The impacts of extreme climatic events on pastoralists and predators in East African rangelands

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‘I, Claudia Amphlett, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.'

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Abstract

Climate change is likely to bring changes in climate variability, precipitation and increase the frequency, intensity, spatial extent and duration of extreme climatic events (XCEs). XCEs are influenced by a wide range of factors, including anthropogenic climate change, natural climate variability, and socioeconomic development. This is particularly relevant to African arid and semi-arid rangelands because of the spectacular levels of biodiversity they sustain against a backdrop of endemic poverty and vulnerability for the people whose home they are. Climate change does not work alone but in synergy with other well-known stressors, in particular habitat loss and fragmentation. These stressors as well as other factors such as changes in land use and land cover, increase in population and spread of settlements confine biodiversity to small fragmented areas and restrict people's use and mobility. In addition, climate change will likely exacerbate already social, political and economic impacts of many rural poor, undermining human security and affecting all levels of biodiversity. As XCEs are projected to increase in this region, this thesis places itself within the growing body of literature that evaluates the effects of impacts of XCEs. This thesis used a mixed method approach to understand and evaluate the impacts of recent XCEs on pastoralists and large carnivores in Kenya. This thesis finds that pastoralists suffer enormous livestock losses during XCEs when compared to non-XCEs. In response to the increase in frequency and severity of impacts, pastoralists are responding in new ways to try to minimise the effects. Large carnivores were more likely to choose land uses that pastoralists also used more often during the XCEs. Habitat fragmentation, restriction in mobility and increases in XCEs frequency, will likely create a situation that could potentially increase interactions between pastoralists and predators, intensifying human-wildlife conflict in this region.

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Acronyms

BEA	British East Africa
CBNRM	Community based natural resource management
CPR	Community property resource
EGV	Ecogeographical variable
FAO	Food and Agriculture Organization
FMD	Foot and mouth disease
FG	Focus group
GCM	Global Climate Models
GDP	Gross Domestic Product
GIS	Geographical Information Systems
GPS	Global Positioning System
GoK	Government of the Republic of Kenya
HHS	Household survey
HWC	Human Wildlife Conflict
IDP	Internally Displaced Persons
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for conservation of Nature
KNBS	Kenyan National Bureau of Statistics
KI	Key informants
KWS	Kenya Wildlife Services
LME	Linear mixed effects

MRC	Mpala Research Camp
NESC	National Economic and Social Research Council
NGO	Non-Governmental Organisation
NRT	Northern Rangeland Trust
PA	Protected area
PCA	Principle Component Analysis
PRA	Participatory rural appraisal
RRA	Rapid rural appraisal
SLWDP	Samburu and Laikipia Wild Dog Project
KRWDCP	Kenya Rangeland Wild Dog and Cheetah Project
SSI	Semi-structured interview
UTM	Universal Transverse Mercator
US	Unstructured interviews
VHF	Very High Frequency
XCE	Extreme Climatic Event

Chapter 1 Introduction

This thesis investigates how changes in climate impact on pastoralist livelihoods and wildlife in Laikipia, Kenya. It looks specifically at the effects of extreme climatic events, focusing in particular on the effect of severe drought in Laikipia, an area dominated by livestock but also exceptionally rich in wildlife.

As is inevitable with interdisciplinary work, the thesis draws on material from a wide range of disciplines. This introduction reviews the state of knowledge for East African rangelands on climate change; pastoralism and livelihoods; biodiversity, conservation and tourism; carnivores, and human wildlife conflict. Given this breadth of relevant literature, the introductory review seeks to focus on the area of intersection between these potentially divergent themes.

1.1 Climate change and variability

Global climate change is without doubt one of the most pressing concerns of our times (Karl et al., 2009) with global average surface temperatures having increased 0.74 ± 0.18°C over the last century (IPCC, 2007b). According to the International Panel on Climate Change (IPCC) it is 'unequivocal' that the climate system has warmed, with the majority of the warming *very likely* (>90%) to be due to human-induced increase of atmospheric greenhouse gas concentrations (IPCC, 2007a). Climate change is also likely to bring changes in climate variability and precipitation, and increase the frequency, intensity, spatial extent and duration of extreme events (Adger et al., 2010; IPCC, 2012). Extreme climatic events (XCE) are defined as "*the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends ('tails') of the range of observed values of the variable*" (IPCC, 2012).

Modern day climate change is likely to have significant impacts compared with past climate variation owing to the interactions between rapid climate change and substantial anthropogenic habitat destruction and modification (Walther, 2010). However, predicting the impacts of climate change and XCEs on ecosystems, wildlife and human well-being remains a significant challenge to research (Jentsch et al., 2011; Rounsevell et al., 2010). Africa in particular is one of the continents seen to be most vulnerable to climate change and climate variability. This is because of the high proportion of arid and semi-arid rangelands in which

production is constrained by plant-available moisture (itself determined primarily by rainfall and temperature), and because current coping strategies are already stretched by existing development challenges, particularly endemic poverty, complex and poor governance, ecosystem degradation, and complex disasters and conflicts (Boko et al., 2007; IPCC, 2014).

The last 30 years have seen an increase in frequency of drought in East Africa because of warming in the Indian Pacific Ocean (Williams and Funk, 2011). Projected warming in Africa is expected to be above the global annual mean for all seasons (Boko et al., 2007). According to Lyon and DeWitt (2012) there has been a recent and abrupt decline in the long rains in East Africa since around 1999, largely driven by changes in large scale seas surface temperature mainly in the tropical Pacific.

Changes in climate might amplify water scarcity by 30-40% for 1.7-2.7ºC of warming that could affect around 40% of the global population. For example, in one model water scarcity increased sharply with mean temperature increases up to 2.3ºC above preindustrial levels in East Africa (Gosling and Arnell, 2013). Risks to water resources in Africa are considered medium-high at 2ºC increase and high to very high at 4ºC increase (Gosling and Arnell, 2013).

1.1.1 Extreme climatic events

The human impacts of XCEs such as drought, floods, tropical cyclones and hurricanes are largely determined by people's exposure and vulnerability (IPCC, 2012), encompassing a wide range of factors, including anthropogenic climate change, natural climate variability, and socioeconomic development. Impacts are considered disasters "*when they produce widespread damage and cause severe alterations in the normal functioning of communities or societies*" (IPCC, 2012). XCEs can be the result of a single extreme event, successive extreme or non-extreme events, including non-climatic events. For example, some XCE droughts may be the result of successive weather or climate events that are, individually, not extreme themselves (though their cumulative effect is extreme). Extreme weather events are classified as acute extremes that happen quickly and follow a short but severe course (three months or less). Climate extremes are classified as chronic extremes that last longer than three months *or* conspicuous by their frequency (Stephenson, 2008). Accumulative effects, in relation to drought, are dependent on previous years' rainfall.

However, impacts are not always negative: flood-inducing rains can have beneficial effects on the following season's crops (Khan, 2011), while an intense freeze may reduce insect pests at the subsequent year's harvest (Butts et al., 1997). Commonly though, XCEs have a massive impact on human welfare, being responsible for important economic and human life loss (Honda et al., 2012),

East Africa is likely to see an increase in mean annual precipitation (Christensen et al., 2007). Model simulations predict a high confidence that heavy precipitation intensity will increase (Seneviratne et al., 2012), with rainfall as potentially as problematic as drought. In some Global Climate Models (GCM) models, the highlands in East Africa are expected to receive higher rainfall which would result in marginal lands becoming more productive, although this would be off-set by changes in land use systems and increase in human population (IPCC, 2014).

Increase in XCEs could possibly result in the loss of arid semi-arid land (ASAL) productivity (Ericksen et al., 2012). Changes in ASALs vegetation composition might also shift more towards browse species (Ericksen et al., 2012).

In Africa, pastoralism, traditional rain-fed agriculture and wildlife are particularly affected by XCEs. However, information on observed frequency and projections of XCEs in Africa is limited despite frequent reporting of such events (IPCC, 2012).

1.1.2 Impacts on people

The world's climate continues to change at unprecedented rates and communities' vulnerability to risks associated with climate change may exacerbate ongoing social and economic challenges, particularly for societies that depend on resources sensitive to climatic changes (Adger et al., 2010). The IPCC states, "*human-induced climate change is happening and all societies must learn to cope with the predicted changes including warming temperatures, drier soils, changes in weather extremes, and rising sea levels"* (IPCC, 2001). However, these effects will be unevenly distributed between countries, communities and families, and those exposed to the most severe threats are least likely to be able to cope (Smit and Pilifosova, 2001; IPCC, 2014). Social, political and economic factors will likely exacerbate climate change impacts for many rural poor, especially in developing countries, undermining human security as well affecting all levels of biodiversity (Bellard et al., 2012). Climate change is expected to increase the frequency and severity of impacts on human populations from many types of extreme events, such

as droughts, floods, tropical cyclones and wildfires, leading to an increase in deaths, disease and injuries (O'Brien et al., 2008; Ericksen et al., 2013; Seneviratne et al., 2012).

Many of the world's poorer countries include considerable areas of rangelands that experience highly variable and often unpredictable resource availability, with rainfall being the main limiting factor (Davies and Nori, 2008). In these regions most livelihoods are reliant on natural resources and environmental goods and services. These include water, seasonal grazing land, minerals, wild foods, charcoal and medicinal plants. Climate change will lead to three key types of change for pastoral systems in East Africa: increase in maximum and minimum temperatures, changes in the duration, occurrence and intensity of precipitation events, and increase in the CO_2 concentrations in the atmosphere (Ericksen et al., 2013), all affecting availability of key resources and consequently livestock and farm production. Kabubo-Mariara (2009) found that a 1% increase in temperature could reduce revenues from livestock by 6% across Kenya. Higher temperatures reduce reproductive rates in livestock (Hansen, 2009) as well as weakening their overall performance (Henry et al., 2012). Projected climate changes could result in declining returns from livestock keeping (IPCC, 2014).

Rangelands are areas with high climatic variability, and increasing fragmentation means people, livestock and wildlife have to make ever more effort to counterbalance the effects of XCEs such as extreme drought (Galvin, 2009). In addition, the customarily key coping strategy of mobility is being more and more constrained for pastoralists, who are also experiencing decreases in herd size (Galvin, 2009). Communities such as pastoralists living in ASALs continuously adapt to make use of the erratic environment. For centuries they have done this by using a suite of mechanisms to cope with change in ways that have made communities resilient (Table 1.1) and allowed them to exploit their environment sustainably throughout history (Galvin, 2009; Davies and Nori, 2008; Little and McPeak, 2014). These mechanisms are as much social and political as husbandry-related (Leslie and McCabe, 2013; Little and McPeak, 2014). However, with Africa expected to be the continent worst hit by climate change (Boko, 2007), and with rural coping strategies undermined in many countries owing to population growth, land conversion (Walther, 2010) or resource capture, their past resilience may collapse (Homewood in Leslie and McCabe, 2013; Little and McPeak, 2014). Although managing climate variability and climate risk is a not new challenge for

pastoralism (Ericksen et al., 2013) the broad consensus is that increase in XCEs will worsen food security in Africa, which already suffers from a major deficit in food production (Desanker and Magadza, 2001).

Table 1.1 Coping strategies used by pastoralist communities living in ASALs.

Livestock mobility	Redistributing assets
Livestock species diversity	Livelihood diversification
Maximising stock densities	Labour migration
Herd splitting	Use of wild foods
Grazing reserves	Opportunistic cultivation
Using emergency fodder	Culling weak livestock for food

(adapted from Davies and Nori, 2008; Boko et al., 2007).

The limits to pastoral coping strategies were made starkly clear during East Africa's 2009 XCE. For example, in Amboseli, Kenya, 85% of the cattle and 65% of the sheep and goats associated with the ecosystem died during the drought (Western et al., 2009a), alongside over 75% of the wildebeest (*Connochaetes taurinus*), zebra (*Equus quagga)* and buffalo (*Syncerus caffer*).

1.1.3 Impacts on biodiversity

Climate change and biodiversity are widely recognized as being interconnected by the changing environmental conditions within which a species lives (Perrings, 2010). Although species have responded to climate change throughout their evolutionary history (Harris, 1993), the major concern today is the rapid rate at which climate change is happening (Platts et al., 2014a; Schneider and Root, 1998). The broad conclusions are that climate change is already inducing an adaptive response on the part of the world's biota (Perrings, 2010). These include changes in species distributions and abundance, changes in the timing of reproduction in animals and plants, changes in animal and bird migration patterns, and changes in the frequency and severity of pest and disease outbreaks (Perrings, 2010). However, climate change does not impact on biodiversity alone but works in concert with other well established stressors, in particular habitat loss (Root et al., 2003).

Climate change is not likely to affect all species equally, with some species or biological communities more prone to extinction than others (Platts et al., 2014a; Jetz et al., 2007; Mace et al., 2005). Vulnerable species are identified as those having one or more of the following features: restricted habitat requirement, reduced mobility, small or isolate populations, and limited climatic ranges (Mace et al., 2005; Foden et al., 2008). Climate change will also alter spatial and temporal patterns of temperature and precipitation, which are the two most fundamental factors determining the distribution and productivity of vegetation. For example, the range and distribution of antelope and gazelle are likely to alter (Desanker and Magadza, 2001). These represent very important food sources for large predators, which would consequently be impacted too.

Present climate change trends are likely to continue, with some scenarios indicating that as many as 30% of species will be lost as a consequence (Thomas et al., 2004). Three main approaches are used to forecast climate change impacts on species distributions, abundance and extinctions, and include projecting species loss, focussing on either future changes in species range or species extinction or changes in species abundance. However current approaches to such predictions are seen to have considerable weaknesses. All three modelling approaches have so far largely focused on one axis of response (change in space), largely overlooking the importance of the other aspects such as genetic, interspecific relationships, community productivity and ecosystem servies. In addition, they seldom account for the mechanisms of these responses (plasticity and evolution) (Bellard et al., 2012).

1.2 Pastoralism and livelihoods

Pastoralist groups across Africa share parallel constraints and opportunities in livestock production despite residing in diverse environments and keeping a variety of animal species and breeds (Fratkin and Smith, 1994). East Africa has a very large diversity and number of pastoralist societies of whom many combine keeping cattle and with farming. Pastoralism has for centuries been the dominant form of land use across East Africa in ASAL areas where rainfall is the constraining factor (eg. Spear and Waller, 1993). The great majority of Africa's pastoralists have customarily occupied large tracts of communally shared land, with kin and community being primary networks for managing herding and security (Galvin, 2009; Homewood, 2008). Household livelihoods are often (and have long been)

diversified through wage labour, trade, fisheries or wildlife based activities (Homewood, 2008). Pastoral production provides subsistence living, customarily based on milk (Sadler et al., 2009; see also Chapter 4) but also other livestock products (meat, blood and fat, with manure and hides serving other subsistence needs: Dahl and Hjort, 1976). Keeping large, diverse herds and using seasonal movement through the landscape has allowed pastoralists to develop an ecologically and economically effective production system (Homewood, 2008). Pastoralism has coexisted with wildlife for millennia and is seen as a land use system often compatible with wildlife conservation (Western, 1982; Homewood and Rodgers, 1991; Nelson, 2012). Pastoralism has customarily relied on access to key resources through seasonal transhumant movement across extensive communal lands. However, increased pressure to privatize land, whether for commercial ranches or other non-pastoral uses has led to widespread sedentarization among formerly more mobile pastoralist communities as well as in-migrant groups. The subdivision of land typically limits mobility and leads to loss of access to key resources for people and livestock (Homewood et al., 2009). Accessing key dry season/drought resources, such as water and dry season grazing is critical to surviving during times of extreme drought (Niamir-Fuller, 1999; Miller, 2015), causing heightened competition for grazing, potentially leading to conflict. Customary institutions for tenure and access, generally working as common property resources (CPR) (but see Behnke, 2017) have mediated resource competition for pastoralist communities across sub Saharan Africa for millennia. Nonetheless, access to key resources has continually been contested by different ethnic and occupational groups (Homewood, 2008; Behnke, 2017). Conflict can be exacerbated by pressure from development initiatives such as mining, commercialisation of farming, increase in areas expropriated for PAs and conservation, and by the shift to private land tenure. On top of socio-political and economic drivers, increased livestock predation from protected species such as lions can add to the stress of XCEs on pastoralist households.

1.2.1 Management of rangelands

Since the beginning of the twentieth century, pastoralist land use and livestock management has been portrayed as environmentally problematic because of the assumed tendency of pastoralists to overstock and overgraze, postulated to cause degradation of rangelands (Lamprey, 1983). Seasonally bare ground was feared to ultimately lead to decline in primary and secondary production (Lamprey, 1983).

This perspective was epitomised by Hardin's (1968) 'Tragedy of the Commons' theory. This postulates that absence of regulation in communal pastoral systems leads to overgrazing, as a result of each pastoralist wanting to pasture more individually owned livestock on communally owned land. 'Tragedy of the Commons' thinking has underpinned influential national and international policy pressure to privatise rangelands. Over the last decades a new understanding has emerged, recognising, in many situations, effective regulation of communally managed common property resources and of their fundamental difference from the open access situation described by Hardin (Ostrom et al., 1999). This debate continues with new thinking around quite what CPR management and conversely open access may denote (Behnke, 2017) A parallel debate over the extent to which ASALs operate as equilibrium or non- (or dis-)equilibrium systems (Vetter, 2005; Behnke et al., 1993) has similarly driven recognition of the ecological efficacy and sustainability of mobile pastoralism (Scoones, 1993).

1.2.2 Rangeland tenure and access

Customary land tenure systems in African rangelands have generally been based around what has come to be known as CPR, with rights of access to grazing land, water and other key natural resources determined by birth, kinship, investment of labour, and social networks but also open to negotiation through social contracts. Boundaries around key resources have commonly been fuzzy in terms both of social composition and membership of different user groups and also in terms of spatial extent of boundaries around point-centred key resources (such as major wells: Homewood, 2008). Cooperation is both open-ended and continually re-negotiated, allowing flexible use and response to seasonal, annual and long-term changes for the different overlapping rights of people using these resources (Homewood, 2008; Behnke, 2017). Such customary law is rarely binding beyond that community (Alden Wily, 2011). Changes in land tenure and use, especially with privatisation, often result in fragmentation of once contiguous land (Galvin, 2009), constraining pastoralist mobility and their capacity to cope with seasonal change (Galvin et al., 2001; Bedelian, 2014). As a consequence subsistence pastoralism is becoming increasingly difficult to pursue, with fewer people able to live this way on the dwindling areas available (Homewood et al., 2009; Sandford, 2013).

