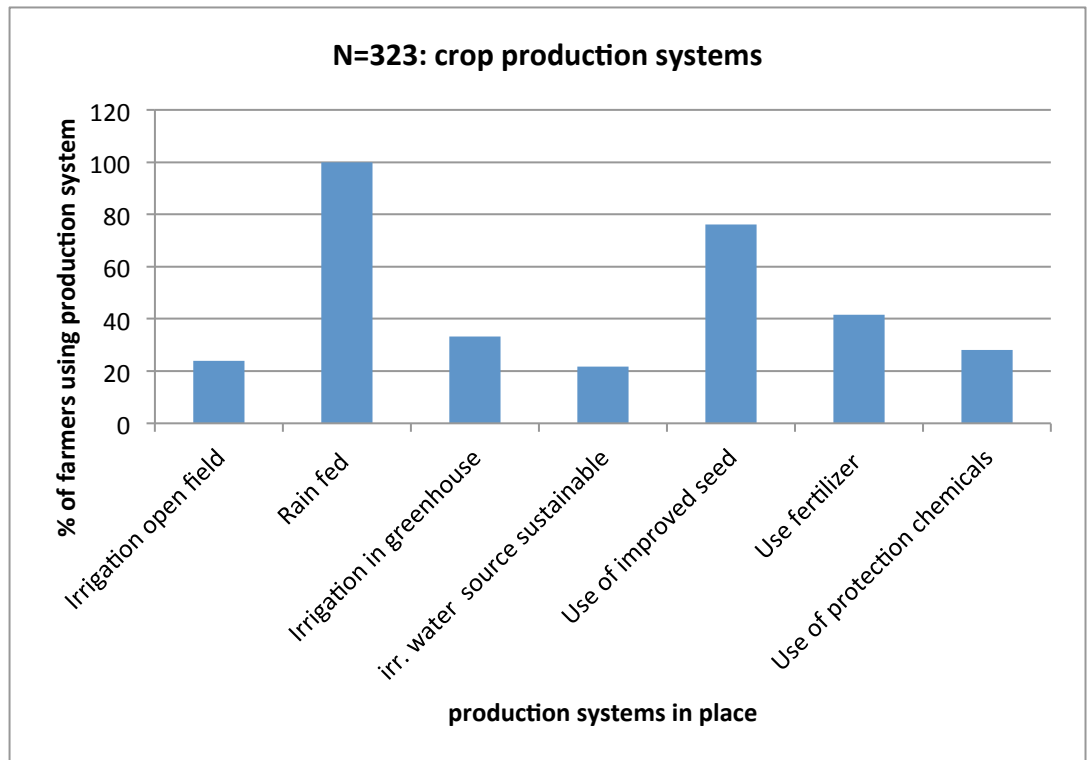


Figure 4.10: Crop production intensification information

All farmers do rain fed crop production. Use of improved seeds had been adopted by 76% of the producers, 41% use fertilizer, 28% use crop protection chemicals and 21% had a sustainable source of irrigation water. Irrigation in greenhouses was practised by 33% of the producers while 23% did open field irrigation. Field observation noted that borehole owners practise open field irrigation for low value crop like maize as opposed to those who had green houses.

Crops grown in greenhouses included tomatoes, cucumbers, capsicums, spices and flowers for export. Rotational crops included kales, spinach, onions and courgettes.

Proportional piling results during FGDs indicate that “ Most of the immigrants 90% originate from high potential areas and are used to crop production; with the introduction of simple green houses in 2009 and availability of borehole water, they ventured into commercial horticulture production with the aim of targeting Nairobi and nearby urban centres for market”.

KII respondent from Sholinke said “more indigenous people do crop production because it supplements livestock feeding under livestock intensification production system through crop residues and products of crop failures”. KII from Kisaju said “The indigenous site the cultivated plots below the cow sheds in a gently sloping area. During the rainy season erosion of manure fertilizes the field with little effort”. “Self-sufficiency in vegetables has led to many farmers planting vegetables on sacks or installation of bucket drip irrigation”.

(iv) Water

Water as a natural resource is constrained due to land use/cover change and Figure 4.11 gives the main sources in the community.

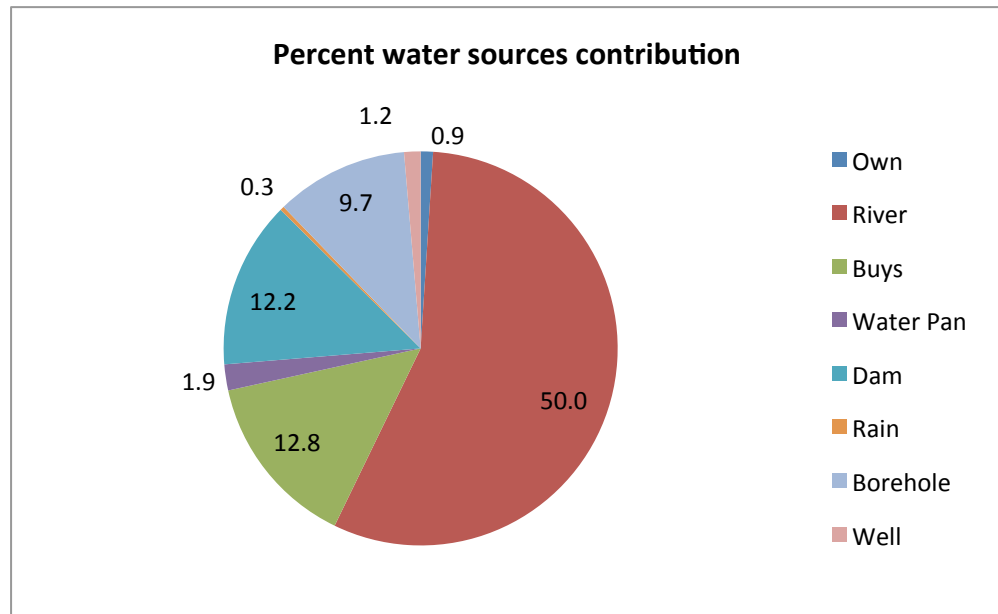


Figure 4.11: Community water sources

Rivers are still the major source of water followed by water pans. Water that is sold is acquired from several sources like boreholes, dams, water pans and wells.

Rain as source of water is not reliable since the amounts and distribution varies greatly. The rainfall distribution in the study area was acquired from the Kenya Meteorological Services (KMS), Maasai Technical Institute in Isinya station; Figure 4.12 gives the annual distribution while Figure 4.13 gives the five years' monthly distribution trend.

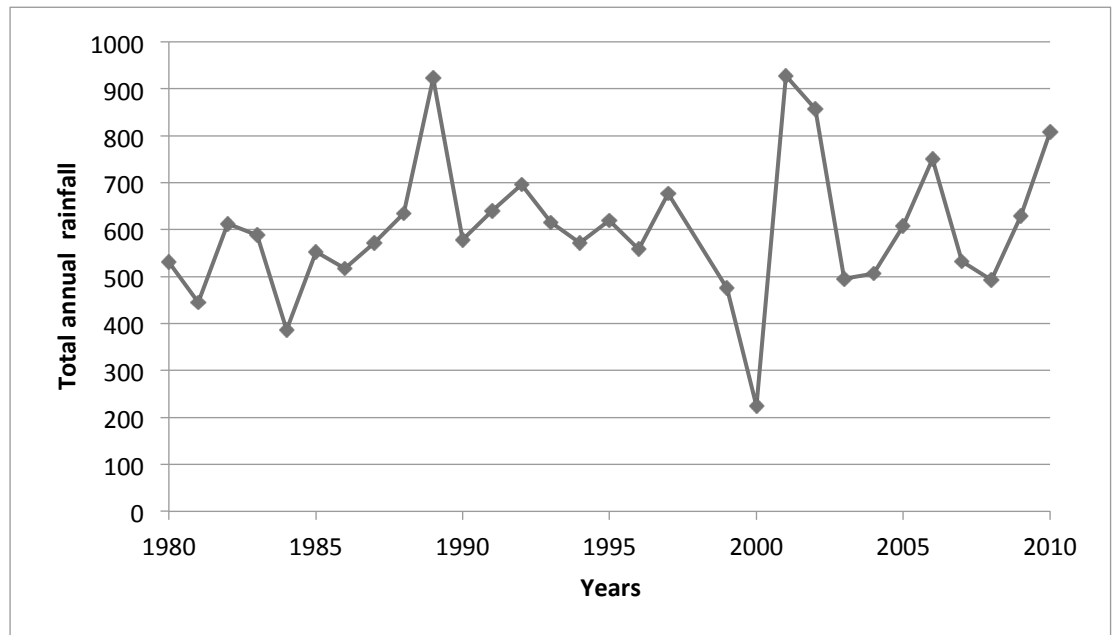


Figure 4.12: Total annual rainfall distributions for the period 1980-2010
Source of data: KMS (2014)

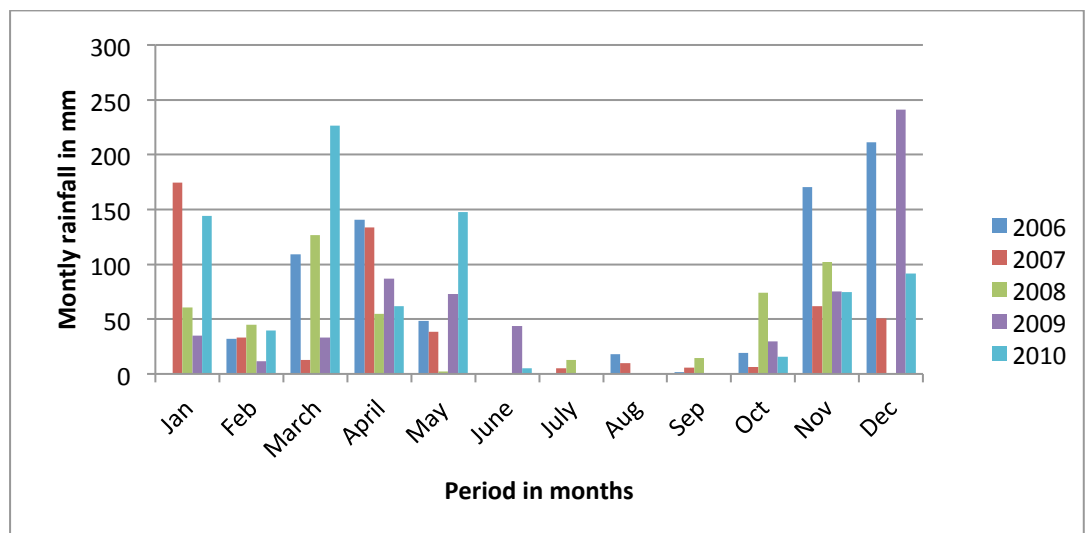


Figure 4.13: Monthly rainfall distributions for years 2006-2010
Source of data: KMS (2014)

The five year period demonstrates that distribution and amounts of rainfall received are quite skewed hence one cannot plan agricultural production activities based on prediction since the pattern and amounts vary from year to year. The total rainfall in the year 2006 was 750 mm but 382 mm was in the months of November and December while 243 was received in the months of March and April that means 83% of the rain was received during these months and the 17% in the rest of the months. In 2009 50% of the total rainfall was received in December and November while 25% was received in April and May then the rest of the months received the balance of 25%. In the year 2010 44% of the short rains were achieved in the month of January alone while 86% were achieved in March and April alone for March -April –May period.

(v) Community insights about water

FGDs from Kitengela and Isinya divisions said; “that water availability from boreholes and shallow wells led to increase of green houses and open field irrigation”. KII from Sholinke said; “Water availability has made it possible to do crop production even at a small scale of having a kitchen garden using irrigation kits supplied by NGOs like Farajaratia”. Water accessibility as a resource is constrained; “in one FGD a respondent said due to increase in number of fences animals under free range with shared water resource are having difficulty in movement”. This has resulted to construction of individual

water pans with controlled accessibility and animals grazing under rotation in paddocks”.

KIIs revealed that emerging new technologies like greenhouses and fish ponds have introduced farming ventures that were not seen in the 1990s “Basic greenhouse structures emerged as a new technology for adoption from 2009 for horticultural production and fishing farming in earthen ponds due to water availability and extension services from the agriculture sector departments”. The location of water sources has greatly influenced the areas where fish farming is located. “Currently there is one certified breeder in Kisaju area of Isinya who supplies fingerings to farmers”. “These farmers consist of both indigenous and immigrants who benefited from the economic stimulus project from the Ministry of Fisheries”.

(vi) Community approaches in achieving resilient livelihoods due LUCC

At the household and community level some factors played a key role towards resilience as the land holding sizes decreased; diversification to other income generating activities, immigrant’s influence, water availability and quality, improved infrastructure and diversification to ensure food security through adoption of new and improved technologies to increase farm productivity even though some challenges were experienced as a result.

(vi) Diversification to other income generating activities

Kitengela Division has a lot of picnic resorts, a KII respondent said “they never thought it was possible to tame and rear ostriches, a venture undertaken by the Ostrich farm”. “But from a reliable source he reckoned that the farm produces ostrich products like meat, eggs, leather and feathers for export to the United Kingdom and carries out income generating sporting activities”. In Kitengela Division FGD a respondent said “selling water was so profitable that those owning boreholes did not feel the economic justification of irrigating low value crops like maize in open fields instead of planting high value horticultural crops, a trend that was observed among borehole owners”.

(vii) Immigrants’ influence

Field observation and key informant interviews revealed that “most immigrants practice livestock keeping systems suitable under factors in consideration; *(a) security*; when they keep indigenous cows they get stolen hence they keep dairy under zero grazing to cushion themselves, *(b) target market*; the immigrants carry out production with a particular market target especially dairy cows, broilers, layers and fish, therefore to get good returns they practise intensification”.

In Kitengela FGD a respondent said “crop production by indigenous was adopted due to influence from immigrants who made them realise that with little effort one can achieve good yield from previous livestock pens”. “There are changes in tastes leading to a desire to plant crops like vegetables in their

kitchen gardens to supplement their diets due to immigrant influence”. In one FGD a respondent said “due to increase in fish and poultry products availability and socialisation with the immigrants the Maasai are slowly warming up to eating chicken and now fish”. “Initially they started eating maize meal in the ratio 1:3 (maize meal: meat), but with the acceptability of vegetables the ratio has been reversed at household level except when the household head eats at social places”. “These actually influenced crop production and changed the perception from tedious cultural activities to one of crops are actually a security in case of drought, in reference to kitchen gardens in small plots and fish farming”.

