RANGELAND RESOURCE DYNAMICS AND THEIR IMPLICATIONS FOR PASTORAL LIVELIHOODS IN AMBOSELI ECOSYSTEM, KENYA

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DECLARATION

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

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This thesis is dedicated to my father David Maitumo and mother Joyce Maitumo who worked tirelessly to make ends meet to secure an education opportunity for me, and never ceased to give encouragement and moral support during my studies.

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ABBREVIATIONS AND ACRONYMS

ACC	African Conservation Centre
ACP	Amboseli Conservation Program
ANOVA	Analysis of variance
FGD	Focus group discussion
GIS	Geographic Information System
LARMAT	Land Resource Management and Agricultural Technology
QGIS	Quantum Geographical Information System
TLU	Tropical Livestock Unit
WISP	World Initiative for Sustainable Pastoralism
GPS	Global Positioning System
IK	Indigenous Knowledge
KAP	Knowledge, Attitudes and Perceptions
KRA	Key Resource Areas
NGO	Non-Governmental Organizations
SPSS	Statistical Package for Social Sciences
WISP	World Initiative for Sustainable Pastoralism
LULCC	Land Use and Land Cover Change
ECF	East Coast Fever

ABSTRACT

Worldwide, rangeland ecosystems have experienced tremendous land use changes in the recent decades that have triggered numerous ecological, social and economic dynamics with adverse implications on its inhabitants. These changes have set in motion a number of social, ecological and economic transformations that have undermined the key livelihoods of pastoral communities and the ecosystem integrity at large. Research gaps exist on local community attitudes and perceptions on these change dynamics, their implications on pastoral livelihoods as well as coping mechanisms employed by these communities in response to them. This study was therefore carried out in Amboseli ecosystem in Kajiado County in Kenya to assess communities' perceptions of spatio-temporal changes in range resources over the last four decades. Moreover, the perceived causes of rangeland resource change and the long term implications on household herd size and mobility were determined. Participatory mapping was done to assess the extent of resource changes and the causes of their perceived changes. In addition, semi-structured questionnaire was administered to households to gather information on the rangeland status, utilization and the effects of observed changes on household herd holdings and mobility.

Diminishing grazing land was perceived as the main change in pastoral resources over the last four decades. The decline was more pronounced in the sedentary (50%) and semi nomadic (47%) land uses. This trend was attributed to expansion of cultivation and settlements, which significantly increased by 26% and 17% respectively in sedentary site, and by 17% and 12% respectively in semi nomadic sites during the period under investigation. This was partly attributed to land tenure changes in both sites. Most (79%) of the respondents reported having observed changes in areas of grazing, settlements, cultivation among others, which they attributed mostly to human population growth, expansion in cultivation, land use changes and

reduced rainfall. Results also indicate that the average household herd size was bigger in nomadic site (40.8 Tropical Livestock Unit (TLU)) than in sedentary (22.9 TLU) land use site. The majority of the respondents in nomadic (79%), semi-nomadic (73%) and sedentary (64%) reported a declining trend in household herd size. These declines were mostly attributed to recurrent droughts, loss of grazing lands through expansion of cultivation and human encroachment and the changes in land use. Improving the local livestock breeds (27%) for better returns and diversification of livelihoods (22%) were mentioned as key strategies by the community in addressing the changing rangeland conditions in Amboseli Ecosystem.

Pastoralism remains an important livelihood strategy to majority of households in the study area, and therefore approaches of restoring herd mobility as a key coping strategy under conditions of spatial and temporal resource variability is critical to sustainable livestock production in the Amboseli Ecosystem. Participatory approaches of resource assessment provide entry point for eliciting communities' perceptions on the resource changes, their causes and the community responses to the perceived changes, and are crucial prerequisite for sustainable community-based range use planning and management.

Key words: Community perceptions, Land use types, Local knowledge, Rangeland condition, and Rangeland resource changes.

CHAPTER ONE: INTRODUCTION

1.1 Background information

World rangelands cover about 30-40% of Earth's surface that support 1 to 2 billion people and provide habitats for domestic livestock and wildlife (Niamir *et al*., 2012, Booker *et al*., 2013). The rangelands are extensive natural landscapes dominated by natural grasses, forbs and shrubs (Werber and Horst, 2011), and are managed with little or no external input. According to Schulz *et a*l., (2010), natural landscapes have recently been transformed by human activities into cultural landscapes throughout the world.

African rangelands are home to 268 million people and occupy 43% of the continent's surface area (Anderson, *et al*., 2004). The potential land cover of the Eastern African rangeland ecosystems is largely bushland (33%), woodland (21 %), desert and semi desert (26 % of the land surface) while only 12% is natural forest with less pure grassland comprising 7% (Reid *et al*., 2005). In Kenya, 80% of the land area is rangelands that support 25% of the country's human population, 52% livestock population and 90% wild plants and animals (Otuoma, 2004).

Many rangeland ecosystems have experienced land use and land cover changes in the recent years. Globally, in the past 25 years in United States total cropland, pastureland and rangeland decreased by 76 million acres from 1982 to 2003 and developed land increased by 36 million acres (48%) (JunJie, 2008). This involved clearing large tracts of intact land to pave way for other land uses. Over the last 50 years, land use change in East Africa rangelands has been occasioned by agricultural expansion and urbanization at the expense of traditional grazing land (Maitima *et al.,* 2010). Amboseli Ecosystem in Kajiado County of Southern Kenya, exemplifies some of the rangelands in the region that have experienced significant ecological changes over

the last few decades. Several studies have illustrated the long term changes in Kajiado County (Campbell *et al*., 2003; Campbell *et al*., 2005), Amboseli Ecosystem (Western and Nightingale, 2003; Western, 2006; Kioko *et al*., 2011).

Changes in traditional institutional are some of the underlying factors attributed to land cover modifications in Amboseli Ecosystem. Changes in land tenure system have resulted in land subdivision and, consequently socio-economic and socio-ecological changes that have adversely impacted the grazing areas (Ogutu *et al.,* 2014). Further, immigration by neighboring communities have additionally contributed to habitat loss through clearing of grazing land to pave way for cultivation thereby reducing important range resources among them wet and dry grazing areas (Kioko and Okello 2010). In addition to the rangeland changes, in the recent decades, frequent droughts have become a common phenomenon in the area with adverse impacts on livestock production (Nkedianye *et al*., 2011). This has been exacerbated by restriction of herd mobility, which has been the key strategy for coping with the uneven distribution of resources in time and space.

Pastoral communities inhabiting range ecosystems have been relying on traditional knowledge to monitor the range condition trends and make sound judgment on resource management strategies. However, at the beginning of the 20^{th} century many scientific approaches for monitoring the range condition trends emerged (Hunt *et al.,* 2003). Geographic information systems (GIS) technology is one of the most used approaches today and has increasingly been recognized as an important tool for assessing rangeland resource changes over time to inform management strategies. GIS involves assembling and managing large spatial layers in databases to be analyzed and displayed in maps for visual representation to aid decision making processes (Steyaert and Goodchild, 1993).

It is, however, widely accepted that integration of modern and traditional knowledge is likely to give more accurate and better results in range condition assessment. The integration provides information easily interpreted and appreciable by local communities in making sound decisions to achieve sustainable land use.

This study applied both participatory resource mapping and conventional GIS to assess the extent and drivers of land use and land cover changes over the last four decades in the Amboseli Ecosystem. Amboseli Ecosystem is a typical semi-arid landscape that supports pastoral livestock herds and wild animals. Its vegetation is characterized by mixed grass-tree communities of varying structure and composition in time and space (Hobbs *et al*., 2008; Marchant, 2010).

1.2 Problem statement

Globally, fragmentation of rangeland ecosystems disrupts the structure, composition and their processes, thus reshaping their functions and affecting their quality and quantity (Hobbs *et al.*, 2008). The rangeland changes have been mainly attributed to changes in climate, socio-demographic, economic, cultural and ecological attributes which exert pressure on natural resources (Enete and Amusa, 2010; Rija *et al*., 2013).

Reduction in traditional grazing areas through habitat loss by either settlement or overexploitation of resources in the Sub Saharan Africa amounts to approximately 3.5 million km^2 (Curtin and Western, 2007). Land use transformations through recent land use policies of wildlife conservation, expansion of cultivation in grazing lands and land tenure reforms have been and are still being experienced in pastoral range ecosystems (Oba and Kaitira, 2006). This is consequently reducing key range resources amongst them dry and wet season grazing areas and migratory corridors linking heterogeneous landscapes. These trends have adverse impacts on pastoral communities who mainly depend on livestock production for their livelihoods.

In East Africa, rangeland conversion to croplands and urbanization has been observed in recent decades as a result of rise in human population (Maitima *et al.*, 2009; Nzunda *et al.*, 2013). According to Western *et al.*, (2009), wildlife numbers have shrunk by 35% to 50% over the last 30 years in Kenya, while in some parts certain wildlife species have disappeared. These trends are mainly due to expansion of farming into the wetlands, which traditionally acted as wildlife habitats and dry season grazing refuge for livestock.

Loss of drought refuge areas in the Amboseli ecosystem has been partly due to creation of the Amboseli National Park on land historically used for grazing by Maasai community (Okello and Kioko, 2011). The restricted access to these areas has increased vulnerability among pastoral communities due to the observed ecological changes and the frequent droughts (Western and Nightingale, 2003). Settlement of local pastoralists promoted by establishment of group ranches and later privatization of arable land, and leasing them to non-pastoral communities for cultivation has added to the conservation challenges (Okello, 2005). Maitima *et al.*, (2009) highlighted that the changes have been fueled by demand for agricultural products by the growing human population, and the large scale investors involved in commercial farming.

In the past, unrestricted mobility enabled the Maasai to recover from stochastic events such as drought and disease outbreaks. However, following the establishment of Amboseli National Park, herd mobility has been compromised. This has led to confinement of pastoralists to smaller areas mainly the wet season grazing lands (Okello, 2005; Okello and Kioko, 2010). The restricted movement has led to negative attitudes on wildlife conservation by the community (Okello, 2005). In addition, population increase has resulted in settlement around the protected area resulting in blockage of wildlife migratory corridors.

1.3 Justification

A number of ecological studies have been carried out in the Amboseli ecosystem (Western and Maitumo 2004, Western 2006, Western *et al.,* 2009, Okello and Kioko 2010, Kioko *et al.,* 2012). Most of these studies have determined changes on different habitats and ecosystem disturbances to inform policy and development. A few studies have investigated the local community's knowledge, attitudes and perceptions (KAP) in mapping pastoral resource trends over time to inform the development of strategies for sustainable range management in the area.

Most of these studies have however used either GIS technology or other conventional methods separately, with little or no regard for indigenous knowledge. This study therefore integrated scientific approaches, local knowledge, attitudes and perceptions (KAP) in assessing resource trends and their perceived drivers. This approach provides the first step in establishing sustainable strategies towards mitigating the effects of long term resource changes, and providing information for strengthening participatory planning processes. Analyzing community views helps in coming up with site specific, relevant and workable solutions to conservation problems in a given area. Involving local community in identifying appropriate strategies for counteracting observed long term changes ensures ownership of the subsequent resource management plans, actions and their sustainability.

This study sets the basis for monitoring key resources in rangeland ecosystems to determine their trends for the purpose of adaptive management decisions and strategies. As indicated by Wasonga *et al.,* (2011), the knowledge and understanding expressed by local community in range assessment is more superior in quality and resolution to those gathered remotely and modeled digitally. In addition, monitoring rangeland by local communities to inform sustainable

resource planning and use is essential as it helps in observing changes in the health of the land over space and time.

1.4 Broad objective

The main objective of the study was to assess community perceptions on rangeland resource trends in Amboseli ecosystem and their perceived drivers so as to guide decision on land use planning and sustainable use of the pastoral resources.

1.5 Specific objectives

The specific objectives of the study were to:-

1) Assess perceptions on spatio-temporal changes in range resources among the pastoral communities in the Amboseli Ecosystem.
2) Analyze perceptions of pastoral communities on the causes of long term changes in range resources and human-wildlife co-existence in the Amboseli Ecosystem.
3) Determine the impacts of long term land use changes on herd size and mobility among pastoral households in Amboseli Ecosystem as perceived by the community.

1.6 Research questions

1) What are the community's perceptions on spatio-temporal changes in pastoral resources in the Amboseli Ecosystem?
2) What are the perceived causes of the long term resource changes by the local community in the study area?
3) What are the effects of long term land use changes on household herd sizes and pastoral mobility in the study area?

1.7 Thesis organization

The schematic organization of this thesis is shown in Figure 1.1. The thesis is organized into seven chapters. Chapter one presents the background information of the study regarding rangeland ecosystems, trends in different range resources at global, regional and local scales. In addition, the chapter presents problem statement, justification of the study and objectives. Literature review on key rangeland resources, ecosystem goods and services, local indigenous knowledge, trends on resource changes, causes of changes and implication of changes on pastoral livelihoods are presented in chapter two. Chapter three presents the study area and the research design. The objective on assessing perceptions on spatio-temporal changes in range resources is presented in Chapter four. Chapter five addresses the perceptions of pastoral communities on causes of long term changes in range resources and human-wildlife co-existence in the study area. Chapter six presents the third and last objective, which address the impacts of long term land use changes on herd size and mobility among pastoral households in Amboseli ecosystem. The conclusions and the study recommendations are presented in chapter seven, while the questionnaire and Focus Group Discussion (FGD) checklist are presented in the appendices section.

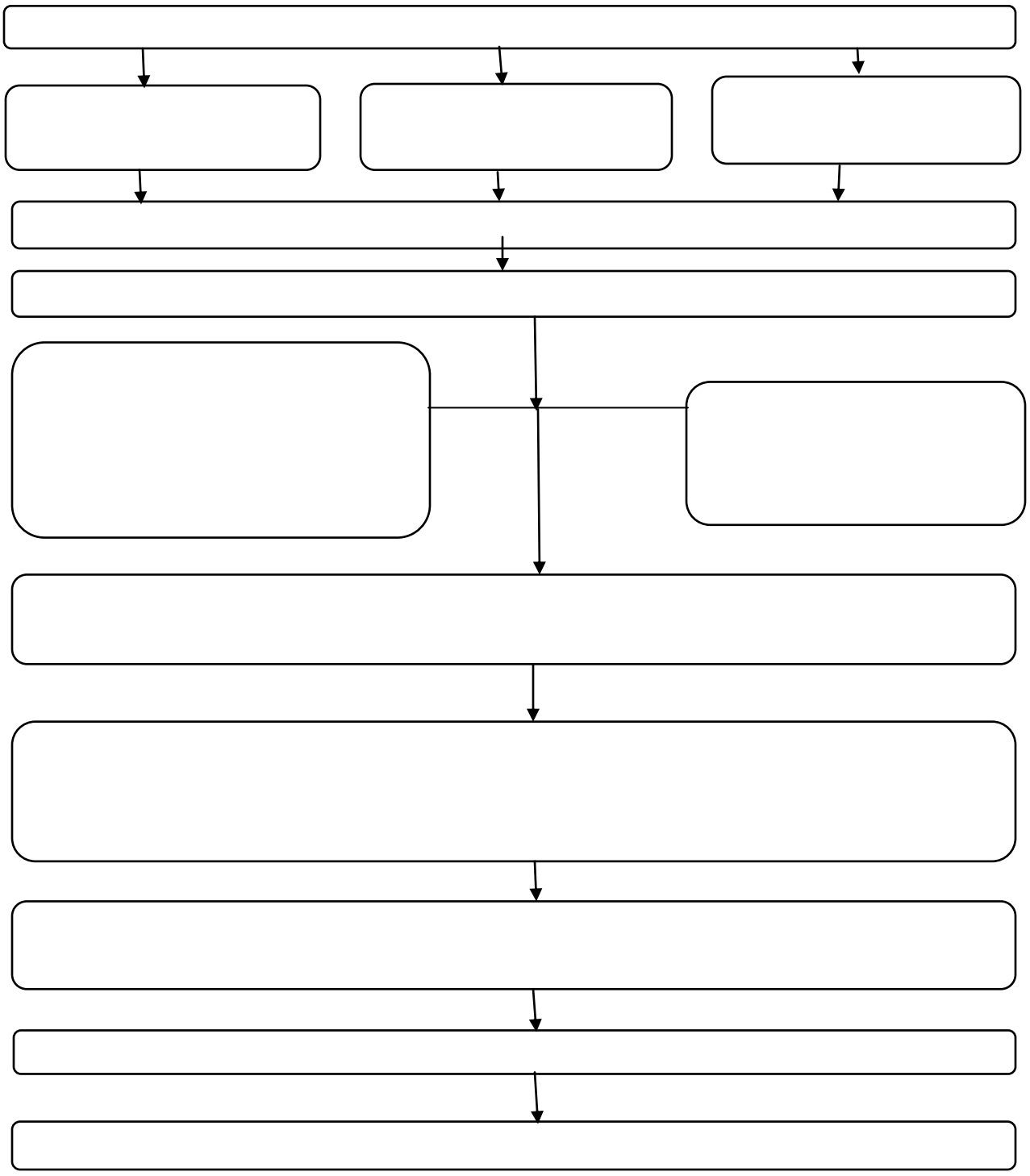


Figure 1.1: Thesis plan

CHAPTER TWO: LITERATURE REVIEW

2.1 Rangeland resources and their values

Traditionally, the key resources essential for sustenance of mobile livestock production in the rangelands include pastures, corridors that link seasonal grazing areas, pastoral settlements and markets (Behnke and Freudenberger, 2013). Rangelands are extremely important to societies for the ecosystem supportive, regulatory, and provision services they provide to societies (Skaggs, 2008; Bekele and Kebede, 2014). Globally, over 200 million pastoral households and over one billion livestock heads including camel, cattle and smaller livestock are supported by the rangelands (Dong *et al.*, 2011). Rangeland ecosystems provide habitats to nearly half of the endemic bird species and the largest concentrations of terrestrial wild animals (Niamir *et al.*, 2012, Western *et al.*, 2009). In addition, there are more than 270,000 plant species supporting diverse ecosystems in rangelands globally (Ullah and Rashid, 2014).

In East Africa, range plants have been used for medicine, timber, fodder and shade on the farms and in cultural rights and sites (Maitima *et al.*, 2009; Ullah and Rashid, 2014). Plant resources are important sources of forage providing vital essential elements to herbivores among them energy, protein, minerals and fibre (Ullah and Rashid, 2014). The Amboseli Ecosystem in Kajiado County of Southern Kenya's rangeland, is a semi-arid savanna environment where water availability is highly seasonal and an important factor determining the structure and efficiency of large mammal community (Western, 1975). The area has swamps which supply adequate water and considerable forage and act as incredible concentration areas for up to 90% of all wildlife during dry season (Western, 2000).