1.2.3 Ideal free distribution

The ecological theory of ideal free distribution (IFD) or density-dependent habitat selection (DDHS) (Sutherland, 1983), has been used to analyse the interrelationship between pastoralism and resource use in relation to natural resources availability, and in relation to other users. IFD assumes that the distribution of a population of grazers (or other resource users) is governed by environmental conditions: put simply; herbivores will distribute themselves according to availability of key resources. The basic premise of IFD is that all users have unrestricted access to all resources as well as knowledge of their location and availability. However, changing social and political landscapes, delineated by different property rights of fair access, constrain the validity of this theory as applied to people rather than more freely mobile wildlife. The foremost factors which undermine ability to maintain pastoral mobility are increasingly the expansion of cultivated areas; loss of livestock corridors/transhumance routes; privatization of land; increase in fences on properties (Evans & Adams 2016); and growing social conflict and insecurity (Galaty, 2013; Letai & Lind, 2013; Butt, 2010; Goldman & Riosema, 2013; Leslie & McCabe, 2013). Pastoralist movements have always been driven by a combination of socio-political and institutional as well as ecological factors. Before the arrival of the British during the colonial years, different Maasai sections, and other pastoralists before them, continually contested access to and control of fertile, better watered uplands such as Laikipia (Spear and Waller, 1993).

1.2.4 Land expropriation

Land acquisition in rural areas in developing countries is not a new occurrence, happening throughout history since well before colonial times (Cotula, 2013). Today it can be seen as a form of land grabbing or neo-colonialism (Fairhead et al., 2012) or environmental imperialism (Galaty, 2013). There is a rising trend of state-mediated lease or sale of land and water to foreign investors for cheap food crops, especially to those countries that are financially rich but resource poor in terms of cropping potential (eg. Gulf States, China). Higher commodity prices and growing global concerns over food security since the food crisis in 2007/8 are driving increase in investment. Africa is attracting a wide variety of foreign investors eager to facilitate commercial expansion in the agricultural sector, alongside other land uses eg tourism (Zoomers, 2010). Similarly global demand for biofuels, carbon and non-agricultural commodities mean foreign investors are increasingly gaining

control of farmland, which in many cases further threaten small-scale farming and rural livelihoods through reduced access to resources (Cotula et al., 2009).

Land grabbing is defined by the international Land Coalition's Tirana Declaration as acquisitions or concessions that are one or more of the following:

> • in violation of human rights, particularly the equal rights of women;
> • not based on free, prior and informed consent of the affected land-users;
> • not based on a thorough assessment, or are in disregard of social, economic and environmental impacts, including the way they are gendered;
> • not based on transparent contracts that specify clear and binding commitments about activities, employment and benefits sharing, and;
> • not based on effective democratic planning, independent oversight and meaningful participation (in Blomley et al., 2013).

Africa is experiencing unparalleled interest from international investors, particularly agri-businesses (Perrings, 2010). For example, Ethiopia has 1,300 international investors holding commercial farm licences. Although they make up only 1% of total land, these are the most productive areas in the country (Graham et al., 2009). Kenya's land expropriation deals have recently increased in ASALs, once regarded as unimportant and of low value to national economic growth (Nunow, 2012). The acquisition of ASALs by various stakeholders undermines pastoral productivity and makes pastoral landholdings vulnerable (Galaty, 2013). The most valued pastoral lands are being acquired by a diversity of actors from both domestic and foreign, and state and non-state stakeholders. These include agro-industrial companies, intending to enhance food security in their own countries with highly efficient commercial agriculture (Galaty, 2013; Perrings, 2010), wildlife conservation and tourism initiatives aiming to protect wildlife as well as increasing high-end tourism (Friis and Reenberg, 2010; Galaty, 2011), mining, and settlement schemes (Galaty, 2013). Little is known about these present deals because they are conducted in non-transparent ways with many officials reluctant to discuss the details of any intended purchases (Nunow, 2012). These formal shifts in land tenure can make livelihoods of local communities vulnerable as well as having significant impacts on local ecology (Galaty, 2013).

To take an East African "wetland in dryland" example, the Tana delta in Kenya has seen violent clashes between farmers and livestock keepers in recent years, with one recent report recording over 150 people being killed (Duvail et al., 2012). The conflicts exemplify the underlying issues that vulnerable people face by being excluded from access to land and water. The Tana delta supports a diverse range of livelihoods including small-scale agriculture, livestock keeping, fishermen and forest users. Nonetheless, large areas have been acquired for the production of biofuels (*Jatropha*) and sugarcane, which not only excludes people from using the land for traditional grazing but also places increase pressure on water resources. Furthermore, in 2012 the Tana delta was decreed a Ramsar site despite vigorous opposition by the local communities (Duvail et al., 2012). The case study on which this thesis focuses, Laikipia, is itself at the time of writing a hotspot of such conflict (see below).

Land grab also often operates directly at the local scale. In pastoralist systems pressured to privatise land, wealthier owners with larger herds selling considerably more animals and benefitting from commercialisation can use their influence to gain more control over key resources such as water and grazing (Catley & Aklilu, 2013). These stakeholders have financial and political capital to secure control of resources, especially where formal institutional arrangements for tenure are vague. Less well-off pastoralists are essentially excluded from accessing these resources when communal resources become privatized, eventually forcing them out of pastoralism (Catley & Aklilu, 2013). This is not least because increase in appropriation of communal water and rangeland by commercial owners and elite pastoralists further constrains the ability of poorer herders to respond to drought. Another common problem is insufficient compensation given to communities evicted from conservation areas, for example Mkomazi Game Reserve, Tanzania (Brockington and Homewood, 1996). Many pastoralists have been displaced, pauperized or pushed out of pastoralism because of commercialization, population growth and continued droughts, whereas drought resistance of the elites has improved. This partially explains why the livestock export trade in the Horn of Africa continues to grow (reaching USD1bn in 2010) despite recurrent droughts and increasing levels of destitution (Catley & Aklilu, 2013).

Green land grabbing mostly refers to land lost to conservation but can also include appropriation for other environmental ends, and is an emerging development that is growing in significance (Fairhead et al., 2012). Conservation initiatives and

ecotourism are among the main causes of land acquisition today in East Africa in general (Zoomers, 2010), including Laikipia (See Chapter 2 and 5).

1.3 Conservation

1.3.1 Protected areas

Protected areas (PA) have been the backbone of international conservation strategies since the beginning of the 20th century (Adams, 2004). The dominant conservation narrative has long been to protect biodiversity by separating people and wildlife (Hutton et al., 2005). This involved creating areas that excluded access by local residents (Adams and Hulme, 2001). Protectionist conservation, also known as 'fences and fines' or 'fortress conservation' is largely state-controlled with those communities living adjacent to the protected areas often not being involved in the management of the areas (Adams and Hulme, 2001; Brockington, 2002). The creation of modern protected areas was based on the first national parks model (Yellowstone National Park) in the USA. The idea of wilderness without people has been a strong driver of conservation for protecting biodiversity (Neumann, 1998; 2004). Most of the protected areas created in East Africa are found in ASALs that were formerly used by pastoralist communities. Protected areas expanded rapidly after World War II, around the global south, when East Africa experienced a 'conservation boom' during this period (Neumann, 2002).

In Kenya the many 'parks' that were established, now managed by the Kenya Wildlife Service (KWS) (Sindiga, 1995), were created without sufficient understanding and/or thought for existing social and ecological factors relevant to local communities and ecosystems. Parks denied local people invaluable herding and agricultural resources and in some instances fishing rights (Sindiga, 1995). In fact the state has long considered indigenous use of natural resources as destructive to wildlife, backward and incompatible with wildlife safari tourism (Akama, 2004). Subsistence hunting was prohibited and officially classified as poaching (MacKenzie, 1987). Local ecological knowledge has regularly been sidelined (Goldman and Riosema, 2013). By excluding local communities from using key resources such as water, pasture, firewood and wildlife from within the established parks, the colonial and later the post independence administration created conflicts between the demands of Kenya's wildlife-based tourism and the well-being of local people (Sindiga, 1995). In particular, tensions rose between the parks and

local communities as most large mammals moved seasonally beyond park boundaries into adjacent lands (Western, 1982).

In Kenya, land privatisation has meant those families customarily resident and grazing their herds in such areas, but poorly placed to establish land titles, lose access but receive neither compensation nor ongoing benefits from Community Based Conservation or conservancy initiatives (Bedelian, 2014).

1.3.2 Community conservation

Following independence, a new conservation direction emerged that included local communities rather than excluding them, started to form in Africa (Adams & Hutton, 2007). Rather than the dominant colonial view of protecting wildlife by excluding people, conservation prescriptions began to include local communities living in areas where wildlife also occurred. Community conservation emerged as the new orthodoxy and was seen as a way to try and alleviate friction between often divergent aims of or the one hand conserving wildlife while on the other sustaining the well-being of local communities by recompensing those people who shared their land with wildlife (Adam & Hutton, 2007). However, positive outcomes have been scarce and there is little proof that joint conservation and development objectives have been met (Adams et al., 2004; Roe et al., 2015).

One such community conservation approach is Community Based Natural Resource Management (CBNRM), which seeks to give natural resources a meaningful use value to rural communities who bear the cost of living alongside wildlife (Harrison, 2001). It has been widely recognised that conservation of wildlife needs the support of local communities (IIED, 1994). Projects, often tourism related, are initiated with local communities where a share of the revenue raised is directly given back to local people (Harrison, 2001). However, one of the problems cited with CBNRM is that it is too easily dominated by elites both politically and financially (Dressler et al., 2010). The majority of CBNRM initiatives are funded by international benefactors and Non-Governmental Organisations (NGO), which ultimately limit independent local decision making (Dressler et al., 2010).

1.3.3 Trends in wildlife populations in East Africa

Wildlife populations are being threatened on a global scale. Between 1970 and 2012 the average population decline for vertebrates was 58% (Gaind, 2016). The main reasons cited in the report for the losses are habitat loss and degradation, caused by increasing pressure on the land for food and energy. The trend in Africa has also seen significant declines in large mammal populations in PAs of ~59% between 1970-2005 (Craigie et al., 2010). East Africa, and Kenya in particular have shown a drastic decline in wildlife numbers, in part due to the expansion of farming into the peripheral pastoral lands (Ottichilo et al., 2000; Ogutu et al., 2016). However, some disaggregated analyses show wildlife increased gradually on open communal land where seasonal pastoralism is still practiced (Western et al., 2009b). Although multiple factors play a part in wildlife declines, habitat loss and fragmentation, largely due to cultivation, is considered the primary reason (Norton-Griffiths and Said, 2010). Increasing pressure from diverse actors to privatise ASALs presents a serious threat to both wildlife and pastoralism. Subdivision can exclude wildlife from access to critical key resources and can block movement between vital wet and dry season areas. Similarly, people and livestock lose access to key resources and experience increasing constraints on movement between, and competition for, those key resources that remain (Homewood et al., 2009). Thus the potential for conflict is likely to intensify.

Although species extinction is a natural process, and would occur without human actions, biodiversity loss in recent times has accelerated enormously, with extinction rates not seen since the last global mass-extinction event, during the Cretaceous period 65 million years ago (Mace et al., 2005; Barnosky et al., 2011). Up to half of species within well-studied higher taxa are threatened with extinction, according to the IUCN Red List, though fewer than 10% of named species have been assessed in terms of their conservation status (Mace et al., 2005). Biodiversity loss and the threat of species extinction are associated with anthropogenic drivers such as habitat change, loss and destruction; invasive alien species; introduced pathogens; overexploitation and climate change, with climate change one of the drivers most difficult to reverse (Mace et al., 2005) and with effects that are difficult to predict. However, not all species are equally at risk from the effects of climate change (Devictor et al., 2010). Those species seen as already vulnerable are more prone to extinction (see Chapter 7, Figure 7.1) due to direct and underlying effects (Mace et al., 2005) and there is a clear trend for higher levels of threat

among the larger species. Ecological traits of species associated with high extinction rates include high trophic level, low population density, slow life history or low fecundity, and small geographical range size (Purvis et al., 2001). These traits explain nearly 50% of the total between-species variation in extinction risk in carnivores. The remaining variation can be accounted for by external anthropogenic influences, irrespective of a species biology (Purvis et al., 2001).

A growing human population and the demands put on global resources to meet their own requirements increasingly impact on wildlife populations. Changes in habitat, the fragmentation of landscapes into smaller isolated habitat patches intensifies the interactions between people and wildlife and the potential for conflict increases. This is particularly relevant to ASALs because of the spectacular levels of biodiversity they sustain against a backdrop of endemic poverty and vulnerability for the people whose home they are. In particular, East Africa is unique in having retained relatively intact megafauna well into the 20th century (Western et al., 2009a). Clashes between people and wildlife over decreasing resources, and tension between development and conservation will only further exacerbate conflict.

1.4 Human wildlife conflict

Humans and wildlife have coexisted for millennia in many different ways across a variety of habitats worldwide. However, over the last decades rapid human population increase, changes in land use and land tenure, habitat loss, and spread of settlement increasingly confine biodiversity to small fragmented areas, while also restricting people's land use and mobility. The unparalleled speed and magnitude of human modification of the Earth's surface and their spatial reach (Lambin and Meyfroidt, 2011) have resulted in increased potential for conflict between people and wildlife. Agricultural land is expanding in about 70% of countries, (FAO, 2003) and humans now require about 40% of global primary production to support them (Vitousek et al., 1986), creating massive knock-on effects on biodiversity, especially megafauna (Barnosky et al., 2012). As well as impacts on other species, this rapid land conversion is accompanied by major distributional effects between and within human groups, driving increasing irregularities, poverty and dispossession.

According to the International Union for Conservation of Nature (IUCN), human-wildlife conflict (HWC) occurs when "*wildlife's requirements overlap with those of human populations, creating costs to residents and wild animals*" (Madden, 2003). HWC exists in one form or another all over the globe. For example, human/crocodile conflict has been reported in 33 countries straddling both the tropics and subtropics (Lamarque et al., 2008). HWC encompasses a wide variety of circumstances, for example: livestock predation by wolves (*Canis lupus*) and spotted hyaena (*Crocuta crocuta*) (Swenson and Andrén, 2005; Ogada et al., 2003), grazing competition between livestock and wild ungulates (Butt and Turner, 2012; Tsering et al., 2006); crop-raiding by white-tailed deer (*Odocoileus virginianus*) and African elephants (*Loxodonta africana*) (Naughton-Treves and Treves, 2005; Davies et al., 2011), wild carnivores transmitting diseases to humans or livestock (Thirgood et al., 2005), and attacks on humans by tigers (*Panthera tigris*) and lions (*Panthera leo*) (Goodrich et al., 2011; Packer et al., 2005). Regional forms of these different conflicts are relevant to pastoralists in East Africa. For this study competition for grazing, livestock predation and disease are three of the conflicts focused on in some depth (see Chapters 5 and 6).

1.4.1 Predation

Predation on livestock is perhaps the most commonly cited cause of HWC (Thirgood et al., 2005). It is very widespread and can cause substantial economic losses (Thirgood et al., 2005). And although HWC has existed for millennia (Woodroffe et al., 2005a) it is the increased spatial and temporal overlap of humans and wildlife in a landscape with diminishing resources, which has intensified HWC and which now threatens many species that are of conservation importance (Frank et al., 2005; Woodroffe et al., 2005b). In this context HWC poses an urgent challenge to large carnivore conservation, particularly for African large carnivores, whose declines have led the IUCN to list many of them as threatened species[1] (IUCN, 2012).

[1] African wild dog (*Lycaon pictus*) status – endangered; African lion (*Panthera leo*) status – vulnerable; cheetah (*Acinonyx jubatus*) status – vulnerable and leopard (*Panthera pardus*) status – near threatened. IUCN red list population trend for *all* species – decreasing (IUCN 2012).

1.4.2 Grazing competition

Livestock and ungulates range widely to find water and pasture to utilise the broad range of grassland communities (McNaughton & Georgiadis, 1986), with pastoralism thought to be more compatible with wildlife more than other land use systems in ASALs (Butt and Turner, 2012). The seasonal availability of high-quality grazing spatially and temporally in ASALs allow livestock and wildlife to forage without overlapping. However, competition for water and pasture increases during 1) the dry season, or 2) when access is restricted and spatial overlap of livestock and ungulates increase (Butt and Turner, 2012).

1.4.3 Disease transmission

As pasture areas become smaller and increasingly restricted, risk of transmissible and vector-borne diseases is likely to increase (Reid, 2012). Diseases may be transmitted between livestock and wildlife either directly through infected body fluids or aerosols (rinderpest, malignant catarrh fever) or by biting insect vectors (tsetse and trypanosomiasis, tickborne diseases such as East Coast fever, among many others). In both cases environmental conditions may exacerbate transmission. For example, extreme rainfall increases in insect vector populations. Extreme drought events force wildlife and livestock into sharing eg. water sources more intensely, which could increase transmission (Thornton et al., 2009).

1.5 Carnivore ecology and conservation

Large carnivores are highly adaptable and live in a range of different ecosystems (Macdonald, 1989), often in complex assemblages (Loyola et al., 2009). However, they are some of the most threatened species globally (Ripple et al., 2014) and have suffered substantial population declines, range restriction and habitat loss (Ceballos and Ehrlich, 2002). Declines are attributed to habitat loss, changes in land use and land cover, geographical range restriction, disease, interspecific competition and persecution from humans among other factors. Many large carnivore species are highly vulnerable to these factors largely because of their ecology. (Woodroffe and Ginsberg, 1998; Purvis et al., 2001). Therefore they are more likely to become locally extinct in fragmented habitats, increasing the risk of extinction (Purvis et al 2001). Large carnivores live at low densities, require extensive areas to sustain viable populations, are large-bodied, have slow growth rates and represent the first high trophic level (Woodroffe & Ginsberg, 1998; Purvis et al., 2001; Sillero-Zubiri

and Laurenson, 2001). These factors increase their vulnerability to the risk of local or global extinction (Ripple et al., 2014).

1.5.1 Importance of conserving large carnivores

The importance of conserving large carnivores goes beyond the immediate benefit to the individual species. Large carnivore species can provide ecological and economic benefits (Durant et al., 2011). Large carnivores can have significant roles in the regulation of ecological interactions underpinning a healthy functioning ecosystem (Ritchie & Johnson, 2009) and their loss can bring about radical changes in community structure and biodiversity, leading to acute costs for that ecosystem (Terborgh et al., 1999). Apex predators have key influences on trophic structure and biodiversity in many terrestrial, marine and freshwater ecosystems (Estes et al., 2011). Ecological theory foresees that three key elements provide the basis for major shifts in ecosystems following changes in abundance and distribution of apex species: 1) ecosystems are shaped by apex predators through downward impacts on prey species; 2) ecosystem dynamics are non-linear forming distinct basins of attraction. Systems can be pushed over basin thresholds when perturbations occur, with systems arriving at alternative stable states 3) ecosystems are connected over a range of spatial scales forming an extremely intricate system whereby all species can affect one another through biological and physicochemical processes (Estes et al., 2011). Collectively, these three key elements potentially lead to conditions for trophic downgrading (Estes et al., 2011).