4.8.2. Negative Impacts on Resilient Livelihoods at Household and Community Level

The negative impacts experienced were related to resource use conflict, decline in pastoralism knowledge among the youth, decline in pastures accessibility due to fences and low quality water from boreholes. While positive impacts were experienced in relation to increase capacity of women on livestock production skills in addition to changes in gender roles.

(i) Resource use conflicts

Fragmentation has led to increased incidences of interaction leading to resource use conflict among livestock, wildlife and residents. FGDs revealed varied types of conflicts in all divisions; “Conflict from trespassing neighbours’ animals (goats, cows, sheep and chicken) is widespread. There have been cases

of reports of crop damage at the chief's office; advice to take cases forward to extension officers leading to litigation". In one FGD a respondent said; "even if the neighbour abuses her it is okay since her livestock would have eaten by that day and she is assured of milk production". "Poisoning of chicken by neighbours or sometimes they are eaten. Fine fencing by use of chicken wire is the adopted solution for the affected farmers. The number of goats has decreased over the years due to lack of shrubs for browse and conflict from crop damage due to trespass onto neighbours' farms given that the population has increased. Homes with established planted trees have no goats". Figure 4.14 shows how homes with goats shield trees from browsing damages.



Figure 4.14: How Homesteads with goats protect trees

In Enkirigiri FGD a respondent said; “There is still adequate space to practise nomadism for sheep and cows but not goats. Once immigrants buy land they fence. “Goats are enemies of development since they trespass to neighbours resulting in conflict, they eat all shrubs in site and their numbers are easily wiped out by Contagious Caprine Pleural Pneumonia (CCPP) and diarrhoea for shoats’ diseases. The diseases affect the goats during re-stocking with livestock from Northern Kenya and during heavy rains”.

(ii) Knowledge

Acquisition of indigenous knowledge and skills in livestock production by the youth is no longer possible. In Olturuto IDI with an elderly man revealed “youth of these days do not know the lineage of their livestock” He said for people of their age if an in-calf cow was stolen and hidden, if the cow was sold or slaughtered afterwards, their generation could be able to identify the calf as belonging to their herd if found. This is because there were marks which were associated with the genealogy of livestock from particular household, just like people. But for youth of nowadays that ability has been lost. They go to school and completely lose attachment with livestock, pasture attributes and medicinal plants”. “Livestock knowledge has improved among the women due to the fact that they carry out many livestock production activities to fill the gap left by school going children and household heads who are currently involved in diverse income generating activities. For example they freely administer drugs”.

(iii) Fences and water quality

Through field observation and FGDs respondents said “many institutions have bought and fenced land for expansion, which makes it unavailable for nomadism even though it is captured as rangeland in Landsat imageries analysis results”.

A Kitengela KII said “In Kajiado North Sub-County one can drill a borehole and get either saline or non-saline water depending on area and underground parent rock. Hence lucky farmers can use borehole water for drip irrigation without issues”. In Ongata Rongai FGD a respondent said “they did not know that the water was saline since the areas where most immigrants come from have none saline water from boreholes, they only realised after they were shown salt deposits at the site of drips by extension officers. This was followed by taking of water and soil samples for analysis and further advice”.

(iv) Changes in gender roles

KIIs, FGDs and IDIs identified income from land sale as the main theme associated with land use/cover change that has impacted on gender roles. The use of income from land sale to drill bore holes, construct houses, buy assets and pay wages has had a great impact on gender roles over time since it increased the ability of individual households to carry out transactions. FGDs from Isinya and South Kekonyokie divisions revealed;

“The area has few manyattas (traditional Maasai houses) located only in the rural areas of Ilipolasat and Oloiyangalani; role of women to construct, do repair and maintenance of houses does not exist anymore among the indigenous Maasai. Proceeds from land sales are used to construct better houses. In other cases ladies use income from milk, manure, chicken and others like beadwork to purchase materials and construct houses. In areas far from the urban centres, some households have manyattas which they use as kitchens or occasionally when they have visitors and more room is required”.

All FGDs said that access to water depends on many factors like physical location and infrastructure in addition to household economic status. “In some households men arranged for water to be brought from boreholes/water pans using pick-ups or donkeys. Water harvesting for domestic use was done from iron sheet and tile roofs. In some cases workers were also used to collect water from boreholes with donkeys. While in some cases women still fetched water using donkeys. The role of fetching water is no longer purely performed by women as it was in the 1970s”.

Milking of livestock as role that was a preserve of women among the indigenous Maasai is no longer true. KIIs said; “Milking is still done by indigenous women though this role changes when a household has many lactating cows in which case workers assist under the supervision of wives. Among the immigrants milking is done by both genders, though under

commercial production dairy farming the household head takes charge through workers or machines”.

A KII from Oloosirkon; “Cooking for the family was ordinarily done by wives even after delivery and in poor state of health. Proceeds from land sale can now be used to engage house helps to assist during these periods a practice they have copied from the immigrants”.

Men used to take the role of livestock grazing and drugs administration, a KII respondent from Oloolotikoishi said “Indigenous Maasai women are doing more supervision including drug administration as men are engaged in many activities and stay out late. Those HH below 45 years among the indigenous (50%) had neglected household responsibilities as they indulge in partying after selling land”.

“Sheep and cows are not normally herded if grazing within the locality. They are opened for in the morning to go for grazing and then come back at dusk under the supervision of the wives. During dry periods the household head hires workers to graze animals as they search for pastures while wives are left to take care of remaining livestock. Those that have bought land in other areas like Sultan Hamud and Mashuru have hired workers to graze animals. Children go to school hence owners have to hire workers but to avoid conflict for those with low stocks they tether them”.

Men in young families have neglected their duties and responsibilities due to income from sale of land. An IDI from Kisaju said “married men ages 25-40 behave recklessly since they can afford to hire services they spend most of their time drinking and looking for more buyers to continue with their lifestyles. They rarely come home except to sell land and livestock”.

4.8.3 The impacts of land/use cover change on ecosystem services

The impacts of land use/cover change were analysed with the following services in mind; Provisioning services; basically food, water, pasture, raw materials and minerals; Regulating services like climate variability and disease; supporting services nutrient cycling like and cultural services like recreation and aesthetic experiences.

Analysis was carried out on livestock and crop production activities to identify the challenges experienced and coping strategies adopted by each gender with ranking on the occurrences. Table 4.9 presents the challenges experienced by wives due to land use/cover changes with respect to livestock production activities.

Table 4.9: Wives' livestock production challenges and coping strategy

Challenge		Coping strategies	Number of respondents	%	Rank
Declining land size	Inability of land to produce adequate pastures leading to low production of milk	Keep few improved livestock	68		
		Buy hay	28		
		Diversify to chicken keeping	83		
		Engage in petty trade	168		
Total on declining land sizes			347	83	1
Fences	Hindering accessibility to Water points	Buy water, Rain water harvesting	235	56	2
Encroachment on dry season grazing areas	Migration of livestock leading to low milk available	Milk sheep and goats for home consumption	87		
		Engage in petty trade to buy milk	89		
	Total on encroachment				

Wives' main challenge was on food security as they linked decline in land holding sizes to decreased amounts of milk produced. Diversification to chicken and petty trade were the main coping strategies adopted in addition to milking sheep. The other challenge was water, in addition to buying they have improved the rain water harvesting techniques in that they can even harvest from a manyatta (traditional Maasai house) as shown in Figure 4.15.



Figure 4.15: A household in Oloiyangalani showing an improved Manyatta with water harvesting structures

The challenges experienced and coping strategies adopted by household head due to land use/cover changes with respect to livestock production activities are presented in Table 4.10. Lack of adequate pastures was the main challenge experienced due to land use/cover change. Inability to cope with natural shocks ranked second whereby drought, disease and migration expenses were the main issues and relevant mitigation measures were employed to cushion them. Invasive weeds ranked third though they were mostly seen in the rural sub-locations of Enkirigiri and Ilipolasat while human wildlife conflict ranked fourth though the complaints were mainly from those bordering the Nairobi National Park and along wildlife corridor areas.

Table 4.10: HH livestock production challenges and coping strategy

Challenge		Coping strategy	Count	%	Rank
Declining land size	Lack of adequate Fodder	Migration	86		
		Reduce livestock numbers	11		
		Improved breeds	155		
		Buy hay	20		
		Control breeding	67		
Total on declining land sizes			339	81	1
Inability to cope with natural shocks					
a).Drought	Lack of Fodder	Migration	32		
		Reduce livestock numbers	11		
		Adoption of improved breeds	46		
		Control breeding	34		
		Buy hay	10		
	Lack of Water	Buy water, dig shallow wells and boreholes	24		
		Migration	26		
b).Disease	Loss of livestock	Buy replacement stock	28		
	Livestock Morbidity	Use herbs/medication and supplements	24		
c).Drought mitigation expenses	To cushion individual HH	Fence land to avoid trespass	16		
		Reduce livestock numbers	9		
		Improve breeds	32		
	Migration expenses to access pastures in neighbouring areas/ newly acquired land parcels	Avoid using vehicles and move in groups slowly	23		
Total coping with natural shocks			315	75	2
Fences	Lack of access to Water	Buy Water, dig shallow wells and boreholes	167		
	Lack of access to Fodder	Reduce livestock numbers by improving breeds	122		
Total on fences			289	69	3
Invasive weeds	Decreasing amount of pasture available	Manually removing the <i>Ipomoea Kutensis</i> from pastures	17		
		Avoiding the areas invaded with <i>Ipomoea Kutensis</i>	18		
	Encroaching on Homesteads	Abandoning homes invaded by <i>Opuntia subulata</i>	6		
Total on invasive weeds			41	10	4
Human wildlife conflict	Due to increase in population and development; increase on livestock predation	Report to Kenya wildlife Services	35	8	5

Crop production is carried out by many immigrants and has been adopted by the indigenous to augment household food due decline in land holding sizes as a result of land/use cover changes. The main challenges experienced were crop failure and low yields due to inadequate husbandry techniques and damage from wildlife. The challenges were ranked and coping strategies as tabulated in Table 4.11

Table 4.11: Crop production challenges and coping strategies

Challenge		Coping strategy adopted	Rank
Adapting to crop production and tedious cultural practices	Crop failure/Low yields due to inexperience in crop husbandry and poor timing	Engage immigrants to do land preparation/ Buy Food	1
Drought	Crop failure; Inadequate water for irrigation	Plant small area	2
Damage by livestock	Inadequacy of fencing near homestead	Decrease area under crop production and then fence	3

The simple green house technology was adopted mainly by immigrants for horticultural crop production but many failed due to several reasons as shown in Figure 4.16.

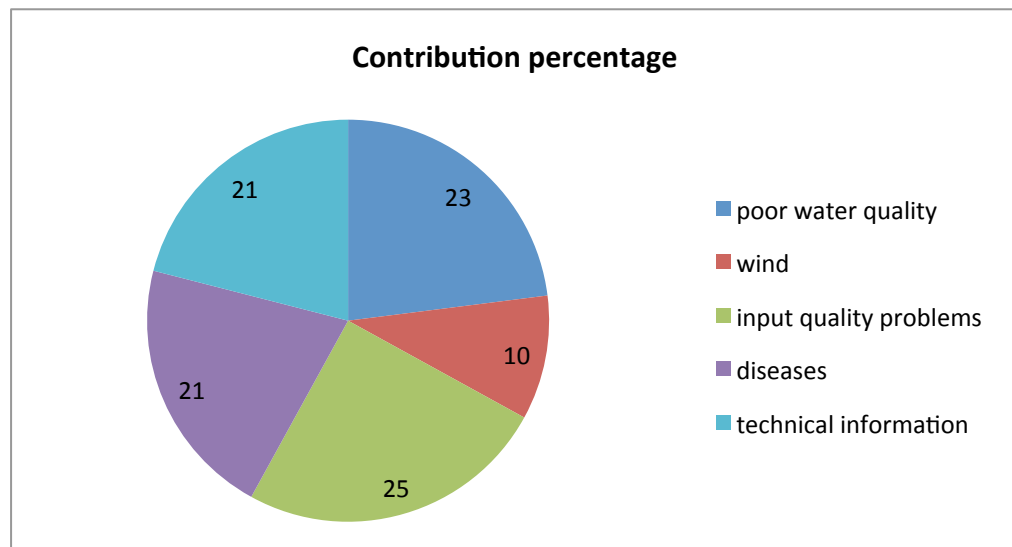


Figure 4.16: Reasons for failed greenhouse project

The area being a rangeland has no wind breaks; hence 10.3% of the greenhouses were blown off by strong winds. Borehole was the main source of water used in drip irrigation by small scale farmers even though it was saline in some cases.

(i) Community insights on food security impacts as a result of LUCC

KII, FGD and IDI identified fragmentation leading to decreasing land size and fences, as the main theme associated with the food security challenges experienced since they impacted on the production systems used and achieved yields. The sub-themes related to achieved yields at end of each season included land degradation and technical know-how.

(ii) Fragmentation and fences

The land available for grazing livestock has decreased due to selling and fencing. FGDs revealed that; “Both genders face the problem of looking for

adequate pastures for livestock and looking for funds to purchase food since the production capacity of the land has been interfered with”. Proportional piling results revealed that “90% of food insecure indigenous were those who had sold most of their land and were now destitute. While 99% of immigrants were food secure due to diversification in both crops and livestock production activities”.

IDIs from Kisaju and Ololoitikoishi revealed that some household heads sold land fraudulently “where they received cash/bought alcohol in exchange for a thumbprint on a land transfer form. They sold the land in the belief that the transaction did not take away their right to the land; as a consequence, they believed that they would still let their herds graze the land only to realise there is no access due to fences”. “Some with educated children have managed to revoke such transactions but many are languishing in poverty”.

Increase in population and livelihood activities have resulted in increased demand for water hence affecting crop and livestock production activities in turn. To cope with this challenge FGDs listed several strategies adopted in mitigation; “some have constructed water pans for water harvesting during the rainy season. Women have put up facilities for roof catchment for domestic use while some have dug wells within homesteads. Some residents have constructed boreholes, whereby a community in the vicinity can buy water for use. Some NGOs like Farajaratia Trust, AMREF, NIA and Government

projects like Arid Lands Management Programme (ALMP) have helped to construct water harvesting and put up small irrigation systems”.