Most pastoral households in the area have settled at strategic vantage positions to allow access to wetlands during the dry spells. This has enabled them to access year round pastures and thus

reduce livestock losses associated with pasture and water scarcity during droughts. Wetlands found in the rangelands are vital for survival of livestock, wildlife and human beings as they provide diverse and important functions, such as habitats for wildlife, food chain support and stabilization mechanisms. In addition, they also support ground water recharge and discharge, nutrient cycling and support of other ecosystems (Githaiga *et al.,* 2003). Wetlands provide late season forage reserves to livestock and wildlife which congregate around them during the dry seasons and droughts. More also, aesthetic value of wildlife in rangelands generates income to local communities through tourism (Western and Nightingale, 2003).

2.2 Trends in rangeland resource

Most rangelands in Africa have increasingly been converted to croplands (Lambin *et al*., 2001; Tsegaye *et al*., 2010). The percentage land cover under natural vegetation which supported extensive livestock production experienced major declines between 1700 and 1990 (Tsegaye *et al*., 2010). Tsegaye *et al*., (2010) estimated the extent of global land cover change from woodlands and forests to croplands to be from 4.7 million km^2 to 6 million km^2 since 1850 to date.

In Kajiado County of Kenya, pastoral and wildlife dispersal areas have been converted to settlements leading to increase in cultivation (Morara *et al*., 2014). Kioko and Okello (2010) reported major changes in the Amboseli Ecosystem over the last three decades. The changes include increase in frequency of drought, soil erosion, human population, as well as decline in amount of rainfall, number of livestock, grazing land, herbaceous cover quality and quantity. Common disturbances like droughts, flooding and other disasters like disease outbreaks have become recurrent in the Amboseli area in the recent years (Table 2.1). Extreme droughts as those

experienced in Kenya during 1973 – 77 and 1983 – 84, are accompanied by huge livestock losses, which greatly undermine wellbeing of pastoral households (Western, 2000).

Table 2.1: A timeline of drought and other disasters in Kajiado County

Period	Events	Impacts
1890-92	Major drought and cattle disease	About 90% of livestock lost
1909	Outbreak of East coast fever (ECF)	undocumented
1911-12	Migration of Masaai population from Laikipia to southern Kenya	Large livestock losses
1918	Drought and diseases	undocumented
1925-27	Severe drought	Famine and 15% cattle lost
1929	Severe drought	Approx. 50,000 cattle lost
1933-35	Severe drought	Famine approx. 35% livestock lost
1938-39	Drought	undocumented
1943-46	Severe drought	Famine
1948-50	Failed rains, diseases outbreak	undocumented
1952-55	Drought followed by floods	70-90% cattle mortality
1960-61	Severe drought	Famine 50-70% livestock lost
1963	Flooding	undocumented
1973-74	Drought	35-40% livestock lost
1976	Severe drought	Food shortage
1983-84	Severe drought and ECF outbreak	50-70% livestock lost
1986	Disease outbreak	undocumented
1989	EL Nino event	undocumented
1991-92	Drought	undocumented
1995-96	Severe drought	Famine
1998	El Nino event	Flooding
1999-2000	Drought	50% cattle lost
2005	Severe drought	85% livestock lost
2006	El Nino	undocumented
2009	Severe drought	85% livestock lost
2010	El Nino	Flooding

Source: Carabine, (2014)

2.3 Use of local knowledge in assessment and management of range resources

Mugabe *et al.,* (2001) describes local knowledge as the totality of all knowledge and practices used in the socioeconomic and ecological aspects of life. It is applied in daily life in many developing countries in various social aspects including food security, development and problem solving (Correa, 2001). It has played a key role in economic and cultural development of human kind for many years (Ghorbani *et al.,* 2013). Local knowledge also known as indigenous knowledge (IK), is a recent growing field of inquiry both nationally and internationally as an extensive and valuable knowledge system (Battiste, 2005). It is verbally transmitted from one generation to another and has been used for many centuries by indigenous communities. Over the years, local knowledge has been applied by the pastoral communities to monitor range and livestock condition. It enables local resource users to make useful judgments on the status of range resources to guide sustainable use.

2.4 Drivers of land use changes in rangeland ecosystems

The driving forces of land use change are complex and linked to each other as they evolve over time (Olson *et al.,* 2004). The causes are multifaceted as they take different forms in different landscapes. The causes and processes are influenced by interacting biophysical and societal factors and the management strategies employed by the landscape inhabitants. Western *et al.,* (2009) highlighted that in the recent decade, East Africa megafauna declined sharply due to rising human and livestock populations, settlement pressure, land developments, cultural change, poaching and commerce. Biotic diversity are greatly affected by changing land use and land cover which have a great impact on the climate of landscapes which later affects soils leading to land degradation (Lambin *et al.,* 2001). Habitat loss has been a major crisis affecting biodiversity

and has been a key determinant to predicting extinction and threatened species in biodiversity hotspot (Falcucci *et al*., 2007). The major causes of land use change are discussed below.

2.4.1 Demographical factors

Population increase has been an important driver of the observed trends in land use land cover. Msoffe *et al*., (2011) and Okello and Kioko (2010) observed that population increase in the rangelands is driven mainly by natural growth and immigration of other ethnic communities. Many rangelands across the world have experienced population increase as people migrate, settle and open up the grazing lands for agricultural activities. In Kenya, Kajiado County exemplifies such rangelands that have experienced great changes in tenure and population growth in the last four decades (Campbell *et al.*, 2005, Ntiati, 2002). Population increase in the County has increased in high potential ranges such as Ngong hills, Loitoktok, Rombo, among others (Campbell *et al.*, 2003). The immigrants who come from already overpopulated high potential areas in Kenya mainly practice crop cultivation as their key source of livelihood (Campbell *et al.*, 2003).

2.4.2 Economic factors

The ethnic composition of the semi-arid area of Amboseli has changed with immigration of different cultural groups, resulting in integration of new lifestyles and practices among pastoral communities, some of which have led to opportunities for economic diversification (Western 2000). Okello and Kioko (2010) noted that agricultural activities have increased in the rangelands in Amboseli Ecosystem. Urbanization in rangelands is minimal as described in Lambin *et al*., (2001) but the linkages between urban and rural societies bring up issues of land use land cover change. The observed rise in business centres and market places in the rangelands is a clear indication of increased trade in pastoral areas. Business centres have created market

days where pastoralists who subsisted on livestock now get involved in buying and selling of their livestock to purchase other commodities including agricultural products. Through capacity building, pastoralists have diversified their economies through formal and informal employment. The tourist facilities both within the protected, unprotected and private areas have provided alternative livelihood options to the local communities in rangelands. As noted by Serneel and Lambin *et al.*, (2001), increased awareness on the importance of education has provided alternative jobs to many pastoralists through formal employment.

2.4.3 Cultural factors

Customary institutions are gradually losing their importance in natural resource governance as the traditional communities embrace modern lifestyle (Western, 2000). The erosion of traditional herding practices is accelerated leading to loss of rangeland use governance and other adaptive husbandry practices (Western and Nightingale, 2003). In a study carried by Okello (2005), the changing attitudes of Maasai towards wildlife conservation are the driving forces for land subdivision and fragmentation around Amboseli. The restricted use of traditional drought reserves by the locals due to the establishment of Amboseli National Park has led to resentment and limited support for wildlife conservation by the community. Dislike of wildlife by local communities and loss of value to their culture has contributed to changing land use options. Changing pastoral lifestyle as a result of interactions with neighboring communities has led to supplementation of their diet of milk, meat and blood with agricultural products. This change has resulted in transformation from pure pastoralism to other forms of land use such as agro-pastoralism with adverse implications on the rangelands.

2.4.4 Climatic factors

Whereas climate change affects all sectors of the economy, it is particularly a concern in the already vulnerable arid and semi-arid lands where it has adversely impacted on water and grazing resources that support extensive livestock production. Altmann *et al*., (2002) reported increasing daily temperatures and fluctuating rainfall pattern in Amboseli Ecosystem since 1976. Highly variable rainfall and temperature in the drylands demonstrated by recurrent droughts have significant effects on the structure, composition and densities of flora and fauna in various range habitats (Kideghesho *et al*., 2013). Transition between woodland and grassland, although mainly driven by biotic factors like heavy browsing by large ungulates, fire, invertebrates, pathogens, and natural succession, is to a great extent exacerbated by climate change. Combinations of climatic and anthropogenic factors that include overgrazing and drought, and poor resource governance have adverse effects on land use and land cover changes (Werber and Horst, 2011).

2.4.5 Globalization and urbanization effects on rangelands

As described in Olson *et al.,* (2004), globalization entails variety of events and processes which affect land use. The authors explain that rapidly changing international and national markets for agricultural products and changing national access to international markets affects land use. Increased competition between and within countries that produce marketed products has led to employing large tracts of intact rangelands. Economic diversification and international influence on national policies further stirs up the changing land use in the rangelands (Olson *et al.,* 2004). This has a negative impact on biodiversity and the different habitats which are very essential for the survival of pastoralists who rely on natural resource base for livestock production. In addition, the sprawling of urban centres increasingly observed in Amboseli rangelands has reduced land for grazing over the years.

2.4.6 Technological factors

Developments in the rangelands such as water provisioning, medical services and social services in rangelands contribute to population growth of pastoralists and land shortage (Western and Nightingale, 2003). Basic amenities like electricity and access roads connecting to business centres leads to major reduction in land cover (Morara *et al.*, 2014). Transformations due to residential and urban development, as well as bush encroachment lead to range degradation rendering land unproductive for pastoralism (Hobbs *et al.,* 2008).

2.5 Ecological and economic importance of pastoralism in rangelands

Pastoralism is the main livelihood in most rangeland regions in Africa providing livelihoods to millions of people (Nkedianye *et al.,* 2011). The systems range from pure nomadic and semi nomadic to sedentary production systems (Riginos *et al.,* 2012). In pastoral communities, livestock serve as wealth accumulation, social prestige, social security, for marriage gifts and debt payment (Bekele and Kebede, 2014). Sale of livestock also provides income to pastoralists (Nyariki *et al*., 2009). In addition, pastoralism provides direct values like milk, beef, hides for subsistence and export as well as indirect values like income from tourism, sustainable land use and biodiversity conservation (Hesse and MacGregor, 2006).

Pastoralism maintains indigenous plants and bird species more effectively than crop cultivation and any other land use system as it is cognitive of the spatial and temporal heterogeneity and is designed to harness resources that are unevenly distributed through mobility. As observed by Hobbs *et al*., (2008), large herbivores grazing on rangelands has been the only sustainable way of turning solar energy into food for people as rainfall is insufficient to sustain arable agriculture in the arid and semi-arid rangelands.

2.6 Effects of land use change on pastoral livestock production

Land use changes in the rangelands from nomadic pastoralism to sedentary pastoralism have adversely affected pastoral livestock production (Nyariki *et al*., 2009). The changes have led to reduction in herd mobility, grazing land, household livestock holdings, with adverse impacts on pastoral livelihoods. The vast lands which supported large livestock herds have reduced due to subdivision and fragmentation. In addition, they have deteriorated and lost initial productivity making them unable to support and sustain the large herds. Sedentarization of pastoralists reduces their mobility which results in degradation around key resource patches, and consequently vulnerability of the pastoral households to droughts and other shocks (Kirwa *et al*., 2012). Vegetation clearing in the rangelands to pave way for settlement and other development reduces land for grazing. Loss of livestock due to shrinking rangelands has resulted in increased poverty and vulnerability for pastoral households and erosion of their resilience against future shocks in the drought prone savannas of Zimbabwe (Moyo *et al*., 2013).

Land use and land cover changes have been major global concern to conservationists and researchers (Msoffe *et al.*, 2011). Land use change has great impact on livestock base as it reduces grazing areas affecting food security for the pastoralists. Current and future expansion of cropping in these lands is expected to replace savanna vegetation viable for grazing in the rangelands (Olson *et al.*, 2004). The expansion of cultivation in Kenyan rangelands has led to restriction of pastoral herd mobility in the recent decades (Amwata, 2013.

Traditionally, flexibility in accessing the varied resources enabled efficient and sustainable utilization of rangeland ecosystems. However, misconceptions on the poorly misunderstood pastoral production have been pushing for land subdivision and fragmentation in the rangelands in most parts of the world (Sendalo, 2009) therefore making herd mobility difficult. Continuous

grazing on small and fragmented parcels of land leads to loss of vegetation and subsequently soil erosion. This has undesirable effects on the rangelands productivity as it impairs functional characteristics of plants, leading to loss of vegetation impacting on rangeland health (Okello *et al.,* 2011).

Pastoralism is on decline partly because of land scarcity and corresponding decline in water availability. High cost of livestock production, limited ready livestock markets, loss of herding labor and erosion of customary pastoral practices amplify the effects of changing land reforms in the rangelands (Okello, 2005). More also as grazing pressure increases, desirable grass species decline leaving increaser species of low forage quality and quantity, which are less preferred by livestock and wild animals, further impacting the pastoral economy (Okello *et al.,* 2011).

The consequences of sedentarization of pastoralists include degradation of the vegetation and soil that leads to loss of productivity as has been observed in some areas of the Amboseli rangelands (Western, 2000), with adverse impacts on pastoral livelihoods (Hobbs *et al.,* 2008). As reported by Western *et al*., (2015), Amboseli ecosystem has lost productivity and this is evident in the low biomass production per unit of rainfall in the recent years. Unsustainable use through overstocking and overgrazing has great impact on the biodiversity of the area, consequently affecting the natural resource base. This further makes the Maasai pastoralists more vulnerable to the changing land use as their livestock do not get sufficient pasture to sustain production.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 STUDY AREA

3.1.1 Location and geographical characteristics

The study was conducted in the Amboseli ecosystem located in Kajiado County in the southern Kenya. The ecosystem comprises Amboseli National Park and surrounding group ranches. The group ranches include Olgulului, Kimana, Mbirikani, Kuku A and B, Eselenkei and Rombo group ranches.

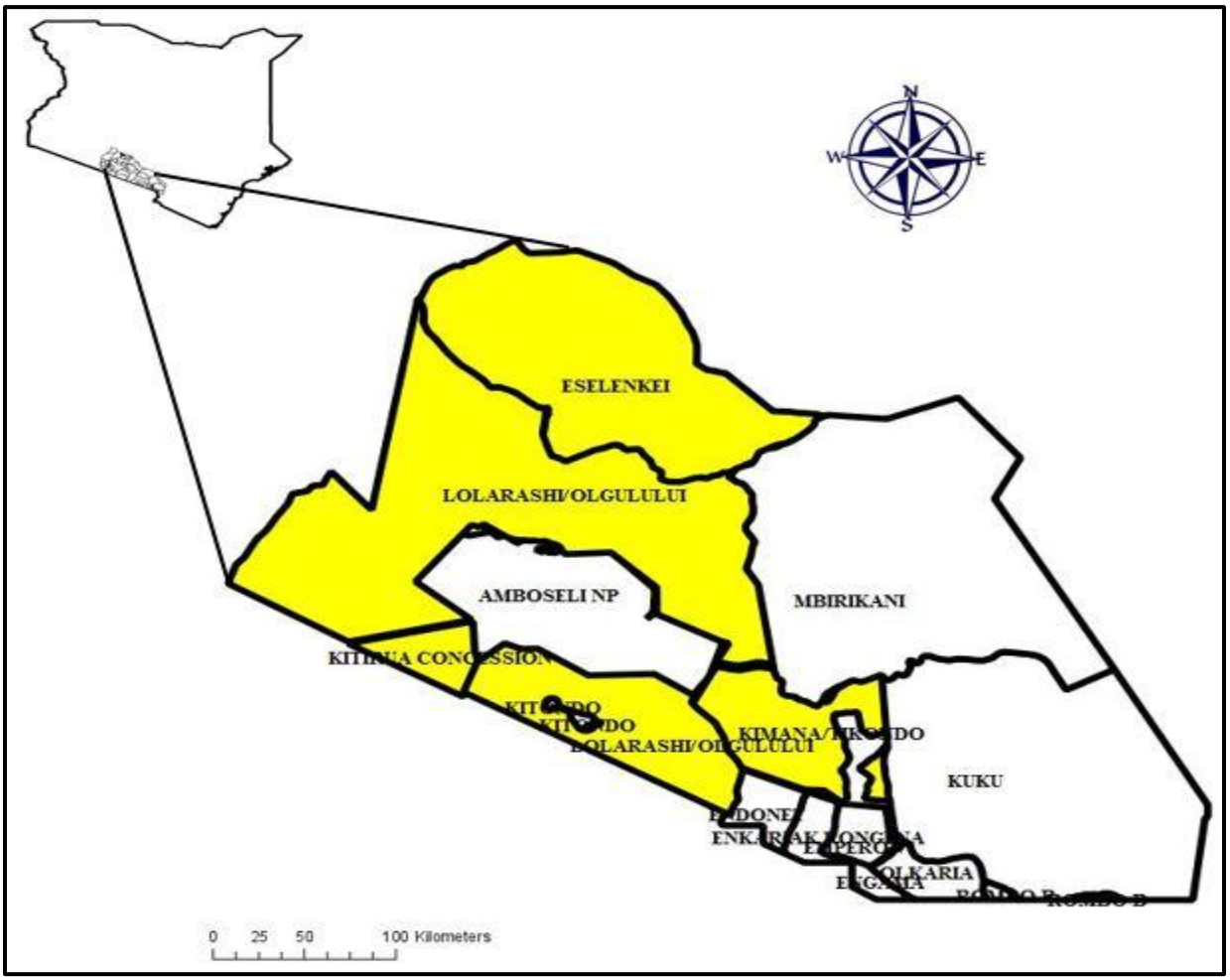


Figure 2.1: Map of the Amboseli Ecosystem

The ecosystem covers almost 3000 km^2 with a 600 km^2 dry season grazing reserve in and around Amboseli basin (Western, 1975). Western and Maitumo (2004), describes the basin as a dried out pleistocene lake lying 1200 m above sea level. It falls on the Kenya side of Tanzania border immediately north of Mt Kilimanjaro (Western, 2006).

3.1.2 Climate

The ecosystem is semi-arid (Agro-climatic zone VI) characterized by a warm and dry climate with temperatures fluctuating between 14^{o}C and 30^{O}C (Kioko and Okello, 2010, Kioko *et al.*, 2012). Temperatures vary seasonally and range as high as 35^{o}C in February and as low as 12^{o} C in July (Okello and Kioko, 2011). There are two rain seasons with short rains occurring between October and December and long rains between March and May, and the annual rainfall ranges between 250 and 300 mm (Okello *et al.*, 2011). The rainfall of the area is low, erratic, unpredictable and unreliable. Large variations in rainfall occur in time and space which depicts the complex patterns related to the equally complex physical features in the study area. Due to the low and unreliable rainfall, most parts of the study area cannot sustain rain-fed agriculture.