Carnivore conservation has primarily focused on conserving populations within protected areas owing to the majority of threats being anthropogenic (Woodroffe, 2001). However, PAs are unlikely to adequately provide long-term conservation solutions for many threatened species, especially for wide ranging species such as carnivores (Woodroffe and Ginsberg, 1998). Wildlife that range beyond PA boundaries into adjacent unprotected areas are exposed to threats on these reserve borders, which act as key population ‘sinks’ (Woodroffe and Ginsberg, 1998). Moreover, large dangerous carnivores such as lions are often eradicated from areas with people because they present a very serious threat. In addition, people may also retaliate against or reduce cooperation with conservation authorities if they feel that their own needs are being subordinated to those of wildlife, or that conservation authorities exclude them from decisions that affect their interests (Madden, 2008).

1.5.2 Climate change and carnivores

With the African continent expected to experience the greatest burden of climate change (Boko et al., 2007) the distribution of climate conditions is altering and species differ in their ability to keep pace with these changes (Loarie et al., 2009). It is difficult to predict the magnitude of climate change impacts on species and how these impacts may in turn affect ecosystems as well as other species that are part of that system (IPCC, 2007). However, climate zones may be changing too quickly for species to shift their distribution, which will threaten populations.

Understanding the impacts of XCEs on large carnivores is of particular importance, both because their biological traits make them more susceptible to the impacts of climate change, and also because the flat topography of large carnivore savannah habitat offers few refuges, despite the orthodox view that mountain ecosystems are the most threatened by climate change (Loarie et al., 2009). Finally, climate impacts on carnivores could have wider implications for ecosystems in ASALs because of the important role these species play in shaping savanna ecosystems (Chapter 7).

1.6 Conceptual framework for this study

I outlined in Section 1.2 how people and wildlife's mobility and changing access has been fundamental in shaping ASALs. This has been vital in a landscape which can be defined by highly-variable climate (Homewood, 2008). However, Hardin's (1968) 'Tragedy of the Commons' narrative of environmental damage through overuse of commonly accessed resources enabled global policies to 'protect' these environments through exclusion of local users (Berkes, 1985). Ostrom's (1990) 'Governing the Commons' criticised Hardin's prescription that only privatising the management of natural resources would ensure sustainable use of natural resources. Ostrom (1999) argued that many 'commons' are actually governed by collective CPR management and that privatising the commons was not the only choice for managing natural resources sustainably; indeed, overarching government 'rules' on sustainable use may hinder long-term sustainability (Dietz et al., 2003). In Colonial Africa, local natural resources management systems developed over centuries, were disregarded and replaced with colonial rules of use, often leading to overuse or destruction (Dietz et al., 2003). Natural resources are part of complex socio-ecological systems made up of multiple subsystems and

interactions between different users are subject to negotiation and potential conflict (Ostrom, 2009; Chapter 2). Capturing resources through exclusive rights of use can exacerbate tension between local users (Robbins, 2004; Chapter 2). In Kenya, 'parks' or 'reserves' were demarcated as a way of 'controlling' (restricting) local users access to natural resources and have led in some cases to tension between neighbours (Chapter 2). As private individuals as well as international organisations engage in wildlife conservation and/or ecotourism (Zoomers, 2010) there has been growth in PAs and access to and use of key resources has become increasingly constrained.

Figure 1.1 outlines the components of this thesis's interdisciplinary approach to understanding the impacts of XCEs on people and wildlife interactions in East African rangelands. It summarises the conceptual framework drawn from the factors and processes reviewed in the preceding sections. XCEs (drought, flood, extreme rainfall events) (Box A in Fig 1.1) impact on the availability of key resources such as grazing, water, minerals, non-timber forest products (NTFP) that are key to domestic livestock and pastoralists, and also key to wildlife prey species and to the predators that depend on those prey. Dry season grazing areas are critical in ASALs because they maintain and provide water and pasture longer into dry/drought seasons, although extreme droughts are likely to worsen their variability (Miller, 2015). Climate change does not work alone but in tandem with socio-political drivers (Box B in Fig 1.1), such as habitat loss and fragmentation, changes in land use and/or tenure, impacting on the availability of and access to resources, especially dry season grazing areas (Miller, 2015).

Pastoralists depend on dry season areas during drought and extreme drought times to provide livestock with pasture and water. Herders will usually split their herds with cattle (and often sheep) being taken to these dry season areas. Traditionally mobility allowed pastoralists to travel to access water and pasture during extreme drought times that they wouldn't use in wet seasons; flexible resource use pivotal to living in ASALs. However, many of the former dry season refuges in areas such as this thesis, Laikipia case study, are now protected areas, either through formal state protection, or private individuals protecting areas. Without access to dry season areas there is reduced availability for grazing options for pastoralists' livestock. Livestock are weakened and losses are very likely to increase. Impacts on households are felt more severely compared to the wet season (when pasture and water are more plentiful around the home) due to these increased losses. Apart

from starvation that is usually associated with extreme droughts, livestock can suffer more acutely from diseases as well as an increase in threat from large predators.

Dry season refuges are also important for wildlife populations and are of considerable value for wildlife conservation (Miller, 2015). The majority of the PAs found in East Africa are geographically positioned in areas with key dry season grazing and water, which help sustain wildlife populations and to protect them from the socio-political drivers constraining pastoralists (Miller, 2015). Climate change impacts on wildlife will differ across species but evidence shows that it will be a major driver of extinctions during the 21st century (Foden et al., 2008).

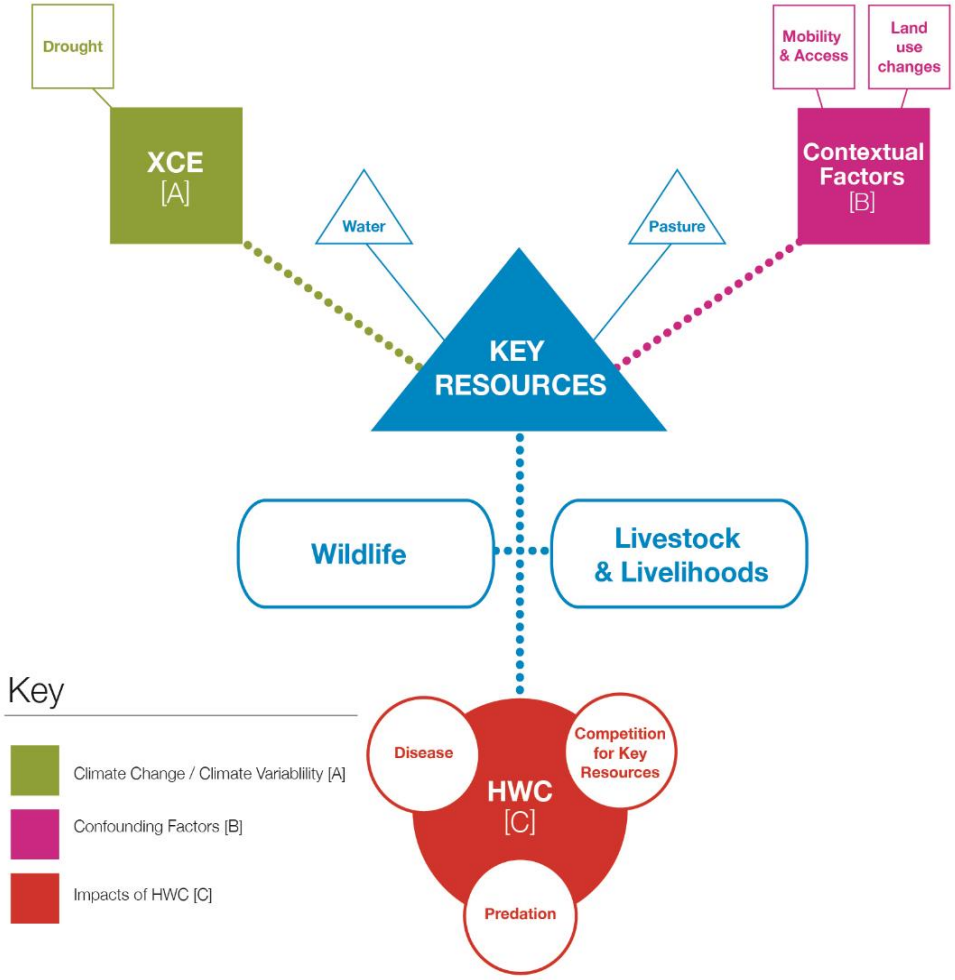
The disconnect across ASALs owing to habitat loss and fragmentation, and changes in land tenure and land use mean important seasonal migration routes for wildlife *and* livestock are threatened (Galvin, 2009; Goldman and Riosema, 2103). Mobility, or conversely its restriction affects the ability of livestock and wildlife to access key resources in a dynamic environment. Climate change amplifies the effects of socio-political drivers already impacting on pastoralist livelihoods and wildlife populations. As competition for those key resources increases during XCEs due to reduced availability, and as mobility is made more challenging, wildlife and livestock occupy smaller areas that will potentially lead to a greater possibility of HWC to occur (Box C in Fig. 1.1). This thesis leads up to the conjunction of three areas of HWC: predation, competition for key resources and disease.

1.7 Research questions and thesis structure

This introduction has set out the crucial need to understand the impacts of climate change, XCEs in particular, and their interaction with development-driven changes on interrelationships between people and wildlife, specifically carnivores and pastoral livestock. While there are few data on long-term climate change that would allow us to do this for East African rangelands, we can use recent XCEs and their known impacts on wildlife, livestock and people to illumine likely future changes. Few studies have aimed to simultaneously examine both the impacts XCEs and socio-economic variables that are likely to influence levels of conflict between people and wildlife, and potentially increase interactions. The study will

aim to contribute to filling this gap in the current knowledge of HWC. The thesis will focus on Laikipia for reasons set out in Chapter 2.

Figure 1.1 Flow chart summarising the interactions on which this thesis is focused. Green represents climate change, including XCEs. Pink represents intercurrent socio-political factors impacting on people and wildlife in East African rangelands. The data chapters focus on livelihoods largely generated by pastoral livestock and on wildlife. The impact of XCEs are explored in the context of socio-political factors such as mobility and access and human wildlife conflict



Changes in land tenure access and control have been occurring in Laikipia for centuries. The shift from communally owned land to private ownership has altered the ways pastoralists are able to use the landscape and access resources. The consequences of fewer areas available to access key resources means a potential increase in conflict between people and wildlife. Socio-political factors are being made worse by human induced changes in climate, specifically the increase in occurrence and severity of extreme droughts. Traditional coping strategies that were once pivotal to pastoralist communities living in highly variable climate are becoming less effective, leading to pastoralists having to adopt new ways to respond to these challenges.

This thesis addresses the following research questions (RQ) arising from the literature review:

1.7.1 Research questions

A. What are the differences in herd management between drought and non-drought periods?

A1. How do pastoralists manage their herds seasonally?

A2. How does this compare with an extreme drought year?

A3. How important to pastoralists in Laikipia is the strategy of splitting herds during XCEs?

B. How important is income from livestock compared to other sources of household income?

C. What are the main coping strategies adopted by pastoralists in Laikipia during XCEs? How do changes in land use and land tenure affect access to water and pasture?

C1. What are the main land types used by pastoralists during XCEs?

C2. How have changes in land use, land tenure and fragmentation affected access to important dry season/drought resources?

C3. Do all herders pay for access to water and pasture during XCE year?

C4. Do all pastoralists migrate during XCE years?

D. What are the impacts of extreme climatic events on livestock holdings for Laikipia pastoralists?

D1. What are the patterns of and trends in livestock holdings?

D2. How do livestock losses compare between XCE and non-XCE years?

D3. How do patterns of loss compare for different livestock species?

D4. Do livestock loss patterns vary with wealth and different study sites?

D5. What are the main causes of livestock loss for XCE and non-drought years?

E. What are the impacts of extreme climatic events on habitat selection for large carnivores in Laikipia?: What are the implications for human-wildlife conflict?

E1. What are the main conflicts pastoralists associate with wildlife?

E2. What are the impacts of XCEs on large carnivore movement and behaviour, and the implications for HWC?

1.7.2 Thesis structure

In this thesis, I explore the impacts of extreme climatic events on pastoralist communities and their interactions with wildlife in Laikipia, Kenya. Climate change works in tandem with other socio-political drivers, in particular habitat loss and fragmentation I also look at changes in the landscape that is shaping Laikipia today.

In Chapter 2, I first give an overview of Kenya looking at its livestock sector and the biodiversity of the country. I then describe the study area, Laikipia, including its history since colonial administration, wildlife present and the people and land use today. I detail the characteristics of the three local study sites, Il Polei, Il Motiok and Lekji Village, within Laikipia.

Chapter 3 outlines the main methods used in the study and the mixed methods approach to the research. The chapter explains the two different wealth ranking methods used, and the methods used to collect household socio-economic data. It also includes a section on household characteristics and explains the household unit of analysis that was used in this study. Then it goes on to describe the large carnivore dataset that was made available to me, and used in Chapter 7.

Chapter 4 is the first of four data chapters in this thesis. It describes herd management across the three Laikipia study sites and how this differs between drought and non-drought years. The chapter looks at how important herd splitting is for the communities and the use of pastoral livestock products across the seasons and during an XCE year (RQ A). It then compares the importance of livestock income to other sources of household income (RQ B).

Chapter 5 focuses on the main strategies pastoralists adopted to access pasture and water during the 2009 XCE (RQ C). I document the new ways Laikipia pastoralists have responded to socio-political impacts on mobility during the extreme drought by moving longer distances and/or by paying cash to non-Maasai landowners.

In Chapter 6, I explore how XCEs impact on livestock holdings (RQ D). I specifically look at livestock loss in XCE and non-XCE years. The chapter starts off by looking at how many livestock were kept immediately before two extreme drought years (2000 and 2009) and then numbers kept for the two most recent 'non-drought' years at time of study (2011 and 2012). Patterns of livestock loss are explored by wealth, species and main causes of death.

Chapter 7 starts by giving a brief overview of the different wildlife species with which pastoralists experience conflict in Laikipia (RQ E.1). The chapter then goes on to explore the impacts of climate on habitat selection by wild dogs on Laikipia during XCE and non-XCE years. This chapter – indeed this entire thesis – was originally intended to present data collected on XCEs and HWC between lions and pastoralists in Amboseli, Kenya. However, due to last minute unavoidable changes (see Chapter 2), the study site moved to Laikipia north-central Kenya, where I was

able to access data on African wild dogs (*Lycaon pictus*) (made available by Prof. Rosie Woodroffe) (RQ E.2). Although I was given to understand I would be able to use large mammal (≥10kg) aerial data from the Department of Resource Surveys and Remote Sensing (DRSRS) on all large carnivores, prey species, grazing competitors and disease reservoirs, it eventually became clear DRSRS data would not be made available to me in a form I could use for disaggregated spatial analysis. Chapter 7 therefore focuses on spatial use of Laikipia, ASALs by African wild dogs, and generalises the implications to pastoralists/predator interactions more broadly.

Chapter 8 revisits the main research questions and places the thesis findings in the context of the state of knowledge.

Chapter 2 Study Area

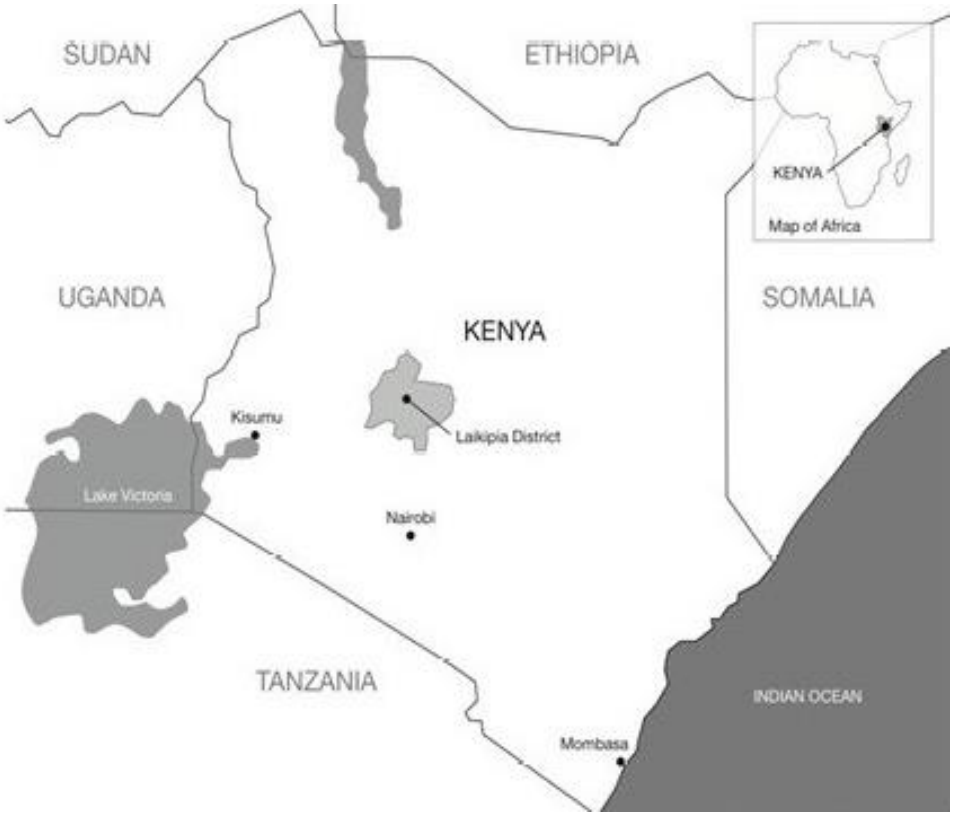
2.1 Chapter overview

This chapter introduces the study area, Laikipia District and the three study sites where research for this thesis was undertaken: Il Polei and Il Motiok, (both community group ranches in Mukugodo Division) and Lekiji Village. To put Laikipia District into context, I first give a general overview of Kenya (2.2), providing context of the livestock sector (2.2.1), Kenya's biodiversity (2.2.2), wildlife policy (2.2.3) and tourism (2.2.4), before introducing the study area (2.3). Firstly, I give an overview of Laikipia's wildlife (2.3.1) and biophysical characteristics (2.3.2) followed by a brief summary of the history of pastoralism (2.4) and formation of Laikipia since colonial times (2.5) and how that history has ultimately shaped the present day dynamics of Laikipia. This will help to put into context the current residents and land uses in Laikipia (2.6), conflict and violent clashes in the area (2.7). I then look at the three study sites in more detail (2.8) and how they fit into Laikipia landscape, starting with Mukogodo Division (2.8.1) then focusing down onto Il Polei, Il Motiok, and Lekiji Village (2.8.2). For the purpose of this study I focus on local pastoralism and the Maasai people both because they dominate the livestock sector in the area and also because of their complicated shared history with the British since the late 19th century.