“Planting of drought tolerant seeds especially sorghum, maize, cow peas and pigeon peas provided by several NGOs; World Vision, German agro-action, Maasai Aids Awareness Programme (MAAP) and Compassion International. Road runoff is harvested and used to grow high value crops such as bananas, mangoes and chewing cane”.

A KII from Ilipolasat said: “Invasive species cause vegetation degradation and limit amount of pasture available to livestock. Some families have moved away from homesteads once they are surrounded by the thorny and prickly invasive species”. KIIs from Kitengela and Ongata Rongai Division said; “Some indigenous people sell their land and use the proceeds to buy larger pieces in Mashuru and Sultan Hamud where they hire workers to herd livestock. “Some use the proceeds to construct a commercial building (plot) - this ensures the household has guaranteed income for their needs. The practice started from around year 2000. With the appreciation of land value more indigenous people are getting influenced by their peers to follow suit”.

Hiring of grazing land outside the division is a common practice adopted by some households to mitigate lack of pastures. Proportional piling during FGDs from all four divisions revealed that; “20-30% of the indigenous hire farms where they graze during periods of adversity” while “50-70% of immigrants

who do commercial dairy production hire land for fodder production either in or outside Kajiado North Sub-County”.

FGDs and KIIs revealed that livestock spreading was adopted by the indigenous in Kajiado North Sub-County to mitigate adverse weather conditions “It involves the division of the herd into smaller numbers and driving each of them to a relative or friend where they are looked after together with the host's herd. In so doing, expect to reduce the risk by keeping their 'wealth in different baskets” and enhancing survival rates in case the rains fail. The areas that were common for spreading were Tanzania, Mashuru, Namanga and Magadi”.

KIIs from Kitengela and Ongata Rongai revealed “that households redistribute portions of their herds for long periods and swap/share pastures. Parcel sharing translates into more grazing flexibility, particularly when it occurs between households in different locations.” This has been possible because many indigenous have bought land in other locations after selling land in Kajiado North Sub-County as revealed by the household survey”.

Opportunities in and around urban areas are many especially for the immigrants, KIIs from Kitengela and Ongata Rongai said “urban areas coping mechanisms have evolved; petty trade-kiosks, making liquid/selling soap, getting group loans and engaging in petty businesses, moving to towns and carrying out menial activities like washing clothes, salon work, digging,

construction, cooking and selling to construction workers, hawking milk/eggs/other foods/second hand clothes”.

“The area under crop production has increased over the years as noted by FGDs; “Currently the land holding sizes cannot meet their requirements through pastoralism alone. Other intervening factors like drought, climate variability, pests and diseases affect their production yields. Adoption of crop production and higher yielding animals by the indigenous who have copied the immigrants is a major coping strategy. Proportional results from Kitengela FGDs revealed that pure indigenous animals are kept by less than 5% of all Kajiado North Sub-County “Cross breeding the high yield animals with the locally adapted to increase adaptation and coping to harsh climatic/disease conditions e.g. dorper with local sheep, Sahiwal dual purpose cow with Zebu. Many immigrant farmers keep emerging livestock like quails, fish and bees”.

A KII said there was rampant “Human-wildlife conflict in Kitengela area bordering the Nairobi National Park and the wildlife corridor, as residents’ lose livestock to the big cats. They report to Kenya Wildlife Service (KWS) but compensation is hardly adequate”.

A KII from Sholinke said crop destruction and livestock predation has increased over the years; “Monkeys and baboons from the national park have turned into pests that attack chicken taking chicks and eggs hence affecting production. They also harvest crop produce (like people) long before it

matures; by the time maize is ready for roasting they would have harvested half the farm. Putting scare crows, embracing firm fencing and security enhancement have been adopted in mitigation”.

There is increased incidence of pests and diseases due to congestion FGDs reiterated that;

“Animals are affected as they move long distances in search of grass during the dry periods since they lack access to fenced fields. The indigenous believe congestion due to increase in population leads to high rates of interaction and disease incidence unlike before”. Coping strategies adopted include use of veterinary medicines for livestock and going to hospital when sick”.

(iii) Environmental degradation

Environmental degradation was attributed to decreasing pastures and water. Most FGDs acknowledged that “they had experienced a gradual decline over the years in water supply for agriculture and domestic use affecting both genders since this leads to crop failure and loss of animals”. “Women realise a decrease in milk production as cows are moved in search of pasture. Herders control breeding through use of plastic barrier (“echoniolmergeshi”) fixed on males to hinder mounting to avoid bearing of young ones during the dry periods”.

In one KII a respondent said “Drought has been largely attributed to environmental degradation arising from the destruction of vegetation in the

natural environment. Drought creates harsh climatic conditions that are not favourable to both plant and animal life”. “In addition other disasters like forest fires and collapse of mine walls cause misery to innocent people. This is because the miners are mostly outsiders and the indigenous people do not foresee the environmental impacts of mining activities when they sell or lease their land for such activities”.

One KII informant from Ilipolosat said the water ponds have been put to some positive use through; “Utilisation of water captured in excavation pits after mining for livestock and irrigated crop production”. “Some immigrants breed mud fish for home use and selling purposes”. Livestock traction causes a lot of degradation due to large numbers to drinking points, a KII from Oloolotikoishi said “some farmers have started restricting entry to water pans unless they are related and do share grazing areas”.

To mitigate low yields a KII from Oloiyangalani said, “Acquisition and blending of soft and hard fat from the slaughter house in Kiserian provides cheap fat that is used for a long period since small amounts meet their requirements. They fry vegetables with it or in times of scarcity they add to *ugali* (cereal prepared from maize flour) with salt to improve the energy content”. Men sell animals to buy hay or move animals to dry season grazing grounds. Some proceeds from animal sales are used to buy household food”.

The dorper sheep adopted in 1986 yields more meat within a short time and also produces milk. “Women milk dorper sheep to supplement family requirements during the dry periods since they are never moved far to look for pasture”. “The Government and some NGOs like Neighbours Initiative Alliance (NIA) in collaboration with World Food Programme supply relief food during dry periods to the vulnerable; mainly “widows, orphans and elderly”.

During the drought when cows have migrated they use acacia seeds to feed goats. In Oloyiangilani female FGD the respondents said; “they shake the yellow acacia trees to drop the seed pods which are rich in nutrients to be used as feed. The goats get water once or twice in a week. This is adequate for them to be able to get enough milk for the family. The family sometimes feeds once a day during times of scarcity”.

Uncontrolled extraction of natural resources namely; water abstraction, forest products, quarrying and mining have degraded the environment. FGDs from Kitengela and Ongata Rongai divisions revealed that; “With the provision of electricity infrastructure, the able immigrants and indigenous people drill boreholes within close proximity. This leads to drying of many shallow wells. Both genders are affected by the lack of adequate water for domestic use and agricultural production systems activities”.

KII from Kitengela said “Uncontrolled stone quarrying activities in Noompopong area of Oloosirkon area has resulted in a lot of degradation, such that no crop or livestock production activities can take place there”.

“Mining leads to land degradation, inert waste generation, loss of fauna and flora, ground water disturbance”.

One IDI respondent said “The trees have multiple purposes. There is a huge demand for herbal medicine both for livestock and humans. Genuine herbalists and quacks have penetrated the trade leading to unsustainable harvesting of forest products. Over time the beneficial species will be extinct. People who depend on this trade to put food on the table have been affected as natural forests have decreased and some of those trees cannot be cultivated”. “To cope they realised that forming of common interest group of genuine herbalists was inevitable. “They are cultivating some medicinal plants that are frequently used within their compounds as fences or shade. They also share information of the current source of trees not found in the area”.

(iv) Lack of technical know how

Inadequate information on crop production husbandry practices leads to crop failures. In one FGD the respondents said “Crop production is alien to the indigenous Maasai. Pastoralism is their way of life. Scouting for pests and disease is an uphill task. Whereas the crop cultural practices are labour intensive unlike their indigenous livestock. In many instances the indigenous may wait until the rains start before they commence on land preparation”. “As

opposed to the immigrants who plant before the rains start. The immigrants rarely experience complete crop failure”.

Sometimes dependence on hand-outs contributes to crop failure as revealed by a KII from Olturuto; “When the indigenous are given seed after crop failure by NGOs and government, for the following season they do not plan to purchase their own even when they are able.” When they receive the seeds late they just plant without realising they are bound to have crop failure”.

Aggressive marketing agents who promise a lot but are unavailable as revealed by FGDs in Ongata Rongai and Kitengela; “Some companies dealing with supply and construction of greenhouse promise training and extension services, but these are not normally forthcoming leading to crop failure”. Some farmers do not know the properties of greenhouse paper as revealed by KII from Kitengela; “Use of old and unsanitary greenhouse papers from flower farms which are not effective and sometimes come with diseases is a common cause of crop failure”. “Planting of wrong crops in greenhouses e.g. onions and spinach, which take up to three/six months with low returns in comparison to inputs/what alternative crops can give from green houses. Poor planning in planting of horticultural crops; harvesting season falls during the glut period in the country hence farmers do not gain much”.

Inherent features in the area like shallow soils and flat terrain with little cover affects crop production; KII from Kitengela said; “Borehole water is saline in

many areas and thus leads to gradual decline in fields' overtime". "Quality of water used, source being borehole, the salinity level is sometimes high in some areas". "Strong winds destroy green houses and cause soil erosion hence decreasing yields". "Erratic storm runoff and greenhouses roof catchment causes soil erosion that sweeps away crops, livestock and top soil leading to gullies".

Planting of trees and putting up soil conservation structures at relevant areas has been adopted in mitigation. "Planting of woodlots and fruit trees is affected by shallow soils which inhibit root establishments soon as hard pans are experienced". Serious farmers have adopted recommended field preparation methods as advised by extension officers.

The immigrants have superior production systems as compared to indigenous: this affects value of returns achieved; KII from Kitengela said: "In times of a glut in milk production indigenous farmers were experiencing losses due to lack of proper market outlets as opposed to the immigrants who sell throughout the year". To cope they adopted several options; "they have formed groups that bulk milk and take to sell in urban centres and Nairobi; an organised women group developed Kule Dairy firm in 1995 to help in marketing their milk. The Dairy Board of Kenya trained the women on milk products management and handling".

Kitengela and Ongata Rongai divisions KII said; “Mushroom production is done by a few immigrants who understand the market since the crop is highly perishable. The indigenous do not know that they can be consumed or have any nutritional value. Fish, pigs and rabbit production and consumption is mainly by the immigrants, the indigenous do not want to be associated with such. Farmers fear bees since swarms have killed their livestock before”. To cope with the challenges consultation with relevant ministries has improved.

4.9 The Expected Outcomes of Land Use Master Plan and Wildlife Conservation Lease Programme

Analysis was carried out to give current status and community perception on the Isinya/Kipeto/Kitengela LUMP and wildlife conservation lease programme, this was followed on the outcomes in relation to the resilient path ways and expected outcomes

4.9.1 Isinya/Kipeto/Kitengela land use master plan

The respondents were subjected to several aspects with regard to LUMP ranging from; awareness, participation in drafting, future, community support and benefits among others Figure 4.17 gives the community gendered perception on the selected aspects land use master plan legislation.

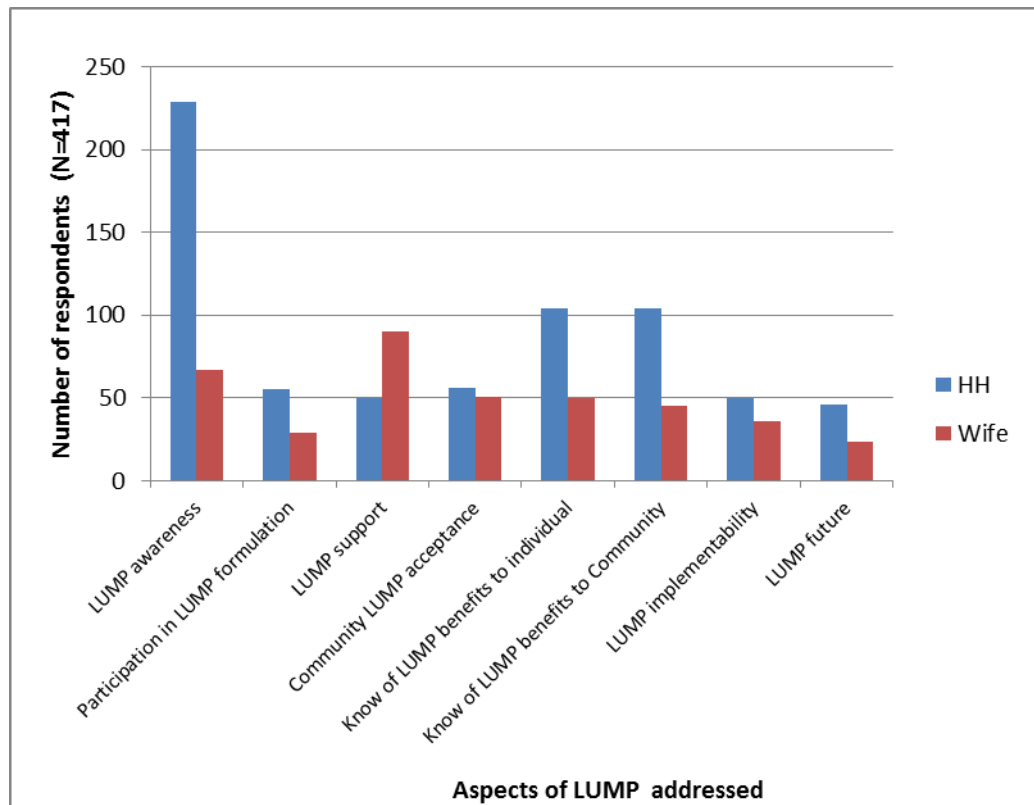


Figure 4.17: Community perceptions on LUMP

Majority of household heads were aware of LUMP and the benefits as compared to wives while the wives if given a chance will support the implementation.

The respondents were asked as to what the government should do about LUMP given the level of awareness and whether it was implementable and had a future. The results are given in figures 4.18 for household heads and 4.19 for the wives respectively.