3.1.3 Soils and Water resources

The soils vary depending on the terrain and altitude. They are young and undeveloped poor in nutrients and susceptible to erosion (Kioko *et al.*, 2012; Mose *et al.*, 2013). Western and Maitumo (2004) define Amboseli basin soils as alkaline and locally saline. Permanent water sources in the area are a few springs in Namelok area, Isinet and Kimana area and in the Lake bed of Amboseli basin in the protected area. Swamps are fed by underground aquifers that are recharged by water from Mt. Kilimanjaro and run-off during wet season. The swamps serve as dry season grazing reserve for both the wildlife and livestock (Okello and Kioko, 2011; Mose *et al.*, 2013).

3.1.4 Vegetation

The various vegetation classes include dense and open woodland and bushed grassland, grassland and dwarf shrub grassland swamp edge and permanent swamps (Western, 2006, Kioko *et al.*, 2012)). The area is dominated by *Acacia xanthophloea* and *Acacia tortilis* and *Commiphora* species. *Azima tetracantha* and *Sueda monoica* occupy the lowlands. Reduction in the woodland has been observed in the ecosystem due to human encroachment and agriculture expansion (Okello and Kioko, 2010). Western and Maitumo (2004), points out habitat change as a result of livestock overgrazing, elephant destruction and climate change and variability.

3.1.5 Wildlife

The ecosystem has a large population of elephants (*Loxodonta africana*), zebras (*Equus burchelli*) and wildebeest (*Connochaetes taurinus*), with a rich carnivore population of lions (*Panthera leo*), hyenas (*Crocuta crocuta*), cheetahs (*Acinonix jubatus*), leopards (*Panthera pardus*) and jackals (*Canis aureus*) (Okello and Kioko, 2011). During the 2009 drought and aftermath, depredation rate was high on livestock due to the high mortalities of wild ungulates. The diverse and complex habitats are also home to over 400 species of birds. The high relative densities and species richness of wildlife in the ecosystem has made the area a top tourist destination in Kenya.

3.1.6 Local community and their livelihoods

Amboseli area is inhabited by the Maasai pastoralists who mostly keep cattle, goats, sheep and donkeys. The population is low and sparsely populated but recently human settlement has increased along rivers, swamps and shopping centres and other social amenities within the area. Growth of towns and business centres in the ecosystem has also been observed. Pastoralism has been the most viable land use system alongside wildlife conservation in the area. However,

following settlements of most households, a number now practice farming along rivers and swamps initially used as dry season and drought reserves. Important characteristics of some of the group ranches in the study area are shown in Table 3.1.

Table 3.1: Key characteristics of the sampled group ranches in Amboseli Ecosystem

Attribute	Kimana G.R	Olgulului G.R	Eselenkei G.R
Division	Loitoktok	Loitoktok	Loitoktok
Land tenure	Private	Communal/private	Communal
area		Approx 1570km^2	Approx 800km^2
Ethnicity	Ilkisonko Maasai +other tribes	Ilkisonko maasai	Ilkisonko Maasai
Group ranch members	843	3418	1250
Main livelihood	business, cultivation and livestock production	Livestock based with some range of cultivation, tourism and business	Livestock production
Main Land use site	Sedentary	Semi nomadic	Nomadic

3.2 RESEARCH DESIGN

The study area was stratified into nomadic, semi nomadic and sedentary land use sites, based on the dominant land uses pre-determined by Campbell *et al*., (2003). These land use types also represent different land tenure transformations, with nomadic site being predominantly undivided, and semi nomadic and sedentary sites partially and exclusively subdivided into private parcels of land respectively.

The periods under study included pre-park (1967-1976); pre-settlement (1977-1986); post settlement (1987-2006) and post 2009 drought (2009 – 2015) period. The four historic periods were chosen to match the main changes in land cover and land uses partly contributed by changing land tenure and pastoral practices documented by the Amboseli Conservation Program

(ACP), a Non-Governmental Organization that has been conducting ecological monitoring in the area since 1967 (Western and Nightingale, 2003; Western and Maitumo, 2004; Western, 2006).

Multi stage sampling method was used to select the study sites and respondents. In the first stage, preliminary surveys and interviews in the study area were used in selecting the study sites, which formed the clusters. The clusters included three land use sites namely, nomadic (Eselenkei group ranch), semi-nomadic (Olgulului group ranch) and sedentary (Kimana group ranch). Nine villages were randomly selected, three from each land use site in the second stage. One hundred and twenty respondents from nomadic, 131 from semi-nomadic and 83 from the sedentary land use site were randomly selected for individual interviews in the third stage, making a total of 334 respondents.

Three FGDs were conducted, one in each site, aimed at soliciting community perceptions on the extent of resource change over time. The participants who included youths, elderly men and women practicing varied economic activities, were identified with the support of village elders, based on their knowledge on environmental changes and familiarity with the landscape. Each group of ten was composed of three older men (above 70 years), two younger men (18 to 60 years), two older women (above 70 years), and three younger women (18 to 60 years), from across the three land use types. The young men and women were useful in sketching the resource mental maps, in addition to contributing information about resource changes for the past twenty years. The older men and women gave information on the status of resources during pre-park and pre-settlement periods. The participants were separately guided through discussions on the extent of land use and land cover change (LCLCC) observed in pastoral resources and their perceived causes over the last four decades.

3.3 SAMPLE SIZE DETERMINATION

The target populations of interest for this study were the registered group ranch members who represented respondents from each of the three land use sites sampled. Each member in the target population was given an equal and independent chance of selection. According to Mugenda and Mugenda (2003), a 10% of the target population is considered minimum, which was applied in selection of the subjects to be interviewed for this study. The information gathered from the sampled subjects of the survey was used to generalize the population of interest. The registered group ranch members are shown in Table 3.1.

CHAPTER FOUR: COMMUNITY PERCEPTIONS ON SPATIO-TEMPORAL CHANGES IN PASTORAL RESOURCES IN THE AMBOSELI ECOSYSTEM, SOUTHERN KENYA

SUMMARY

Resource changes observed in rangeland ecosystems have triggered a myriad of ecological, social and economic dynamics, often with adverse implications on pastoral livelihoods. This study applied an integrated approach using local knowledge and spatial technologies to assess the long term changes in pastoral resources, and their implications to pastoral livelihoods in Amboseli ecosystem in Southern Kenya. Reduction in grazing land was perceived by the community to be the main change in pastoral resources that has occurred over the 40 years period. The decline in grazing land was reported to be more pronounced under sedentary (50%) and semi nomadic (47%) land uses than in the nomadic pastoral land use sites (30%). This trend was attributed to expansion of cultivation and settlements, which increased by 26% and 17% respectively in sedentary and 17% and 12% respectively in semi nomadic during the period under study, due to land tenure changes. The use of participatory resource mapping provided an entry point for eliciting community perceptions of problems facing them to guide sustainable resource planning and action at a local level.

Keywords: community perceptions, land use type, land use and land cover changes, rangeland resource trends.

4.1 INTRODUCTION

Globally, over 200 million pastoral households and over one billion livestock herds that include camel, cattle, sheep and goats are supported by the rangeland ecosystems (Alkemade *et al.*, 2011; Dong *et al.*, 2011; Bekele and Kebede, 2014). Rangelands are often referred to as pastoral lands,

because pastoralism characterized by extensive livestock production is the main land use activity in these areas. They provide daily and seasonal forage, water resources and breeding grounds to large concentrations of terrestrial wild animals and livestock (Curtin and Western, 2008; Western *et al.*, 2009; Niamir *et al.*, 2012; Mbau, 2013).

Rangeland ecosystems consist of various resources with many ecological, social and economic values (Little and Mcpeak, 2014). The key resource areas as described by Worden *et al*., (2003) and Ngugi and Conant (2007), form the fundamental components that influence ecological patterns and processes in the rangeland ecosystems. The key resource patches include dry and wet season grazing areas, variety of habitats, salt licks, watering points, and migratory corridors, which link seasonal grazing areas with settlements and markets (Behnke and Freudenberger, 2013)

Rangelands are undergoing land use and land cover changes, mostly through conversion to croplands and human settlements (Tsegaye *et al*., 2010). Worldwide, an estimated 4.7 million km^2 of grassland and 6 million km^2 of woodland have been converted to croplands since 1950 (Tsegaye *et al*., 2010). In Kenya, land use changes in rangelands have been mostly attributed to permanent settlement by pastoral communities as a result of population growth and partly to the establishment of protected areas in Kenya since the 1940s (Kioko and Okello, 2010; Morara *et al*., 2014). The result is curtailed mobility of pastoral herds which undermines extensive livestock production in the rangelands.

In Kajiado County, wildlife dispersal areas have been converted to settlements, leading to increases in croplands, fragmented habitats and reduction in riverine vegetation (Campbell *et al*., 2005; Morara *et al*., 2014). The Amboseli Ecosystem in Kajiado County exemplifies the changes observed in most Kenya's rangeland ecosystems. Some of the resource changes reported in

Amboseli include declining habitat diversity, loss of woodlands and decline in range productivity (Western and Van Praet, 1973; Western, 2006; Western and Maitumo, 2006; Western *et al*., 2015; Kioko and Okello, 2010). The changes are affecting the provision of ecosystem services such as forage production and supply of raw materials, impacting negatively the pastoral livelihoods (Caldas *et al.*, 2015). The long term resource changes have resulted in a number of challenges, including restricted livestock mobility, decline in grazing areas and increased conflicts over natural resources (Egeru *et al*., 2014). Restricted mobility is known to lead to increased grazing pressure that predisposes soil to erosion and lowers rangeland productivity and consequently livestock production (Msoffe *et al*., 2011).

Traditional institutions which regulated rangeland resource use for centuries are increasingly becoming ineffective, leading to deterioration of range ecosystem services. Traditionally, resource monitoring and assessment by the local communities enabled good judgment on sustainable utilization (Ghorbabi *et al*., 2013). Although rangeland monitoring and assessment by local communities has been shown to be effective in tracking resource dynamics, combining local knowledge and practices with conventional approaches gives a better understanding of rangeland ecosystems (Msoffe *et al*., 2011; Dabasso *et al*., 2012; Suleiman and Ahmed, 2013; Belay *et al*., 2014). As indicated by Angassa *et al*. (2012), seeking perceptions of local communities on LULCC and pastoral resources over time is crucial in devising proper management systems for sustainable use of arid and semi-arid landscapes.

This study was therefore conducted to understand community perceptions on spatio-temporal dynamics of pastoral resources in the Amboseli Ecosystem. The participatory approach was considered an entry point for local involvement in-perceiving their problems and designing sustainable land use and natural resource practices.

4.2 DATA COLLECTION AND ANALYSIS

Participatory mapping of resource changes over the past 40 years was done with the community to provide the past and current extent of various resource patches in the different land use sites during the period under study as described in Chapter three of this thesis. The community identified grazing land, settlements, cultivated, bare land and trading centres for each of the three land use sites under study separately. The participants of the community resource mapping exercise were asked to sketch the changes across the areas they used within the Amboseli Ecosystem for the period between pre-park and post 2009 drought. The mapping process began with the most recent, the post 2009 drought period, followed by post settlement, pre-settlement and pre-park period in that order. Physical features like roads, schools, springs and boreholes acted as reference points to identify the extent of the various land use and land cover types during the periods under study. After resource mapping, field observations guided by key informants selected during the mapping exercise were conducted along transects to identify the mentioned resources and physical features in each site.

The twelve drawn community resource maps, four from each site were scanned using a digital camera and geo-referenced using Quantum Geographical Information System (QGIS) software version 1.8.0. Five coordinates collected in the specific study sites during field observations were used as control points to guide the geo-referencing exercise. The key features and locations on the geo-referenced images were retraced onto overlaid shapefiles as polygons, lines and points representing the four study periods for the three sites. The extents of the perceived resource changes over the study periods were determined from the maps using QGIS. The data was then transferred to excel to generate the graphs and tables showing the extent of resource changes.

Chi-square goodness of fit test was used to determine whether the extent of the resource changes over time differed significantly over the study periods (Okello and Kioko, 2010).

4.3 RESULTS

4.3.1 Resource changes in nomadic land use site

The resource trends in the nomadic land-use sites during the pre-park to post 2009 drought period are presented in the community mental maps in Figures 4.1 and 4.2 Grazing areas ($\chi 2 = 55.50$, df = 3, $p < 0.001$) and livestock routes ($\chi 2 = 35.85$, df = 3, $p < 0.001$) were reported to have declined significantly over the last four decades. The maps show that settlements increased from 98.7 km^2 during pre-park period to 279.3 km^2 in the post 2009 drought period.

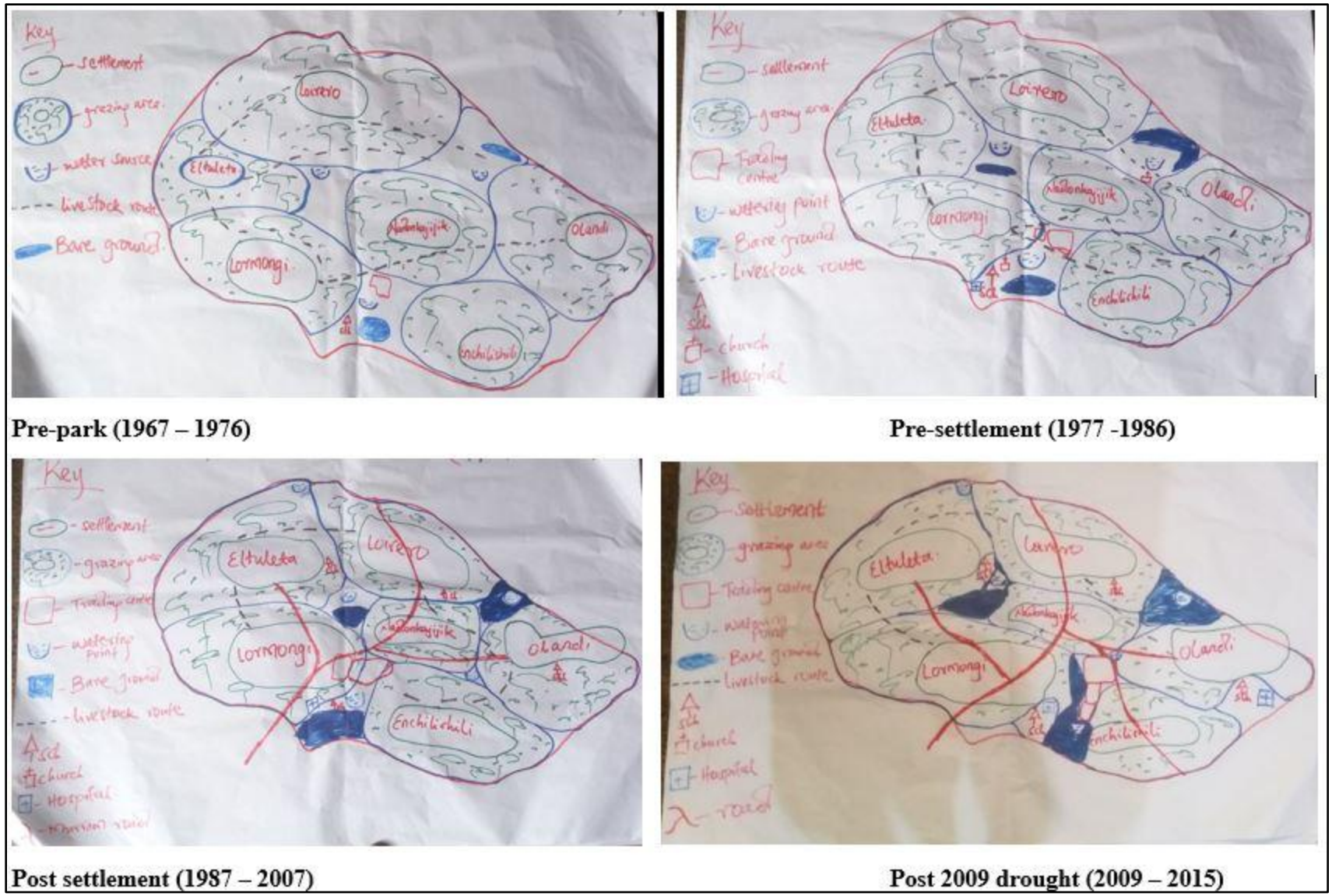


Figure 3.1: Pastoral resource change maps for nomadic land use site

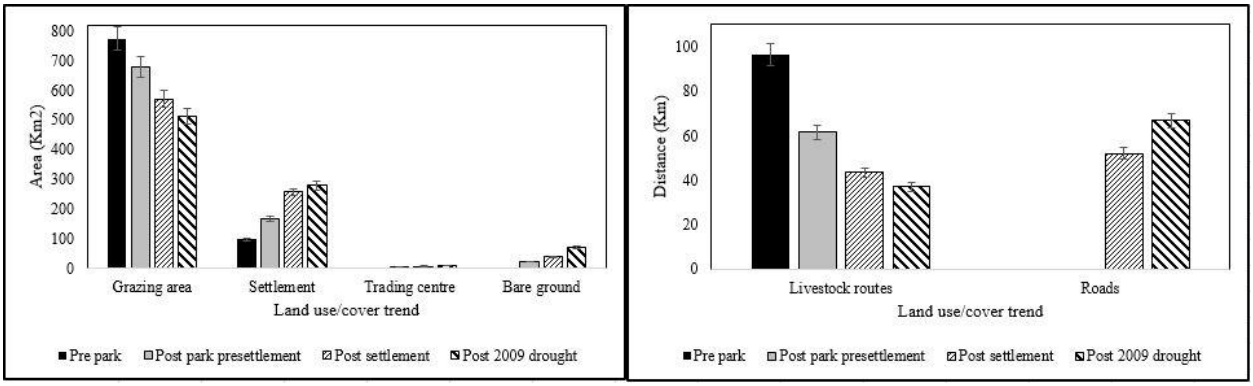


Figure 4.2: Land use and land cover changes in the nomadic land use site

Estimations derived from the resource maps drawn by the community showed that grazing land declined by 30% and settlements increased by 21% over the last four decades (Table 4.1). Routes used for daily livestock grazing and migration declined by 38% over the same period. Trading centres increased from nearly zero to 1% of the area between pre-park and the post-2009 drought period.