2.2 Kenya

The Republic of Kenya is located in East Africa (Figure 2.1) on the equator bordering the Indian Ocean and forms part of the Horn of Africa along with Ethiopia, Somalia, Eritrea, Djibouti, Sudan and Uganda. It has a great diversity of ecosystems ranging from deserts to snow-capped mountains, with altitude ranging from sea level to the 5,199m peak Mt Kenya, which is Kenya's highest mountain. Kenya's GDP is derived mainly from the service sector (53.3%), to which tourism is the principal contributor, agriculture (29.3%) (including livestock) and industry (17.4%) (CIA, 2014). However, these figures do not take into account the very considerable informal pastoral livestock production sector, estimated to contribute as much again as officially documented agricultural GDP (Behnke & Muthami, 2011). Kenya is divided into 4 geographic regions: the Rift Valley and associated highlands, ASALs, Lake Victoria and the coast. ASALs constitute the majority

Figure 2.1 Map of Kenya showing locality of Laikipia District.



(~80%) of land in Kenya and make up the northern and eastern regions of the country. Kenya's ASALs are largely given over to livestock keeping and/or wildlife based enterprises. Areas with good agricultural potential represent only about 18% of Kenya but support 80% of the population (FAO, 2005).

Rainfall is bimodal with the long rains falling April-May and the short rains falling November-December (Hastenrath & Polzin, 2010). Rainfall differences do occur, for example in parts of Laikipia County, 'lake' rains fall during the month of August (Georgiadis, 2011). Kenya is classed as only having very low levels of renewable water resources – below 800m^3 per person per year (FAO, 2012). Delayed or insufficient rainfall is cited as one of the risks that will affect Kenya's economic growth in the future (Boko et al., 2007). Increase in frequency of extreme droughts in ASALs puts growing pressure on resources and leads to intense competition for the available water and grazing. Often areas where there are good levels of forage after a drought may not be used because of security issues especially the problems associated with cattle rustling (Kaimba et al., 2011).

Kenya gained independence from the British in 1963. In 2010, Kenya adopted a new constitution to provide a framework to tackle the core bases of conflict, most notably in response to the violent conflicts that occurred in the disputed general elections of 2007. The new constitution involves quite fundamental changes and gives much more power to regional governance. The constitution is expected to improve Kenya's prospects for democracy, justice and respect for human rights. For example, the National Land Commission was established to look into historical injustices surrounding land tenure and to provide more rigorous review on titling and registration of land to improve gender inequalities (Kramon and Posner, 2011). Land ownership in Kenya as elsewhere is a key source of power and wealth and often central to conflict between different stakeholders over access. There are concerns that some communities will seek to reclaim land previously acquired illegally (ILCA, 2001), which might result in increased tension and conflict.

2.2.1 Livestock sector

Kenya's livestock sector is part of a North East Africa market that interacts across national boundaries and is the predominant basis of livelihoods for those that live in ASALs. Over 70% of livestock herds in Kenya are raised by pastoralists, providing 90% of employment and 95% of family incomes among pastoralists (FAO, 2005). Small East African Zebu cattle are widely distributed over diverse ecological regions and produce up to around 67% of the beef market. These animals are resistant to disease, poor nutrition, water shortage and climatic extremes. They grow slowly and survive harsh conditions and are relatively cheaper compared to exotic breeds such as Boran (Tully, 2014) with which they are increasingly crossbred.

Quantifying the value livestock provides to a country such as Kenya can often be difficult. It is frequently claimed by livestock authorities that livestock production is underrepresented in the estimated GDP of African nations. This is often because national herd numbers are poorly known. However, a joint review undertaken by the Intergovernmental Authority on Development (IGAD) and the Kenyan National Bureau of Statistics (KNBS) (Behnke & Muthami, 2011) demonstrated that Kenya's livestock contribution to its GDP was significantly greater than the official estimates in 2009. In Behnke & Muthami's report (2011), livestock contribution to Kenya's GDP was two and a half times greater than the official estimates (KSH345bn compared to KSH128bn). Of this, milk is the most economically important product contributing approximately 74% of the total gross

value of livestock to the agricultural sector (Behnke & Muthami, 2011). Approximately 80-90% of meat consumed in Kenya is from livestock raised by pastoralist communities in Kenya (Kahi et al., 2006) as well as from neighbouring countries such as Ethiopia, Somalia and Tanzania. This figure is considerably higher than meat consumed within Kenya from commercial ranches (2%). Pastoralists have customarily kept livestock not primarily for the commercial market but chiefly for subsistence livelihoods and as a wealth store, (alongside periodic sales). Keeping livestock provides a number of benefits including provision of credit, insurance and a way of sharing risk (Behnke & Muthami, 2011). The Kenya livestock sector is thus dominated by small producers. By contrast to their importance in national consumption, small holders contribute only a small per cent towards the national export market (2%), largely through sales of hides and skins (Behnke & Muthami, 2011).

Climate variability plays an important factor in livestock production in Kenya with extreme droughts having occurred approximately once every 5-10 years since records began. Now, however, predicted increases in drought frequency and severity are likely to cause significant long term decreases in livestock numbers across Kenya's ASALs (Herrero et al., 2010). In 2009, Kenya experienced an extreme drought which recorded the highest number of losses for both livestock and wildlife populations due to drought (Herrero et al., 2010). Approximately 64% of cattle and 62% of sheep were lost nationally (Zwaagstra et al., 2010).

2.2.2 Biodiversity

Kenya supports over 35,000 species of fauna and flora (Lusweti, 2011). Approximately 8% of land surface are protected for conservation purposes, including 22 terrestrial national parks, 28 terrestrial national reserves (Watson et al., 2010). About 35% of Kenya's wildlife populations can be found in formal state-gazetted PAs (National Parks and National Reserves) (Georgiadis, 2011). Of the remaining 65%, 40% is on private and communal land (Western et al., 2009a) and 25% on rangeland (much of it held in trust by local governments). As these areas are not formally protected, the future of Kenya's wildlife depends on the success of conservation on private and communally owned lands (Georgiadis, 2011). Recent research on wildlife abundance across Africa has shown declines in both protected and unprotected areas (see Craigie et al, 2010; Western et al., 2009a) with many species ranges now restricted to protected areas (Newmark, 2008).

2.2.3 Kenya's wildlife policy

Kenya's wildlife policy before 1975 covered strict protection of wildlife in parks but also live capture and export from reserves and private land. Revenue was substantial and went directly to the landowners. For example, Mbirikani Group Ranch, adjacent to Amboseli National Park earned $35,000 per year from hunting fees in 1975. This figure, adjusted for inflation, was considerably more than the Group Ranch earned ten years later from tourism (Norton-Griffiths et al., 2008). In 1975, the wildlife policy introduced was focused on using the benefits gained from parks to keep migratory routes open. It also addressed participatory issues around landowners and those living adjacent to reserves. Apart from community conservation policy developments, President Kenyatta banned hunting of wildlife other than game birds as a rapid response to resolve corruption in the hunting industry removing a major source of potential income. President Kenyatta died in 1978 and given intense international pressure around animal welfare and conservation, the temporary hunting ban remained as a taboo subject for discussion in the political arena (Homewood et al., 2009).

However, recent literature has reported Kenya's wildlife population trends as being in precipitous decline (Craigie et al., 2010; Western et al., 2009a; Ottichilo et al., 2001), especially in parks and adjacent areas. Aggregated wildlife populations in parks declined by 48% from 90,691 to 47,599 and declined in adjoining areas by 45% from 133,758 to 73,394 between 1977 and 1997. Populations within Kenya National Parks account for approximately 10% of all Kenya's wildlife and populations within Kenya's national reserve - the Maasai Mara account for 25% of Kenya's wildlife. Nationally, there has been a 38% decline in wildlife from 17 Counties in Kenya's rangelands during the same period (Western et al., 2009a). Studies on the impacts of land use on large mammals found that species richness, occupancy and abundance for large mammals in Kenya were higher in private conservancies (managed for livestock and wildlife and tourism or research) and private sanctuaries (managed for black (*Diceros bicornis*) and white rhinoceros (*Ceratotherium simum*) than on fenced or community group ranches (Kinnaird and O'Brien, 2012). The IUCN Red List cites, 29 mammals, 35 birds, seven reptiles, nine amphibians, 69 fish and 187 plant species currently threatened in Kenya. Overall, Kenya has a total of 42 endemic species of which 43% are threatened, including 53% of endemic mammals, 75% of endemic birds and 35% of endemic amphibians are threatened (IUCN, 2013).

Government policy appears to have been ineffective with regards to conserving Kenya's wildlife. National and local wildlife populations declined by over half for the period 1977-2007 according to the Department of Remote Survey and Remote Sensing aerial mammal data. For some species, losses are much higher. There have nevertheless been a few notable exceptions to this trend. Elephants and rhinos suffered steep declines during the 1970s and 1980s. For elephants increase in numbers during the 1990s was owing to a ban on ivory trading and rigorous in-country enforcement, the population has since been suffering from the global resurgence in illegal wildlife and ivory trade (Wasser et al., 2015). A small increase in black rhino numbers is due to new partnerships between wildlife authorities and private landowners with heavily guarded small sanctuaries (Georgiadis, 2011).

2.2.4 Tourism

Kenya has one of the most developed tourism industries in sub-Saharan Africa. Tourism is the second highest source of foreign income for the country after agriculture. It generated US$1.2 billion (KSH96 billion) in 2012 (KNBS, 2013). This is an increase of ~54% compared to 2009, although 2009 was a drought year. Tourism is one of Kenya six Vision 2030 priorities (GoK, 2008). It has been estimated that over 60% of Kenya's tourism in major tourist areas is under foreign ownership and management (Sindiga, 2000).

Kenya's rich biodiversity, especially its savannah megafauna, makes it a popular destination to view wildlife. As with most other African countries, Kenya's tourism industry began in the period of big-game hunting expeditions by adventurous pioneers and fortune seekers from Europe and North America (Akama, 2004). However, the numbers of professional hunters seeking prized trophies in the African savanna raised Western conservation concerns. The colonial government made numerous laws aimed at protecting Africa's unique wildlife by means of organised safari tourism activities in designated areas. In 1939, subsequent to pressure from British conservationists, the British government selected a game committee, which was to study and make recommendations for setting up parks in Kenya and in other African colonies (Lusigi, 1978). Thus, the creation of wildlife parks and reserves in Kenya followed: Amboseli National Reserve in 1947, Tsavo in 1948, Nairobi National Park in 1947 and Mt Kenya 1949. National parks were conceived as:

a) Areas under public control, the boundaries of which should not be altered or any portion be capable of alienation except by competent legislative authority.

b) Areas set aside for the propagation, protection and preservation of objects of aesthetic, geological, prehistoric, archaeological, or scientific interest for the benefit and advantage of the general public.

c) Areas in which hunting, killing, or capturing of fauna and destruction or collection of flora is prohibited except by or under the direction of park authorities (Lusigi, 1978).

At independence, the Kenya government realised the importance of developing tourism to generate much sought after foreign exchange. An unrestrictive policy was in place whereby foreign and multinational investors provided the initial capital to develop large-scale tourism (Akama, 2004). Tourism rapidly grew from the 1960s-1990s, mainly through a low-mid market focus on national parks and the coast (LWF, 2008). From the initial stages of developing tourism in Kenya, and similarly with other African countries, largely external groups invested in accommodation and infrastructure, without a great deal of involvement from indigenous communities. For example, the first hotels and lodges were built in Nairobi by resident European developers. Thus, minimal interaction existed between Western travellers and local communities (Akama, 2004).

Today, Kenya's current tourism policy is more diversified and includes ecotourism, community based tourism, agrotourism and promotes the idea of dispersing tourism more geographically. Kenya has a Vision 2030 programme as a major directive of their national economic growth (GoK, 2007). The vision is "Kenya will become a top ten long haul tourist destination offering a high end diverse and distinctive visitor experience". Theirs goals are to: quadruple Gross Domestic Product (GDP) contribution to ~KSH80bn; raise international visitors from 1.8 to 3 million; raise the average spend per visitors from ~KSH40,000 to ~KSH65,000. The main elements of Kenya's tourism strategy for 2030 are: develop three resort cities, two at the coast and one at Isiolo County, north east of Laikipia; restrict the numbers of visitors at the most popular parks and make them more expensive; develop new facilities at less exploited parks; develop high niche tourism products such as eco and water based tourism (GoK, 2007; LWF, 2008). Kenya's large carnivore populations represent a major tourist attraction with lion sightings in particular rated as among the most highly valued experiences. Large carnivores are

thus an important source of tourism revenue for many protected areas (Balmford et al., 2009). More recently, the growth of tourism on the Kenya coast and northern rangelands has been threatened by insecurity, particularly in neighbouring Somalia but also internally.

2.3 Study area

Laikipia County (36˚11' - 37˚24' and 0˚18' - 0˚51' N) is predominantly a plateau that forms part of the central Rift Valley Province. It spans an area of over 9,666km^2 and forms part of the 40,000km^2 Ewaso ecosystem (Georgiadis, 2011). Laikipia lies on the equator with Mt Kenya to the east by the lower slopes and the Aberdares Range to the south-west, approximately four hours' drive north of Nairobi (Figure 2.1). The Rift Valley escarpment lies to the west and the arid pastoralist counties of Samburu and Isiolo, extend to the North. The Laikipia plateau is an area of rolling low hills at an elevation of between 1700-2000m and is bisected by the Ewaso N'yiro River. It is home to multiple different ethnicities and communities with diverse groups of people engaged in pastoralism, commercial ranching, farming, horticulture and wildlife conservation (Mkutu, 2001). Pastoralism, mostly involving Maa-speaking Maasai, dominates occupations in the County.

2.3.1 Wildlife in Laikipia

Contrary to the trend of decline in large mammal numbers in Kenya, Laikipia has seen an increase in wildlife populations (Kinnaird et al., 2010). This can largely be attributed to extensive privatization of these rangelands, with many properties being managed as wildlife conservancies, ecotourism operations and sanctuaries for black (*Diceros bicornis*) and white rhinos (*Ceratotherium simum*) (Kinnaird et al., 2010). However the increase in wildlife numbers, especially in plains zebra (*Equus quagga*) and elephants (*Loxodonta africana*) (Georgiadis, 2011), was almost certainly due to predator suppression in the area up to the 1990s. During the 1980s Laikipia County ranchers' attitudes towards wildlife shifted, especially with respect to predators. Wildlife seen at the time as a problem and/or competition in Laikipia, were suppressed in favour of beef production on the large-scale ranches.

Over time, there was increasing acknowledgement of the potential value wildlife offered to those on whose land they resided (Georgiadis, 2011), with economic incentives (a weakening beef market and the need to find income from other

sources) being the primary reason for this change. Opinions shifted at the same time as changes happening in African conservation generally, with the long-established focus on individual large mammal species conserved in protected areas being superseded by an ecosystem/landscape approach to conservation (Western et al., 1994; Adams, 2004). The shift in focus from beef production to wildlife conservation resulted in a remarkable increase in wildlife abundance, with Laikipia's wildlife numbers today surpassed only by Kenya's Maasai Mara National Reserve. Laikipia supports the world's largest remaining concentration of Grevy's zebras (*Equus grevyi*) (Figure 2.2) and reticulated giraffe (*Giraffa camelopardalis reticulata*) as well as retaining more endangered mammals than anywhere else in Kenya (Georgiadis, 2011).

Figure 2.2 Grevy's zebra on Ol Jogi Ranch, Laikipia.

It supports an intact large carnivore community, comprising lion (*Panthera leo*), leopard (*P. pardus*), cheetah (*Acinonyx jubatus*), spotted hyaena (*Crocuta crocuta*) and striped hyaena (*Hyaena hyaena*), which have persisted in the region despite extensive human population growth and use of the landscape (Frank et al., 2005). African wild dogs (*Lycaon pictus*) recolonized Laikipia spontaneously in 2000 (Woodroffe, 2011; Ogada, 2003), after being locally extinct since the 1980s (Fanshawe et al., 1997). The majority of these carnivore species are considered

globally threatened[2]. Nonetheless, with the ending of severe predator control and the recovery of predator populations since the late 1980s (Georgiadis et al., 2007) some species of grazing animals have seen a decline in number including hartebeest (*Alcelaphus busephalus*), eland (*Taurotragus oryx*), waterbuck (*Kobus ellipsiprymnus*), buffalo (*Syncerus caffer*), and Thomson's gazelle (*Eudorcas thomsonii)*. These declines parallel increases in predator abundance, suggesting that predator suppression was a primary contributor to the growth in wild herbivore abundance seen earlier in Laikpia (Georgiadis, 2011). Notwithstanding these declines, Laikipia's impressive wildlife populations have made it one of the most important tourist destinations for wildlife safaris in East Africa. There is a relatively advanced infrastructure network including airstrips to facilitate movement between isolated tourist destinations in the region (Sumba et al., 2007). In particular, Laikipia has focused on exclusivity with its high-end resorts offering luxury tourism in remote places (Sumba et al., 2007). According to Laikipia Wildlife Forum (LWF):

> 'Laikipia is widely accredited as Kenya's premier safari destination with ideals and practices that are at the forefront of conservation tourism'.

LWF was established in 1992 by private and communal landowners in response to a Kenya Wildlife Service (KWS) initiative to engage local communities in conserving wildlife occurring outside protected areas in Laikipia. By 1995, LWF had become a charity and was the first forum to foster development and conservation aims on a County-wide basis in Kenya. It relies largely on donor funding and membership fees to operate (LWF, 2008). Since its creation, LWF has expanded its remit to include management of essential environmental resources and improving livelihoods and security. Membership includes 36 large scale ranches, 47 community ranches, 50 tour operators, 54 individuals and eight interest groups. LWFs mission is:

[2] African wild dog (*Lycaon pictus*) status – endangered; African lion (*Panthera leo*) status – vulnerable; cheetah (*Acinonyx jubatus*) status – vulnerable; leopard (*Panthera pardus*) status – near threatened; striped hyaena (*Hyaena hyaena*) status – near threatened and spotted hyaena (*Crocuta crocuta*) status – least concern. IUCN red list population trend for *all* species – decreasing (IUCN 2012).

> ‘To conserve the integrity of the Laikipia ecosystem, by creatively managing natural resource to improve the livelihoods of its people’.

LWF prides itself on Laikipia not being formally protected and for its being predominantly unfenced, allowing wildlife to move freely throughout the landscape.

On the whole though, livestock outnumber wild ungulates throughout the region (Khaemba et al., 2001). None of the area is formally protected although ecotourism ventures and some commercial ranches have fenced their boundaries to exclude and/or protect either livestock or wildlife. Their doing so results in a fragmented landscape where mobility is restricted for people, livestock and wildlife.

However in recent years more fences are being erected, which restrict the movement of wildlife and undermine the landscape/ecology approach to conservation that Laikipia embraced. Fences have been put up to exclude either cattle or wildlife. Fences have been used to protect wildlife for a variety of reasons, including anti-poaching, reducing human-wildlife conflict and human encroachment (Somers and Hayward, 2012). Although fences can reduce human-wildlife conflict, they may also prevent the movement of people and restrict access to key resources for both people and wildlife (Gadd, 2012; Durant et al., 2015). Fecnes can also injure, and sometimes kill wildlife and livestock (see Figure 2.3).