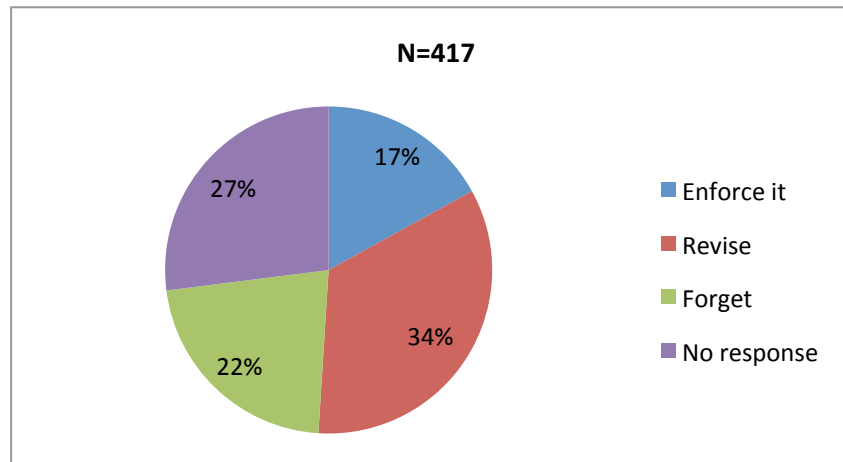


Figure 4.18: HH LUMP recommendations

Revise = Revise the LUMP with more community participation and enforce it

Forget = Government should forget about it, since it is not implementable

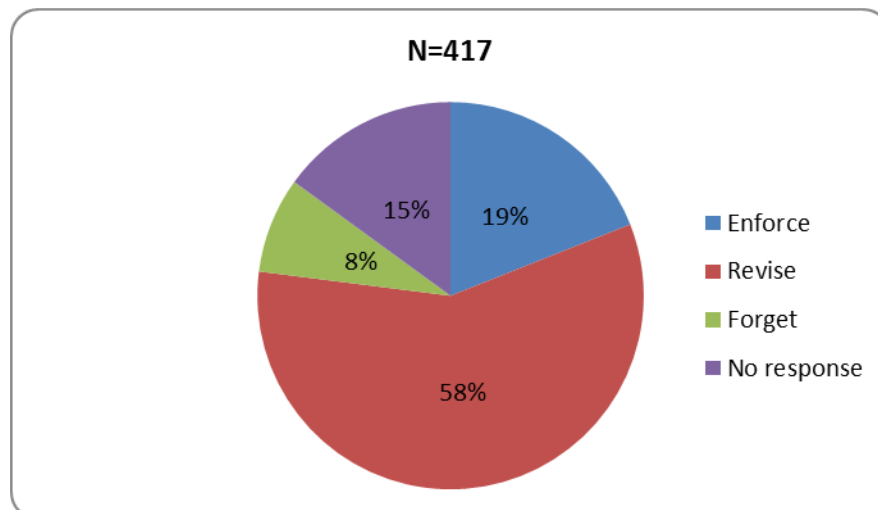


Figure 4.19: Household Wives LUMP recommendations

More women 58% recommended revision than men 34% while more men 22% recommended that WCLP should be done away with compared with women at 8% since it was not implementable.

4.9.2 Wildlife conservation lease programme

The respondents were subjected to several aspects with regard to WCLP ranging from awareness, participation in drafting, community support, acceptance and future among others results are as tabulated in Figure 4.20.

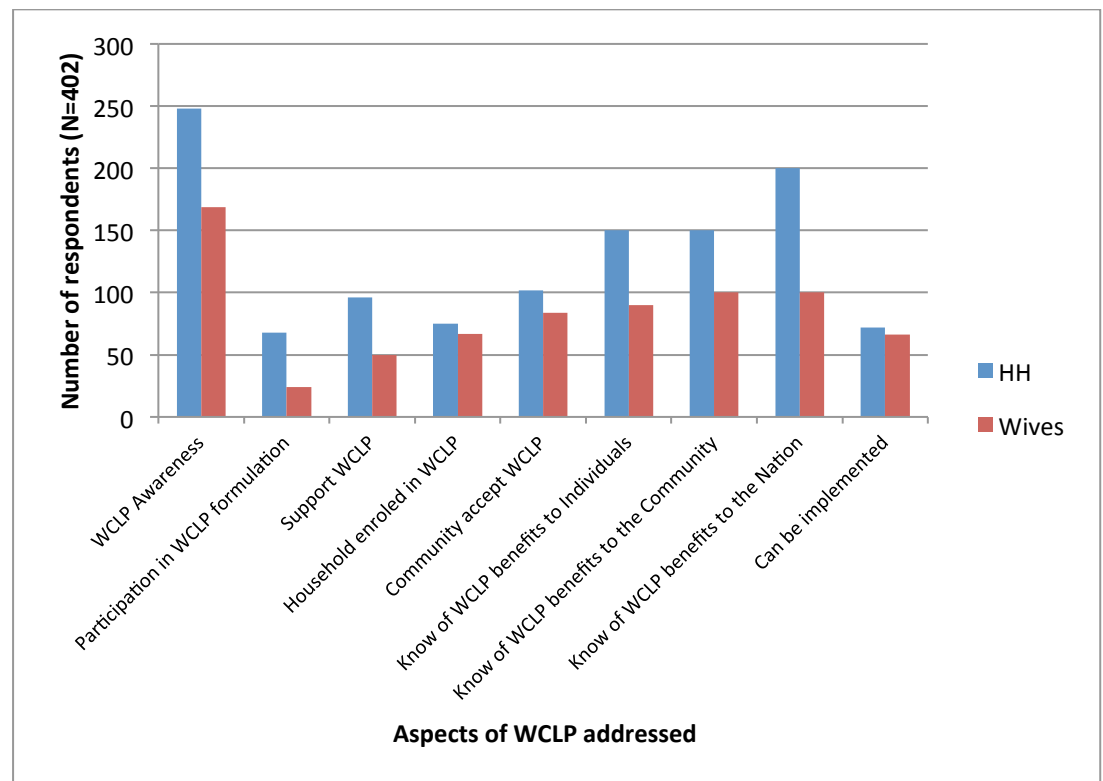


Figure 4.20: Community perceptions on WCLP

The respondents were asked about their recommendation to the government and stakeholders (NGOs, CBOs, ILRI, Friends of Nairobi National Park and International organisations) on the WCLP after the above scores on community acceptance and implementation possibility. The outcomes are presented in Figure 4.21.

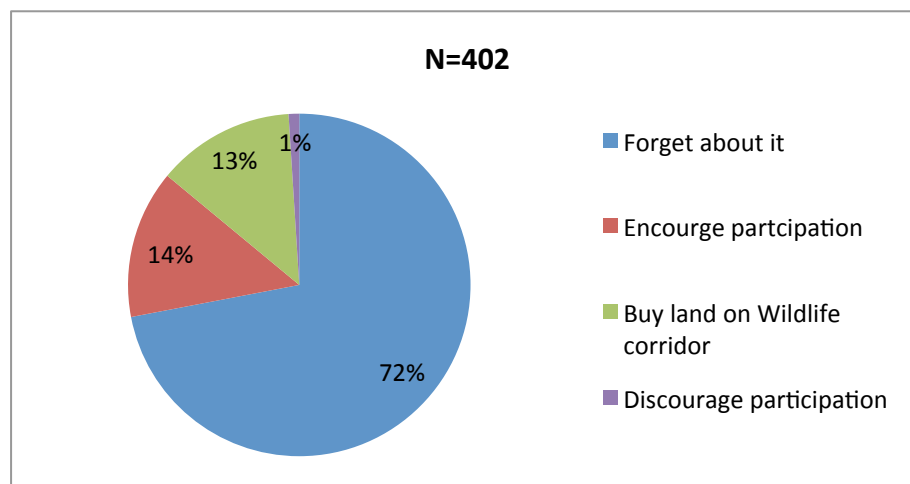


Figure 4.21: Community recommendations on WCLP

72% of the households said the stakeholders should forget about WCLP and Nairobi National Park should be made a zoo or game reserve, 14% the residents should be encouraged to participate by increasing compensation rates, 13% stakeholders should buy land from farmers at market rate and fence it off and 1% non-participating farmers should be discouraged from grazing at the wildlife corridor after selling their land. The respondents gave various reasons on basis of their recommendations as tabulated in Table 4.12.

Table 4.12: Respondent recommendation’s basis on WCLP future

Recommendation	Reasons for choice
Encourage participation by increasing compensation rate	Decreases temptation to sell to meet family obligations
Forget about it and make Nairobi National park a zoo/game reserve	It is late land is already too fragmented
Buy the land on wildlife corridor from farmers at market rate and fence it	It will ensure non-interference with the corridor
Discourage non-participating farmers from grazing in the area after selling their land	The indigenous being social find difficulty to deny neighbours access to pasture and water

The community identified complaints associated with implementation of WCLP as listed in table 4.13.

Table 4.13: Complaints associated with WCLP

COMPLAINT	% of respondents affected
Discouraging low compensation rate	85
Stiff competition with the livestock for water and pasture especially during the dry periods given that there is a decline in land holding capacity	60
Wildlife facilitates the transmission of certain livestock diseases e.g. East Cost fever (ECF), increasing veterinary care costs and high mortality rates	50
Maintaining fences around homesteads and other structures, indirectly through labour	68
Livestock predation and destruction of crops by wildlife	90

4.9.3. Community insights on LUMP and WCLP impacts on household and community resilient pathways and expected outcomes.

Participation, valuation of alternative livelihoods and population increase were the main themes emerging from FGDs, KIIs and IDIs for both LUMP and WCLP.

(i) Land Use Master Plan

a) Participation

The communities' lack of effective participation shows gaps that would have been used to dispel the fears and paint a clear picture of household and community benefits. FGDs revealed the following; *Gender*; "Few women participated actively since culture does not allow women to attend such activities". *Origin*; "Immigrants see that others who want to buy land can be locked out". *Occupation*; "Those who get livelihood from broking land will lose income generating activity". *Immediate needs* "The benefits from use as agricultural land were not realistic as some areas were rocky with no grass or shrubs, meanwhile crop production experienced perennial failure due to lack of rains; to the indigenous it was thus advantageous to sell such areas".

More men than women know the details of LUMP. Some claim they heard from friends, neighbours or chief. A respondent from a women's FGD in Oloolotikoishi said "Chief told them to attend baraza but did not fully understand why and some did not understand the issues at hand fully during the formulation process discussions". This resulted in suspicions from the community about the intentions of the LUMP. Meanwhile "many of those who had bought land and had only fenced it were absent since they do not live in the area".

Those who are fully aware of the benefits support it. Proportional piling results from all FGDs; "revealed that more women 60% want LUMP enforced than

men 30% because they themselves are voiceless in the community. Wives want land use master plan implemented to control household heads from selling land irresponsibly. “Men were wondering why the government wants to interfere with individual properties in Maasai land unlike other areas, hence low support”. In one FGD a respondent asked; “why the government is advertising their land?” When interrogated to explain further they said; “By developing the LUMP and designating the minimum holding size the government is saying, there is land in Kajiado North Sub-County for sale. This is wrong for those who had no intentions to sell; they actually get tempted to sell” “The master plan was inviting people from other communities to come and buy land from the Maasai.” It was an advertisement in disguise”.

Men saw that this was a way of denying them the right to make decision as they please and they asked; “Where in the country is this legislation being used? Is it a way to confirm that the Maasai are ignorant and not capable of making wise decisions with regard to land”? “They should return Nairobi area as part of the historical injustice done to the community then we can listen”.

Current methods of community awareness and participation on change of user are not effective. During a FGD in Kitengela respondents said; “The government should devise a better method of communicating to the people on land use change. The change of user advertisement in the daily newspapers by immigrants is not effective in reaching the target audience:

- Many indigenous people do not read newspapers

- The advert has only the plot number hence readers may not know the exact physical location
- The two weeks' notice is too short to take grievances to the lands board
- Most advertisers do not put a sign post on the land they intend to change as required
- Most times the grievances are overlooked by the land board -- an example was given of Jamii Bora Trust whereby developments were legally allowed to continue despite objections from several stakeholders (Republic of Kenya, 2005)

Even if the government revised LUMP, participation of current residents will not be representative as absentee owners make a big percentage since many of those who have bought are yet to fence, built and move in. They work far and may not be free to participate during week days”.

b) Valuation of alternative livelihoods

The Value of land in Kajiado North Sub-County when used for agricultural production in comparison to other activities it makes sense to sell than continue in the current status, KIIs revealed that “some household heads have sold and invested in flats, borehole construction, resorts and picnics developing and they are financially secure as opposed to their earlier status”. “Therefore pastoralism should not be the focus as the only livelihood activity when doing LUMP”.

FGDs from Isinya and Kitengela acknowledged that intensification on small sizes of plots can support families better than large bare lands affected by climate variability, “immigrant farmers who have adopted new farming

ventures like dairy cows, pigs, fish and commercial poultry are realising good returns as compared to original owners who sold the land”.

c) Population increase

LUMP has not been fully enforced since legislation and a lot of subdivisions have been done to uneconomical sizes. Respondents revealed during KIIs “There is no community goodwill. The value of land is high while the agricultural productivity is low, sell and use proceeds to buy cheaply somewhere else, many have sold and moved south. When group ranches were subdivided only those above 25 years benefited. Since then the youth have grown up and matured. They have their own homes. They also need their share of inheritance from the parents to achieve independence. Hence the need to subdivide and fragmentation will continue with time”.

All FGDs felt that “There is no future because the land is heavily fragmented through selling of parcels of up to 50MX100M; most absentee owners are planning to fence. If all current owners fence within three years the rural areas will look like a town. With the coming of Konza Techno-City the areas bordering, Athi River will be highly fragmented due to rise in demand for housing and other basic amenities like schools, hospitals, water, electricity and market centres. The level of infrastructures is projected to improve with better railway, electricity, water and all weather roads. With such a projected increase in population fragmentation is inevitable”.

The resilience of the land from natural shocks like bad weather has been reduced due to population increase from the indigenous and immigrants. One KII from Sholinke said; “He witnessed several indigenous sell all their land due to congestion and use the proceeds to buy land in other areas like Mashuru and Bisil to continue with their pastoral activities”. “They complained of lack of adequate pastures and water as a result of recurrent droughts and increased incidence of pests and diseases”. “They were able to buy larger pieces of land with few neighbours”. “Land that was originally owned by one household gets 50-100 new owners depending on the size. They will erect fences and the fragmentation will continue”.