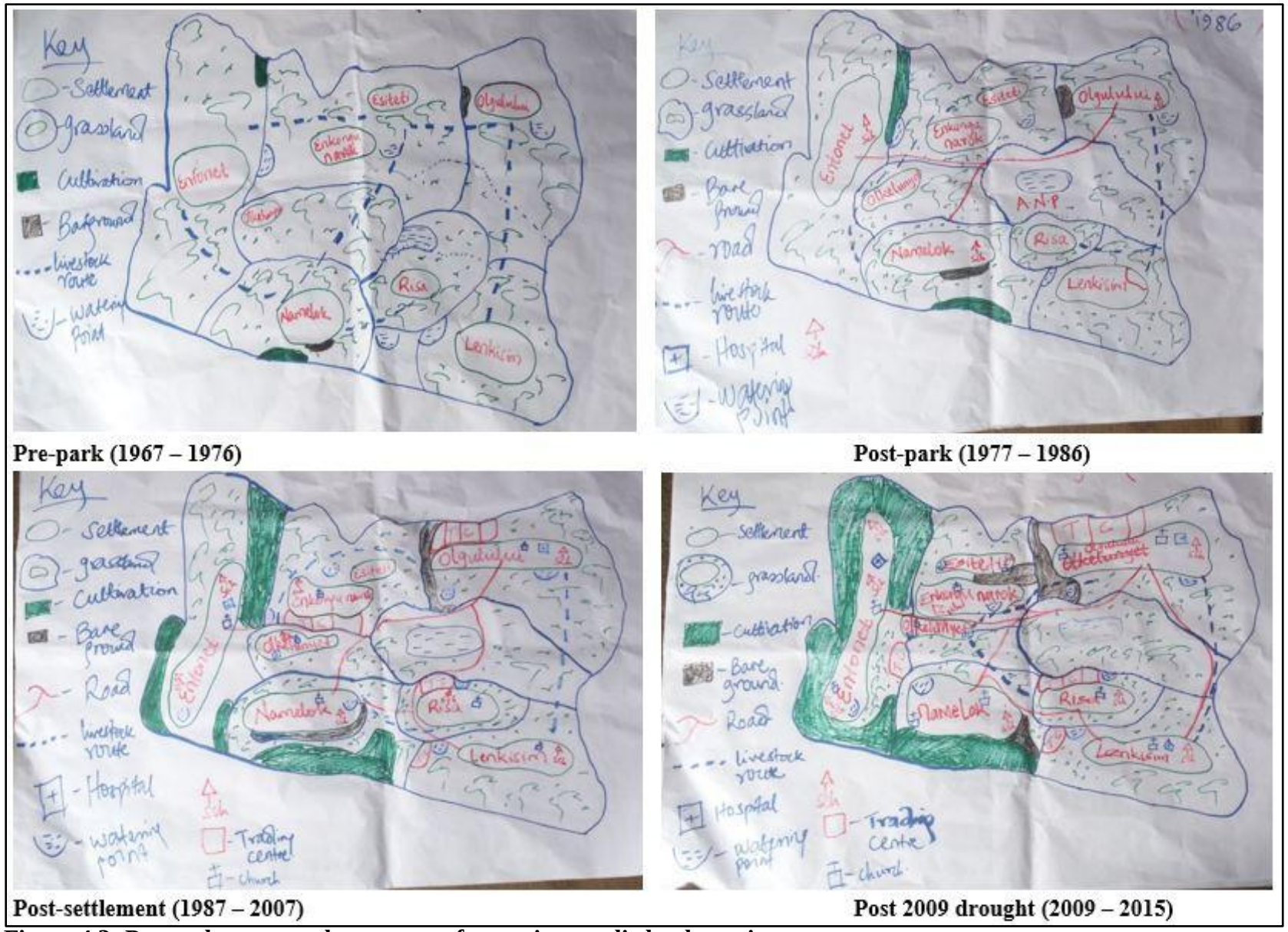
Table 4.1: Extent of resource changes derived from the resource maps for nomadic land use site

Resource/cover	Percent changes in pastoral resources between 1967 and 2015			
	Pre park - Pre-settlement	Pre-settlement - post settlement	Post settlement - Post 2009 drought	Pre park - Post 2009 drought
Grazing area	-10.9	-12.4	-6.5	-29.8
Livestock routes	-36.0	-55.0	-61.7	-38.3
Settlement	7.8	10.2	2.5	20.6
Trading centre	-	0.3	0.4	0.7
Roads	-	-	28.7	28.7
Bare ground	2.3	1.8	3.6	7.7

4.3.2 Resource changes in semi-nomadic land use site

Figure 4.3 shows the perceptions of the community on resource changes in the semi-nomadic land use site over the last four decades. Crop cultivation was shown to have started in the post-

park period (1976- 1986) and trading centres emerged during the post settlement period (1987 – 2007). Whereas the grazing land ($\chi 2 = 391.4$, $df = 3$, $p < 0.001$) and livestock routes ($\chi 2 = 44.73$, $df = 3$, $p < 0.001$) decreased as shown in Figure 4.4, areas under cultivation ($\chi 2 = 487.71$, $df = 3$, $p < 0.001$); settlement ($\chi 2 = 76.15$, $df = 3$, $p < 0.001$); trading centres ($\chi 2 = 146.77$, $df = 3$, $p < 0.001$); bare ground ($\chi 2 = 38.83$, $df = 3$, $p < 0.001$) and road infrastructure ($\chi 2 = 104.24$, $df = 3$, $p < 0.001$) were reported to have increased significantly over the last four decades.



Pre-park (1967 – 1976)

Post-park (1977 – 1986)

Post-settlement (1987 – 2007)

Post 2009 drought (2009 – 2015)

Figure 4.3: Pastoral resource change maps for semi-nomadic land use site

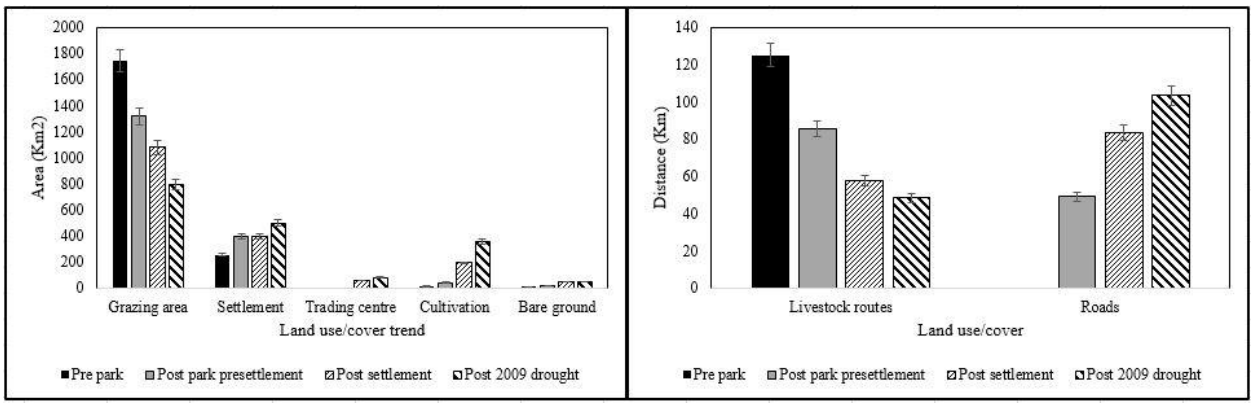


Figure 4.4: Land use and land cover changes in the semi-nomadic land use site

The extent of resource changes presented in Table 4.2 show that area under cultivation increased by 1.4% between pre-park and post park period, 7.5% between post-park and post settlement, and 8% between post settlement and post-2009 drought period, indicating an overall change of 16.8%.

Table 4.2: Extent of changes in resources derived from semi-nomadic land use resource maps

Resource/cover	Percent changes in pastoral resources between 1967 and 2015			
	Pre park - Pre-settlement	Pre-settlement - post settlement	Post settlement - Post 2009 drought	Pre park - Post 2009 drought
Grazing area	-21.1	-11.7	-14.1	-46.9
Cultivation	1.4	7.5	8.0	16.8
Livestock routes	-31.5	-32.9	-15.4	-61.1
Settlement	7.0	-0.1	5.0	11.9
Trading centre	0.0	2.9	1.1	4.0
Roads	-	70.0	23.7	110.3
Bare ground	1.0	1.4	0.1	2.0

Contrary to the increase in settlement and cultivation, grazing areas declined by 47% and the livestock routes linking seasonal grazing resources shrank by 61% thereby reducing herd

mobility. The road network was perceived to have increased by 110%, with 70% of the rise occurring between post-park and post settlement, and 24% between post-settlement and post-2009 drought periods.

4.3.3 Spatial and temporal resource changes in the sedentary land use site

The resource maps showed significant changes ($p < 0.001$) in range resources in the sedentary land use site. The long term changes included a decrease in grazing land ($\chi2 = 75.89$, $df = 3$, $p < 0.001$) and livestock routes ($\chi2 = 66.77$, $df = 3$, $p < 0.001$), a significant increase in areas under cultivation ($\chi2 = 124.55$, $df = 3$, $p < 0.001$), and trading centres ($\chi2 = 17.83$, $df = 3$, $p = 0.0005$). Livestock routes in the pre-park and post-park period were lost in the post-settlement and post-2009 drought periods (Figure 4.5). The trends in the various land use and land cover types in the sedentary land use site over the study periods are shown in Figure 4.6.

Over the last 40 years, the grazing land declined to a half by the post-2009 drought period in the sedentary land use site as illustrated in Table 4.3. The reduction was attributed to increases in cultivation (26%), settlements (17%) and trading centres (5%). Areas under cultivation increased by 26% over the study period. The number of watering points in the area increased from three in pre-park to 13 during the post-2009 drought period.

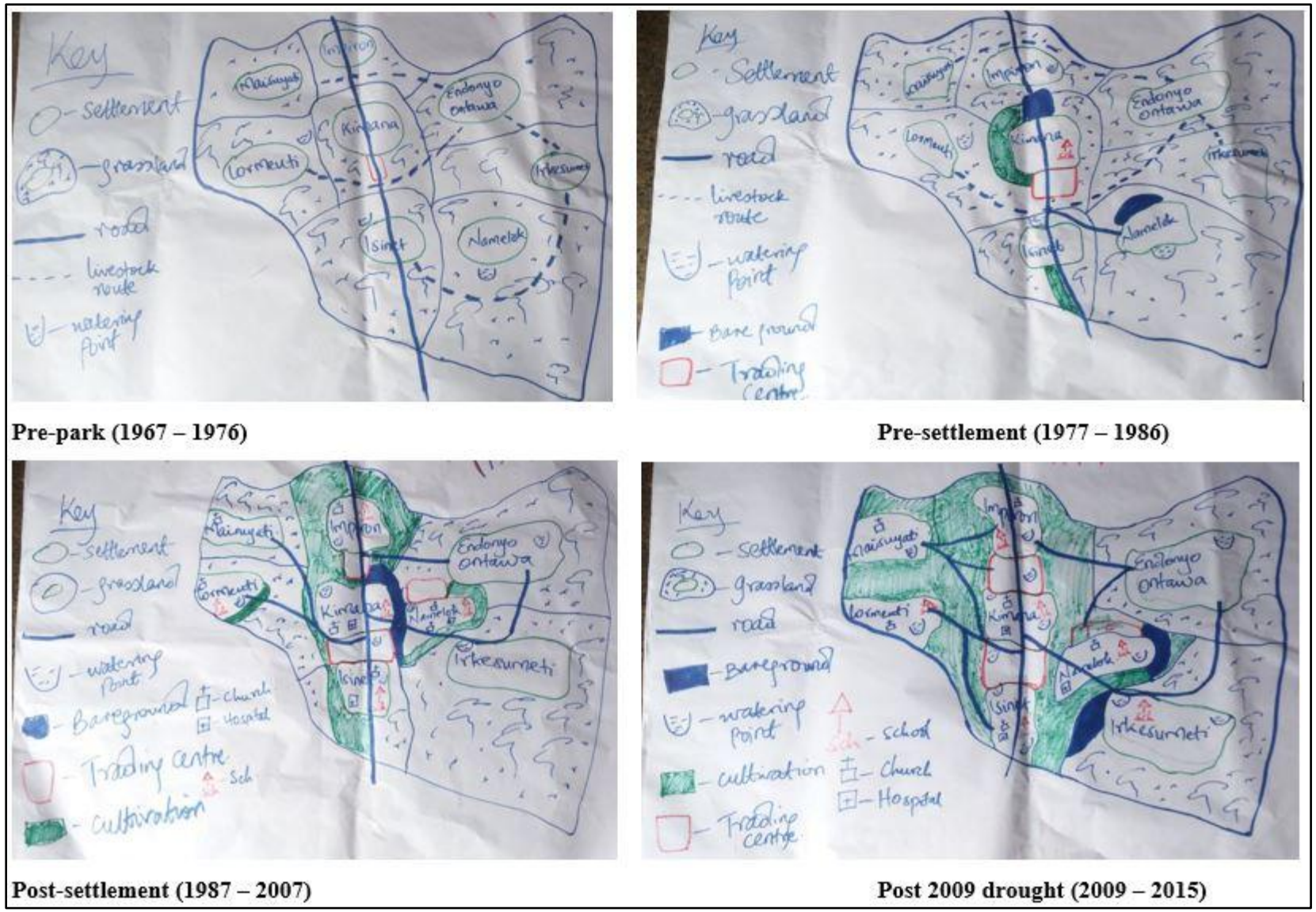


Figure 4.5: Pastoral resource change maps for sedentary land use site

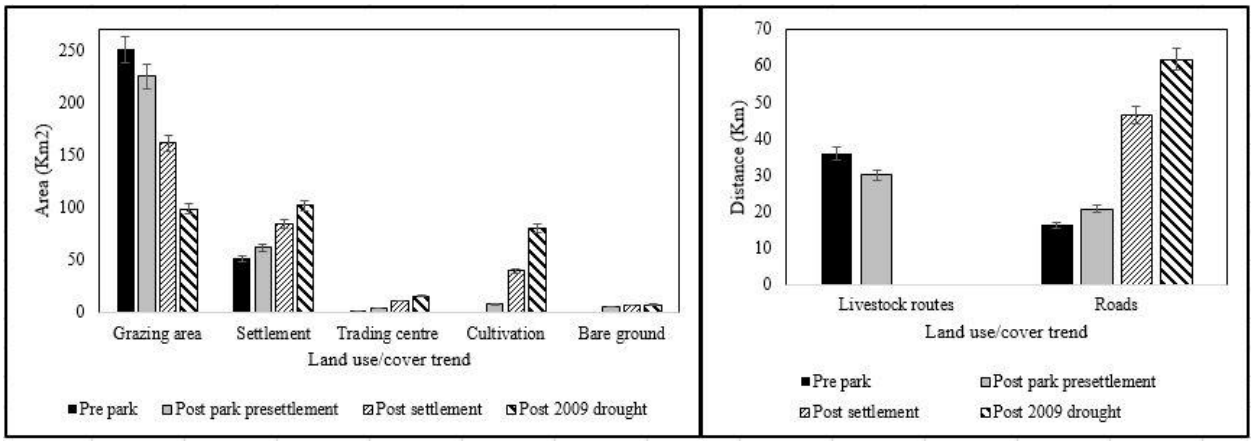


Figure 4.6: Land use and land cover changes in the sedentary land use site

Table 4.3: Extent of changes in resources derived from sedentary land use resource maps

Resource/cover	Percent changes in pastoral resources between 1967 and 2015			
	Pre park - Pre-settlement	Pre-settlement - post settlement	Post settlement - Post 2009 drought	Pre park - Post 2009 drought
Grazing area	-8.4	-21	-20.8	-50.0
Cultivation	2.6	10.4	13.3	26.4
Livestock routes	-16.3	-	-	-
Settlement	3.3	7.5	5.8	16.6
Trading centre	0.8	2.4	1.5	4.8
Roads	26.9	25.1	32.8	179.2
Bare ground	1.7	0.6	0.1	2.4

4.4 DISCUSSIONS

Pastoral resources were reported to have generally changed across the three land use types in Amboseli Ecosystem. The most notable changes were the reduction in the grazing areas in all sites and increase in cultivation activities. Greater reduction was reported in the semi-nomadic and sedentary than nomadic land use sites. The grazing areas and associated vegetation in all the study sites were mentioned to have declined significantly over the period under study. This was attributed to the rising grazing pressure due to restricted herd movements as a result in changes

in land tenure. Differential disappearance of preferred forage species and habitats reported by respondents indicate that the pasture quality as grazing area has deteriorated over time.

It seems that reduction of grazing area and degradation in pasture resources does reflect the expansion of cultivation and increased grazing pressure, as suggested by the respondents. Kioko *et al*., (2012) reported similar observations in Amboseli ecosystem. In their study, respondents reported the disappearance in certain grass species over the last few decades, which they attributed to grazing pressure and deforestation. This has resulted in increase in bare land in the Amboseli ecosystem. These perceptions are in line with the findings of different authors (Western and Nightingale, 2003; Western and Maitumo, 2004; Western, 2006; Kioko and Okello, 2010; Msoffe *et al*., 2011; Morara *et al*., 2014), who indicated declining trends in habitat diversity, woodlands, grass quantity, conversion of large tracts of land into settlements, croplands and trading centres, and a reduction in both dry and wet season grazing areas. The loss of habitat diversity (Western, 2006) and grassland productivity (Western *et al*., 2015) has been reported in the study area. These authors attributed the changes to increased human activities. Similar results attributing the decline in grazing areas and conditions to the expansion of crop cultivation have been reported in the semi-arid areas of Karamoja in Uganda (Egeru *et al*., 2014).

Extensive traditional livestock production associated with herd mobility is still prominent in the nomadic land use site where land has not been sub-divided. In this site, herd mobility was reported as an important strategy that allows pastoral households to cope with stresses and shocks such as droughts and disease outbreaks. According to World Initiative for Sustainable Pastoralism (WISP) (2008), well-governed mobile pastoralism is conducive to biodiversity conservation and sustainable land management. Settlements in the nomadic land use site are mostly temporary, intended to support mobile livestock production and exploit varying pasture

conditions between locations and in response to seasonal fluctuations. Settlement location and turnover reflects social and physical factors which favor extensive traditional livestock production systems (Western *et al*., 2009, Nkedianye *et al*., 2011).

Land subdivision in semi-nomadic and sedentary land sites, has reportedly reduced grazing areas and herd mobility, both of which undermine the effectiveness of mobile pastoral systems (Western *et al*., 2009; Groom and Western, 2013). Curtin and Western (2008) and Kioko and Okello (2010) reported that restricted mobility has led to loss of biodiversity, rangeland health and the resilience of grassland response to drought.

As reported by Okello and Kioko (2011), the rise of crop cultivation in the Amboseli ecosystem has led to loss of grazing land and livestock herds (Western and Nightingale, 2003), forcing households to switch to alternative livelihoods. The expanding road network in the Amboseli region, especially the recent construction of the Emali – Loitoktok tarmac road has greatly improved access to markets, further stimulating conversion from pastoralism to farming in the prime grazing lands (Okello and Kioko 2011; Kioko *et al*., 2011). Mbau (2013) in a study of land use changes in Taita-Taveta, and Maitima *et al*., (2009) in their study of the linkages between land use, land degradation and biodiversity loss in East Africa, showed that increase in crop cultivation reduces grazing area. They observed that such trends were triggered by road /infrastructure developments and greater returns from cultivation than pastoral livestock production.

4.5 CONCLUSIONS

The most significant changes perceived by communities in the Amboseli region are reduction in grazing land and decline in the abundance and variety of pastures across all sites. The changes are more pronounced in semi-nomadic and sedentary than nomadic land use sites. Sedentary and

semi-nomadic land use sites reflected greater transformations in land tenure from group to individual ownership, an expansion of crop production and a reduction in grazing land. The main drivers of sedentarization, rangeland fragmentation and degradation seem to be land tenure shift from group ranches to private ownership. In the nomadic land use site, extensive traditional livestock production is still possible due to limited farming activities.