2.3.2 Biophysical characteristics

Laikipia daytime maximum temperatures average 32^{o}C. Rainfall is relatively low (400-800 mm annually) with a highly variable and trimodal configuration, falling mainly in April–May (long rains), August (lake rains) and November (short rains) (Georgiadis, 2011). Rainfall patterns differ across Laikipia. North Marmanet experiences the highest rainfall; Mukogodo and Rumuruti divisions the lowest (Mkutu, 2001). Laikipia has two perennial rivers (Ewaso N’yiro and Ewaso Narok) and numerous run-off catchment dams, particularly on commercial properties. The majority of these hold water well into the dry season, although all dry out during drought periods (Georgiadis et al., 2003). Laikipia’s climate renders much of this area unsuitable for arable agriculture (Georgiadis, 2011). Laikipia’s ecosystem is mainly *Acacia* scrubland and has two major soil types, black cotton and red soil.

Figure 2.3 Young giraffe caught in the electric fence that borders Ol Jogi Commercial Ranch.

On the central high plateau, impeded drainage dominates with deep clay "black cotton" vertisols. Similar soils occur elsewhere on the plateau as they do in many other parts of East Africa, supporting some of the most productive rangelands in the region. Approximately 10% of Laikipia is underlain by black cotton (Young et al., 1998). Red rocky friable soils exist on more sloping topographies (Young et al., 1995). Both soil types are typified by numerous isolated "glades" throughout a mixed wooded/shrubby landscape, which are usually less than 10,000m^2 in area. Larger areas are often referred to as plains. Glades are treeless, have high levels of mineral nutrients and are preferred by wild and domestic herbivores (Young et al., 1995). Black cotton plant communities are comparatively less diverse when compared with red soils. The overstory is largely whistling thorn, which accounts for over 50% woody cover throughout this ecosystem. Five grass species and two forbs make up the majority of groundcover on these soils (Young et al., 1998).

2.4 The history of pastoralism in the area

Laikipia region has long been both ecologically and ethnically diverse. People could exploit different ecological niches for economic gain through using

interconnecting networks. The last 2000 years has seen a shift from mixed farming where agro-pastoralists grew crops alongside keeping livestock, to more specialised, independent economies of pastoralism, agriculture and hunter-gathering that worked together symbiotically (Waller, 1976).

By the eighteen and nineteen centuries Maasai pastoralism had become the dominant form of land use in ASALs across a large area of East Africa (Spear and Waller, 1993). The Rift Valley in particular provided a north-south axis for Maasai communities and a corridor for expansion, largely at the expense of other pastoralist groups. The drive for expansion was to secure access to scarce natural resources - water and grazing (Waller, 1976; Galaty, 1993). To put into context the position of the Maasai of this study, I first describe events occurring prior to the arrival of the British.

A series of devastating events in the latter part of the 19th century left the Maasai weakened and unable successfully to defend previous grazing areas. Other ethnic groups such as the Kikuyu and Kalenjin were making inroads into the Rift Valley, encroaching on what had formerly been contested border areas prior to their occupation by Maasai as grazing areas, and which had reverted to being unoccupied.

The *Iloikop* Wars (1840s-1870s) saw violent confrontations between pastoralists and settled people, contesting control over permanent water sources and grazing areas (Waller, 1976; Galaty, 1993). They initially started because too little grazing was available, and ended with under-exploitation leading to encroachment from outside (Waller, 1976).

These wars were followed by a series of devastating epidemic disease outbreaks affecting livestock and leaving much of the country with diminished numbers of herds. In 1883, Maasai herds in the Rift Valley were ravaged by bovine Pleuro-Pneumonia for several years followed by a rinderpest (*iodwa*) epidemic in 1891, which spread rapidly throughout Maasailand causing further devastation and loss. Herds were virtually obliterated, with mortality around 90%. This period was known as *emutai* in Maa, which means ‘wiped out’. It was also known as ‘The Disaster’ or ‘When the Cattle Died’. Full recovery took a further 10 years and was partly sustained by large-scale stock raiding and/or through Maasai sections regrouping with their remaining stock (Waller, 1976). An outbreak of small-pox

followed in 1892 and caused widespread disease and famine among human populations (Spear and Waller, 1993).

In addition, Maasai raids were becoming less successful and thus less profitable. This was partly because of improved defences as well as improved types of social mobilization of Maasai neighbours. The Maasai sought refuge where they could but were confronted with considering three alternative livelihood options: 1) becoming *Iltorrobo*[3] and changing their livelihoods from pastoralism to hunting and gathering, 2) regrouping in their grazing areas and plundering their kin and neighbours or 3) living temporarily as refugees with adjacent agricultural communities, making use of pre-existing networks in the hope of eventual return to their former pastoralist groups. Another option available to the Maasai was to hire themselves out as military clients to local chiefs, who were Kikuyu, Chagga or Luhyai to participate in raiding livestock, thus getting a share of the spoils (Waller, 1976).

Early in the 1890s the "War of *Morijo*" began between the Loita and Purko Maasai sections over raiding and counter-raiding attacks, which had intensified in the wake of the smallpox outbreak in 1892. Both groups had suffered great losses during *emutai*. Adding complexity to this struggle was the rivalry between two *laibon*[4] brothers, Olonana and Senteu along with their followers, over who should succeed their father as prophet and ritual leader.

Intercommunity violence and warfare, especially during the *Iloikop* wars almost eradicated the Laikipiak Maasai (Galaty, 1993). The Laikipiak Maasai were originally believed to have disappeared (Sobania, 1993), but it is now thought they were actually absorbed by the Purko, Kisongo and other cultural groups, or temporarily became *il-torrobo* (Sobania, 1993).

Therefore, by the time the British arrived Maasai society had undergone severe disruption, with certain sections experiencing periods of fragmenting, dispersing, re-grouping or being assimilated by other sections (Galaty, 1993). Indeed, the

[3] *Iltorrobo - refers to people without cattle such as hunter- gatherers.*

[4] The laibon is a ritual figure consulted in the Maasai society as a healer and prophet. Although political control in Maasai society lay with the elders and their function was to rule (*aitore* in Maa), two *laibons* had acquired considerable political power during the *Iloikop* Wars, shifting the division of power in favour of *laibons* (Waller, 1976).

splitting and reforming of groups were persistent features of Maasai society for the better part of the 19th century.

2.5 Colonial history

Colonial rule by the British began in 1895 under the control of the East Africa Protectorate (EAP). At the start of the British rule, widespread resistance from local communities meant the British often ruled by force. To help facilitate colonial rule as well as providing logistical access for the British to expand its control over EAP, the Uganda Railway was built. Construction started on the coast in Mombasa in 1896 and by 1901 reached Kisumu on the shores of Lake Victoria in West Kenya, connecting the interior with the coast. It also ran through some of the best grazing areas in the Highlands of Kenya. This was about 10 years after the Berlin Conference had outlined Africa's future under European control, dividing it up regardless of already existing cultural and linguistic inter-relations and boundaries between indigenous communities living there. The area that is present day Kenya, together with then Tanganyika became a British colony in 1920, known as British East Africa (BEA).

Britain encouraged emigration to Kenya and in particular the Kenyan Highlands were largely converted into settler farms (later known as the White Highlands because of the considerable numbers of British and Europeans living there). The British imported British land titling legislation with the administration issuing and regulating grants to settlers. In 1902 the Crown Land Ordinance provided sales of land and leases to settlers but also emphasised that any 'uninhabited' land was to return to the Crown to be given to settlers (Morgan, 1963). Leases were initially short but through pressure from settlers a further Ordinance in 1915 gave nine hundred and ninety-nine year leases to settlers, leading to an increase in demand for land suited to large-scale farming and settlement (Morgan, 1963). Lands near to the Uganda railway were assigned to settler farmers irrespective of the fact that they were already occupied by local indigenous communities (Morgan, 1963).

The British created some opportunities incidentally enabling the Maasai to rebuild a pastoral life rather rapidly. The British sponsored stock raids, for example against the Kikuyu, inviting Maasai age-set leaders (*Il aigwanak*) to assemble their age-mates to participate in the raids. They were paid by results being allowed to keep a substantial proportion of the captured stock as well as receiving support against

their enemies (Waller, 1976; Spear and Waller, 1993). Table 2.1 shows an example of the livestock captured during British sponsored raids.

The British were also keen to utilise the military resources of the Maasai for a number of other reasons. Firstly, at the beginning of British control in EAP, administration was maintained by a sparse number of regular forces that were unable to exercise effective control over local communities.

Table 2.1 Operations (1893-1906) in which Maasai levies were used (after Waller, 1976: p.552).

Date	**Expedition against**	**Maasai**	**Cattle**	**Shoats**
Nov 1893	Kabete	87	6	922
Jun 1894	Githunguri (Kikuyu)	124	10	847
Jul 1894	Githunguri (Kikuyu_	220		1,100
Nov 1895	Mwala (Kamba)	800	2,150	
May 1897	Kamasia	200	307	8,000
Jun 1897	Nandi	400	137	1,500
Nov 1899	Kamelilo (Nandi)	75	58	1,072
Jul 1900	Nandi	300	3,466	29,306
Sept 1902	Maruka/Tetu (Kikuyu)	300	1,300	10,000
Feb 1904	Iriaini/Mathira (Kikuyu)	450	1,087	8,150
Mar 1904	Embu	400	498	1,500
Jun 1905	Sotik (Kipsikis)	600	5,000	
Sept 1905	Kisii	150	5,000	
Oct 1905	Nandi	300+	16,213	36,205

A limited budget and too few troops contributed towards the British seeking support from local groups (Waller, 1976). Thus an informal alliance with the Maasai could provide the British with cheap local security as well as bolstering their standpoint for future conflicts with various groups. Secondly, the British were all too aware that the Maasai themselves could pose a serious potential threat to British control if they were in any way antagonised. For example, the Maasai were capable of disrupting lines of communication during the Uganda railway construction, forming road blocks as well as attacking unprotected construction workers. In the Kedong Valley, substantial numbers of railway workers were killed by Maasai facing extreme provocation (Waller, 1976).

This mutually beneficial arrangement continued until the beginning of the 20th century, when the relationship started to fall apart. The immediate, mutually advantageous aims of the alliance had been achieved and differences in attitudes started to surface. There were a number of reasons for the change: 1) the War of

Morijo ended, which had been central to intersectional rivalry and one of the main causes of unrest, 2) rivalry between the two *laibons* (Olonona and Senteu) and their supporters was brought to an end, 3) the near completion of the Uganda Railway meant that the Maasai were unlikely to impact on communications, 4) the Maasai had regained a measure of economic prosperity after civil war and their herd numbers had recovered (Waller, 1976). The British required Maasai support less often and felt more confident of their authority over them. They exercised this new confidence in a number of ways. For example they initially introduced pass laws to limit the movement of Maasai people, leading eventually to the forced removal of the Maasai from the Highlands, to make way for white settlers.

Two reserves were earmarked for the Maasai in perpetuity under the terms of the 1904 Maasai Agreement between the British and Maasai elders. One was in the North of Kenya (now Laikipia) and one in the South (now Kajiado and Narok Districts). The two reserves offered varying degrees of quality of natural resources needed for livestock keeping. Laikipia was abundant in water and pasture. There were very few or no big game, which meant fewer tick hosts and reduced grazing competition. In contrast, the Southern Reserve was drier, had fewer sources of water and was infested with tsetse disease vectors (Waller, 1990; Hughes, 2006). In the Northern Reserve, the Maasai and their herds thrived and rose in number. However, East Coast Fever (ECF) was spreading from the south of the country much to the alarm of the British. Beef and dairy ranches established in the Highlands were vulnerable to infection. This resulted in the British coming to covet ECF-free Laikipia for the purpose of establishing beef and dairy ranching beyond the reach of ECF. In 1911 the British went back on their Maasai Agreement and coerced the Maasai to move from the Northern Reserve to the Southern Reserve to make way for white settlers. The Maasai elders reluctantly authorized the second move in 1911 (Hughes, 2006).

Historically Laikipia had been inhabited by a mixture of Maa-speaking pastoralists (Spear and Waller, 1993) from the *Iloikop* sections, comprising Laikipiak, Samburu, Mumonyot, Leuaso and Digiri Purko Maasai communities, which coexisted alongside groups of hunter-gatherers, in particular *the Il torrobo* and *Mukogodo* (Letai & Lind, 2013; Lane, 2010). The impact of the Iloikop wars on the Laikipiak saw them defeated (by the Purko and Kisongo) and disappear or become assimilated by other groups, such as the Purko and Kisongo (Sobania, 1993). When the Maasai were forced to move to the Southern Maasai Reserve not

all of the groups left Laikipia. Five groups[5] remained behind. They were able to do this by declaring themselves Yaaku speaking hunter-gatherers at the time. The British looked sympathetically on the hunter-gatherers, as they saw them as being systematically victimised by other more powerful tribes in the area (Herren, 1988; Cronk, 2002). It was agreed that an area in Laikipia would be set aside for those remaining. In 1936 Dorobo Reserve, now known as Mukogodo Division, was created by the British, originally as a refuge for the hunter-gatherers *il-torrobo* (singular *ol-torrobo*) or "Dorobo[6]" or Mukogodo and who later became known as Mukogodo Maasai. The location of Dorobo Reserve was earmarked in the north-east edge of the plateau, an area unwanted by the British because of its poor agricultural potential. Furthermore, it was a way to control and restrict movement of the Maasai and their livestock across the area. The British appointed chiefs for the area although little attention was given to this part of Laikipia until the late 1950s (Herren, 1987). After the establishment of the reserve, the Maasai initially moved widely across the plateau, taking advantage of the plentiful grazing and water to increase herd size. This was possible because many of the white settlers, largely ex-servicemen from the First World War awarded land as part of a resettlement Scheme, did not start fencing their land until after the Second World War.

Although the demarcation secured land rights for the Mukogodo groups, the change in land tenure and land use caused the loss of approximately two-thirds of the land they had previously exploited for their livestock (Herren, 1990). Eventually, movement was further constrained in the reserve by fences separating it from the large-scale ranches of the white settlers in the south and west and from government-controlled livestock quarantine blocks to the north and east. All sides were closely patrolled by police to prevent the Maasai from expanding their movements outside the reserve (Letai & Lind, 2012; Herren, 1991).

Kenya gained independence from the British in 1963 and Crown land was transferred to government land (Kanyinga, 2009). Most of the large commercial ranches that had been established during the early 20th century by the British settlers were retained by the Kenya government as part of an agreement between

[5] Mukogodo (or Yaaku), Mumonyot, Il-ngwesi, Digiri and Leuaso (Herren, 1998).

[6] Dorobo is an anglicised term for *il-torrobo*.It also signifies "tsetse fly" – a derogatory term for impoverished pastoralists turned hunter gatherer (see Spear and Waller, 1993).

the colonial government and the Kenyatta administration (Letai, 2011). Kenya's first president Jomo Kenyatta's government formed land-buying companies and procured around 30% of ranch land in Laikipia or Kenya, establishing large scale ranches and farms. Much of this land was given to landless Kikuyu, supporters of Kenyatta. Most of the Kikuyu title-holders used this land as a guarantee to secure bank loans with land buying companies. As the land was unsuitable for cultivation, they never actually settled there. Since the 1970s, Maasai, Samburu and Pokot herders have been using this land for grazing livestock. Increased interest in these lands both for farming and luxury residencies has resulted in pastoralists being evicted (Letai and Lind, 2013). These small-holder farms are still present today in Laikipia and are perennial hotspots of conflict (Letai and Lind, 2013). However, some communities have refused to leave and have taken action in the courts (see Section 2.9).

Land in the dry north east of Laikipia was later divided into group ranches to settle Maasai pastoralists under the World Bank rangeland development programme. Adjudication began in 1972 and was part funded by USAID. The Group Representative Act of 1976 set out the boundaries for properties and was meant to bring land tenure security to many people in Kenya. For example, Mukogodo Division was divided into 13 group ranches for pastoralists to settle. Concurrently, Maasai elites received land titles as individuals to establish 36 private ranches. However, it was not until the 1990s that the group ranches started to function as such (pers. comm, Mukogodo Division residents). The changes in land tenure were also to encourage pastoralists to adopt "modern" ways of managing livestock. Herds were expected to be managed jointly, which was seen as a way of reducing land degradation in the area. Individual herding within a shared common resource was thought to lead to overexploitation of that resource (Hardin, 1968) (see Chapter 1). Even so, no changes in livestock management occurred and pastoralist communities in Mukogodo Division continued to graze their herds in customary ways. Additionally, other land remained as government land or was registered as outspans (government areas kept available for mobile herds in transit to rest and refresh) (Letai, 2011).

2.6 People and local land use today

Laikipia landscape is now a mosaic of land uses and competing interests, where pastoralism coexists alongside commercial ranching, smallholder agriculture,

horticulture, cash cropping, hunting and gathering, luxury tourism and conservation (Letai & Lind, 2013) (Figure 2.2). Farming is practised in adjacent parts of land on the slopes of Mt Kenya and the Aberdares Range mainly by Kikuyu people (Letai & Lind, 2013). (Figure 2.2). The region is a mixture of diverse human land uses and conflicting attitudes towards wildlife (Sundaresan et al., 2008). The biophysical conditions in Laikipia are mostly suited to livestock production either in the form of traditional pastoralism or commercial ranching, which are the two main economic activities in the area (Ogada, 2003). In addition, there are subsistence agropastoralism and forested areas. A number of commercial ranches also engage in ecotourism (Sundaresan et al., 2008). Large-scale commercial ranches, high-end tourist lodges and safari enterprises are mostly run by Europeans. Thus there is a mixture of land tenure regimes with the landscape divided up into privately, publicly or communally owned properties (Georgiadis et al., 2003) (See Table 2.2).

Table 2.2 Summary of different land uses in Laikipia County (table taken from Letai, 2011)

Type of tenure regime	**Total land area in acres**	**Total in number**	**Mean area (km^2)**	**% land occupied in the County**
Large scale ranches	3,794	48	79	40.3%
Large scale farms	140	23	6	1.5%
Group ranches	702	13	54	7.5%
Small holder farms	2,562	122	21	27.2%
Forest reserves	701	4		7.5%
Government land (outspans)	620	36	17	6.6%
Others	?	?		9.5%

Today, ethnically diverse communities including Maasai, Kikuyu, Meru, Boran, Turkana, Samburu, Kalenjin and Pokot inhabit Laikipia alongside Europeans (Mkutu, 2001; Buncle, 2008), who settled here at the beginning of the 20th century to establish large-scale ranching. The Samburu, Kalenjin, Boran and Turkana occupy the semi-arid part of the County and the Kikuyu and Meru occupy the urban and arable parts (Mkutu, 2001). The Maasai groups found in Laikipia today are a result of people moving between being (and inter-marrying between) hunter-gatherers some originally of Maa speaking and others of different linguistc ans culturally hunting and gathering origins (Spear and Waller, 1993) and Maa speaking pastoralists (Section 2.6.) The principal Maasai livelihood in Laikipia

today is livestock keeping, discussed in more detail in the next section. In addition to keeping livestock, pastoral communities in Laikipia also engage in agriculture, tourism, conservation and construction among other occupations (see Chapter 4).