CHAPTER FIVE

5.0. DISCUSSION

5.1 Introduction

The discussion of the research is presented in four subchapters 5.2 to 5.5. In subchapter 5.2 the state of the land is discussed through extent of land use/cover change in Kajiado North Sub-county for the period 1980-2010. Sub-chapter 5.3 the driving forces and how they contribute to the state of land are discussed through a discourse of the factors that contributes or impedes to land use/cover change. Sub-chapter 5.4 presents the adaptive and absorptive capacities developed in response to the impacts of land use/cover change on ecosystem services and resilient livelihoods in Kajiado North. Sub-chapter 5.5 presents the discussion on the community responses to transformative capacity of LUMP and WLCP at household and community level on expected outcomes.

5.2 The Extent of Land Use/Cover Change in Kajiado North Sub-County for the Period 1980-2010

Satellite image analyses showed that significant land use / cover changes occurred in Kajiado North sub-County between 1984 and 2010. There was general decrease of both range land (31.45%), bare ground (34.31%) rocky areas 51.66%. Pastoral and wildlife dispersal areas were converted to settlement areas that led to increases in built-up area by 1531.7%, crop land by 1025% and woodlots and riverine vegetation by 2960%. The time period coinciding with the highest population increase (1999 to 2009) also coincides

with the highest increase in riverine vegetation and woodlots and corresponding increase in human dominated activities of agriculture as the rocky areas decreased due to excavation of building material. Contrary to our expectation population growth would result in an increasing pressure on limited resources and contribute to a decrease in vegetation covers and agriculture with a corresponding increase in bare grounds as found out by (Dewan and Yamaguchi, 2009). The increase in woodlots and riverine vegetation is actually beneficial to the ecosystem given that forests ecosystems play a key role of maintaining biological diversity and provide environmental services to humans and nature UNEP, (2002). These results highlight the possibility of minimising population and economic growth impact on ecosystem services.

Our findings support the role of human-environment systems in relation to LUCC context of broader conditions with positive outcomes of welfare on the environment (Lambin, *et al.*, 2003). However our results on increase in small scale crop production and built-up area near the Nairobi National Park are consistent with those of Majaliwa *et al.*, (2010) in similar studies around Kibale National Park Uganda. The trends in water bodies can be attributed to decline in the water pans and dams which were done by Kenya Livestock Development Project (KLDP) Phase II, that initiated infrastructural development under the Arid and Semi-arid Project from 1987 whereby several subsurface dams and pans were constructed, Rutten, (1992 but had silted by 2000, Republic of Kenya, (2008) but again individuals and the government initiated construction

to address declining water availability through the Arid Lands Resource Management Project, Republic of Kenya, (2010). The general trend of decline in rangelands and water will impact negatively on the future of pastoral activities in Kajiado North as confirmed by earlier studies by Nkedianye *et al.*, (2009) who also noted that fragmentation had reduced accessibility to the range resources.

5.3 The Socio-logical Factors Which Contribute or Impede LUCC in Kajiado North Sub-County

Emergence land use cover change due to sale discourse. Since the 1990s, researchers and stakeholders have been aware of sale of land as a major driver of LUCC and so they embarked on ways to mitigate the rate. The household survey revealed that land use/cover changes in this Sub-County have been occasioned by the increased demand for land resources for individual and institutional property developments together with agricultural activities, infrastructural improvement and population increase. The findings revealed that 94% of the sold land underwent change of use/cover to meet these demands while 6% was due to coping strategies adopted to ensure food security and meet other livelihood needs.

Both quantitative and qualitative results revealed that selling at the household level was influenced by peer pressure, temptation from appreciating prices and low age of household head. These results are consistent with those of Rutten,

(1992). On other hand they contradict what Rutten found out in some aspects given that some households are selling land to move away to less congested areas, invest in income generating ventures like flats and drill boreholes to sell water while instead of young people selling to adopt to good lifestyles old people have started selling after witnessing what immature sons can do with land once the household head passes on. Buyers were influenced by availability of basic infrastructure as revealed by spatial regression results and qualitative interviews which identified factors like roads, electricity, water, hospitals and schools to be the main drivers. The urban centres which have all these basic infrastructures had more influence and these results are consistent with the findings of (Olson, *et al.*, 2004a; Ogutu, *et al.*, 2014) where infrastructure contributed to sedentarisation of the semi-nomadic pastoralists.

The binary logistic regression revealed that at the household level land was more likely to undergo change in use/cover if the household head and wife perceived that the parcel of land they own was adequate in supporting their household livelihood which meant that they could spare some, if wives could make decision on income generating activities, if a household owned land in other locations and if current owner was immigrant. Similar results were reported by (Briassoulis, 2003; Campbell, *et al.*, 2005) whereby they confirmed that in addition to household attributes like age, gender and education, internal and external processes also affect household land use decision making for example site specific conditions and climate change.

Land use practices also contributed to LUCC through cultivation with incidences of crop failure and ensuing erosion. This is consistent with (Lambin, *et al.*, 2003) on expansion of crop production in drylands that increase the vulnerability of human-environment systems to climatic fluctuations thereby triggering degradation. Mining and quarrying activities produced a lot of inert waste and un-rehabilitated excavations captured as bare and rocky, these areas possess a potential of conversion to income generating activities like Haller's park in Mombasa successfully through land reclamation and building of animal sanctuaries (Siachoono, 2010).

Communal ownership of land was the main factor impeding land use change in Kajiado North sub-county at the community level as observed in the field and confirmed by KIIs in Oloseos. This is in line with the government policy of sustainable management of community land (Republic of Kenya, 2009). At the household level, age of household head if above 50 years, education level of at least diploma and ability to get alternative source of livelihood discouraged selling and this is consistent with the findings by Rutten, (1992) however additional factors like awareness of the constitution and exposure to immigrants also contributed. Rural sub-locations with poor infrastructure experienced low change use/cover as confirmed by Ogutu *et al.*, (2014); this was also true for those enrolled in the WCLP as expected (Republic of Kenya, 2005).

5.4 How the LUCC has Impacted on Natural Resources and Livelihoods

LUCC has occasioned the decline in land resources leading to diversification and intensification of livestock and crop production systems, diversification to alternative income generating activities which in turn have had negative impacts on socio-economic and ecosystem services at household and community level as each livelihood activity competes for the limited resources in the fragile semi-arid ecosystem. Several adaptive and absorptive capacities have developed overtime at the household and community level in response to the effects of declining land sizes.

5.4.1 Livestock production systems

The indigenous currently own an average of 144-188 acres with a range of <10 to a maximum of 400 acres as opposed to the time of subdivision whereby the lowest had about 100 acres and the largest were over 500 acres Rutten, (1992) even though those with large pieces were few. The immigrants own from less than one acre to forty acres. This makes it possible for the indigenous to practice semi-nomadic pastoralism livestock production system. Both quantitative and qualitative results reveal that declining lands sizes result to inability of land to produce adequate pastures to sustain pastoral family livelihoods comfortably though adoption of strategies like acquisition of more land in other areas can cushion herders but the practice is at a very low level of 1%. Resident Maasai increasingly employ combinations of livelihood strategies, but the foundation of the economy is livestock-raising as confirmed by, Boone *et al.*, (2005).

Our results are similar to findings in previous studies by (Nkedianye, *et al.*, 2009; Nour and Kasimbu, 2010; Homewood, *et al.*, 2012), on mobile communities in Kenya which revealed that land fragmentation, lack of land use planning and an influx of large numbers of people from outside the County were key constraints to the sustainability of the pastoral livestock keeping system.

The herd structure is changing towards fewer native cattle, more sheep, fewer goats and more crossbred cattle due to fragmentation of lands that poses new, considerable challenges for mobile pastoralism. The major changes in Kajiado North have been deliberate moves to improve breeds and types of animals kept as revealed by the household survey and field observations this is mainly towards improving livestock productivity through changing of animal characteristics as argued by Little *et al.* (2007).

Fifty two per cent of respondents have improved breeds of cattle and sheep and in particular the Sahiwal was preferred for both milk and meat. These results are consistent with research attributes identified by Muhuyi, *et al.*, (1999), in Kenya and Zafar, *et al.*, (2008) in Pakistan the origin of Sahiwal breed of cattle. Interviews revealed that the dorper sheep is well adapted to climate, requires less herding labour and gains weight fast thus yields better market returns and these results are consistent with those of (Audho *et al.* 2009; Nyariki *et al.*, 2009). However in some instances goats are being replaced by sheep because

of their ability to cause conflicts through trespass and changes in vegetation that favour short grasses. These results are consistent with those of Ogutu *et al.*, (2014) in their study on changes in vegetation browsing preferences in Kajiado due to land use/cover change.

Our field findings confirm that Maasai (indigenous) still depend on livestock for their subsistence which is in line with other findings from a multi-sites studies of Maasai livelihoods by (Kristjanson, *et al.*, 2002; Olson, 2006; Homewood, *et al.*, 2012) which emphasized that livestock contributes half or more of the mean annual income for most households. However livestock numbers per household had declined over the years and these findings are consistent with those (HPG, 2009), who reiterate that people/livestock ratios have declined in pastoralist households to a level below what is ‘viable’ for sustainable pastoral livestock production. Our findings revealed that there were mobility constraints due to fences and this is consistent with those of (Orindi, *et al.*, 2009; Nkedianye, *et al.*, 2011) who attributed fences to high population density.

Most livestock owners jointly with relatives, neighbours or friends move their livestock in search of pasture during drought and engage herders to decrease costs. Meanwhile 1% of the indigenous had bought land in other divisions and others had relatives/contacts for livestock spreading to other areas including neighbouring Tanzania where the ties cushioned them during times of difficulties especially drought in addition to controlled breeding through of

plastic barriers. These results are consistent with those of IOM on migration of livestock due to drought ((IOM, 2010) and Liljestrand, (2012) on use of plastic barriers. Livestock remains critical to their livelihood strategy: preserving and building up herds is such a priority that households will reduce consumption in order to avoid selling livestock or sell land to facilitate restocking as revealed during household survey and KIIs and this result is consistent with that of Simpkin, (2005) in his regional studies of livestock in the Great Horn of Africa. On feeding goats with acacia pods as a coping strategy towards drought the results are consistent with recommendations on the nutritive capacities of acacia by Hayward, (2004).

Interviews revealed that immigrants are doing well with intensive livestock keep systems whereby they have ventured into exotic dairy cows, broilers, layers and pigs for both subsistence and commercial purposes. These results are similar to those of Munyasi, *et al*, 2012) though the extents are higher in Kajiado North. Contrary to what had been reported earlier by (Rutten, 1992; Olson, *et al.*, 2004b; Homewood, *et al.*, 2012) fish and wildlife rearing especially quails and ostriches are new income generating ventures. This has impacted on the indigenous who have adopted some of these ventures given that through interaction with neighbours and outside world, they become more able to assess the relevance of new technologies and ideas thus they exercise a choice as emphasized by Bebe *et al.*, (2012). These results are consistent with those of (IUCN, 2010) on intensification of peri-urban areas in Africa.

5.4.2 Crop production systems

The changes in crop production are related to broad forces such as changing markets, population growth and migration, changes in land tenure and other policies, economic factors, social factors and environmental conditions. Crop production is practised by majority of the immigrants 92.4%. Diversification, towards high value cash and food crops, has been adopted by many immigrants whereby intensification through use of fertilizers, crop protection chemicals and improved seeds is practised under irrigation in green houses and along rivers for commercial horticulture for export flowers, spices and vegetables. These results are consistent with those of Olson *et al.*, (2004), the major additions being use of basic green houses to boost horticulture.

Our findings are in agreement with those of (Nyariki, *et al.*, 2009; Reid, *et al.*, 2008), that demonstrated pastoral households use crop agriculture to support pastoralism, by reducing the need for the family to sell livestock to buy grains during dry periods. Further, Lynn, (2010) argues that despite the risk of crop failure in this semi-arid ecosystem, cultivation is an important component of contemporary pastoral livelihoods, boosting food production, maintaining livestock herds, and buffering household vulnerability which was confirmed by qualitative interviews. Changes in social, economic and cultural norms due to interaction between the indigenous and immigrants are causing a shift in food production and consumption habits in Kajiado North. Similar scenario has been witnessed in Tanzania pastoral areas, (Lynn, 2010; McCabe, *et al.*, 2010;

Sangeda and Malole, 2014) where pastoralists adopted crop production due to changing cultural and social norms to be food secure.

Our results reveal that many pastoralists are exiting from traditional ‘highly mobile’ forms and entering into agro-pastoralism, sedentarisation or other livelihood options in Kajiado North, these results are consistent with those of (Nyariki, *et al.*, 2009; Galvin, *et al.*, 2013) on transformation of pastoralist livelihoods in transition. While studies by (Nkedianye, *et al.*, 2009; Nour and Kasimbu, 2010), revealed that high levels of fragmentation and fences had compromised the traditional mobility within the pastoralist system in Kajiado North, our findings projected a more gleam picture as acquired parcels were due to be subdivided further for development. As per our findings in Kajiado, pastoral livestock production will increasingly be affected by competition for natural resources, particularly land and water as revealed by studies (Rutten, 2005; Nour and Kasimbu, 2010; Thornton, 2015) and confirmed by field cases of trespass and human/ wildlife conflicts. Women suffer more when milk production decreases due to decreased pastures and/or livestock migration than men even though they milk sheep to cope because of their inherent weaker ability to adapt to climate change than men as confirmed by (UNCCD, 2007; Abebe, 2014) among pastoralists.

The household survey ranked declining land sizes leading to inadequate pastures as the biggest challenge, this was followed by water – these findings are consistent with those of Nkedianye *et al.*, (2011) on their studies on

drought impacts on Maasailand. The main drivers in the livelihood systems of ASAL areas are water and pasture as the key determinants of pastoral livestock systems and hence livelihoods and the main link to challenges in food security in Kajiado North. Our findings reveal that levels of precipitation and distribution were major limiting factors on livestock and crop production in Kajiado North and this consistent with the studies by Rutten, (2005). Field observations revealed widespread irrigation along rivers and near boreholes leading to increased demand for water and these results are consistent with those of Olson (2006) and Jaetzold *et al.*, (2011) on immigrant farmers in Kajiado.