The study shows that the use of community perceptions through participatory resource mapping is a useful tool for engaging local communities in mapping status of resources over time, a prerequisite for sustainable community-based resource use planning and management.

CHAPTER FIVE: PASTORAL COMMUNITY PERCEPTIONS ON THE CAUSES OF LONG TERM CHANGES IN RANGE RESOURCES AND HUMAN-WILDLIFE CO-EXISTENCE DYNAMICS IN AMBOSELI ECOSYSTEM, KENYA

SUMMARY

The drivers of land use and land cover changes in rangeland ecosystems range from biophysical, societal to management factors and are varied, complex and interlinked. Focus group discussions and individual interviews were conducted in sites representing different land use types to assess the communities' knowledge, attitudes and perceptions on the range resource changes, causes and responses to changes over the last four decades in the Amboseli Ecosystem. Most (79%) of the respondents reported having observed changes in rangeland resources which they attributed mostly to increase in population, increased cultivation, land use changes and reduced rainfall. Improving the local livestock breeds (27%) for enhanced productivity, and diversification of livelihoods (22%) were mentioned as key strategies by the community in addressing the perceived changes in the study area. These perceptions provide guidance in engaging the community in targeting participatory approaches for sustainable environmental and natural resource management in pastoral areas.

Key words: Rangeland resources, pastoral resource dynamics, community responses; land use and land cover change, community perceptions.

5.1 INTRODUCTION

Land use change is one of the major causes of environmental degradation globally (Maitima *et al.,* 2010, Msoffe *et al.*, 2011). The drivers of land use change are complex, interlinked, changing over time and differ between landscapes (Campbell *et al*., 2003; Olson *et al.*, 2004). The causes

range from biophysical to societal factors and management strategies. Land use changes are normally pervasive and may affect the ability of rangeland ecosystem to continue providing the goods and services upon which mankind depends (Lambin *et al*., 2001).

In arid and semi-arid landscapes of Africa, human population growth has increased the demand for and pressure on natural resources by intensifying both the use and control of the land (Dale *et al*., 2000). In addition to population increase, agricultural extensification and intensification, sedentarization and urbanization, poor land use planning, weak governance and overexploitation of natural resources pose great challenges to management of range ecosystems. These challenges have consequently impacted on the ecological and socioeconomic activities resulting in land use and land cover changes (Worden *et al*., 2003; Olson *et al*., 2004; Maitima *et al*., 2009; Angassa *et al*., 2012). In Kenya, land use changes have fragmented and transformed wildlife habitats and dispersal areas, resulting in range degradation and rising human-wildlife conflicts (Ogutu *et al*., 2014). In the rangelands of Kajiado County that is predominantly occupied by the Maasai community, large areas of pastoral grazing have been lost to protected areas and individual ranches (Kioko and Okello, 2010). For example, settlements in Amboseli ecosystem increased from under 1,000 in 1973 to over 10,000 by 2000 in the high potential arable areas (Western and Nightingale, 2003; Ogutu *et al*., 2014). The changes in the rangelands have increased the environmental vulnerability of pastoral communities thereby negatively impacting the extensive livestock production, which is the main source of livelihood in the Amboseli ecosystem (Western and Nightingale, 2003).

Community perceptions of environmental changes and their causes are essential in assessing vulnerability of pastoral livelihoods and galvanizing responses to changes (Angassa *et al*., 2012). This study investigated the perceptions of the Maasai communities on the causes of long term

changes in the Amboseli ecosystem. The findings are expected to guide identification of sustainable approaches to natural resource management in pastoral areas.

5.2 DATA COLLECTION AND ANALYSIS

To assess the views of the community on the current status and causes of long term changes in range resources, and human-wildlife co-existence dynamics on pastoral land, individual interviews using a semi-structured questionnaire and key informants interviews were conducted in the three land use sites. Information on general rangeland status, views on human-wildlife interactions and community responses to rangeland condition changes were solicited through household interviews. Focus group discussions were used to determine the perceived causes of resource changes over the last four decades in nomadic, semi-nomadic and sedentary land use site. Perceptions on the causes of change on pastoral resources were determined and ranked in order of importance, as indicated in the FGD meetings at each site.

Descriptive analysis was performed on data from household interviews to generate frequencies of the responses on views of range conditions and, human-wildlife interactions, the causes of rangeland resource changes and their implications for pastoral livelihoods. Chi-square goodness of fit test of significance was used to determine difference of the responses on issues under study between the sites at $P \leq 0.05$.

5.3 RESULTS

5.3.1 Status of pastoral resources as perceived by the community

The majority (79%) of the respondents noted that the general status of the rangeland resources have changed over the last 40 years ($\chi^2=112.68$, df = 1, $P < 0.001$). Most of the views varied significantly ($P < 0.001$) with gender, age, type of land use site, education level and type of settlement (Table 5.1). In the different land use sites, the majority (86% in nomadic, 69% in semi

nomadic and 71% in sedentary sites) of the respondents reported poor status of pastoral resources.

Table 5.1: Pastoral community perceptions on the status of range resources disaggregated by households' socio-demographic characteristics

Socio-demographic attribute of the respondent		Perceived Condition of the range			Chi-square goodness of fit
		Good	Moderate	Poor	
Gender	Male	13 (10)	48 (36)	71 (54)	$\chi2$=38.77, df=2, P<0.001
	Female	3 (1)	17 (8)	182 (90)	$\chi2$=294.37, df=2, p<0.001
Age	21-30	1 (3)	15 (38)	23 (59)	$\chi2$=19.08, df=2, p<0.001
	31-40	5 (6)	14 (18)	59 (76)	$\chi2$=64.39, df=2, p<0.001
	41-50	3 (3)	15 (15)	81 (81)	$\chi2$=106.91, df=2, p<0.001
	51 and above	7 (6)	21 (18)	90 (76)	$\chi2$=100.39, df=2, p<0.001
Land use site	Nomadic	3(3)	13(11)	104(86)	$\chi2$=154.85, df=2, p<0.001
	Semi-nomadic	12(9)	29(22)	90(69)	$\chi2$=77.05, df=2, p<0.001
	Sedentary	10(12)	14(17)	59(71)	$\chi2$=53.52, df=2, p<0.001
Education level	None	14 (5)	56 (19)	229 (76)	$\chi2$=260.6, df=2, p<0.001
	Primary	0	6 (29)	15 (71)	$\chi2$=16.29, df=2, p<0.001
	Secondary	1 (8)	3 (25)	8 (67)	$\chi2$=6.5, df=2, p<0.039
	Tertiary	1 (50)	0	1 (50)	*
Main livelihood	Cultivation	0	1 (50)	1 (50)	$\chi2$=1, df=2, p=0.606
	Cultural tourism	0	4 (44)	5 (56)	$\chi2$=4.67, df=2, p=0.097
	Formal employment	0	0	8 (100)	*
	Informal employment	1 (100)	0	0	*
	Livestock	14 (5)	47 (17)	217 (78)	$\chi2$=256.11, df=2, P<0.001
	Small business	1 (3)	13 (36)	22 (61)	$\chi2$=18.5, df=2, p<0.001
Settlement	Permanent	13 (7)	38 (21)	132 (72)	$\chi2$=129.08,df=2, p<0.001
	Seasonal	3 (2)	27 (18)	121 (80)	$\chi2$=154.54, df=2, P<0.001

Note: % frequencies of responses are given in brackets, * - no analysis was necessary since there no figure to compare with.

Figure 5.1 shows the trends for various rangeland resources in the nomadic, semi-nomadic and sedentary land use site over the four study periods. Abundance of pastures and tree cover were reported to have decreased in all study sites. In the semi-nomadic area, tree cover remained the

same during the pre-settlement and post-settlement periods, and has remained highest after the post 2009 drought. Total livestock numbers were reported to have increased in both nomadic and semi nomadic land use sites over the study period. However, in the sedentary area, the numbers only increased until the reported losses in the 2009 drought which caused great decline. Whereas household livestock diversity and holdings decreased in the nomadic and semi-nomadic site over the study period, an increase was reported in the sedentary site until the post settlement period. Wildlife numbers followed a similar trend in all the land use sites, showing increase from pre-park period and later declined between the post-settlement and post 2009 drought period. Abundance of pastures and variety of habitats was shown to have declined over the last four decades in all the sampled study sites.

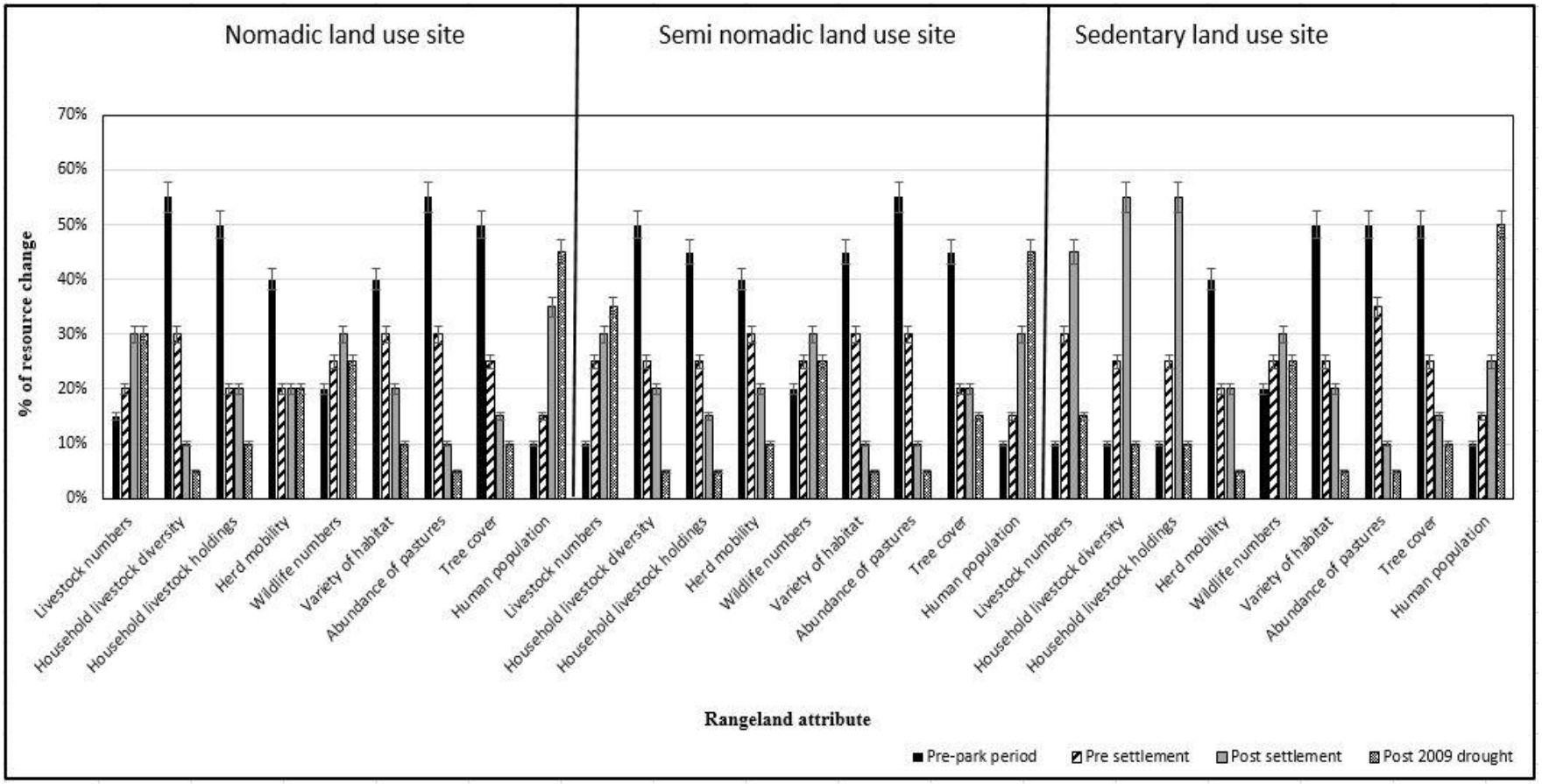


Figure 5.1: Perceived changes in range attributes in the nomadic, semi-nomadic and sedentary locations during the period under study (Source: Focus Group Discussions during the study)

5.3.2 Perceived causes of long term changes in pastoral resources

Reasons attributed to the changes in pastoral resources over the last four decades in the three land use sites are presented in Figure 5.2. The reasons for the increase in livestock numbers varied across the sites. Increased human population was mentioned most often for the increase in livestock in nomadic (50%) and sedentary (50%) sites, and diversification of livelihoods (42%) in semi-nomadic area. Frequent droughts (42%), changing land use (58%) and increased cultivation (50%), were cited most often as the causes of reduced household herd size in nomadic, semi-nomadic and sedentary land use sites.

The increase in droughts was attributed to reduced vegetation cover (50%) and reduced rainfall (25%) in the nomadic site, and to climate change (67%) and reduced tree cover (17%) in semi nomadic site. In the sedentary land use site the droughts were attributed to changing land uses (50%) and reduced vegetation cover (25%). Reasons for the decrease in grazing areas ranged from population increase (42%) and loss of land productivity (42%) in nomadic sites, to increased cultivation (67%) and population increase (17%) in semi-nomadic areas, and land subdivision (50%) and restricted movement (33%) in sedentary sites. Decline in migratory routes was attributed to reduced land productivity (67%) in nomadic areas, increased cultivation (40%) in semi nomadic and land subdivision (58%) in sedentary areas. The reasons cited for the increase in cultivated land varied from reduced household herd size (50%), to increased human population (35%) and reduced grazing areas (30%) in nomadic, semi nomadic and sedentary areas, respectively. Perceptions of the causes of other rangeland resources are presented in Figure 5.2.

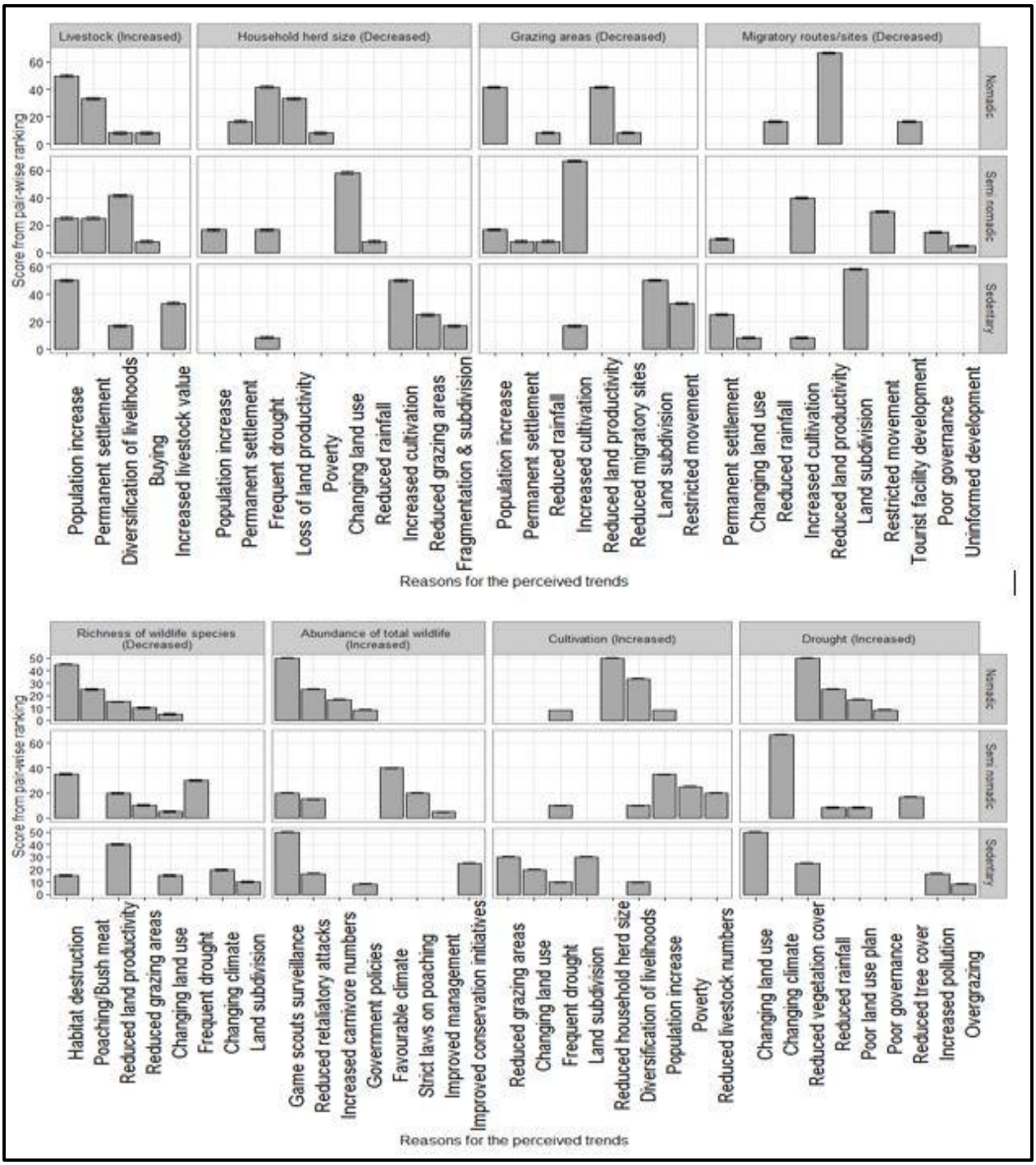


Figure 5.2: Perceived causes of rangeland resource changes in the nomadic, semi-nomadic and sedentary land use sites (Source: Focus Group Discussions during the study)

5.3.3 Implications of the resource changes on availability and accessibility

Table 5.2 shows the perceived trends in the availability and accessibility of the various rangeland resources in the nomadic, semi-nomadic and sedentary land use site. A majority in all sites reported a decrease in dry season grazing reserves over the last four decades. Views on availability of migratory routes were also similar for all sites, with majority of the respondents mentioning decreased accessibility. Insignificant difference was found in availability ($\chi^2 = 4.31$, df = 4, P = 0.366) and accessibility ($\chi^2 = 3.63$, df = 4, P = 0.458) of dry season grazing reserve among the sites. Other changes, including the availability of watering points, medicinal plants, spiritual sites and salt licks showed site-specific differences ($P < 0.001$).