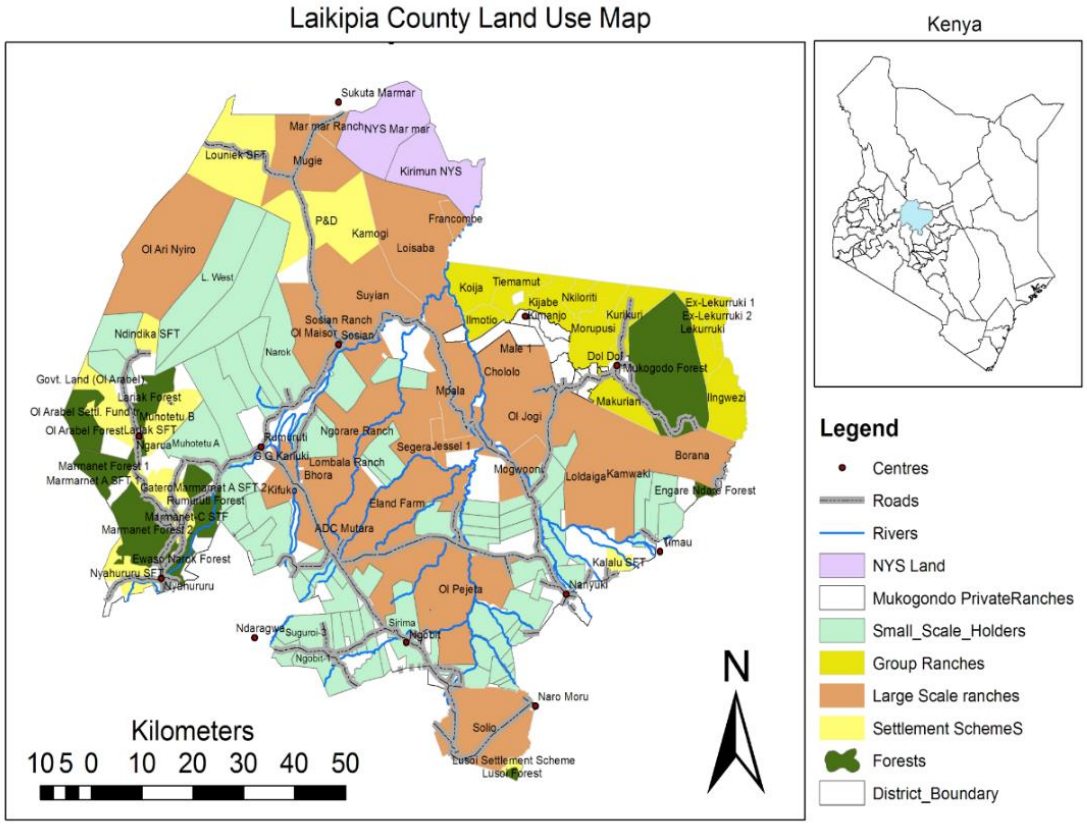
2.6.1 Land use and livelihoods in Laikipia

2.6.1.1 Pastoralism

Pastoralism can be seen in the broadest sense to be the key agricultural production system in ASALs (Rass, 2006). Defining pastoralism ought to include two important concepts: people raising livestock and the mobility of those people and livestock (McCabe 1994). Livelihoods depend largely on the raising of domestic animals, which include cattle, sheep, goats and camels (Fratkin 2001). Pastoral groups such as the Maasai are classed as semi-sedentary (Fratkin et al., 1994). Because ASALs are dominated by highly variable and unpredictable rainfall patterns leading to changeable primary production, livestock have been pivotal to pastoralist's livelihood strategies because they can be herded to exploit patchy vegetation growth in areas where rain has fallen (Galvin, 2009; Homewood, 2008). The mobility of livestock is considered a rational response to seasonal changes in rainfall and vegetation (McCabe, 1994) and has proven an important strategy to cope with uncertainty and the risks associated with living in ASALs (Niamir-Fuller, 1999; Leslie and McCabe, 2013). Transhumance between spatially distant areas makes use not only of pasture for livestock, but also other resources such as water and minerals. Health and production of transhumant animals can be significantly improved compared to sedentary herds. (Homewood, 2008; Behnke et al., 2016). However, in Kenya this land use system is threatened by widespread privatization into sub-divided holdings (Homewood et al., 2004).

While livestock are central to subsistence in these rangelands, most pastoralists diversify their livelihoods with complementary activities (Fratkin et al., 1994). They also live alongside other groups with different land uses.

Fi gure 2.4 Map of Laikipia County today showing different land uses (map from Letai, 2011).



2.6.1.2 Large-scale commercial ranches

There are 48 large scale ranches which make up the majority of land in Laikipia today. The largest is Laikipia Ranching (92,555 acres), Ol Pejeta (90,000 acres), Loisaba (62,093) and Ol Jogi (54,049 acres). The smallest is Andrecaple (416 acres). Most of these ranches were acquired during colonial rule. It is still the most important private ranching region in Kenya (Heath, 2001), selling largely to high-end butchers in Nairobi (Letai and Lind, 2013). Many of the large-scale ranches (~70%) act as conservancies for wildlife and engage in and/or receive benefits from tourism (Romañach e al., 2010), mostly high-end tourism. Some of the ranches also rent out dry season/all year round grazing for neighbouring community group ranches' cattle herds.

When the Maasai land campaign began in 2004 to address historical injustices on land based on the British-Maasai agreements of 1904-1911, it was discovered that some of these ranches have no legal documents (Letai, 2011).

Since independence, large scale ranches have been used for an additional source of income: British Army training/drill exercises. Initially Mpala Ranch and Lewa Farm were used for military exercises, but other large scale ranches such as Ol Jogi, Lolldaiga, Ole Naisho and Ol Pejata are also incorporating military training/drill exercise as part of their land use. There are no data for this new form of land use, nor for how much is being paid (Letai, 2011).

2.6.1.3 Large scale farms

There are 23 large scale farms held by individuals in Laikipia. This land was acquired when Kenyatta was subdividing land after independence or by land buying companies that used this land for collateral to access bank loans. Suguroi (4,527 acres) and Murera (1,386 acres) are farms belonging to land buying companies. Individual farms include Rware-3 (1,089 acres) (former President Kibaki's family), Mathenge (1,817 acres) (former provincial commissioner in Kenyatta and Moi regimes) and Mohammed (1,092 acres) (former chief of general staff of the armed forces of Kenya). Colonial descendants still with farms today include Jennings (2,123 acres), George (1,970 acres) and John C. Cardoville (1,077 acres). Many of the large scale farms, especially those near a permanent water source have been acquired by multinational companies for horticultural purposes,

wheat farming and high quality beef cattle ranching. Crops grown include supermarket vegetables and flowers which are mainly exported to European markets (Letai, 2011).

2.6.1.4 *Smallholder farms*

There are 122 smallholder farms in Laikipia. These were initially large farms that were sub-divided into smaller plots of approximately 2-5 acres in size. Three types of different groups farm this land today 1) those who bought the land and settled subsequent to pressure in ancestral home lands; 2) those who bought land for speculation in the hope of price rises later and 3) those that bought land to use for guarantees to access bank loans (Letai, 2011).

2.6.1.5 *Government land*

There are 36 government land outspans in Laikipia. The land is used for a variety of purposes including training military and national youth service, livestock holding grounds for veterinary services during quarantines or land used by agricultural development corporation and research institutions for research purposes (Letai, 2011). Only five out of the original 36 government outspans have not yet been settled on or appropriated. The remaining five are managed by government parastatals such as the Agricultural Finance Corporation or the military. Not only senior government officials, politicians and military personnel but also large-scale ranch managers, whose properties adjoin outspans, have found ways to appropriate this land (Letai, 2011).

2.6.1.6 *Forest reserves*

The two subcategories of forest reserves are intact forest (~4.75%) and disturbed forest (~2.75%). The intact forests are generally managed by, and lived in by pastoralist communities or conservation groups, such as Lewa Wildlife Conservancy, jointly with communities, while the Kenya Forest Service take more of a supervisory role. Most of these forests are used for herding livestock in the daytime and are vacated at night, except Mukogodo Forest where pastoralists live seasonally (Letai, 2011). Disturbed forests have lost vegetation cover mainly due to human activities or settlement. The Kenyan Government allows cultivation inside the disturbed forest on condition that farmers integrate cropping with tree planting (Letai, 2011). Agro-pastoralists were allocated land by Moi's government in forest

reserves such as Marmanet as thanks for backing the regime. However, agro-pastoralists living in Marmanet were constantly under the threat of eviction from 2002 or from Kibaki's government and now from present Uhruru Kenyatta's government because of alleged over exploitation and diminished water levels in the rivers, whose sources stem from the forest. Ewaso Narok, Rumuruti and Lariak forests have all been encroached upon by human activities (Letai, 2011).

2.6.1.7 Mt Kenya

Although not contained within Laikipia itself, the Mt Kenya Forest Reserve is described here as it constitutes an important extension of forest reserve land accessed by Laikipia pastoralists.

The Mt Kenya region, Mt Kenya Reserve and Mt Kenya National Park (hereafter Mt Kenya), consists of seven counties (including Laikipia). Mt Kenya includes a forest reserve, covering approximately 496,363 acres, which is one of most ecologically and commercially important natural forest systems in Kenya (Wass, 1995). The forest forms a major water catchment area, supplying a quarter of Kenya's population across more than half of Kenya's land area (Wass, 1995). It feeds into the two main tributaries that traverse Laikipia – Ewaso Nyiro and Ewaso Narok (Georgiadis, 2011). The tributaries are important not only for the communities living adjacent to the forest, but also to pastoralist rangelands, rainfed and irrigated subsistence agriculturalists, commercial farmers and urban centres in downstream catchment areas (Emerton, 1995).

The region has six diverse agro-ecological zones that show a varied physical environment of an almost equatorial type of climate in upper-lands and semi-arid and arid environments in the lowlands (Kareri, 2010). Average rainfall in the region is ~1600-2000mm per annum. The upper-lands occur in the upper northwest region of the study area and are generally humid to sub humid, often with thick forest vegetation. The lowlands show strong gradients in terms of average rainfall, temperature and vegetation characteristics. Temperature can vary greatly with altitude with temperature ranging from ~4 to ~32 degrees Celsius. Due to the combination of climate, a variety of conditions exist that facilitate diverse farming ranging from subsistence to export-oriented commercial farms, and from extensive large-scale farms to very intensive small-scale farms and livestock-keeping (Van de Steeg et al., 2009).

Historically Mt Kenya was managed by local communities with access limited to local clan-based groups including the Embu, Kikuyu and Meru (Emerton, 1999). Their local institutions governed the rights of access and use of forest products (Emerton, 1995) and land use activities were characterised by small-scale farming, animal husbandry and logging (Tanui, 2006). Since colonial times land use has been influenced by the introduction of commercial agriculture (Tanui, 2006). Changes in external management all led to increase in forest regulations and decrease in community rights to manage and utilise forest resources (Emerton, 1999). For example, local communities were coerced to undertake soil and water conservation measures on their farm. The soil conservation policy was seen to be a way to control local land use by firstly the colonials and then by the Kenya Government after independence (Tanui, 2006). In addition to these changes, the region saw rapid population growth that meant some communities had to migrate to reduce the pressure on the land, spreading into the forest reserves and settling in the surrounding marginal areas (Tanui, 2006).

Today the majority of agriculture in the area is geared towards the export market and includes large commercial crops such as tea, coffee and cut flowers (Justus and Yu, 2014). The horticultural sector in the region is seen as a success and is likely to increase. It is one of the major export industries in Kenya. However recent agricultural intensification of tea plantations was linked with forest decrease and land degradation in one area, in other areas encroachment of human activities (Willkomm et al., 2016).

Also impacting on the area is climate change. Declining rainfall has culminated in Mt Kenya glaciers losing ~92% of their mass in the last century. In the recent past, melting snow contributed to the rivers and kept the catchment humid, while moderating the dry seasons. Snow-melt periods have now shortened, which has implications for the river flow and springs, especially during the dry season (FAO, 2010).

2.7 Conflict in Laikipia

Over time, Maasai access to important resources on Laikipia has diminished because of a variety of processes put in place to restrict movement of pastoralists and their livestock. In the last 40 years communal grazing land in Laikipia has been reduced substantially as foreign settlers, local investors, and ranchers have bought

and begun fencing large tracts of land, limiting pastoral grazing lands in the region and restricting mobility (Mkutu, 2001; Letai and Lind, 2013). The region has over time become fragmented as borders have crystallised, either by construction of fences along property boundaries or by administrative barriers (Letai and Lind, 2013). As outlined in Chapter 1, land grabbing by elites, such as Kenya's ruling class, is so widespread that it is scarcely considered illegal (Markakis, 1999) or is presented in ways that appear to be legal.

Today land is changing hands both with and without the knowledge of the Ministry of Lands. For example, 16 of the 48 large scale ranches are internally subdivided into smaller plots according to the Ministry of Local Government (Letai, 2011). According to unsubstantiated opinions expressed by local government officials, this can be because each of the plots of land is actually owned by different people, who individually pay the land rate depending on the size of the plot. Several allegations have suggested that these divided parcels of land have been sold to white Zimbabweans and retiring Europeans wanting to settle in Kenya. What is evident is the increase in luxury residences emerging on some of the divided plots of land. Another theory is the buildings are in some cases tourist accommodation built and let out without government knowledge or license. There is however insufficient information known about these changes in land regime for the Ministry of Lands to corroborate any of these claims (Letai, 2011).

Former large-scale ranch managers are collaborating with the Ministry of Lands officials to consolidate subdivided plots into larger holdings. By acting as brokers between the farm owners and the (mostly) European buyers, they are able to sell the amalgamated plots. Nevertheless the new owners may not be aware until much later of the complex transactions that are involved in such contracts and the potential problems that may arise particularly with respect to the controversial status of pastoralist squatter (Letai, 2011). Examples of where this has happened include Ethi (4,742 acres), East Laikipia (12,152 acres) and Kimakandura (10,139 acres) (Chapter 5).

There are a number of possible reasons as to why there is a rapid increase in land deals developing in Laikipia. The most obvious one is investment, largely in tourism and wildlife conservation. Changes in the land reform agenda as part of the new constitution in 2010 has also been cited as another motive. The inequitable land distribution that harks back to colonial days and persisted through Independence has often been at the centre of disputes between pastoralists and

large-scale ranches. For example, during the Maasai land campaign in 2004, pastoralists invaded large scale ranches with their livestock and refused to leave protesting against the historical injustices pastoralists suffered because of the British-Maasai agreements of 1904-1911 (Letai, 2011). High profile commercial ranch invasions and attacks have become frequent news in 2016-2017

2.7.1 Violent clashes

The increase in violent conflicts occurring between communities in Laikipia is due to the increased pressure on water and land use, decreased access to land, people's increasingly explicit sense of political and economic marginalisation, lack of suitable state response to the worsening security situation and the proliferation of weapons across the region (Mkutu, 2001). Traditionally, Maasai elders would keep the peace in society by enforcing specific rules, duties and rights. In recent years there has been a breakdown of customary governance, partially through integration into the wider economic and political system (Mkutu, 2001). Before 1979, cattle raids in Laikipia were relatively few and the cattle stolen were regularly recovered (Mkutu, 2001). By contrast, cattle raiding now involves lethal encounters between armed raiders and pastoralists (AK-47s being the weapon of choice). Use of automatic weapons in raiding began in the early 1960s (Cliffe and Markakis, 1984). Arms bought today are largely obtained from the Pokot district in Kenya as well as Sudan, Uganda and Somalia. Different ethnic groups - Maasai, Kipsigis, Samburu, Pokot and Kikuyu - are involved in raiding. In particular, conflict between the Pokot and the Turkana is one of the oldest conflicts in northern Kenya (McCabe, 2004). Tension between the two groups has been further strained by successful oil-prospecting missions and the building of a geothermal power plant on land claimed by both groups (Greiner, 2013). Automatic weapons have brought a new dimension to conflict, with pastoralists choosing to arm themselves for a variety of reasons. Communities arm themselves to protect their lives and livelihoods against those who threaten them. Those who do not currently have arms want to acquire them so they can protect themselves and their livestock (pers. comm. community members, Il Polei Group Ranch). In response to the increase in violence against Maasai by armed raiders, the Kenyan government decided to provide home guards to protect the communities. Unfortunately, this only led to the increase of small arms in the hands of untrained men, and allegations that the home guards were at the vanguard of the raids taking place (Mkutu, 2001).

2.8 Study sites

Two of the study sites, Il Polei and Il Motiok, are found in Mukogodo Division, while the third study site, Lekiji Village, is located to the south, bordered by large-scale commercial ranches and a main road (Table 2.3). I sought to identify three areas which would capture a gradient from remote areas likely representing more traditional pastoralism, through an intermediate site, to a more recently settled site with more mixed and diversified livelihoods including more recent in-migrants and/or displaced people, representing the case increasingly found across many Kenya pastoralists areas. Prof. Rosie Woodroffe suggested Il Polei, as one of her research assistants lived there. Through him, I was able to meet easily with the Group Ranch Committee as well as the Chief to get the approval required for conducting research. In addition, it was easily accessible by road, largely being able to drive through Ol Jogi Ranch. Il Motiok had very close connections with Mpala Research Centre and Mpala Ranch. However, access to this group ranch was not available all year as the river (Ewaso Nyiro) would run very high and fast in the rainy season, making it impossible to drive across it. And because of security issues during the 2007 general elections, MRC didn't advise I stay there unless I could leave the group ranch immediately by the crossing the river. The 2012 general elections occurred during my fieldwork period in Kenya. Lekiji Village was suggested as a comparison site to study by the Mpala Ranch manager, Mike Littlewood, because firstly it was a settlement that had had so little socioeconomic research carried out there and also because it differed quite a lot from the other two study site Maasai group ranches. In addition, he had good relations with Lekiji and was able to introduce me to the Chief without any problems. In this section, I first describe Mukogodo Division and then Il Polei and Il Motiok. Following this, I describe Lekiji Village.

2.8.1 Mukugodo Division

Mukogodo Division comprises 13 group ranches and covers an area of approximately 1,100km^2 with a forest reserve of about 300km^2, and which covers around 7.45% of Laikipia County. Rainfall in this part of Laikipia averages ~400mm per year and falls mainly in April-May and November-December. The landscape is characterised by acacia-savanna and open grasslands, with two major rivers: Ewaso Nyiro and Ngara Ndare. There are no perennial rivers in Mukugodo. To the south are the large-scale ranches and to the north and East is land now

settled by the Samburu but which was previously a Livestock Marketing Division holding ground (Herren, 1988).