The demand for water is made worse by the export flower farms, ostrich and chicken farms, private boarding schools, recreational facilities the training institutes and emerging alternative livelihood ventures. Rutten, (2005), argues that all of these activities have a high demand for water and careful monitoring is needed to be able to determine sustainable water supply for both crops and livestock production. Water availability, coupled with its quality, is also important for agricultural livelihood production activities as household survey and KIIs revealed quality of water was one of the reasons for failed greenhouse projects.

Our findings revealed of community complaints on uncontrolled water abstraction leading to drying of shallow wells and this is consistent with the findings of Mwangi and Rutten, (2009) who argued that throughout the 1990s

shallow wells operated smoothly providing water for livestock and household uses. This came to a halt from 2005 onwards when shallow wells in the neighbourhood of deep boreholes started to dry. This was confirmed by KIIs and most FGDs as some indigenous did not know how to construct shallow wells initially until they were able to hire experienced immigrants. Meanwhile some of the boreholes in Kajiado are within the prohibited distance of 800m from any other source of groundwater; this finding is in line with that of Rutten, (2005). Complaints of pollution were noted during interviews with those near flower farms and industries; the results are also consistent with previous findings on mining and small leather industry activities in Athi River that pollute the streams in Kajiado North, Rutten, (2005).

The current status of land was considered degraded by 34% of the respondents which they attributed to increased human activities like cultivation, waste disposal, and introduction of invasive species, un-rehabilitated stone and gypsum quarrying mines. The results are also consistent with previous findings (Kabubo-Mariara, 2005; Maitima, *et al.*, 2010) where environmental degradation is a major issue in intensifying systems especially ASALs with low productivity potential, poor soils and poor physical characteristics which are aggravated by increasing human and livestock populations as the case in Kajiado North. Field observations identified pasture degradation due to overgrazing and encroachment by invasive species leading to existence of poor quality pastures in the rural locations of Kajiado North. These results are consistent with those of Kidake *et al.*, (2015) about ipomoea species invasion

in Southern Kajiado. *Ipomoea Kutensis* and *Opuntia Subulata* weeds had invaded three rural sub-locations: this affects pasture quality and quantity, Pavanello and Levine, (2011) argues that pastures quality goes beyond the species composition and the presence of palatable or poisonous plants and amounts.

Our findings revealed that crop failures due to climate variability and inadequate crop production skills were impacting negatively on food security. These findings are consistent with the research by, (Kristjanson, *et al.*, 2002) which showed that diversification into cropping appeared to be a quite shaky option in Kajiado, with many households not getting a harvest even in a year considered to be a ‘good rainfall year’. In semi-arid Ethiopia (Desta and Coppock, 2004), decline in household per capita cattle holdings and population pressure led to diversification to crop production to achieve food security even though there were high chances of crop failure which relates to the situation in Kajiado North as per our findings. One positive finding from interviews is that crop failure products complement livestock fodder.

Competition for resources has led to increased human/wildlife conflict and trespass cases which in turn pose challenges to production activities through predation, diseases and pests. As per our findings, this human-wildlife conflict losses erode the farmers’ diversification economic benefits as confirmed in similar studies in Kenya by Kristjanson *et al.*, (2002); Waweru and Olelebo, (2013) and Hariohay and Roskaft, (2015) in Tanzania. Inability to cope with

natural shocks was ranked second by the household heads that identified drought, disease and drought mitigation expenses as the main challenges that sometimes lead to livestock loss, the results are also consistent with previous findings by, Nkedianye *et al.*, (2011) that associated the loss to competition. Interviews revealed that incidence of diseases had increased even though use of veterinary medicine was at 64%: this was attributed to congestion and decreased mobility which is in line with findings of, (Kristjanson, *et al.*, 2002; Nyariki, *et al.*, 2009).

Our findings revealed that as the Maasai become more sedentary doing agropastoralism with fences, they tend to develop and maintain few, close ties in sharing resources especially water and pastures. The communal way of sharing resources is declining over the years as confirmed from earlier studies by (Campbell, *et al.*, 2005; Nkedianye, *et al.*, 2009) this is compounded by trespass and human wildlife conflicts.

Socially, at the household level, there have been gradual changes in gender roles over time due to LUCC as revealed by qualitative interviews. This has been influenced by the families' financial status, education levels, shocks to the household and interaction with immigrants from other communities and the results are consistent with those of Cochrane *et al.*, (2005).

Traditional indigenous pastoralism knowledge acquisition among the youth has declined; this knowledge is particularly important in decision making with

regard to shocks and livestock movements in search of resources as emphasized by Galloway, (2010). Meanwhile women's knowledge had improved with increased responsibilities and our findings are consistent with those of Flintan, (2008) on studies on pastoral women empowerment.

5.5 The Expected Outcomes of LUMP and WLCP Regulations in Controlling LUCC

The results from both quantitative and qualitative interviews reveal that LUMP may not achieve the objective of offering guided development and controlling LUCC and fragmentation. Even WCLP may not achieve the anticipated voluntary enrolment target which in turn limits LUCC and facilitates wildlife dispersal and movement. The two legislations did not take into consideration the realities on ground at the formulation since stakeholder participation was quite low leading to low awareness of the objectives and benefits at household and community level.

5.5.1 LUMP

Field observation confirmed projections in increased fragmentation as parcels of land are due to undergo further subdivision by Sacco's, institution of higher learning and property developers which is consistent with findings by (Rutten, 2008; Nkedianye, *et al.*, 2009) given current trends, the most likely scenario in the next few (e.g. five) years will be a significant upsurge in built-up area and a steady rise in crop land. This situation is exacerbated as a number of buildings go up without reference or adherence to any physical plan, (Republic of Kenya,

2008; Kioko and Okello, 2010). Brockerhoff, (2000), defines a sprawled urban area as one in which land is developed by; roads, buildings, and other infrastructure at a faster pace than population growth which is actually the case given that built up increased by more than 1531% as population increased by 15.07% during the study period.

The household survey revealed that 58% of wives and 34% of the household heads recommended revision of LUMP with more participation of all stakeholders on the ground since at project formulation only 21% of household heads and 11% of wives participated. With reference to the current constitution in formulation of legislation at all levels of Government, it is a requirement that the public should be facilitated in public participation and involvement in the legislative (Republic Kenya, 2010).

There is still some good will on revision from the stakeholders only that this time they suggested all owners should be involved including absentee owners. Not all in the community were at the same level on understanding LUMP especially when the results of each gender were studied separately, hence to participate fully, they may need additional capacity building to improve awareness and to strengthen implementation success as they confront and solve problems locally as recommended by, Chambers and Ham, (2004).

One of the main public domain failures is lack of participation of indigenous peoples in decision making processes regarding land and resources that directly

impact on their livelihoods as argued by Olanya, (2013) as revealed in Kajiado North. However in much of Sub-Saharan Africa, UN-Habitat, (2010), decision-making has been only consultative rather than genuinely participatory, with the attendant lack of effective impact; a scenario we can identify with in Kajiado North. The LUMP act was not backed by rules and regulations to govern enforcement developed through public as required by Constitution 2010. This explains weak enforcement on the ground.

Unrestrained spread of informal settlements in the absence of government guidelines and poor enforcement is pervasive in many Eastern African urban centres UN-Habitat, (2010) and in developing regions, urban expansion has taken the form of ‘peripherization’ that is characterized by large peri-urban areas with informal and/or illegal patterns of land use, (UN-Habitat, 2013; UN, 2013). Ideally, the bulk of the initiatives that are geared to addressing urban sprawl need to take place at the planning level of government (UNEP, 2002; Koomen, 2008): from case studies, it was found out that whereas in Canada and USA the government planned from the start by instituting long range transportation systems in Kajiado North the LUMP was initiated after sprawl had taken place.

It is evident that it is in the poor planning and management of growth in Kenyan cities and towns, where the difficulties surrounding the land tenure reform originate (Bassett and Jacobs, 1997; Musakwa, 2013): for instance, within urban centres such as Kajiado North, a plethora of problems

surrounding land management and tenure exist, including ineffective land use planning; expensive, inefficient and inequitable infrastructure provision; constrained ability to generate local revenues from land taxes; lack of access to land for informal sector activities and general administrative chaos arising from incomplete legal application of the reforms, unclear administrative jurisdictions and a general disregard for the requirements of the formal land tenure system by landowners.

5.5.2 WCLP

Participation gap is bad for conservation as it separates the main players from project initiation which has a bearing on successful implementation. As per our findings, participation during WCLP formulation was at 17% - this result is due to the distribution of the sampled households that included locations that were far from the dispersal area; however proportional piling results placed the level of participation for the affected locations at 40%.

Very few women participated at project formulation and according to Watanabe, (2008) under the GEF project report in Central America, Vanuatu and Ecuador revealed that early involvement of indigenous representation that includes women and youth in project design was essential, and this could save time while avoiding serious problems in the long term which was not the case in Kajiado North. Meanwhile qualitative interviews revealed that women did not actively participate due to socio-cultural norms and our findings are

consistent with those of Nkedianye *et al.*, (2008) when they found out that women actually just sit and listen only in such meetings.

Our findings reveal that 16% of the women were aware that their families were enrolled to the easement programme as opposed to 19% of the household heads. This affects level of conservation as recommended by (Flintan, 2008) since benefits due to them are neither known, nor felt and their livelihood activities will not change to embrace conservation. This falls short of the Government requirement on management of environment and natural resources according to Constitution 2010 (Republic of Kenya 2010), “The public should be encouraged to participate in the management, protection and conservation of the environment”.

Brown *et al.*, (1992) describe the communities around a protected area as being in a "bargaining zone" where locals, managers, development agencies, and non-governmental organisations (NGOs) bargain with each other to achieve their own objectives. However, since the bargaining power of the community is generally less than that of the management agency, the education and training offered to communities is often biased toward the perceptions and goals of the management agency rather than the needs of the community. This was the case as revealed by qualitative interviews and low support for the project at only 23% even though project awareness was at 61%. Knowledge of the benefits to the household and community were at 37% this is quite encouraging given that the results capture the entire study area as opposed to the dispersal area alone.

The function of community participation can be viewed from two broad perspectives, coercive or interactive. The difference between these perspectives is the level of input from, or power given to, the community. In the coercive approach, protected-area managers try to "sell" the idea of protection to the communities because they feel the protected areas are doomed unless local communities "buy into" them. Our findings revealed that enrolment to WCLP was at 19%. This result is contrary to what was found by The Wildlife Foundation at 104% with 417 families of the targeted 400 households (GRM, 2013). This contradiction can be explained by the fact that the sampled households included locations that were far from the wildlife dispersal areas which included the urban sub-locations. The interactive point of view is that sustainable development and benefits to the protected area and surrounding communities are possible only to the extent that local people are involved and also perceive the benefits. This view is reflected in the way Kajiado North residents have handled the easement project whose future is uncertain in reference to their recommendation whereby 72% want the project done away with and make Nairobi National Park a zoo.

On the other hand, 13% of the respondents were of the view that the wildlife corridor land should be bought from farmers by the government or any other conservation organisation at the market rate. The residents' recommendation of government to buy the wildlife corridor is similar to Transfer of Development Rights (TDR), (Pruetz and Standridge, 2009; Cohn and Lerner, 2003; Walls

and McConnell, 2007), practised in United States of America (USA) for more than 40 years as a mechanism for preserving farmland, open space, and natural resources. In USA, TDR and easements have success stories (Walls and McConnell, 2007; Jacobs, 2014; Ferguson, 2009), in several States where forests, wetland and landscapes have been conserved as TDR markets work as a land preservation tool when landowners are willing and able to sell development rights, and developers are interested in buying those rights.

The indigenous inhabitants have traditionally tolerated wildlife mixing with livestock but lately there have been an increasing number of complaints as human wildlife conflicts become more rampant, competition for resources intensifies, while compensation rates remain low and disease transmission between wildlife and domestic livestock becomes more noticeable. Human-wildlife conflicts were experienced by 60% of respondents whereby 80% were on livestock and 20% on crops. The livestock were attacked by lions, leopards and hyenas while crops were affected by baboons, monkeys, porcupines, birds and zebra. These results are similar to those conducted earlier in the Maasai regions in Kenya (Nkedianye, *et al.*, 2009) in Kajiado and (Nyariki, *et al.*, 2009) in the Mara ecosystem.

Competition for forage between wildlife and livestock for pastures and browse was experienced by 46% of the respondents, they identified zebras, gazelles, wildebeests and buffaloes as main wildlife that graze in their farms competing with livestock even though they had not enrolled in the easement programme.

These results are consistent with those of (Fratkin, 2001; Olson, *et al.*, 2004b; Reid, *et al.*, 2009) for the East African region, while in Kajiado by (Cochrane, *et al.*, 2005; Ogutu, *et al.*, 2014).

Other than wildlife conflicts the 30% residents experienced conflicts which they attributed to increase in population on the following aspects: crop damage by livestock (sheep, goats, cows and chicken), boundary disputes and access road disputes. These results are consistent with most studies conducted in Kajiado (Reid, *et al.*, 2008; Nkedianye, *et al.*, 2009; Campbell, *et al.*, 2005) and they are mainly attributed to increase in population and crop production activities. The creation and maintenance of fences to prevent trespass reinforces co-operation between the agricultural and pastoral sectors even though the associated costs for large areas are prohibitive. These findings are supported by those of Orindi *et al.*, (2009) where he argues that, very narrow corridors often tempt hungry animals to graze on the crops on either side; pastoralists have to use more labour to keep their herds under control, and the potential for aggravating the conflict between cultivators and pastoralists is apparent.

Low compensation rates was the major discouraging factor for those willing to enrol; however all is not lost, at least 15% felt that the residents should be encouraged to participate in the easement programme by increasing the compensation rate. This will discourage them from selling. The findings of this study seem to be consistent with other research where a similar bottleneck was

overcome in Tanzania to manage natural resources successfully through a bottom-up approach of involving communities with creative mechanisms for channelling benefits at an improved rate, Sachedina and Nelson, (2012).