Table 5.2: Perceived trends in resource availability and accessibility across the land use types

Resource characteristics	Land use type									$\chi 2$ and P value
	Nomadic (n=120)			Semi nomadic (n=131)			Sedentary (n=83)			
	Constant	Decreased	Increased	Constant	Decreased	Increased	Constant	Decreased	Increased	
Dry season grazing reserve availability	21(17)	98(82)	1(1)	33(25)	98(75)	0(0)	21(25)	62(75)	0(0)	$\chi 2$=4.31, df = 4, P = 0.366
Dry season grazing reserve accessibility	19(16)	86(72)	15(12	26(20)	95(72)	10(8)	20(24)	56(67)	7(9)	$\chi 2$=3.63, df = 4, P = 0.458
Water point availability	23(19)	31(26)	66(55)	29(22)	47(36)	55(42)	35(42)	11(13)	37(45)	$\chi 2$=23.46, df = 4, P < 0.001
Water point accessibility	7(6)	30(25)	83(69)	4(3)	46(35)	81(62)	8(10)	12(14)	63(76)	$\chi 2$=14.76, df = 4, P = 0.008
Migratory route/site availability	18(15)	89(74)	13(11)	32(24)	83(63)	16(13)	27(32)	48(58)	8(10)	$\chi 2$=9.22, df = 4, P = 0.056
Migratory route/site accessibility	8(7)	104(87)	8(6)	17(13)	88(67)	26(20)	14(17)	64(77)	5(6)	$\chi 2$=20.13, df = 4, P < 0.001
Medicinal plants/firewood availability	35(29)	79(66)	6(5)	45(34)	78(60)	8(6)	16(19)	48(58)	19(23)	$\chi 2$=23.66, df = 4, P < 0.001
Medicinal plants/firewood accessibility	31(26)	86(72)	3(2)	46(35)	77(59)	8(6)	23(28)	48(58)	12(14)	$\chi 2$=14.51, df = 4, P = 0.005
Spiritual site availability	31(26)	74(62)	15(12)	46(35)	68(52)	17(13)	34(41)	25(30)	24(29)	$\chi 2$=23.26, df = 4, P < 0.001
Spiritual site accessibility	6(5)	114(95)	0(0)	0(0)	131(100)	0(0)	2(2)	81(98)	0(0)	$\chi 2$=10.40, df = 4, P = 0.034
Salt licks availability	44(37)	69(57)	7(6)	103(79)	15(11)	13(10)	56(67)	18(22)	9(11)	$\chi 2$=67.08, df = 4, P < 0.001
Salt licks accessibility	37(31)	60(50)	23(19)	87(66)	18(14)	26(20)	56(67)	10(12)	17(21)	$\chi 2$=58.36, df = 4, P < 0.001

5.3.4 Perceptions on human-wildlife interactions in changing pastoral lands

The community views on human-wildlife interactions over time are shown in Table 5.3 below. The majority of the respondents in nomadic (68%) and semi nomadic (54%) sites viewed wildlife as problematic. Only in the sedentary site did as many people see wildlife as useful (43%) and as problematic (42%) as well.

Table 5.3: Views on human-wildlife interactions across the study sites

Household views		Land use site			
Community views	Response	Nomadic (n = 120)	Sedentary (n = 83)	Semi nomadic (n = 131)	$\chi 2$ & P value
View on wildlife	Problematic	82(68)	35(42)	71(54)	$\chi 2$=14.38
	Useful	30(25)	36(43)	42(32)	df=4
	Neutral	8(7)	12(15)	18(14)	P=0.006
If benefitted from wildlife	Yes	45(51)	42(55)	67(57)	$\chi 2$=6.69, df=2 P=0.035
Type of benefit	Bush meat	2(4)	0(0)	0(0)	$\chi 2$=55.48 df=10 P<0.001
	Development project e.g schools, dispensaries	7(16)	3(7)	10(15)	
	Employment in conservation organizations	17(38)	8(19)	5(7)	
	Payment for ecosystem services	3(6)	2(5)	15(22)	
	School bursaries from tourism revenue	15(33)	17(40)	7(10)	
	Sale of artifacts to tourists	1(2)	12(29)	30(45)	
Reasons for not benefitting	Exploitation by leaders	42(65)	24(69)	40(80)	$\chi 2$=3.32, df=4 P=0.190
	Don't know how to benefit from wildlife	23(35)	11(31)	10(20)	
Had negative experience with wildlife	Yes	100(89)	40(53)	97(77)	$\chi 2$=30.37, df=2 P<0.001
Kind of negative experience with wildlife	Destruction of crops	10(10)	2(5)	1(1)	$\chi 2$=19.88 df=7 P=0.011
	Destruction of water Infrastructure	1(1)	4(10)	4(4)	
	Killing people	4(4)	4(10)	8(9)	
	Livestock predation	81(84)	31(74)	78(86)	
Trends of human wildlife conflict	High	105(87)	39(47)	94(72)	$\chi 2$=42.64
	Moderate	0	4(5)	1(1)	df=10
	Low	15(13)	40(48)	36(27)	P<0.001

Over half of the respondents benefitted from wildlife in all locations (nomadic; 51%, semi nomadic; 57%, sedentary; 55%), with the type of benefits varying by location. Respondents who reported little benefit from wildlife blamed exploitation of community resources on their leaders, or were unaware of how to benefit from wildlife resources. Predation on livestock by wildlife (84% in nomadic, 86% in semi nomadic and 74% in sedentary) was mentioned as the biggest problem in all sites. The majority of the respondents in the nomadic site (87%) and semi-nomadic site (72%) reported high incidences of human-wildlife conflict and far fewer in the sedentary location (47%). A considerable proportion of the respondents (53% in sedentary, 28% in semi-nomadic and 13% in nomadic land use site) reported low human-wildlife conflict over the study period. Those who perceived increase in human-wildlife conflict attributed the rise to an increase in carnivore numbers (49%) followed by increase in droughts (31%) and human encroachment into wildlife habitats (10%) (Figure 5.3).

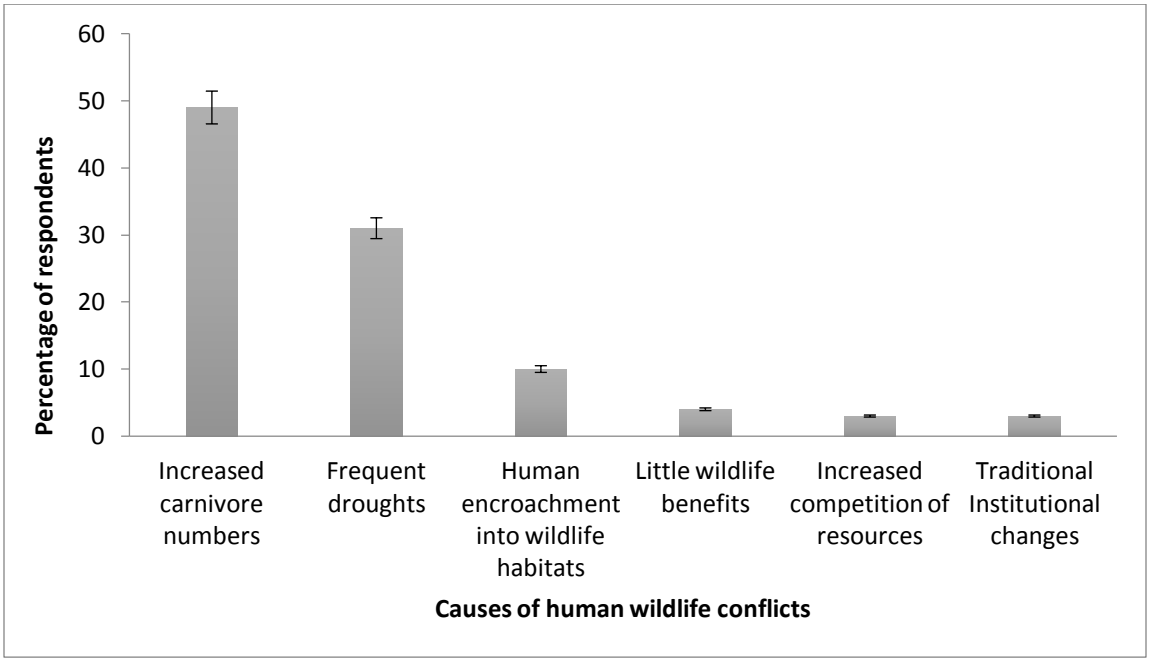


Figure 5.3: Perceived causes of human-wildlife conflicts

Opinions on the different causes of the rising human-wildlife conflicts varied across the study sites ($P < 0.001$). There was significant difference of opinion among the respondents reporting low human wildlife conflict ($\chi^2 = 8.86$, df = 2, p = 0.012). They attributed the low human wildlife conflicts to deployment of game scouts in the area (45%), strict penalties by the government on wildlife offenders (35%), and benefits accruing to the community from wildlife resources (20%). The factors that respondents perceived to contribute to long term peaceful coexistence between wildlife, livestock and people varied significantly (χ^2=213.9, df = 5, $P < 0.001$). The strategies included land use planning (43%), fencing (20%), and community benefitting from wildlife resources (19%), government intervention (8%), translocation of wildlife (5%), and compensation for losses and damages (5%).

5.3.5 Community responses to long term changes in rangeland resources

The most appropriate responses for mitigating long term changes differed significantly across the study sites (nomadic ($\chi^2 = 102.75$, df = 8, $P < 0.001$), semi nomadic ($\chi^2 = 47.38$, df = 8, $P < 0.001$) and sedentary ($\chi^2 = 61.67$, df = 7, $P < 0.001$). As shown in Table 5.4, improving livestock breeds for enhanced productivity was the most commonly cited response in all sites (27%), followed by diversification of income (22%), destocking of livestock (13%), educating children (12%) to diversify opportunities and income, reducing deforestation (11%) and crop farming (7%) as an alternative land use option. Respondents also mentioned rain water harvesting for provision of drinking water year round (3%), enhancing better conservation practices (3%) and land privatization to ensure security of tenure (2%) as other options of coping with observed changes.

In the nomadic (27%) and semi nomadic land use types (36%), improved livestock breeds was the preferred response to change, whereas diversification of income was preferred in settled sites

(37%). Destocking was not mentioned by respondents in the sedentary site despite being mentioned by a majority in both nomadic and semi-nomadic land use sites. Responses differed significantly ($P < 0.001$) across the three study locations, except for land privatization ($\chi^2 = 5.09$, df = 2, p = 0.078) which was least mentioned.

Table 5.4: Community responses to long term changes in Amboseli ecosystem

Community response	Frequency (%)			Goodness of fit test for each factor
	Nomadic	Semi nomadic	Sedentary	
Crop farming	24(7)	6(5)	9(11)	$\chi^2 = 14.31$, df = 2, $P < 0.001$
Destocking of livestock	43(13)	21(17)	-	$\chi^2 = 43.34$, df = 2 $P < 0.001$
Diversification of income sources	74(22)	14(12)	31(37)	$\chi^2 = 48.22$, df = 2, $P < 0.001$
Educating children	41(12)	15(12)	12(14)	$\chi^2 = 22.44$, df = 2, $P < 0.001$
Enhancing conservation practices	8(3)	5(4)	3(4)	$\chi^2 = 2.38$, df = 2, $P < 0.001$
Improving livestock breeds	90(27)	43(36)	16(19)	$\chi^2 = 56.47$, df = 2, $P < 0.001$
Privatization of land	7(2)	1(1)	3(4)	$\chi^2 = 5.09$, df = 2, $P = 0.078$
Rain water harvesting	10(3)	1(1)	4(5)	$\chi^2 = 8.4$, df = 2, $P = 0.015$
Protection of trees	37(11)	14(12)	5(6)	$\chi^2 = 29.18$, df = 2, $P < 0.001$
General responses within specific site	$\chi^2 = 102.75$, df = 8 $P < 0.001$	$\chi^2 = 47.38$, df = 8, $P < 0.001$	$\chi^2 = 61.67$, df = 7 $P < 0.001$	

Grazing management schemes through land use planning was emphasized as a response to the changing land use by the participants in both nomadic and semi-nomadic sites. Local community involvement in land use planning and policy formulations were other key strategies highlighted during the focus group discussions.

5.4 DISCUSSION

5.4.1 Perceptions on trends of rangeland attributes

The majority of respondents reported declining range condition in the Amboseli ecosystem over the last four decades. The decline was reported in dry season grazing areas, the variety of habitats, and loss of pastures and woodlands. The findings corroborate documented changes in the Amboseli area by Western and Van Praet (1973), Western and Maitumo, (2004), Western (2006), and Kioko *et al.*, (2013). The researchers attributed the changes to expansion of crop farming, human settlement, destruction of habitats by elephants, and the establishment of protected areas that excluded pastoralists from accessing the crucial grazing reserves located in the national park.

Community perceptions on rangeland changes in Amboseli corroborate findings of other studies on long-term changes in Kenya's rangelands. For example, Mbau (2013), in assessing land use and land cover changes in Taveta County, observed that habitat cover, mainly woodlands and shrublands declined by 54% and 17% respectively. Similarly, Mundia and Aniya (2006) reported a decline in natural vegetation cover from 357 km^2 in 1976 to 237 km^2 in 2000 in the pastoral areas proximate to Nairobi city. The authors partly attributed the changes in land cover to increased farming activities, infrastructure development and expansion of urban centres in the study areas.

5.4.2 Causes and consequences of long term changes on rangeland attributes

Population growth was identified as the main cause of decline in rangeland resources. The increase in human population has mainly been through increased births of the residents, and immigration from neighboring regions. Similar trends in human population have been reported by both Msoffe *et al.*, (2011) and Okello and Kioko (2010), in Tanzania and Amboseli area

respectively. Olson *et al.,* (2004) attributed the increase in human population in many rangeland ecosystems to high human fertility and a gradual decline in mortality rate due to the improved health care and nutrition. Studies in both Kajiado and Loitoktok by Ntiati (2002), Campbell *et al*., (2003) and Campbell *et al*., (2005) had indicated that the population of immigrants from other ethnic communities has also increased sharply since 1960s, as also noted by respondents in this study. The ever rising human populations in the drylands have led to enormous pressure on the resource base and therefore range degradation.

Increase in livestock numbers was cited by respondents in the nomadic and sedentary sites as a cause of decline in rangeland condition. Nyamasio and Kihima (2014), in their study in Amboseli wetlands observed an upward trend of livestock numbers over the past three decades. The reported upward trend in total livestock numbers and decline in household holdings and herd diversity is contrary to the census report by Western and Nightingale (2003) that shows decrease in family herd size and overall decline in livestock numbers over the last four decades. The perceived increase in livestock numbers, cited in nomadic and semi-nomadic land use sites are as a result of new purchases as they are still the main source of livelihoods in addition to increases in pastoral population who own individual herds. The declining livestock diversity and household herd holdings in all the land use sites may reflect the declining range productivity due to land conversion in the Amboseli Ecosystem over the last four decades.

As reported by Okello and Kioko (2010), the decline in land cover and habitat diversity (Western, 2006), have resulted in rising pressure on the rangelands and sharp decline in pasture production (Western *et al*., 2015). The perceived and observed land use and rangeland changes in the Amboseli Ecosystem is causing a shift towards new forms of land use and diversification of livelihoods (Kioko and Okello, 2010; Okello *et al*., 2011; Niamir-Fuller *et al*., 2012).

Okello and Kioko (2010) noted that agricultural activities have risen sharply in Amboseli over the last 30 years. This matches the perceptions of the respondents that expansion of cultivation in the ecosystem, and more specifically in the sedentary and semi-nomadic land use types, has converted grazing areas to croplands and reduced cover of natural vegetation.

Permanent settlement is most pronounced in the sedentary and semi-nomadic sites, corresponding to the impact of land subdivision in the Amboseli ecosystem. This was also observed by Groom and Western (2013) and Western *et al*., (2009). The general impacts of land subdivision is breaking up of large intact areas of habitats through clearing and conversion of rangeland to other land uses, as also observed by Franklin *et al.*, (2002) in most East African rangelands. Fragmented landscapes result in spatially isolated portions that rearrange the structure and dynamics of the ecosystem and affect their ecological functions (Hobbs *et al.*, 2008). The fragmentation also increases competition between livestock and wildlife (Nyamasio and Kihima, 2014).

According to Okello *et al*. (2011), the pressure for land subdivision in the pastoral areas of southern Kenya has risen and is highest among cultivators, youths and the landless, who want land for private uses, security of tenure and cultivation. The impact of land subdivision in both sedentary and semi-nomadic sites is a decline in their grazing areas and rangeland condition as reported in this study.

The rise in infrastructure development in the remote areas of Amboseli, characterized by expansion of trading centres and road network over the past decades, is perceived to be contributing to deterioration of rangeland condition in the study area. The expansion of trading centres, coupled with improved roads, has promoted agricultural activities and therefore attracted entrepreneurs who convert pastoral lands to other uses.

As indicated by Lambin *et al*., (2001), urbanization in the rangelands has been minimal until recently but is likely to grow strongly. This is evident in the sprawling business centres along roads in the sedentary land area, as well as land privatization that encourage permanent settlements. Morara *et al.,* (2014) observed expansion of urban areas across the landscape in Kitengela area of Kajiado County, which is now largely characterized by developed road network, buildings and other infrastructure on land that was traditionally used for pastoralism. Both the nomadic and semi-nomadic land use sites in the Amboseli Ecosystem have experienced rise in urban centres in the recent decade. These trends are increasingly reducing the scope for traditional livestock practices and therefore impacting negatively on the main livelihood strategy in the Amboseli Ecosystem.

The changes in traditional practices have resulted in the perceived poor status of range resources and match the reported decline in pasture productivity in the Amboseli ecosystem as observed by Western *et al*., (2015). In addition, weakening governance of the rangelands due to breakdown in traditional seasonal grazing practices and land appropriation by leaders and outsiders has added to the decline in rangeland conditions (Jamsranjav, 2009; Groom and Western, 2013; Selemani, 2014).

Frequent droughts were also identified by the respondents as a cause of decline in rangeland productivity. The causes were attributed to climate change, reduced rainfall and habitat decline. The increase in the frequency of droughts cited by the community corroborates the observed pasture shortfalls due to increased grazing intensity in Amboseli area (Western *et al*., 2015). Tuqa *et al*., (2014) reported that rainfall induced droughts have affected livestock and wildlife populations in 1984, 1992, 1999, 2003 and 2009 in the Amboseli area.

5.4.3 Human-wildlife interactions in Amboseli Ecosystem

The abundance of wildlife was reported to have increased in nomadic and semi nomadic areas but showed no change in sedentary sites. Wildlife richness was reported to have declined in all the study sites. The increase in wildlife abundance is contrary to the overall decline shown in censuses conducted since the 1970s (Western and Nightingale, 2003). Zebra and wildebeest numbers have declined steadily since the late 1980s and early 1990s (http://www.amboseliconservation.org/). Moss (2001) and Bulte *et al*., (2006) in their study in the Amboseli area, reported a rise and spread in the elephant populations since the 1970s and in lion and hyena populations as observed by community in the current study. The increase in these high conflict species is the likely cause of the rising level of human-wildlife conflicts reported in all the sites. The community views of wildlife population increase in Amboseli ecosystem also contrasts the findings in other ecosystems, (Stoner *et al*., 2006) in Tanzania, and (Ottichilo *et al*., 2001; Ogutu *et al*., 2011; Bhola *et al*., 2012) in Maasai Mara National Reserve who reported falling wildlife populations. This is the trend in Kenya as a whole, inside as well as outside national parks (Western *et al*., 2009).