Table 2.3 Summary of the three study sites in Laikipia.

Study Site	Size (acres)	Villages	Borders	Aid/donor	Community conservancy area
Il Motiok	~9,000	Olochaki Ilmotio Naserian Loribai	1 large-scale ranch, 2 private farms, 3 group ranches	Mpala Ranch	Yes
Il Polei	~5,000	Olampaa Oloruko Oldupai	2 large-scale ranches, 4 group ranches	Ol Jogi Ranch	Yes
Lekiji	1,000	Lekiji	2 large-scale ranches,	Ol Jogi Ranch, Mpala Ranch	Yes

The major economic activity in Mukogodo Division is livestock production and some of the group ranches such as Il-Ngwesi, Kijabe, Lekuruki and Koija have wildlife conservancies and tourist lodges (Letai, 2011). Il Motiok has an all-women's group tourist lodge and Il Polei has a cultural manyatta, which is run by the women jointly with Munishoi group ranch. Land is communally owned with title deeds mutually held by the registered members of the community group ranch where they live, although not all the group ranches to date have obtained title deeds for their land.

People live with their livestock in a homestead which is encircled by a thorn brush fence corral (boma[7]). Properties are constructed from poles of wood and mud and/or dung and often with a thatch roof, although tin roofs are becoming more common throughout some group ranches.[8] Natural resources are generally used from within the group ranch of which the user is a member, and these resources are collectively managed as 'common property resources' (Ostrom, 1990). Many of the group ranches including Il Polei and Il Motiok also sell sand to middlemen, who

[7] Boma is the Swahili word for a Maasai settlement (or *enkang* in Maa), and is a commonly used term in Kenya Maasai areas.

[8] See Chapter 3, Section 3.6.3 for detailed description of Maasai living arrangements.

then sell on to concrete companies, as a way of raising revenue for the group ranch to use for various projects such as building classrooms, paying for children's school fees, paying for hospital fees and restocking herds of elderly members who have lost livestock during XCEs. However there have been disputes over the ownership of sand and over companies not paying the mandatory levies due. For example, Loata Sand Dealers Cooperative Society is the only company allowed to sell sand on behalf of the four group ranches in that part of Mukogodo Division: Il Polei, Makaurian, Murupusi and Munishoi. During my fieldwork it became apparent that lorry drivers had been colluding with sand brokers to acquire sand without payment. During this time a police barrier at Il Polei along the Dol-Dol road, which is the entry and exit for sand lorries, was removed. This then became the biggest contributing factor to non-payment. Drivers were able to leave without paying as it was near impossible to stop a lorry for the screening of valid receipts. Recent response to this has been local support for a suggestion to put forward by elders for a barrier to be re-introduced and for all sand levies to be paid prior to sand collection. The barrier, now controlled specifically by employees of the sand company, has been re-instated (pers. comm with research assistant).

The area has high levels of poverty and a high number of people are dependent on food relief. Poverty in the area is attributed to: livestock loss due to drought, inadequate pasture, poor management of group ranch, lack of employment opportunities, insecurity arising from banditry and cattle raiding, and the inability to exploit available natural resources (Sumba et al., 2007) because of confinement to limited areas and loss of mobility constraining ability to find pasture in times of low rainfall (Hughes, 2006). Inequitable land allocation during the colonial period and after Independence set the scene for marginalisation of these communities in this area (Letai, 2011). While the community group ranches have remained intact, growth in human population and associated livestock holdings has resulted in overgrazing and there being less pasture available for the community's livestock. In addition recent increases in drought frequency prevents pasture recovering to its fullest potential (Letai, 2011). In some instances, people have left this area to settle elsewhere, solely because of the lack of pasture.

The Naibunga Conservancy Trust (NCT) is established within the Mukogodo Division. NCT was established in 2001-2003 with the help of the LWF and African Wildlife Foundation (AWF). NCT is located in the Western region of the Mukogodo Division and is the collective effort of nine group ranches, including Il

Polei and Il Motiok. None of the group ranches in NCT are fenced, allowing movement of wildlife across the conservancy. Approximately 20,000 people live in the area, mainly Maasai, although other Kenyans and foreigners hold individual farms there. NCT also forms part of the "Linking Livestock Markets to Wildlife Conservation" programme run by the Northern Rangeland Trust (NRT) that aims to give pastoralists both security and incentives to manage their group ranch to NRT's "best practice". NRT buy cattle from best performing group ranches, defined as those that are best managing their group ranch for the benefit of both the community and wildlife, and that sell livestock on for slaughter. For the period 2006-2012 NRT purchased over 5,000 livestock from 11 participating conservancies, from 2,000 individuals, totalling a value of approximately £89,000 (www.nrt-kenya.org/naibunga).

Compared to Il Polei Il Motiok is more remote, with Il Polei having better access to two important towns in the area Nanyuki and Dol-Dol, primarily because of its proximity to the main Dol-Dol road. Nanyuki is a market town supplying many of the farms, ranches and tourist lodges in the local area. It is also the base for trekking excursions on Mt Kenya. Dol-Dol is the administrative seat of Laikipia-North District of which Mukogodo Division is part, and has a market every Saturday. Access to Nanyuki has improved over the recent years owing to the part of the main route into town being resurfaced, largely funded by some of the large-scale ranches such as Mpala and Ol Jogi as well as the British Army, who use the road to access remote areas for live fire training. The road improvements have made journey times shorter and therefore made Nanyuki more accessible. This increases the opportunity for paid work for those communities located near a main road such as Il Polei.

2.8.2 Lekiji Village

Lekiji is unlike the two other study sites because it is not a group ranch and has been settled by a diversity of ethnic groups that include Boran, Kikuyu, Rendille, Samburu, Somali and Turkana. Those that live in Lekiji often refer to it as 'little United Kingdom' because of the ethnic diversity. All residents in Lekiji are engaged in pastoralism.

Lekiji Village is bordered by two commercial ranches Mpala and Ol Jogi. Since 2009 it has been partly enclosed by electric fencing where it borders with Ol Jogi. Since 2012, Lekiji is now completely fenced. Ol Jogi has significant populations of

black and imported white rhinos and Kenya laws states that properties with rhinos require electric fencing and armed guards. Lekiji Village was established on land that was owned by an absentee landlord. The settlement has been classified as illegal with current residents repeatedly contesting the threat of eviction while attempting to assert their status and rights. Disputes over the rights of those people living in Lekiji have been ongoing in the courts for many years. At the time of writing, the dispute over the residing community and land tenure is pending with the Kenya government reportedly buying the land from the current owners and allowing the currents residents to remain living there. Official title deeds are expected to be granted and in doing so, Lekiji Village will acquire group ranch status.

Lekiji Village has a complex history with no official written documentation as to how the diverse community have settled there. When interviewing or speaking with Lekiji Village residents on its origins, my questions were not often answered and when they were they were vague and scant in detail. As a way of constructing a historical picture of this contested land, I interviewed the Mpala Ranch Manager, on the history of Lekiji Village; specifically the tenure and access arrangements to help understand the intricate nature of the politics surrounding Lekiji Village[9]. Mpala's Ranch manager was born in Kenya and has lived and worked in the Laikipia area for over 40 years, and is acquainted with many of the people discussed in the interview. I give a brief synopsis of the relevant details that were established from the interview below:

> The origins of the current known tenure at Lekiji start in the 1950s. Prior to this the ownership and tenure is unknown. It was owned by *individual 1* (expat rancher) who most likely had a house and lived there at some point. Around the same time, *individual 2* (expat rancher) sold off all his larger pieces of land to Ol Jogi Ranch, who allowed him to live on a small bit of land neighbouring Lekiji for the remainder of his life. On his death, the land would revert to Ol Jogi again and his staff would have to vacate. *Individual 2* employed approximately 4-6 families, who included Boran and Rendille ethnic groups and lived with him. *Individual 1* sold Lekiji to *individual 3* who lived on a property elsewhere in Laikipia. When *individual 2* died, Ol Jogi were concerned that the people would not leave. The families (and their livestock) were asked to go to one of *individual 2's* properties elsewhere in

[9] See Appendix 1 (p.265) of transcript of interview with Mpala Ranch Manager about the history of Lekiji village and how the current people became settled there.

> Laikipia. The leader of the families approached *individual 3* (hunter) and said he would look after Lekiji for him. So the families settled on Lekiji. While they were living on Lekiji (during the 1970s), *individual 3* sold the land to two people who were in a *partnership*, who then sold on to a *land buying company* in the 1980s. However, around 1990 the *land buying compan*y sold to *individual 4* (ranch manger), who is the current owner today. During all the time that Lekiji changed hands more people came to settle on Lekiji usually by approaching the leader of the original families and probably paying a sum of money to secure their position on the land. New families are still arriving today.

The first land case involving Lekiji was taken to court approximately 7 years after *individual 2* died, which was around 1971/72. It has been in the courts ever since. The latest development before I left the field was that the government are to buy Lekiji from *individual 4* and the people settled there are to be given formal title deeds to the land.'

The present Kenyan government is attempting to make progress towards settling all internally displaced persons (IDP). In 2012 a draft bill, the Internally Displaced Persons Bill, was proposed as a way of dealing with IDPs. However national policy has not moved any further on implementing the bill, which was seen to hopefully relieve the history of displacement in Kenya. For example, in 2008 it is estimated 500,000 people were displaced nationwide through violent clashes during the general elections, many in Maasai areas (Kanyinga, 2009) including Laikipia. There is also acknowledgement that removing people from an area does not resolve the crisis of IDPs and instead potentially exacerbates IDPs further.

Laikipia is geographically diverse with highly variable climate. Climate gradients are created by Mt Kenya to the south-east and the Aberdare highlands to the south-west (Georgiadis et al., 2007). It is a mixture of land uses, but is dominated by livestock keeping. Subsistence pastoralism relies on the movement of herds to exploit the patchy vegetation (Niamir-Fuller, 1999). However, changes inland use and fragmentation are restricting the mobility of pastoralists, who have lost access to key resources, especially in times of drought. As pastoralist communities become more sendentarized, pressure on resources within the group ranches increases. This loss of access and mobility for pastoralists in Laikipia, is a

continuation of the legacy of land expropriation that has been happening in Kenya for over 100 years (Letai and Lind, 2013).

Chapter 3 General methods

3.1 Chapter summary

This chapter provides an overview of the general research methods used to collect data for this thesis. The thesis uses an interdisciplinary mixed methods approach incorporating both social and biological sciences. Data collection used a range of quantitative and qualitative techniques to investigate the impacts of XCEs on people, livestock and wildlife. The majority of data were collected using interviews with pastoralist communities living in Laikipia, Kenya. Methods used included questionnaires and semi-structured interviews. The thesis also makes use of an already existing longitudinal data set allowing a spatial analysis of African wild dogs range use spanning drought and non-drought years. Specific details of data collection and analysis are given in the relevant chapters.

3.2 Fieldwork

Originally this project was to be based in and around Amboseli National Park in the south of Kenya, close to the Tanzania border. However, my original project partners African Conservation Centre (ACC) with whom I had previously worked with on the large carnivore project initially approved then subsequently withdrew support for my research in Amboseli in January 2011 and instead proposed an alternative study site, Olkiramatian, Magadi, in Kenya South Rift valley. In addition to this, Dr Sarah Durant suggested Laikipia, Kenya where a fellow Zoological Society of London colleague, Prof. Rosie Woodroffe, had established a project conducting research on large carnivores, based at Mpala Research Centre (MRC). Pilot work in Kenya took place from May – July 2011 and gave me the opportunity to visit both locations, discuss in detail how my work would fit in with the relevant people, and decide which site would be the most suitable to conduct my project. It became clear that the research would fit better with the existing work and plans in Laikipia not least because ACC's research in Olkirimatian began to evolve a different direction. Consequently I spent the last month of the pilot study in Laikipia. Although no systematic data were collected during this period, valuable contacts were made across different communities and an invaluable understanding of the area established. Data collection was subsequently conducted during two field seasons in Laikipia (August 2012-April 2013; July 2013-October

2013). The second trip was necessary owing to the impacts the general elections in Kenya had on my data collection in one of the three study sites.

To conduct research in Kenya as a foreign student requires affiliation with a Kenyan research institution. I was affiliated with both Kenya Wildlife Services (KWS) and MRC. Once this sponsorship was set up, I could apply for a pupil's pass, research permit and an alien registration card. All these permissions were granted for a 1 year period.

3.3 Language training

A three week language training for Swahili took place in Tanzania prior to the main field season. This gave me basic conservational skills on which I could improve once in the field. At the start of fieldwork I also invested time learning the local language Maa. This was important because the majority of people within the study sites could not speak Swahili. Swahili speakers were usually younger and/or more educated than those who did not have Swahili. Those with secondary education were also able to speak English. However, my Maa language skills did not develop beyond greetings, very simple questions and a limited ability to follow what was being said. The majority of questionnaires and interviews were conducted in Maa and were translated by the research assistants with whom I worked. A smaller number of interviews were conducted in Turkana, Somali or English. Details on socioeconomic research methods used are given below.

3.4 Selection and training of research assistants

I worked with two research assistants (RAs) who were local residents in the group ranches where I was working. The RAs were instrumental in helping with language, translating, obtaining access to all the community members present as well as helping me find my way around the study site. The RAs played an important role throughout socioeconomic data collection, not least because the methods chosen to collect this data require RAs to be trusted by the community. The age, gender and social standing of RAs influences the quality of data they provide (Bernard, 2006), particularly among Maasai groups which are strongly structured by age and gender. As such, and where possible, I interviewed suitable RA candidates that were put forward by the group ranch committee and/or the chief. After a two week training period in which we went through the questions so

the RAs were familiar with them, we trialled a sample of the questions with members of the community that would not be included in the main study.

3.5 Ethics consent and compensation

Before carrying out the socioeconomic data collection, I obtained verbal and/or written consent from participants when we first met for interview. A paragraph translated into Maa was read out before the interview started. Participants were free to stop the interview at any time without giving a reason. I chose not to record the semi-structured interviews because at the first study site the idea was not welcomed. The socioeconomic data were collected using household questionnaires, semi-structured interviews, focus group interviews and event calendar/timeline series. The latter was used in the household questionnaire and interviews to help people remember dates.

For those people willing to take part in the study I chose to reward participants with non-financial gifts. I decided to give people food and chai, which we would normally have after we had finished the interview or household survey. I always carried with me two large thermoses of hot water, long life milk, sugar, tea, biscuits, cake, sandwiches and eggs. My local name throughout the three sites independently was 'mama chai'. The children that were present in the homestead during the interviews got the majority of biscuits and I always left teabags, milk and sugar. If we were in the trading centre, where there were 'hotelis[10], I would buy lunch for the participant.

3.6 Research methods

This section summarises the different data and methods used in this thesis. The thesis not only uses original data collected by myself, but also makes use of existing data sets. Table 3.1 summarizes the different methods used for each chapter. Table 3.2 shows the number of different methods used at each study site. Methods specific to any one chapter are described in that chapter.

NVivo was originally used to organize and analyse qualitative data collected for this study. It is a useful software that can be used to code themes and interrogate

[10] Small eating houses.

data to help confirm ideas and 'feelings' about what respondents are saying (Sutton and Austin, 2015). However, I found NVivo less useful for any analysis of the qualitative data. I found that re-reading the interviews so that I knew the data intimately enabled me to better understand the issues that respondents were concerned with. These qualitative data, in the form of quotes, are meshed with quantitative data throughout the thesis to support findings.

Table 3.1 Method used, sample sizes, when it was collected and which data chapter they are applicable to.

	Method	**Year collected**	**Chapter**	**Main source of data**
Primary data	Household questionnaire (n=195)	2012-2013	4, 5 & 6	
	Semi-structured interviews (n=25)	2012-2013	4, 5, 6 & 7	
	Key informant interviews (n=24)	2012-2013	4, 5, 6 & 7	
	Focus groups (n=5)	2012	4, 5, 6 & 7	
	Wealth ranking	2012-2013	4, 5 & 6	
	Timeline	2012-2013	4	
	Free list	2012	6	
Secondary data	Remote sensing data	2001, 2006-2012	7	MODIS; Global Forest Watch Data
	Maps	2011	6	MRC
	Wild dog distribution data	2006-2012	7	WDCRP

Table 3.2 Data collection for the three study sites.

	Study site and dates		
Data collected	Il Motiok (Apr 2013, Jul-Oct 2013)	Il Polei (Sep-Dec 20102)	Lekiji (Dec 2012, Feb-Mar 2013)
HHs	77	66	52
SSI	13	0	12
KI	6	12	6
FG	0	5	0
Timelines	0	1 (2000-2012)	1 (2002-2012)
Participant mapping	1	1	1
Free list	1	1	0

3.6.1 Measuring wealth

Assessing wealth should include non-financial aspects of wealth such as health and wellbeing, political influence and authority, as these may be valued more highly than income and may contribute more to long-term prospects (Chambers, 1997; Woodhouse et al., 2015). Wealth ranking using participatory rural appraisal/rapid rural appraisal (PRA/RRA) is a widely used method that allows local people to create locally relevant wealth indicators, rather than ones imposed by outsiders, including researchers (Grandin, 1988). Community members then rank known households in terms of their status with respect to these locally meaningful categories. Wealth ranking using PRA can have a tendency to oversimplify though. It may be able to detect and measure indicators but not what connects them (Aitken & Herman, 2009). It may also fail to capture issues masked by universal sensitivities around social and economic status in this study. People selected for carrying out PRA/RRA included RAs, members of the group ranch committee and respected elders.

To investigate how wealth influences the impact of extreme drought on pastoralist communities I conducted wealth ranking exercises at each of the three research sites. This involved convening a small group of mixed community residents to discuss various wealth attributes between themselves while I sat aside. Characteristics of, and rankings within each attribute were then decided. All households eligible for inclusion in the study were placed into one of four wealth groups (A-D, where A is the wealthiest and D is very poor or destitute). Originally, there were five wealth groups A-E (Table 3.2), but E was combined with D to improve the Linear Mixed Effects (LME) model used in Chapter 5. Although each of the three sites had very similar ideas of what constituted wealth, subtle differences did occur (Table 3.3).

There are other ways to measure wealth within pastoralist communities. One of them uses livestock holdings as a proxy for wealth. The tropical livestock unit (TLU) method uses a common currency making it possible to pool livestock of different species in terms of ecological equivalence. There are a number of different techniques for working this out. For example, the International Livestock Centre for Africa (ILCA) and Sellen (2003) uses one camel is equal to 1 TLU, one cow is equal to 0.71 TLU and goats and sheep are equal to 0.17 (ILCA, 1981).