The findings outlined that understanding the peri-urban community would contribute to natural resources conservation and discourage fragmentation if livelihood benefits are linked to conservation as highlighted by Elliott and Sumba, (2010); on these aspects; clearly understood conservation rationale, profitable interventions, mutually-collaborative and well-performing private sector partner(s), well-grounded community partner(s) with appropriate governance structures in place, contractual community ownership and enforcement of benefit streams, transparent intra-community benefit-sharing arrangements ought to be in place. It is worthy noting that most of these were missing in the current easement programme. From the results it looks like there was a mismatch between the main objectives of conservationists and the indigenous Maasai enrolled in project as some were not satisfied with the benefits and they were going against the easement requirements, which is consistent with the findings of (Rutten, 2004).

It therefore can be concluded that the adoption of major land use reforms through legislation, policy, regulation, physical planning, investment planning, data collection and research reports can only occur when there is the right synthesis of leadership and public opinion in a comprehensive way as recommended by (Belton, 2012) in the USA. Ideally all stakeholders ought to

be involved in decision making and implementation for success of any land use land cover initiatives. Stakeholder engagement broadly refers to a framework of policies, principles, and techniques which ensure that citizens and communities, individuals, groups, and organisations have the opportunity to participate in a significant way in the process of decision-making that will affect them, or in which they have an interest (Russell, *et al.*, 2008; IWC, 2011).

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The study demonstrates a decline in pastoral and wildlife dispersal areas over the period 1980 to 2010 as crop production and built up areas increase. The general trend of decline in rangelands and water resources impacts negatively on the future of pastoral activities. Nevertheless, increasing immigrant populations also plant trees which have a positive impact in the environment despite the fragmentation.

Given the current trends, the degree of land fragmentation and proliferation of fences is bound to intensify in the next few years. The momentum for further subdivision and development brought about by institutions, property developers and speculators is already set. Infrastructural projects in progress like the proposed standard gauge railway, southern by-pass and Konza techno city have a pull effect on speculators who see opportunities in future property developments. From these evidences we infer increased fragmentation in the surrounding areas due to improved infrastructure and further demand for complementary services and goods.

The major socio-logical factors that contribute to land use/cover change are increased demand for land resources for individual and institutional property developments together with agricultural activities, infrastructural improvement and population increase. These demands for land are mainly met through sale

as the indigenous population find it irresistible to hold on to their parcels of land against the escalating market prices. This trend, if not arrested, could lead to significant indigenous populations selling off their land and being left virtually landless and ultimately impoverished as they squander the proceeds from the sale of land on luxuries such as motor vehicles. This land-selling culture is facilitated by the change in land tenure policy that took place in the 1980s. May be there is need to re-look at this policy and insert a clause that would protect the indigenous people from the prospect of landlessness and endemic poverty.

Basic infrastructure like roads, electricity, schools, water and hospitals influenced buyers' choice of physical location. While at the household level, peer pressure, temptation from appreciating prices and low age of household head influenced sellers' decision. Socially the indigenous prefer less congested areas, as the area's population density increases they have devised a strategy of selling and moving to less congested areas. However the drift to less congested areas is bound to end soon as "less congested" areas are getting scarcer by the day. Communal ownership of land, enrolment in WCLP and knowledge empowered household impede land sale and hence LUCC. This strategy should be enhanced to pre-empt defranchisement of the indigenous people from their land while increasing their economic status.

Because of fragmentation, climate variability, resource use conflicts, curtailed accessibility to range resources; the pastoralists are no longer able to derive their livelihood from the land based resources. As a consequence the

indigenous have diversified to property development, drilling boreholes and trade using the land sale proceeds to ensure that the community was resilient contrary to what was the case in the early 1990s where the same was mainly used for leisure. Interaction with immigrants has introduced new lifestyles and tastes that impact on production systems adopted for both crops and livestock. As a result crop production is now practised by many indigenous Maasai to meet the household demand for vegetables and maize meal while consumption of eggs and fish is gaining popularity with accompanied diversification of production ventures.

To mitigate the problem of declining land holding sizes improved livestock under intensive production system are now kept. The Sahiwal is replacing the Zebu while the dorper is replacing red Maasai sheep. In some instances goats are being replaced by sheep because of their tendency to cause conflicts through trespass and changes in vegetation that favour short grasses. Water in the community contributes a lot in improving livelihoods through income generation and adoption of intensification technologies that rely on continuous water supply like green house and fish farming.

Although the status of LUMP and WCLP is difficult to measure and describe, neither WCLP nor LUMP can effectively control fragmentation in Kajiado North. The LUMP actually came in late; it should have come at the time of change of land tenure policy if only the policy makers had foreseen the influx of immigrants due to the physical location of Kajiado North in relation to Nairobi City and institute requisite long range planning. Furthermore effective

land use planning can only be achieved before sprawl and not the other way round.

Increased vulnerability to climate variability shocks was high with households that had sold most of their land and as a result were currently low in terms of levels of human, natural, financial, physical and social capital assets. At the household level there were changes in gender roles, loss in livelihoods due to fragmentation, increase in disease incidences and conflicts leading to a decrease in human wellbeing. While at the community level, sprawl and unguided developments contributed to a good share of negative impacts on the community's resilient pathways; changes in social mores with respect to sharing of resources, increased insecurity, curtailed mobility, increased incidences of food insecurity and litigations due to trespass.

The WCLP initiative was a noble idea in conservation of natural resources in Kajiado North given the fact that the indigenous do not mind wildlife mixing with livestock since time immemorial. Because of human wildlife conflicts, competition for resources, facilitation of disease transmission, low compensation rates, high value of land and alternative land uses, WCLP has not been fully embraced to meet its objectives; partly because the compensation funds provided by stakeholders were not viewed to be adequate when compared to other livelihood alternatives in accordance with valuation for ecosystem services.

The stakeholders did not take into consideration the aspect of population growth for both the indigenous and immigrant overtime and the reality of lateral expansion of the Nairobi City, leading to sprawl. In reviewing the formulation, implementation and future of WCLP in Kajiado County it can be concluded that in many respects, the easement concept proposed by stakeholders turned out to be an artificial creation, lacking a firm traditional, sociological as well as an ecological basis. It was geared to coexistence of wildlife and livestock production while taking no account of pastoralists' strategies and household livelihood needs with respect to the level of fragmentation/fences.

Given that Kajiado North is peri-urban they should have taken into consideration all the factors that affect such transitional areas given that they experience constant population change and disturbance of traditional social, environmental and economic characteristics. Some of these problems are demographic as populations of indigenous, immigrants, domestic livestock, wildlife, continue to grow, all competing for dwindling land resources as infrastructure and basic facilities improve overtime creating more demand and hence more fences. These novel results suggest that households in sub-locations covering WCLP in Kajiado North could offer useful insights on practical sustainable conservation of natural resources through active participation with relevant stakeholders giving particular attention to youth and women who were initially excluded.

6.2. Recommendations

Given the goodwill from the community, revision of LUMP can be revived with more stakeholder participation and awareness creation of the benefits. The Land use cover/ change maps can be used to revise the zonation of areas with respect to livelihood activities. While engaging the community key values and principles for responsible community engagement should be observed;

- ***Participation and consensus-building-*** Involving of men, women and youth in decision making through direct participation and legitimate representative institutions taking multiple stakeholders' perspectives into consideration. This will factor the current land owners in Kajiado North who comprise individuals from different communities and many institutions together with the infrastructure projections in progress like the Standard Gauge Railway, Konza Techno City and Nairobi Southern bypass dual carriage way.
- ***Equity, respect and inclusiveness-*** Ensure that all stakeholders are engaged, with particular effort made to engage marginalised members of the community and ensure respect for different opinions. The contribution from women and youth will improve the final legislation given that they contributed minimally in 2008. This will give room for the concerns of women and youth to be factored in the final rules and regulation which will in turn impact on the implementation.
- ***Accountability-*** Acquire the means to hold decision-makers to their words and deeds. Accountability goes hand-in-hand with transparency and an effective regulatory regime especially where the land board is supposed to

approve the sale of a particular piece of land through effective engagement with family members as required in land transactions by Constitution 2010.

There is need to look for other ways of improving the WCLP compensation rate to discourage selling that increases fences, leading to LUCC. The community should participate actively during formulation revision in reaching the compensation rate decision, otherwise other alternative livelihood options will appear to be more lucrative and hence a better option. A sustainable mechanism of preserving the wildlife corridor acceptable to the community should be considered given that the land is too fragmented resulting in human wildlife conflict. Therefore, to control fragmentation of areas at the fringe of Nairobi National Park it will be appropriate to create a buffer zone with compatible land use systems that support/integrate wildlife conservation. Alternatively, at a pilot level, transfer of development rights can be tried in collaboration with relevant stakeholders to see whether we can copy from developed countries like USA to conserve the area given that the residents suggested that the corridor should be bought at market rates.

On resources extraction, regulations should be observed especially the NEMA guidelines with respect to quarrying, mining and water abstraction so that the end result is not environmental degradation due to unsustainable exploitation. Meanwhile residents need to get proper extension services in intensification agriculture production systems to achieve long term ecosystem sustainability.

6.3 Suggestions for Future Research Work

- (i) Effects of speculation with respect to future infrastructural projects like Standard Gauge Railway, Southern by-pass and Konza Technocity on land fragmentation
- (ii) Extent and effects of irregular and fraudulent land transactions in Kajiado
- (iii) Possibilities of rehabilitating the stone quarries and gypsum mines to income generating enterprises, like Haller's Park in Mombasa

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APPENDICES

APPENDIX I: NAMES OF ADMINISTRATIVE UNITS IN THE STUDY AREA

DIVISION	LOCATIONS	SUB-LOCATIONS
ISINYA	ISINYA	ENKIGIRI
		ILIPOLOSAT
	OLTURUTO	OLTUROTO
		KISAJU
KITENGELA	KITENGELA	KITENGELA
		OLOLOITIKOSHI
	OLOOSIRKON	OLOOSIRKON
		SHOLINKE
NGONG	SOUTH	OLOYIANGILANI
	KEKONYOKIE	KISAJU-NGONG
	OLCHORRO	KIPETO
	ONYOR	OLCHORRO ONYORE
ONGATA RONGAI	LEMELEPO	KAHUHO
		LOWER NKOROI
	ONGATA RONGAI	OLEKASASI
		ONGATA RONGAI
TOTAL	8 LOCATIONS	16 SUB LOCATIONS

APPENDIX II: ETHICAL CONSIDERATIONS

I will aim to protect the dignity and privacy of all participants in the course of the research work. While conducting the Participatory Rural Appraisal (PRA) to select participants for Focus Group Discussions (FGDs) and In Depth Interviews (IDIs), their voluntary consent will be sort after they have been informed of the study objectives, anticipated benefits and potential hazards of the research economically or socially. Their rights to withdraw from participation in the research and their rights to terminate at any time will be guaranteed. During the household survey accountability in the form of representation, documentation of risks and benefits and consultation will be carried out. Respect for community and individual rights will be observed whereas no children will be used in the research and gender representation will be observed since the study addresses gender in the objectives. The confidential nature of their replies and individuality will be kept since all data will be coded and they will be posted with outcomes at end of the research, (Kaufman and Ramarao, 2005).

The study will be approved by University of Nairobi through defending of the proposal at the department and faculty level in College of Agriculture and Veterinary Sciences before I commence the research. Supervision during field activities and data collection will ensure that there will be no fabrication and/or plagiarism.

APPENDIX III: QUESTIONNAIRE FOR HOUSEHOLD SURVEY

IMPORTANT

This questionnaire has been prepared in accordance with the objectives of the study and it is purely meant for academic research. I therefore request you to be truthful and accurate in answering the questions.

Instructions

Put (X) in answering the corresponding questions in the given brackets with either a pen or pencil where you feel not qualified to respond indicate N.O. (no option)

A: BACKGROUND INFORMATION

Respondent: _____ **Location.....sub-**
location.....village.....

Respondent household details

Please fill in the categories as follows;

Gender: 1.Male 2 .Female, **Origin:** 1.Indigenous 2.Immigrant,

Marital status: 1. Married 2.Divorced 3. Widowed 4. Single

	House hold member	Age	Sex	Relation ship with Househ old head	Educat ion Status	Occupa tion	Eth nic gro up	Ori gin	Num ber of years in area	Mari tal statu s
1	House hold head									
2	Wife									
3										
4										
5										
6										
7										
8										
9										

B. LAND USE INFORMATION

B1. Number of acres owned.....,

B2a. Does it adequately support your household livelihood requirements?

1. Yes [] 2.No [].

b. If Yes/No, Please explain briefly

B3. Type of ownership

1.Individual [] 2. Family [] 3.Group [] 4. Communal [] 5.Gift []

Other _____

B4. Land use in livestock production and changes

Total area under livestock production _____						
Animal	Changes in herd attributes and space					
	Breeds		Numbers 1.Increase 2.Decrease 3.No change	Production space 1.Increase 2.Decrease 3.No change	Yields/animal 1.Increase 2.Decrease 3.No change	Reasons for observed changes
	Previous	Current				
Cows: (Local Sahiwal Friesian, Ayshire Crossbreed)						
Sheep; (Local Doper)						
Goats; (Meat, Dairy)						
Poultry; (Local broiler Layers)						
Pigs						
Bees (Hives local KTHB Lungs troth)						

B5. Current livestock production information

Animal type	Feeding system and husbandry							Changes in way you graze animals		
	Nomadism	Close to boma	Tethering	Paddocks	Zero grazing	Water source	Use of Vet. drugs	1.Yes	2.No	Explain
Cows										
Goats										
Sheep										

B6. Land use in crop production.

Total area under crop production _____ Acres

Provide units of measure- Weight-Kgs, 64Kg crates, 50/90Kg bags

Please fill, 1. **hh**=Household head, 2. **W**=wife, 3. **B** =both, 4. **E**=either for owner, decision maker. Contribution to household food fill, {all, some, none}

	Crop	Acre	Approx. Yield/acre	Unit	owner	Decision maker	Contribution to hse/hold food	Any production changes
1.	Maize							
2.	Beans							
3.	Tomatoes							
4.	Kales							
5.	Spinach							
6.	Ind. Veggies							

B7. Crop production information. Please enter 1. Yes 2. No

Rain-fed	Irrigation open field	Irrigation green house	Source of irrigation water	Water source Sustainable	Use of Improved seeds	Use of fertilizers	Use of protection chemicals

B8. Details of other land owned by respondent.