Perceptions on human-wildlife co-existence have changed significantly in Amboseli over the past decades. Okello (2005) and Kipkeu *et al.*, (2014), noted a decline in positive views of wildlife in the Amboseli regions, which they attributed to lack of economic benefits and the drive for land subdivision. The changing perceptions are attributed to human-wildlife conflicts, competition for limited resources and inequitable distribution of benefits from wildlife resources. The growing human-wildlife conflicts were associated with the increase in carnivore numbers in the Amboseli Ecosystem. Okello (2005) and Kipkeu et al., (2014), reported a decline in positive views on wildlife in the Amboseli area which they attributed to lack of economic benefits and the

drive for land subdivision. Over half (51% in nomadic, 57% in semi-nomadic and 55% in sedentary) of the respondents mentioned having benefitted from wildlife resources, despite the high levels of human wildlife conflicts.

5.4.4 Community response strategies to long term changes in pastoral resources

Suggested strategies to address the long term changes in rangeland ecosystems varied between locations. The strategies ranged from individual to local and regional initiatives. Improving the local zebu breeds using the Borana and Sahiwal cattle breeds was the most preferred response in nomadic and semi nomadic sites. Livestock management practices, including mixing of cattle breeds, was seen as an opportunity to improve livestock yields and resilience of herds on communal lands.

The decline in pastoralism evident in the declining number of individual household herd holdings, coupled with challenges of crop cultivation and, restricted movement, are seen as reasons to diversify into income generating activities such as dryland rain fed and irrigation farming. Pastoral and non-pastoral communities alike have intensified their production on the slopes of Kilimanjaro and expanded crops into new areas (Campbell *et al*., 2003).

Formulation and adoption of a range use management system that takes into consideration all land users and meets the needs of livestock, people and wildlife is necessary as reported in all the land use sites. The system enables livestock production systems such as mobility, rotational pasture use through designated wet and dry season grazing areas and building up of cattle numbers as coping strategies to endure the relatively common droughts in the semi-arid environment (Nelson, 2012). In addition, the land use plan helps in maintaining a long term peaceful coexistence of range inhabitants through implementation of set rules and regulations and institutions that govern rangeland use in the changing ecosystems. It maintain wildlife

mobility within and across protected and unprotected areas and also secure the environment as a working place where all rangeland resource users exhibit high degree of spatial overlap and peaceful coexistence (Campbell *et al*., 2003; Msoffe *et al*., 2011; Okello *et al*., 2011; Nelson, 2012). For example, Nelson (2012) describes a locally developed land use plan in Tanzania that has formalized traditional livestock production system into a modern legal form. This has provided a foundation for community based natural resource management as well as payment for ecosystem services while enabling equitable sharing of accrued benefits from rangeland resources boosting conservation initiatives in those areas. An integrated land use planning approach was advocated for by the participants as an important response to changing rangelands in the current study.

5.5 CONCLUSIONS

Major changes in pastoral resources, land use and land cover have been observed in Amboseli ecosystem over the last 40 years. Grazing areas have greatly declined consequently reducing the household herd sizes. Migratory corridors which linked different resources have diminished in the area, therefore undermining access of the critical grazing area in the study area. Population increase, permanent settlements and changing land uses including dry land farming are perceived by the community as the major causes of land use land cover changes in the study area. In addition, changing land tenure in sedentary and partially in semi nomadic area have resulted in restricted livestock mobility which is normally a coping strategy in the semi-arid environments. Improving the local livestock breeds for enhanced production in the changing ecosystems and diversification of livelihoods are major strategies perceived as suitable in addressing the long term rangeland changes in the study area.

Local communities are knowledgeable about their environments, and therefore assessing their perceptions on the causes of long term changes on rangeland resources, as well as suggestions on suitable responses to the perceived changes is an important step in the search of sustainable environmental conservation in the pastoral ecosystems.

CHAPTER SIX: IMPACTS OF LONG TERM LAND USE CHANGES ON HERD SIZE AND MOBILITY AMONG PASTORAL HOUSEHOLDS IN AMBOSELI ECOSYSTEM, SOUTHERN KENYA

SUMMARY

Long term changes in rangeland ecosystems of the world have impacted on livestock production, a key livelihood strategy in these areas. This chapter presents perceptions of the pastoral community on the dynamics of household herd size and mobility under three land use types in the Amboseli Ecosystem, Southern Kenya. A structured questionnaire was administered to 334 randomly selected households in the three land use types to collect data on household livestock herds, perceived livestock trends and their causes, importance of migration and effects of sedentarization and land sub-division on extensive livestock production. The mean household livestock herd size was highest in nomadic (40.8 TLU) and lowest in sedentary (22.9 TLU) land use sites. The majority of the respondents in nomadic (79%), semi-nomadic (73%) and sedentary (64%) reported a declining trend in household herd holdings. These trends were mostly attributed to the recurrent droughts and diminishing of grazing land. Pastoralism remains an important livelihood strategy to majority of households. To achieve sustainable production, interventions such as participatory land use planning should be encouraged to set aside areas for grazing, cultivation and conservation.

Key words: Herd mobility, household livestock trends, rangeland resource changes, community perceptions.

6.1 INTRODUCTION

Land use and land cover change (LULCC) in rangeland ecosystems has been a major global concern to conservationists and researchers (Msoffe *et al.*, 2011). The rangelands covering nearly half of the total land surface in Africa support extensive livestock production and wildlife conservation (Nyariki *et al*., 2009; Kaimba *et al*., 2011; Nkedienye *et al*., 2011; Bekele and Kebede, 2014). Pastoralism, characterized by herd mobility to track grazing and water resources in space and time, has been the dominant livelihood strategy in these ecosystems, supporting millions of people (Nkedianye *et al*., 2011; Tefera, 2014; Berhanu and Beyene, 2015). In East Africa, pastoral societies practicing various forms of pastoralism occupy 82% of total land in Kenya, 50% in Tanzania and 40% in Uganda (GOK, 2009; Reda, 2012). Amboseli ecosystem in Kajiado County is part of the arid and semi-arid lands (ASAL) that constitute the 82% of Kenya's land mass supporting extensive traditional livestock production and wildlife conservation (Campbell *et al*., 2003; Campbell *et al*., 2005)

Major changes have been observed in key pastoral resources in the Amboseli Ecosystem in the past three decades (Kioko and Okello, 2010; Nyamasyo and Kihima, 2014). The long term changes that include declining areas of wet and dry season grazing reserves, woody vegetation and variety of pastures have had negative impacts on pastoralism and wildlife conservation in Amboseli Ecosystem (Kioko and Okello, 2010; Western *et al*., 2015). The resource dynamics have consequently impacted on the livestock production as a key pastoral livelihood which traditionally provided multiple functions. The fundamental functions of pastoral herds include regular provision of food in form of meat, milk, blood, as well as cash income. Livestock are also used to pay dowry, they are a symbol of wealth and prosperity and security against droughts,

disease outbreaks and other rangeland calamities (Nyariki *et al*., 2009; Kaimba *et al*., 2011; Opiyo *et al*., 2011; Schilling *et al.*, 2012).

Declining livestock production and productivity in most pastoral areas is partly due to the expansion of cultivation into grazing areas gradually converting the grasslands ecosystems which are suitable for domestic and wild animals grazing to croplands (Olson *et al.,* 2004). In recent decades, the communally owned wetlands in Amboseli Ecosystem which acted as dry season refuges have experienced dramatic changes in land tenure consequently impacting on land use and vegetation cover (Msoffe *et al*., 2011; Nyamasyo and Kihima, 2014). As indicated by Okello (2012) and Noe (2003), the changes in land tenure have led to changes in land use practice in Amboseli Ecosystem leading to a reduction of the vast grazing lands.

Sedentarization and range fragmentation due to changing land tenure have led to restricted livestock mobility resulting in all season grazing that exerts pressure in certain grazing patches thereby leading to range degradation. Loss of livestock due to factors such as declining land productivity, shrinking grazing areas, restricted movements and the recurrent droughts has resulted in increased poverty and vulnerability of pastoral households, and erosion of their resilience to future shocks (Groom and Western, 2008; Kirwa *et al*., 2012; Moyo *et al*., 2013).

This study was carried out to assess the perceptions of local communities on the effects of resource changes on livestock herd sizes and their mobility based on the changing land tenure system in the Amboseli ecosystem. The study compared individual household herd sizes in three land use sites which included sedentary land use site, where land had been subdivided, semi nomadic (partial land subdivision) and nomadic (no land subdivision). The results of this study are expected to increase understanding on the impacts of the rangeland change dynamics on

livestock production as a key and the most viable land use option in the semi-arid rangeland ecosystems.

6.2 DATA COLLECTION AND ANALYSIS

Both qualitative and quantitative data were collected from household heads using a structured questionnaire. The questionnaire was pre-tested on 30 individual household heads prior to actual study. Four assistant enumerators were trained and evaluated and for suitability in data collection skills for the study. The questionnaire was populated with questions seeking data on livestock herd size, dynamics of livestock production and their management, individual views on significance of migration and benefits of sedentarization, as well as views on land subdivision and importance of communal land tenure.

The collected data were analyzed using statistical package for social sciences (SPSS IBM version statistics 19). The data was analyzed to produce frequency tables on the various attributes under investigation. ANOVA test was used to determine if there was significant difference in household herd size between different socio-demographic attributes in the three land use sites. The Tropical Livestock Units (TLU) commonly taken as an animal of 250kg was used as a standard unit to estimate the household herd sizes (Kristjanson *et al*., 2002). It was assumed that 1 TLU is equivalent to 250 kg live weight; therefore the TLU for different categories of animals were adopted as follows: a cow = 1 TLU, a calf = 0.4 TLU, a sheep = 0.11 and a goat = 0.11 TLU, a lamb = 0.05, a kid = 0.04, a donkey = 0.5 (Kristjanson *et al*., 2002). Chi-square goodness of fit test was used to determine the significant difference on views among households on importance of pastoral mobility and benefits of settling down. Cross tabulation was used to determine the significant difference between households that still migrate, if their

herd sizes have changed and causes of the change, and if they had recovered since the 2009 drought. The level of significance was tested at 5% (Okello *et al*., 2011).

6.3 RESULTS

6.3.1 Households' livestock herd dynamics in the Amboseli ecosystem

The mean household herd size in the three land use types were as shown in Table 6.1. Household herd size differed significantly ($P < 0.001$) between the sites, with the highest average herd size recorded in nomadic site (40.8 TLU), and the lowest in the sedentary site (22.9 TLU). Households with heads aged between 46 and 80 years had larger herd sizes in all study sites with the exception of those aged between 56 and 65 years in sedentary, which had smaller herds.

Table 6.1: Herd size disaggregated by household socio-demographic attributes

Household attribute	Category	Mean household herd size (TLU)			F Value	Sig
		Nomadic (n=120)	Semi-nomadic (n=131)	Sedentary (n=83)		
Herd size	-	40.8	25.0	22.9	9.06	P < 0.001
Age	19 - 25	-	40.6	8.5	2.64	P = 0.023
	26 - 35	25.7	15.6	17.5		
	36 - 45	28.2	13.0	27.4		
	46 - 55	39.2	31.8	36.3		
	56 - 65	60.1	38.0	11.5		
	70 - 80	49.4	23.7	21.7		
Household size	1 - 5	45.5	20.0	20.5	8.23	P < 0.001
	6 - 10	29.6	20.6	17.7		
	11 - 15	46.8	43.8	30.6		
	16 - 20	57.4	42.0	51.2		
Education level of household head	None	41.2	24.1	19.6	1.602	P = 0.189
	Primary	36.9	25.9	39.6		
	Secondary	29.1	55.4	53.6		
	Tertiary	-	-	6.4		
Main livelihood	Crop cultivation	-	-	20.6	1.882	P = 0.083
	Formal employment	-	4.7	13.0		
	Informal employment	-	-	2		
	Livestock production	40.8	34.1	28.0		
	Small businesses		5.4	8.6		
	Tourism		12.4	9.7		

In addition, large households of between 11 and 20 persons owned larger herds than the smaller ones. Herd sizes did not differ significantly (P = 0.189) with education level of the household heads. Livestock production remains the main livelihood in all the land use sites as shown by the average herd sizes amongst the land use types and the households.

6.3.2 Community views on household herd size trends over the last four decades

Majority of the respondents in the nomadic (79%), semi-nomadic (73%) and sedentary (64%) sites reported a declining trend in household herd sizes over the last four decades (Table 6.2). This was attributed mainly to the frequent droughts. The few (21% in nomadic, 27% in semi nomadic, 33% in sedentary sites) who reported an increase in household herd size attributed it mainly to accumulation of livestock through purchases, as well as rapid herd growths following years of good pasture.

There was significant ($p < 0.05$) difference in opinions on whether the household herds have recovered since the 2009 drought or not. Despite the decreasing trends in livestock numbers, majority (59%) of the households in the nomadic area reported recovery in their herds after the 2009 drought. Most (68%) of them attributed the recovery to post drought restocking.

Herd mobility is still being practiced in all the land use sites but is least effective in the sedentary site as reported by 61% of the respondents. The majority in semi-nomadic (61%) and sedentary (54%) who reported the changing mobility patterns attributed it to increased settlements, loss of land productivity, changing weather pattern and restricted pastoral mobility.

Table 6.2: Views of the community on herd size dynamics and management practices over the last four decades

Issue	Response	Frequency of respondents			$\chi 2$ and P value
		Nomadic (n=120)	Semi-nomadic (131)	Sedentary (83)	
Has household herd size changed?	Yes	113 (94)	118 (90)	78 (94)	$\chi 2$=1.854 df=2 p = 0.396
	No	7 (6)	13 (10)	5 (6)	
Which is the perceived direction of change in herd size	Increased	24 (21)	32 (27)	26 (33)	$\chi 2$ = 3.496 df = 2 p = 0.174
	Decreased	89 (79)	86 (73)	52 (64)	
Reasons for increase?	New born	3 (13)	18 (56)	13 (50)	$\chi 2$ = 16 df = 4 p = 0.003
	New purchases	16 (66)	12 (38)	13 (50)	
	Good pastures	5 (21)	2 (6)	0	
Reasons for decrease?	Frequent drought	74 (83)	60 (70)	26 (50)	$\chi 2$ = 27.842 df = 8 p < 0.001
	Selling livestock	6 (7)	1 (1)	3 (6)	
	Livestock diseases	2 (2)	10 (12)	6 (12)	
	Loss of grazing land	5 (5)	7 (8)	11 (21)	
	Poverty	2 (2)	8 (9)	6 (11)	
Has livestock recovered since 2009	Yes	71 (59)	43 (33)	41 (49)	$\chi 2$ = 17.871 df = 2 p < 0.001
	No	49 (41)	88 (67)	42 (51)	
How household livestock has recovered since 2009 drought	New born	11 (15)	19 (44)	20 (49)	$\chi 2$ = 14.725 df = 3 p < 0.001
	Gift	3 (4)		1 (2)	
	Good pastures	9 (13)	9 (21)	2 (5)	
	New purchases	48 (68)	15 (35)	18 (44)	
Reasons why livestock have not recovered since 2009 drought?	Selling livestock	0	5 (6)	4 (10)	$\chi 2$ = 20.052 df = 10 p = 0.029
	Lack of herding labour	7 (14)	7 (8)	3 (7)	
	Livestock diseases	7 (14)	7 (7)	8 (19)	
	Loss of grazing land	18 (38)	33 (38)	6 (14)	
	Poverty	2 (4)	5 (6)	7 (17)	
	Recurrent droughts	15 (30)	31 (35)	14 (33)	
Does household practice herd mobility?	Yes	113 (98)	113 (90)	18 (24)	$\chi 2$ =24.056 df = 2 p < 0.001
	No	2 (2)	13 (10)	57 (76)	
Is mobility still effective?	Yes	105 (88)	105 (80)	32 (39)	$\chi 2$ = 20.01 df = 2 p < 0.001
	No	15 (12)	26 (20)	51 (61)	
Reasons why herd mobility is ineffective?	Lack of herding labour	2 (13)	2 (8)	5 (16)	$\chi 2$ = 8.784 df = 6 p = 0.186
	Loss of land	11 (74)	19 (73)	13 (41)	

	productivity				
	Overgrazing	0	1 (4)	2 (6)	
	Restricted movement	2 (13)	4 (15)	12 (37)	
Has migration pattern changed?	Yes	58 (48)	80 (61)	45 (54)	$\chi2 = 4.115$ df = 2 p = 0.128
	No	62 (52)	51 (39)	38 (46)	
What are the perceived causes of change in migration pattern?	Changed pastoral lifestyle	0	2 (4)	9 (23)	$\chi2 = 60.379$ df = 12 p < 0.001
	Changed weather pattern	10 (16)	19 (37)	2 (5)	
	Increased settlement	20 (32)	8 (16)	5 (13)	
	Lack of herding labour	10 (16)	3 (6)	1 (3)	
	Loss of land productivity	11 (18)	10 (20)	9 (24)	
	Population increase	5 (8)	8 (15)	1 (3)	
	Restricted movement	6 (10)	1 (2)	11 (29)	

Accessing range resources (67%), escaping drought (13%) and evading disease outbreaks (10%) were the most reported benefits of migration as perceived by the respondents. The perceived benefits of sedentarization differed significantly with the majority (44%) of the respondents mentioning ease of accessing social services and amenities. In addition, ease of tending to young and sick animals (23%) and enhancing development of marginal areas (18%) were mentioned as benefits of settling down. Respondents also indicated that when they settle, households are able to diversify their livelihood sources by engaging in various economic activities, and conflicts over resources that do occur as they move with their herds beyond their territories are minimized (Table 6.3).

Table 6.3: Importance of migration and sedentarization as perceived by the community

Migration/sedentarization	Benefit	Frequency of respondents	Chi-square goodness of fit
Migration	Access variable resources	224 (67)	$\chi2 = 474.71$
	Escape disease outbreaks	35 (10)	df = 4
	Escape droughts	42 (13)	$p < 0.001$
	Evade livestock congestion	4 (1)	
	Improves livestock production	29 (9)	
Sedentarization	Better access to social amenities	146 (44)	$\chi2 = 154.05$
	Diversifying household economy	11 (3)	df = 4
	Ease of looking after sick animals	78 (23)	$p < 0.001$
	improves development in an area	59 (18)	
	Reduces conflicts over resources	40 (12)	

The community views from the three land use sites did not differ significantly on the effects of land subdivision on livestock herd size ($\chi2 = 1.133$, df = 2, $p = 0.567$). A significant proportion of the respondents (95% in nomadic site, 95% in semi-nomadic site and 98% in sedentary site) reported that land sub division has affected the household herd sizes in the study area, with the majority (93%, 96% and 88% in nomadic, semi-nomadic and sedentary sites, respectively) reporting a declining effect on their herds (Table 6.4). Despite the implications, majority of respondents still preferred private land tenure system in the sedentary (60%) and semi-nomadic (60%) land use types with least preference in nomadic area (43%). Most of the respondents in nomadic (57%) and a few in semi-nomadic (40%) and sedentary (40%) areas preferred the group ranching system with a few in semi nomadic and sedentary land use sites.