Owns 1. Yes 2. No	Name of area	Number of Acres	Number of years in ownership	Type of ownership-* see code B3 above	Major activity 1. Crop 2. Livestock 3. Other _____

B9. Current total area under other production activities; quarrying, picnic sites, sold, water pans.

Activity	Acres	Main influence of this land use type
Built up commercial		
Picnic sites		
Sold		
Quarrying		
Water pans		

B10. Has your land undergone change of use/cover. Please tick one; Yes[]
No[]

B.11. Please name the change

1.....2.....3.....

B13. Other factors influencing land use change

Please rank the following factors influencing land use change observed in the community

Factor	1=Most to 7=Least influencing factor		
	Owners below age 45 years	Owners above age 45 years	Remarks
1.Appreciation of prices leading to selling			
2.Better returns from current uses than before			
3.Peer influence to sell			
4.Lack of other source of livelihood			
5.Desire to own assets like cars, good house			
6.Congestion(sell to move out to less congested areas)			
7.Subdivision to sons/ and dependants			

B14 a. Are there cases of resource use conflicts? 1. Yes [] 2.No []

B14 b. If Yes, Please explain with examples and give ways of solving each conflict.

Conflict	Resolution
1	
2	
3	

B15. Please fill whether following factors influence immigrants to come to the region and rank them

Factor influencing immigrants	1.Yes/2.No	Rank 1-Most 3-Least
Basic facilities (School, Water, Electricity, Health, access road – make it easy to operate from city)		
Cheap for urban people to build homes		
Land traders who buy and subdivide further		

B16 Please indicate the approximate price per acre in your area in the years below

Year	1980	1990	2000	2010	2012
Price Ksh/acre					

B17. Other than land use change, what else has impact on livelihoods? Please tick

	Climate Variability	Aridity (Drought)	Inflation	Market availability	Market information	inadequate production skills
Remark						

B18.Land Use Change challenges and coping Strategies in the community
Please fill as applicable to you.

Challenge	Area of concern	Coping strategy
e.g. Declining land size	Inadequacy to support food production	Nomadism Irrigation, green house

C.WEALTH INDICATORS

C1.Indicators of wealth, Please tick the accordingly.

Household item/facility	Owns 1.Yes 2.No
Vehicle types/Numbers	
Tractor	
Motor bike	
Bicycle	
Radio	
CCTV system	
Television ordinary	
Pay-TV e.g. DStv,	
Mobile phone	
Solar panel	
Wheelbarrow	
Gas cooker	

Household item/facility	Owns 1.Yes 2.No
Electricity	
Generator	
Borehole	
Water pump	
Water pan	

C2. Type of main house owned Tick the type of material used in house parts

Material used	Walls	Roof
Mud		
Cow dung		
Grass		
Timber		
Iron sheets		
Bricks		

C3. On the basis of this wealth assets in the community {land size, good house, herd size, animal breeds and types, tractor, vehicle, ability to send children to school, ability to hire labour/machines, borehole, water pan}

a. Who is considered as wealthy in the community?

b. Who is considered to be middle group in the community?

c. Who is considered as poor in the community?

C4. Other sources of income, please fill; 1.Yes, 2.No

Type	Gifts	Remittances from inside the country	Remittances from Out of the country	Retirement benefits	Others
Enter 1.Yes 2.No					
Remark					

D8.Land Use Change challenges and coping Strategies adopted in mitigation. Please list the challenges as they affect each gender, (e.g. water, grazing land) and indicate the relevant coping strategies adopted in mitigation.

Gender	Challenges	Coping strategy
Livestock production		
Female		
Male		
Crop production		
Female		
Male		

E. Perceptions on LUMP and WCLP

E1. Information on land use master plan (LUMP) for Kajiado North Sub-County. The Kitengela-Isinya-Kipeto LUMP gives a guideline on minimum land holding sizes with respect to uses in livelihood production activities in designated areas. The legislation was drafted in 2008

	1.Yes 2. No.	Please Explain your answer
Are you aware of LUMP		
Did you participate in its formulation		
Do you support it		
Does the community accept it		
Do you the benefits to individuals		
Do you know community benefits		
Is it implementable		
Does it have a future		

E2. What do you think the government should do about the land use master plan?

1. Enforce it []
2. Revise it with more community participation and then implement it []

3. Forget about []

E3. Please explain your answer to E2 above

E4. Environmental easement project discourages land fragmentation by compensating participating farmers' 4USD/year/acre in three instalments. It allows free movement of wild animals from/into the park and grazing of livestock in the areas not fenced. The regulation has been in operation since 2000.

ASPECT	1.Yes 2.No.	Please Explain your answer
Are you aware of environmental easement project		
Did you participate in its formulation		
Do you support it		
Is your household enrolled WCLP?		
Does the community accept it		
Do you the benefits to individuals		
Do you know community benefits		
Do you of the benefits to the nation		
Is it implementable		
Does it have a future		

E5.What do you think the government should do about the environmental easement project?

1. Encourage participation by increasing compensation rate []
2. Forget about it and make Nairobi National park a zoo/game reserve []
3. Buy the land on wildlife corridor from farmers at market rate and fence it []
4. Put controls to discourage non-participating farmers from grazing in the area after selling their land []

E6. Please explain your answer to E5 above

Questionnaire for wives

B-LAND USE INFORMATION

B19.Number of Acres owned_____type of ownership_____

B21.Do you think your current land size is adequate for your livelihood requirements? Yes [] 2.No []

B22. Explain briefly your answer to B21 above

B23.How do you see the future of your family livelihood requirements with your current holdings given factors like economic, social and climatic conditions?

B24. Please tick how you have been meeting your food requirements over the years

Year	Ways of meeting food requirement			
	Production	Buy	Other	Sell (if surplus)
1980				
1990				
2000				
2010				

C.WEALTH INDICATORS

C5.What are your 5 most important sources of livelihood?

C6.Please rank the following sources of income in the community

	Source of income	Rank 1-Most Least 6-	Remarks
1	Own farm crop production		
2	Leased farm crop production		
3	Livestock production		
4	Waged farm work		
5	Waged non-farm work		
6	Trading_____		

C8. Other than crops and livestock what are your other sources of income?

1. _____

2. _____

3. _____

C9. With this wealth assets in the community {land size, good house, herd size, vehicle, ability to send children to school, ability to hire labour/machines, borehole, water pan}

a. Who is considered as wealthy in the community?

b. Who is considered to be middle group in the community?

c. Who is considered as poor in the community?

D10. Are you free to make any decision on alternative income generation activities without express authority of household head towards food requirements? 1. Yes [] 2. No []

D11. Briefly explain your answer in D10 above

D12. Land Use Change challenges and coping Strategies to attain food security. Please list the challenges as they affect each gender, (e.g. water, grazing land) and indicate the relevant coping strategies adopted in mitigation.

Gender	Challenge	Coping strategy
Livestock production		
Male		
Female		
Crop production		
Male		
Female		

E- Perceptions on LUMP and WCLP

E7. Information on land use master plan (LUMP) for Kajiado North Sub-County. The Kitengela-Isinya-Kipeto LUMP gives a guideline on minimum land holding sizes with respect to uses in livelihood production activities in designated areas. The legislation was drafted in 2008.

	1.Yes 2. No.	Please Explain your answer
Are you aware of LUMP		
Did you participate in its formulation		
Do you support it		
Does the community accept it		
Do you the benefits to individuals		
Do you know community benefits		
Is it implementable		
Does it have a future		

E8. What do you think the government should do about the land use master plan?

1. Enforce it []
2. Revise it with more community participation and then implement it []
3. Forget about []

E9. Please explain your answer to E8 above

E10. Environmental easement project discourages land fragmentation by compensating participating farmers' 4USD/year/acre in three instalments. It allows free movement of wild animals from/into the park and grazing of livestock in the areas not fenced. The regulation has been in operation since 2000.

	1.Yes 2. No.	Please Explain your answer
Are you aware of environmental easement project		
Did you participate in its formulation		

	1. Yes 2. No.	Please Explain your answer
Do you support it		
Is your household enrolled WCLP		
Does the community accept it		
Do you the benefits to individuals		
Do you know community benefits		
Do you of the benefits to the nation		
Is it implementable		
Does it have a future		

E11. What do you think the stakeholders should do about the environmental easement project?

1. Encourage participation by increasing compensation rate []
2. Forget about it and make Nairobi National park a zoo/game reserve []
3. Buy the land on wildlife corridor from farmers at market rate and fence it []
4. Put controls to discourage non-participating farmers from grazing in the area after selling their land []

E12. Please explain your answer to E11 above

E16. Has your family done any land use change? 1. Yes [] 2. No []

E17. If your answer to E17 is yes, please indicate your participation in following activity and impact of decision on food security.

1. Yes=Participation, 2.No=No participation,
3. FaP=Participation with other family members like adult children

Land use change	Participation area					Impact on food security 1.Positive 2.Negative 3. No change
	Decision making	Selection of area	Size in Hectares	Control	Proceed utilization If any	
Sell						
Rent						
Long term lease						

Gift						
Quarrying activities						
Water pan construction						
Dam construction						
Build residence						
Build commercial units						
Uses in crop production						
Livestock production						

E18. Other than land use change, what else has impact on agricultural production? Please tick

	Climate variability	Aridity (Drought)	Inflation	Market availability	Market information	inadequate production skills
Remark						

APPENDIX IV: FGD QUESTION GUIDE

Title:

To gain understanding of how land use/cover change has impacted on socio ecological resilience in semi-arid Kajiado North Sub-County.

Moderator introduction, thank you and purpose (1 minute)

Hello. My name is _____. I'd like to start off by thanking each of you for taking time to come today. We'll be here for about an hour and a half. The reason we're here today is to get your opinions and attitudes concerning land use change and whether LUMP and WCLP can control unplanned fragmentation and land use/cover change in Kajiado North sub-county to ensure ecosystem sustainability and pathways to livelihood resilience in the semi-arid economy. I'm going to lead our discussion today. I am not here to convince you of anything or try to sway your opinion. My job is just to ask you questions and then encourage and moderate our discussion. I also would like to introduce [name of recorder]. [He or/she] will be recording our discussion today for my report.

Ground rules (2 minutes)

To allow our conversation to flow more freely, I'd like to go over some ground rules.

1. Please talk one at a time and avoid side conversations.
2. Everyone doesn't have to answer every single question, but I'd like to hear from each of you today as the discussion progresses.
3. This will be an open discussion ... feel free to comment on each other's remarks.
4. There are no "wrong answers," just different opinions. Say what is true for you, even if you're the only one who feels that way. Don't let the group sway you. But if you do change your mind, just let me know.
5. Just let me know if you need a break. The bathrooms are [location].

Intro of participants (10 minutes)

Before we start talking about [land use/cover change and impacts on socio ecological resilience in semi-arid Kajiado], I'd like to know each of you. Please tell me:

- Your name
- How long you have lived in this area
- If you are an indigenous or immigrant resident of Kajiado North Sub-County.

General questions (10 minutes)

What do you think about land issues in Kajiado North Sub-County?

What general changes have you seen in livelihood production activities?

Specific questions; (they will cover the period before and after change of land tenure from communal land into individual holdings before and after 1980)

1. Land use change; what caused/impeded it, what is the status, what is your projection.
2. Land selling contributes a great deal to land use change, do you think the indigenous community is selling wealth to buy poverty?
3. Can you describe the general trend of agric. (crops and livestock) production?
4. How have these LUCC impacted; on food security? (What has changed), gender roles and responsibilities? (What has changed)
5. What challenges have been experienced as a result of LUCC with regard to agric. Production and other livelihood activities by each gender?
6. How do you rank livelihood production activities? { Who is vulnerable, rich, middle, poor }
7. What can you say is the current general condition of the land with respect to LUCC? When looking at the fertility, pastures, soils, water, degradation, erosion and sizes to support livelihoods.
8. What coping strategies have been adopted by each gender towards food security?
9. How have these land use changes impacted on community social norms {decision making and control of resources use and management }
10. Do you think that there is a significant overall change in crop and livestock production due to land use change over the years? {give examples of food crop production by immigrants under intensification }
11. Land use master plan for Kajiado North Sub-County, have you seen/heard it? Did you participate in the formulation? If yes how? Do you agree with it? What are the general community perceptions about it? Is it implementable? Benefits? Future? Recommendations?
12. WCLP; awareness, participation in drafting, household and community perceptions, future, recommendations about the future.

APPENDIX V: CONSENT FORM FOR RESPONDENTS

My name is Mary Morara. I am a PhD student in Dryland Resources Management at the University of Nairobi, Department of Land Resources Management and Technology (LARMAT). The University has approved my research to be conducted in “*Kajiado North Sub-County on “Socio ecological resilience and pastoral land use change in semi-arid lands”*”. The aim of the study is to investigate whether LUMP and WCLP can control unplanned fragmentation and land use/cover change Kajiado North sub-county to ensure ecosystem sustainability and pathways to livelihood resilience in semi-arid economies. Your household has been selected to participate in an interview that includes questions on topics such as your family background, livelihood activities and assets, food production, participation in drafting WCLP and LUMP the possibility of the two to be implemented and hence control fragmentation. The survey includes questions about the household generally, and questions about individuals within your household, if applicable. These questions in total will take approximately 1 1/2 -2 hours to complete and your participation is entirely voluntary. If you agree to participate, you can choose to stop at any time or to skip any questions you do not want to answer. Your answers will be completely confidential; we will not share information that identifies you with anyone. After entering the questionnaire into a data base, we will destroy all information such as your name which will link these responses to you.

If in the future you have any questions regarding this survey and the interview, or concerns or complaints we welcome you to contact university of Nairobi;

The Dean, Faculty of Agriculture, P.O. Box 29053-00625, Nairobi, Kenya.

Telfax: +254-20-632121

Email: deanagric@uonbi.ac.ke or larmat@uonbi.ac.ke

Please retain a copy of this consent as a record of the contact information and about the study.

APPENDIX VI: PLAGIARISM REPORT

Turnitin Originality Report

SOCIO ECOLOGICAL RESILIENCE AND PASTORAL LAND USE
CHANGE IN SEMI-ARID LANDS IN KAJIADO COUNTY KENYA by

Mary Kerubo

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