Table 6.4: Views of respondents on effects of land subdivision and tenure preferences

Issue	Response	Frequencies of respondents			Chi-square cross tabulation test
		Nomadic (n = 120)	Semi-nomadic (n = 131)	Sedentary (n = 83)	
Does subdivision affects household herd size?	Yes	114(95)	124(95)	81(98)	$\chi 2 = 1.133$ df = 2 p = 0.567
	No	6(5)	7(5)	2(2)	
Does subdivision affects household herd size, how?	Increase	8(7)	5(4)	10(12)	$\chi 2 = 229.79$ df = 2 p < 0.001
	Decrease	106(93)	119(96)	71(88)	
Preferred land tenure	Group ranch	68(57)	53(40)	33(40)	$\chi 2 = 8.413$ df = 2 p = 0.014
	Private land	52(43)	78(60)	50(60)	

Note: Percentages are presented in parentheses

6.3.3 Suggested ways of restoring livestock production in the study area

Restoration of traditional livestock production practices was supported by most (70%, n=234) of the respondents. The customary livestock and range management practices that needed to be restored varied significantly ($\chi^2 = 151.69$, df = 5, $p < 0.001$) among the study sites. These practices included herd mobility (38%), communal land tenure system (32%), and kinship ties (11%), keeping large herd sizes (9%), and pasture management (6%) as well as reservation of dry season grazing areas (4%). Those who opposed the restoration of customary practices perceived them as outdated (53%) and contribute to slow development (20%) in rangelands. Changing pastoral lifestyles (14%) and their unsustainability (13%) were given as other reasons that make customary practices unattractive.

Current range management practices in the area have resulted in decline in rangeland condition as noted by many (62%) respondents. Opinions whether there existed any recognized management system in the study sites differed significantly ($\chi^2 = 8.35$, df = 2, $p < 0.001$). Majority of respondents in both nomadic (64%) and semi nomadic (63%) land use sites noted presence of a recognized range management system in their area and only 46% in the sedentary

land use area. The majority (79%) of those who mentioned absence of a rangeland management system would support implementation of the conventional system in their area. Views on the exact approach varied significantly ($\chi^2 = 86.58$, df = 5, $p < 0.001$) among the respondents. The mentioned options for the rangeland planning of the study area included partitioning of conservation areas (32%), dry season grazing areas or forage banks (22%), migratory corridors (15%), cultivation areas (14%), urban centres (12%) and settlement areas (5%).

The majority of the respondents (90%) supported establishment of information centres to share and access useful information. Among the important information that the community preferred were those related to livestock husbandry (55%), entrepreneurship (39%), crop cultivation (20%), conservation (19%), tourism (5%) and pasture production (4%).

Most (71%) of the respondents noted that the rangeland resource governance system has broken down over time and that the customary institutions were no longer able to regulate resource use. They indicated that the customary resource governance was considered ineffective due to lack of enforcement of the set rules by the elected leaders.

6.4 DISCUSSIONS

It is apparent that many rangeland resources in the study area have changed over time consequently affecting livestock numbers in the three land use sites. Livestock rearing which is the main livelihood strategy in Amboseli Ecosystem has experienced drastic decline due to the changes in rangeland resources. These trends were mainly attributed to reduction in grazing areas as a result of increase in settlements and corresponding human population growth, expansion of crop farming and the frequent recurrent droughts in the area. These factors are also known to restrict livestock mobility, which is a key strategy used by pastoralists to exploit resources in environments that are highly variable in space and time. The community perceptions of the

declining livestock herd size are similar to those reported by Kioko and Okello (2010). The authors attributed the decline in herd sizes to increase in inappropriate land uses at the expense of grazing land, expansion of cultivation areas and clearing of land for settlement leading to loss of vegetation in the area.

The nomadic land use site still supports large livestock numbers and herd mobility compared to the areas where land has been subdivided. The nomadic pastoral system maintains mobile, large scale livestock movement that prevents heavy grazing pressure on grasslands as opposed to the semi-nomadic and sedentary systems (Western et al., 2009; Groom and Western, 2013). Pastoral mobility on communally owned land allows moderate rotational grazing that supports large herds compared to permanent settlements. Continuous grazing that normally occur around permanent settlements leads to overgrazing and land degradation, resulting in decline in range and livestock productivity.

The decline in grazing areas has also partly been attributed to expansion of crop cultivation on productive wetlands. The observed trends have led to decline in vegetation resources and consequently biodiversity in the study area. Coupled with rising human population growth, overexploitation of range resources and restricted pastoral mobility, overgrazing in the fragmented rangelands has led to decline in land productivity as evident in low biomass production per unit of rainfall (Western *et al*., 2015). Severe overgrazing by livestock due to restricted mobility results in changes in biodiversity, as well as decline in range productivity, and land carrying capacity, and consequently land degradation (Nyariki *et al*., 2009). Similar trend on range resources was observed in the Masai Mara Ecosystem, whereby the recent shift from livestock production to crop cultivation has negatively impacted the livestock sector due to changes in vegetation resources (Nyariki *et al*., 2009).

Groom and Western (2013) reported adverse impacts of permanent settlements on pastoral rangelands. The authors indicated that settlements lead to reduction in forage resources, lower grass biomass, and slow grass recovery after prolonged dry periods and reduced seasonal movement of livestock, all of which work in concert to undermine range productivity. In their model, Boone *et al*., (2005), reported reduced livestock numbers in fragmented landscapes as a result of curtailed mobility. As reported in areas where nomadic pastoralism dominates, mobility allows sustainable utilization of rangelands which in turn supports large herds. These findings are consistent with those from the study by Kioko and Okello (2010), in which the community attributed the declining livestock numbers to subdivision of pastoral land and pasture scarcity in the Amboseli Ecosystem.

Subdivision of communal pastoral lands started with group ranch demarcations in 1968, which led to designation of six group ranches in Amboseli Ecosystem. The resultant effect of the subdivision was reduction in the degree of pastoral mobility in the region. Initially, the group ranches were established under the Land (Group representative) Act Cap. 287 of the laws of Kenya with the aim of reducing overgrazing in range ecosystems, improving livestock production and increasing community awareness on environmental conservation (Government of Kenya). Privatization of communal rangeland were further encouraged with the intentions of providing health and education services and increase livestock productivity (Reid *et al*., 2014), objectives that are paradoxically similar to what the respondents of this study suggested. However, the intended objectives were not met as problems of land degradation escalated, thereby further undermining pastoral livestock production.

Given the semi-arid climate of the Amboseli Ecosystem, competing land uses such as cultivation are mostly confined to the high potential areas and require substantial initial investments where

irrigation is involved, therefore leaving pastoralism as the main livelihood strategy in the larger areas of the ecosystem. Utilization of these environments will therefore only remain viable if herd mobility is restored in the changing landscape. Traditional pastoral practices such as keeping large herds, splitting herds during dry periods and keeping mixed species herds that utilize the different vegetation resources need to be restored. Land subdivision in pastoral areas is inevitable, and hence the need for interventions to ensure livestock mobility in the fragmented landscapes. One of the ways is to advocate for community land trust that allows land use zoning to provide areas for conservation, grazing, cultivation and settlements.

6.5 CONCLUSIONS

Long term changes in range resources in the Amboseli Ecosystem have led to decline in size of household herds over the past four decades. The livestock declines were more significant in the sedentary land use site than in both semi-nomadic and nomadic areas under study. Herd mobility is possible in the nomadic land use site due to limited competing land uses in the area. Sedentary site and parts of semi-nomadic site have experienced changes in land tenure from traditional communal system to individual ownership. The changes in land reforms have resulted in restriction of pastoral herds undermining livestock production and promoting permanent settlements in the study area. For sustainable livelihoods and food security to be achieved under the changing landscape in the Amboseli area, interventions that promote sustainable resource governance system are critical. This would entail forming land trusts that advocate for land use planning to maintain good relationship among the multiple land users for sustainability of pastoral system, crop production and conservation of natural resources.

CHAPTER SEVEN: SUMMARY CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

- The Amboseli Ecosystem has experienced socio-demographic, economic and biophysical changes over the last four decades, which include decline in grazing areas, reduction in range condition, loss of woodlands, increase in human population, and encroachment of grazing land by settlements and crop cultivation, changes in land tenure, and collapse of customary institutions that regulated the use of range resources.

- Decline in grazing areas was the main change observed by the community over the last for decades. The decline was more pronounced in sedentary and semi-nomadic land use site than in the nomadic area.

- Grazing areas in the nomadic land use site declined by half. This was attributed to a number of factors which included increase in settlements and loss of land productivity leading to bare grounds and reduction in vegetation.

- Diminishing grazing land in both semi-nomadic and sedentary land use sites was more than double over the last four decades. The decline was attributed to the recent changes in land reforms leading to exclusive privatization of land in sedentary and partly in the semi-nomadic land use sites. The changing ownership of land has led to changing land uses which has eventually negatively impacted the grazing areas.

- Privatization and changes in land uses in Amboseli Ecosystem have negatively impacted on herd mobility which is the main strategy in utilizing the rangeland resources which are varied over space and time. The restricted mobility has caused all season grazing in small areas leading to deterioration of the rangelands.

- Due to long term changes in socio-demographic, economic and ecological changes in rangeland ecosystems, their conditions have declined over time. This in addition to restricted mobility has led to decline in pastoral household herd holdings over the last four decades.

- In response to the observed changes in the rangelands in the recent decades, the Maasai community living in Amboseli area perceives improvement of indigenous livestock breeds to have cross breeds with better returns per animal unit as one option in counteracting the changes. This will help in meeting the future needs where grazing land is becoming limited.

7.2 Recommendations

- In order to restore the sustainable use of the rangelands in the present times, an integrated approach that combines traditional and conventional land use planning should be employed.

- Land policy reforms and decision making process on rangelands need to be participatory and multi-stakeholders processes.

- Establishing communities' perceptions through participatory mapping on spatial and temporal changes is an important technique in monitoring rangeland conditions over time.

- Pastoralism remains a key livelihood strategy in Amboseli area therefore, interventions such as enhancing open access lands that promote herd mobility in the changing pastoral regimes should be advocated for.

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APPENDICES

APPENDIX 1: HOUSEHOLD QUESTIONNAIRE FOR COMMUNITY PERCEPTIONS ON LONG TERM CHANGE DYNAMICS ON RANGE RESOURCES IN AMBOSELI ECOSYSTEM

The purpose of this questionnaire is to collect data to assess knowledge, attitudes and perceptions of the community on the long term spatio-temporal changes on pastoral resources and their impacts on pastoral livelihoods in Amboseli ecosystem. This will involve investigation of perceived changes, their causes and community's responses towards them. The study will also determine the land cover/land use change impacts on household herd size and mobility patterns over a period of 40 years. The results will guide decision making for sustainable use of the pastoral land resources.

1.0 General information

1.1 Date of interview:……..Questionnaire no……..
1.2 County:…….. Group Ranch……
1.3 Location:……Village:……

2.0 Household information

2.1 Household head name……Sex: 1.Male ( ) 2. Female ( )
2.2 Age ……..
2.3 Education: 0 None ( ) 1. Primary ( ) 2. Secondary ( ) 3. Tertiary ( )
2.4 Household size/Composition

Adults	Children		No of children in school	Other dependents	Total
Husband & wife(s)	Boys	Girls			

2.5 Main source of livelihood: 1. Livestock ( ) 2. Crop cultivation ( ) 3. Business ( ) 4. Formal employment ( ) 5. Others ……
2.6 Household herd size and composition:

Species/Class	Total No	Total TLU
Cattle		
Calves		
Goat		
Kids		
Sheep		
Lambs		
Total HH TLU		

3.0 Use value of pastoral resource patches

3.1 Describe the following range resources:-

Key resource area/ Resources	Availability (Increasing, constant, decreasing)	Reason	Accessibility (Increasing, constant, decreasing)	Reason
Dry season grazing reserve				
Watering points				
Migratory routes/sites				
Medicinal plants/ firewood				
Spiritual site				
Salt licks				

3.2 What is your general view on the status of the pastoral range resources?

……..

3.3 What is the reason(s) behind your views on pastoral range resources

……

3.4 What is your perception on wildlife using the same pastoral areas?

……

3.5 Have you ever benefited from wildlife using the same pastoral areas? 1) Yes ( ) 2) No ( )

3.6 If yes, how have you benefited? …….

3.7 If no, why? ……..

3.8 Have you ever had any negative experience with wildlife in your area? 1) Yes ( ) 2) No ( )

3.9 If yes explain?

……

3.10 Human wildlife conflict trends over the last four decades

Trend in human wildlife conflict (Tick appropriate)	Possible causes of the trends
Low ( )	
Moderate ( )	
High ( )	

3.11 What do you think could be the mitigation strategies for the human wildlife conflict?

……

4.0 Perceptions on land cover and land tenure changes

4.1 Have you observed any changes in land cover and pastoral resources over the past 40 years in your area? 1 Yes ( ) 2 No ( )

4.2 If yes describe the general trend of the following range resources in your area over the last 40 years:-

Range resource trends	
Resource	**General trend**
Livestock numbers	
Variety of habitats	
Abundance of pastures	
Abundance of trees	
Dry season grazing reserve	
Migratory routes/sites	
Medicinal plants/trees/firewood	
Wildlife relative abundance	
Wildlife species richness	
Water sources/ Watering points	
Droughts	
Extension of agricultural land	
Infrastructure	
Salt licks	
Spiritual sites numbers	

4.3 Which strategy do you perceive can address the long term changes in the rangelands?

……

5.0 Change dynamics on household herd size, mobility pattern and land tenure

5.1 Has your household herd size changed in number over the last 40 years? 1) Yes ( ) 2) No ( )

a. If yes, has it increased or decreased?

……

b. If increased, through which means? ……

……

c. If decreased, what's the cause(s)? …….

.....

5.2 Has your livestock herd size recovered since the 2009 drought? ……...

If yes, through which means?**.....**

5.3 If no, why? .....……

5.4 Do you still move your livestock in search of pasture and water? 1 Yes ( ) 2 No ( )

5.5 Is it still effective now? 1. Yes ( ) 2. No ( )

5.6 If no how does this restriction affect your livestock?

…….……

5.7 What is the benefit of moving livestock from place to place?

……

5.8 Has the migration patterns changed? 1 Yes ( ) 2 No ( )

5.9 If yes, what has caused the changes?

……

5.10 What are the benefits of settling down by pastoralists?

……

5.11 In your opinion, does land subdivision and fragmentation affects pastoral household herd size?……

5.12 If yes, will it cause an increase or decrease in herd size?**.....**

5.13 Which land tenure system would you prefer appropriate in your area? Communal system ( ) Group ranch system ( ) Privatization ( )

5.14 Do you think there are traditional pastoral practices that should be retained/restored?

.....

5.15 If yes which one should be retained or restored?

……...

5.16 If No, why?

……

6.0 Institutional and capacity building

6.1 Is there a management system of the land use in your area? 1 Yes ( ) 2 No ( )

6.2 If No would you support a land use plan and management system? 1 Yes ( ) 2 No ( )

6.3 What would you want to be the main features to be considered in the land use plan and management system?

……..

6.4 Would you support a physical resource center in your landscape to access and share information about the different land uses? 1 Yes ( ) 2 No ( )

6.5 If yes, what kind of information would you want to access at the resource center?

……

6.6 Has the governance structures on pastoral lands changed over the last 40 years?

……...

6.7 If yes what has changed?

……

6.8 What has caused the changes

……

APPENDIX II: QUESTION GUIDE FOR FOCUS GROUP DISCUSSIONS FOR MAPPING PASTORAL RESOURCE PATCHES AND CHANGE DYNAMICS OVER THE LAST 40 YEARS AND THEIR CAUSES IN AMBOSELI ECOSYSTEM.

Objectives

1. To determine the communities' perceptions on long term land resource changes in Amboseli ecosystem in four different historical periods (pre park, post park pre-settlement, post settlement and post 2009 drought).
2. To investigate the reasons attributed to the perceived long term changes on pastoral resources in the study area.

Variables to consider:-

1. Human population trends
    i. Pre-park settlement (1967-1976)
    ii. Post park pre-settlement (1977-1986)
    iii. Post settlement period (1987-2006)
    iv. Post 2009 drought
2. Settlement patterns
    i. Pre-park period
    ii. Post park pre-settlement
    iii. Post settlement period
    iv. Post 2009 drought
3. Livestock numbers trends
    i. Pre-park period
    ii. Post park pre-settlement
    iii. Post settlement
    iv. Post 2009 drought

4. Household livestock holding (size)
    i. Pre-park period
    ii. Post park pre-settlement
    iii. Post settlement
    iv. Post 2009 drought
5. Herd mobility
    i. Pre-park period
    ii. Post park pre-settlement
    iii. Post settlement
    iv. Post 2009 drought
6. Wildlife trends
    i. Wildlife richness
    ii. Wildlife relative abundance
        - ✓ Prepark period
        - ✓ Post park presettlement
        - ✓ Post settlement
        - ✓ Post 2009 drought

7. Vegetation change dynamics
    i. Variety of habitats
    ii. Abundance of pastures
    iii. Abundance of trees
    iv. Forage production (quality and quantity) (productivity)
        - ✓ To check the trends during pre-park, post park presettlement, post settlement and post 2009 drought
        - ✓ The driving forces behind the observed trends
8. Crop farming dynamics
    i. Pre park period
    ii. Post park pre-settlement
    iii. Post settlement
    iv. Post 2009 drought
9. Infrastructure development (roads, communication networks, social amenities, business centers)
    i. Pre park period
    ii. Post park pre settlement period
    iii. Post settlement
    iv. Post 2009 drought
10. Land tenure changes
    i. Communal
    ii. Group ranch system

iii. Clan ownership
iv. Private ownership

11. Changes in land use systems and livelihoods
    i. Livestock production
    ii. Crop farming
    iii. Conservation/tourism
    v. Business centers

    All within the historical periods (Pre Park, post park pre settlement, post settlement and post 2009 drought)
12. Natural resource governance
    - ✓ Pre Park
    - ✓ post park pre settlement,
    - ✓ post settlement and
    - ✓ post 2009 drought)
13. Human wildlife conflicts
    - ✓ Pre Park
    - ✓ post park pre settlement,
    - ✓ post settlement and
    - ✓ post 2009 drought)
14. Drought trend during the pre-park, post park pre settlement, post settlement period and post 2009 drought.
15. Drought coping strategies (How they have changed) across the four time periods