Adult equivalent (AE) units involve a comparable system based on human energetics, making it possible to combine individuals of different age and sex in a single measure conveying household energetic requirements. Again there are different systems in place to achieve this. In this study AE were calculated following Sellen (2003). Individuals 15-60 years were taken as equal to one AE unit, 7-14 or >60 years were equal to 0.67 AE units and <7 years were equal to 0.25 AE units. As an alternative to participatory wealth ranking in pastoralist societies, where livestock holdings are closely correlated with several dimensions of wealth and wellbeing, it is possible to use TLU/AE as a proxy for wealth.

For this study I used both of the above wealth ranking methods of analysis as a two-pronged approach to help understand how different classifications of wealth may modify analysis results. The results of the wealth rankings carried out within the three research sites are found in Tables 3.4, 3.5 and 3.6.

The two different approaches to wealth ranking give partially overlapping categorisations, with >50%of the 'rich' and the 'poor' WR2 category households being placed in the corresponding WR1 groups A and D. If C and D are pooled, then over three-quarters of the WR2 'poor' households are placed in the WR1 poorest groups. However, around one-quarter of WR2 'rich' are categorised as WR1 poorer groups C and D, and conversely around one-quarter of WR2 'poor' are categorised as WR1 richer groups A and B.

This brings home the fact that a significant proportion of households are diversified away from livestock ownership, and may have low TLU/AE but possess other assets and circumstances locally recognised as wealth. Conversely livestock holdings may be a less clear-cut indicator of wealth than has been found in other recent work (Homewood et al., 2009).

3.6.2 Socioeconomic data

Engaging with people during fieldwork, and being aware of how you are perceived are two important considerations on the quality of data collected when carrying out socioeconomic research (Bernard, 2006). So although I was affiliated with a Kenya Research institution local to the area (MRC) and was also attached to the Samburu and Laikipia Wild Dog Project (SLWDP) (now the Kenya Rangelands Wild Dog and Cheetah Project - KRWDCP) I made it clear in my introductions that I was an independent PhD student from University College London.

Table 3.3 Criteria decided on by local community for attributes of wealth groups for WR1.

	Scoring	Il Motiok	Il Polei	Lekiji
No. of stock kept	A	100+	100+	100+
	B	51-100	50-100	50-100
	C	21-50	20-49	25-49
	D	6-20	10-19	10-24
	E	0-5	0-9	0-5
Education	A	University	University	University
	B	college	college	College
	C	high school	high school	high school
	D	primary	primary	Primary
	E	none	none	None
Employment	A		Civil servant, NGO	
	B		teacher clerical/secretary	
	C		game scout	
	D		casual work	
	E		watchman, cook	
Business	A	matatu operator large shop		supermarket hardware store
	B	boda-boda operator		Shop
	C	small shop	livestock broker boda-boda operator	matatu vehicle
	D	tobacco seller	small shopkeeper	small shop
	E	none		mini hotel kiosk
No. of children	A	10+	10-15	8+
	B	7-10	7-9	6-8
	C	4-6	4-6	4-5
	D	2-3	2-3	2-3
	E	0-5	0-1	0-1
No. of wives	A	4+	4-5	5+
	B	3	3	4-5
	C	2	2	3
	D	1	1	1-2
	E	1	0	0
Luxury items	A	car	car	aeroplane car
	B	boda-boda	boda-boda, T.V	boda-boda
	C	T.V, radio	Radio, bike	T.V
	D	bicycle	bicycle	Bicycle, radio
	E	none	none	None
Political standing	A	everyone will listen	listened to by the majority	everyone will listen
	B	most people will listen	father will listen & women	most people will listen
	C	few people will listen	very few people will listen	few people will listen
	D	his family will listen	only his family will listen	his family will listen
	E	only is wife will listen	only his wife will listen	only his wife will listen

Table 3.4 WR1 - Wealth ranking based on criteria selected by community members. A = very wealthy – D = very poor. The totals show the number of males ≥25 who participated in the study in each study area.

Group	**Il Polei**	**Il Motiok**	**Lekiji**	**Total**
A	11	5	5	21
B	9	15	13	37
C	16	26	10	52
D	30	31	24	85
Total	66	77	52	195

Table 3.5 WR2 - Wealth rankings based on numbers of livestock kept using Tropical Livestock Units (TLUs and Adult Equivalents (AE). Following from ILCA, Sellen (2003). Each area shows the number of males ≥25 who participated in the study.

Group	**Il Polei**	**Il Motiok**	**Lekiji**	**Total**
Rich	8	7	0	15
Medium	14	15	10	39
Poor	44	55	42	141
Total	66	77	52	195

Table 3.6 Table shows the number and percentage of households in each WR2 category which were placed in each WR1 category.

WR2	**WR1**							
	A		**B**		**C**		**D**	
	number	%	number	%	number	%	number	%
Rich	8	53	3	20	2	13	2	13
Med	6	15	10	26	13	33	10	26
Poor	9	6	23	16	39	28	70	50

Before I started any research at each of the study sites, I went with the RAs to every homestead, regardless of whether they were included in the study, so I could introduce myself and my research personally to all the residents. That way, even those people not included in the study understood why they would see me around their village. Whilst collecting socioeconomic data I lived in the group ranches, camping in the community conservation areas that are set aside for dry season grazing. This arrangement was as suggested by the local group ranch leaders. These areas are part of the group ranch bur have no homesteads built there. A per night fee for camping was paid to the group ranch committee, which would in principle benefit the whole community rather than an individual. I drove one of the SLWDP vehicles with the SLWDP logo, but made it clear that the data I was

collecting was not for the SLWDP. Nonetheless it is likely that I was identified primarily as a SLWDP/MRC researcher, which carried inevitable implications for how I was seen and potentially for the way people answered my questions or directed their emphasis on semi-structured interviews (SSI). Interviewees could possibly have given strategic answers because they assumed I am involved with a conservation programme to protect African wild dog. I did not camp at was Lekiji Village because MRC did not consider it safe to do so.

3.6.3 Household surveys

The main method used to collect socioeconomic data was the household questionnaire. These data provided quantitative information on a range of household characteristics that could be compared between homesteads and across the three study sites. Before describing the questionnaire in more detail, first I discuss defining the household and the decision for the unit of analysis in this thesis (see Appendix 2[11] for full household survey).

3.6.4 Sampling framework for household data

A recent census was conducted on Kenya in 2009 and each study site had a copy of their group ranch details. This list formed the basis for initially identifying household that could be included in the study. For each study site, the RAs and I went through the household list of all the resident households to update where necessary. People who had moved away or were deceased, or who in other ways did not meet the requirements for the study, were removed from the list. After this, each homestead was visited to check and further update information on the household list where necessary. Once the final list was drawn up, all males $\geq$25 who owned livestock were identified and a new list created with these selected individuals for the study. This study focused on males because men are the ones who herd livestock over long distances during times of extreme drought and extended dry periods to look for pasture and water. Women usually stay at the homestead to look after the family, often keeping enough small stock to milk for those family members staying behind. As information was going to be collected on where people went with their livestock during XCEs (see Chapter 5), it was essential to speak to men who undertook these journeys away from home.

[11] Appendix 2 – p.271.

Wealth rankings according to local definitions of wealth, produced a framework for stratified sampling (see Table 3.2). Each individual was assigned a unique ID number so data could be handled anonymously in the analysis. Twenty-five was the minimum age chosen because individuals would be asked to remember the XCE of 2000. Many of the younger individuals included in the study, especially those who were educated and worked away from the group ranch, were often difficult to contact. Although people had mobile phones, there was no signal across extensive areas of the group ranches. Mobile phone credit was given to the RAs to contact people identified for inclusion in the study, though this created its own management issues. Interviews were sometimes carried out opportunistically by my RAs in my absence.

A total of n=195 household surveys were conducted across the three study sites (Chapter 3). 178 of these interviews were conducted in Maa, four in Turkana, eight in Somali, and five in English. I was present for the majority, which enabled me to go through the completed questionnaires to check for any mistakes at the time they were carried out. Surveys with misunderstandings, ambiguities or errors that were conducted when I was not present were taken back by the RAs to re-do if the participant was willing. On average the questionnaire took around an hour to complete and were conducted either at the homestead, a friends/family's homestead or in the study area's 'centre'. Location data for the homesteads visited were collected using a hand-held GPS unit. Many of the interviews took place in the 'centre' of each study site, because this was the main meeting place for members of the community and enabled interviewees to meet others before or after the interview. Approximately 2-4 months were spent in each area initially, then routine weekly follow up visits were made to complete SSIs, household surveys (HHS) and key informant interviews (KII) The survey comprised five sections (Table 3.7). Further details of the survey are found in Chapter 4.

3.6.5 Household sample (n=195)

In the final sample, 77 (39.5%) households were members of Il Motiok Group Ranch, 66 (33.8%) were members of Il Polei Group Ranch and 52 (26.7%) were from Lekiji Village.

3.6.6 Defining the household for use as a unit of analysis

The term household involves notions of cooperative living and being economically dependent on each other. It can be defined as those living under the same roof, sharing the same pot or sharing the same herd. The household can be seen as the primary unit of production (Grandin, 1991).

Table 3.7 The five different sections covered in the questionnaire, given in appendix 2[12].

Topics addressed in the questionnaire	Number of questions
Key resources	2
Livestock	5
Household income	1
Extreme drought	4
Household structure	1
Wildlife	1
Human wildlife conflict	1

An alternative approach is to adopt a local definition of the household as it is likely to be more meaningful to participants and RAs (Hampshire and Randall, 2004). Defining the household for this study would have been more straightforward if all the people interviewed were from the same ethnic group. As the majority of participants involved were Maasai, defining the household started from the concept of the Maasai household. The Maasai household is complex and multilevel, and the living arrangements are summarised here as they formed the basis for the study's choice of unit of analysis.

The majority of Maasai families live in a homestead (*enkang* or boma), which is customarily comprised of one or more families or *olmarei (*pl. *Ilmareita)*. The family commonly has a patriarchal head and as many Maasai men are polygamous, the *olmarei* can include more than one wife. Where this is the case, each wife customarily builds her own small house (*aji*) within the *enkang* for herself, her children, any dependents and the periodic presence of her husband (Coast, 2002; Serneels et al., 2009). The *enkang* may thus contain several wives' houses built around one or more linked corrals for livestock (Serneels et al., 2009). However, as noted by Talle (1988) and borne out by Grandin (1991), Coast (2001) and others, there has been a long drawn out decline in polygamous and co-resident extended

[12] Appendix 2 – p. 271

families, with more nuclear families emerging, particularly where land has been subdivided. These smaller nuclear families were the norm in the Laikipia study areas (see below). Also, men have increasingly started to invest in their own separate house, often a cement-floored plaster-walled, tin-roofed permanent structure, either within the *enkang* or in a nearby trading centre. I also found these types of houses built within the *enkang* of two of the group ranches and used as the equivalent to the *aji*, which the women built.

> 'Before, people built temporary houses without thatch roofs. Just using dung and water. We first started using thatching grass around 1989. But now you see semi-permanent houses with tin roofs. You only find traditional houses in the cultural bomas where tourists go.
> *Siriato, male herder, 59*

> 'In 1999/2000 people started to build small shops and this became more important source of income for people. People's homes started to become modern; being better built with corrugated roofs'.
> *IM118, male herder, 53*

Although in previous household surveys in Kenya the *olmarei* was chosen as the unit for analysis (Bedelian, 2014; BurnSilver, 2009) the three study site living arrangements differed enough for me to consider another model that fitted all areas. Il Motiok a small number (5 out of 77) included more than one wife. The few polygamous respondents at Il Polei (n=4, out of 66) lived with just one wife. The other wives lived with the eldest son in a separate homestead elsewhere in Il Polei. At Lekiji Village where ethnicity was diverse all households consisted of one husband, one wife and their dependent children. Therefore I decided to use the nuclear family as the unit of analysis. This was facilitated in two of the study sites by recent household censuses, which gave each nuclear family household their own unique number, while listing all the occupants who resided there. One respondent noted that today's younger generation was living differently to theirs:

> 'People have also changed as well. The older generation lived differently to young people today. People have changed because before the Maasai just used to keep livestock but now they do other activities such as shop keeping, boda-boda driver, carpentry, masons etc etc. This has brought changes to people.'
> *Vermeer, male herder, 69*

The household survey was discussed in detail with my RAs at Il Polei. I explained the information I wanted to get from the questions and between us we were able to improve on the original questions so all people interviewed could interpret them in the same way that we ourselves understood them. The HHS was first tested on 10 individuals before research was carried out. They were then trialled on the RAs friends from neighbouring community ranches or individuals without livestock, who would not be included in the study. A list of all households included in the study and according to wealth was made. The questionnaires were carried out with the head of the household.

The majority of interviews were conducted by the principal investigator (PI) and translated by two local assistants from within each study area. If selected individuals (see Section 3.6.4) had not yet been interviewed for the HHS, and were unlikely to be reached within the time frame of the PI's stay, the trained research assistants continued to collect HHS data alone. One exception to using assistants from within the individual group ranch was using the assistant from Il Polei at Il Motiok when conducting more in-depth semi-structured interview (SSI) and key informant interviews (KII). Because time was a constraint, it was unlikely I could give one of the assistants at Il Motiok sufficient training to be sure he was conducting the interviews well. Permission was granted by the head of Il Motiok group ranch (rather than the local chief) for me to work there with my Il Polei RA. The chief was often very busy and absent, and my assistant at Il Motiok thought it more important to have the support of the chair of group ranch.

3.6.7 Household composition

In Section 3.6.5, I discuss changes from polygamous to nuclear families occurring in Laikipia. This is a trend seen across Kenya. For this reason, I chose to focus on the nuclear family as these households represented the majority of homes I visited and male herders I interviewed. In addition, any further long-term research I plan to conduct in Laikipia, would build on this initial analysis, especially given that more households are likely to live this way.

Overall mean total family size recorded was 5.37 (± SD 2.05). Il Motiok had the largest average family 6.17 (± SD 2.15) followed by Il Polei 5.24 (± SD 2.05) and Lekiji 4.50 (± SD 1.39). Mean total adult equivalent (AE) per household was 3.70 (± SD 1.22). Mean family size for different wealth rankings ranged from 4.74 –

5.76 individuals or 3.37 – 3.87 AE (Table 3.8 and Table 3.9) (see this Chapter; AEs calculated according to Sellen, 2003).

Of the 195 individuals interviewed only 2.6% (n=5) lived in polygamous homesteads co-resident with more than one wife: these were only in Il Motiok. Although n=4 (2.1%) respondents at Il Polei had more than one wife, none of them were co-resident with more than one wife. Other wives lived with other members of the family, usually the eldest son elsewhere in the group ranch. All Lekiji respondents had only one wife in the village. Because the majority of household composition at Il Polei was largely structured on the nuclear family, this decided that the unit of analysis would be the nuclear family rather than using the more traditional family structure *olmarei* (see Chapter 3). Throughout the three areas 8.7% (n=17) were not married (being either divorced, separated or widowed). Mean household size (5.4) was lower than other studies have found in Kenya (9.0) (Bedelian, 2014) and 9.2-12.9 (Coast, 2001). This might reflect the trend towards increasingly nuclear families (Talle, 1988); but may also be due to methodology in that the family unit of analysis for this study was the nuclear family rather than the *olmarei* used in other studies.

The ethnic composition was largely made up of Maasai households although ~11% of respondents, all Lekiji residents were from other ethnic groups (see Chapter 2). Larger families were found in more traditional Il Motiok compared to the other two areas.

Table 3.8 Mean total number of individuals per household and Adult Equivalent for WR1.

HH total	**A**	**B**	**C**	**D**
Mean	4.74	5.44	5.76	5.28
SD	± 2.15	± 1.98	± 2.45	± 1.68
AE total	**A**	**B**	**C**	**D**
Mean	3.37	3.80	3.87	3.68
SD	± 1.15	± 1.12	± 1.53	± 1.13

3.6.8 Data limitations

Some groups of people are underrepresented because they were left out when choosing the sample. The list that was generated from the recent country-wide

Table 3.9 Mean total number of individuals per household and Adult Equivalent for WR2 (based on no. of livestock owned).

HH total	**Rich**	**Med**	**Poor**
Mean	5.38	4.59	5.60
SD	± 2.07	± 1.88	± 2.04

AE total	Rich	Med	Poor
Mean	3.52	2.97	3.92
SD	± 0.62	± 1.17	± 1.23

census, survey carried out in 2009 (see Section 3.6.4) contained all the household and family members of the group ranch. However, but not all of those registered on the census could be included in the study. This was because of the male household head (as sometime the whole family) worked permanently away from the group ranch. Other possible causes of bias were deliberate or accidental misreporting of data. For example, the ethnicity or sex of the interviewer may influence a respondent's answers (Browne-Nunez and Jonker, 2008). Choosing RAs that are well liked and respected in the community would go some way to mitigating this kind of bias. Unintentionally misreporting information because of difficulty remembering past events might also lead to bias. For example, respondents were asked to recall livestock losses from two XCEs occurring three and 12 years prior to interview. Herders will often remember cattle lost many years ago (Homewood et al., 2006a) but sheep and goat numbers and individuals are not so easily remembered.

3.6.9 Semi-structured interviews

Semi-structured interviews (SSIs) were collected from a selection of individuals across all wealth categories. Prior to conducting the SSI I outlined the key issues I was interested in discussing with people with my two RAs at Il Polei. This allowed me to phrase and them to translate the questions in a meaningful way. Interviews were conducted in the respondents' own language and were translated into English during the interview so I could write down what had been said so as much information as possible was recorded. In addition, this allowed me to probe further on an answer if I felt the respondent might have wanted to talk about other issues. That said, SSIs are time consuming (lasting on occasion up to 2 hours uninterrupted) and I found that people often became tired and ended the interview before I was able to cover all the questions. Approximately 13 SSI interviews were

conducted in Il Motiok, due to no focus groups being held in that site, and information was collected on:

1. Types of work through the different seasons.

2. Extreme droughts in the area.

3. Changes people make during an extreme drought.

4. Grazing access in extreme drought periods.

3.6.10 Focus groups

Focus groups (FGs)[13] were used in Il Polei to generate discussion around the themes of climate change and its impacts on pastoralist communities. Rather than refer to climate change directly, I used the term 'changing seasons' to see if climate change emerges from the discussion. FGs are less rigid and concentrate on revealing issues and underlying reasons rather than quantifying public attitudes. They are particularly helpful in identifying and gaining insight into major issues and commonly held perceptions of the community members being interviewed (Bernard, 2006). FG participants were selected by wealth. The wealth category list generated enabled the RAs and myself identify people who were in the same wealth group. My RAs contacted people to ask if they could participate in the FGs and arranged on das according to people's own choosing. Group size varied between 3-6 individuals. Focus groups were carried out in the group ranch committee office. It was not possible to replicate the FGs at Il Motiok and Lekiji. The same FG questions were instead conducted as SSIs. Themes for the questions were the same for SSI interviews.

3.6.11 Key informant interviews

Interviews were carried out with various key informants (KIs) who were selected from within the group ranches. Those chosen were knowledgeable people seen to be reliable and well respected in the community. KIs were from across the different

[13] Appendix 3 – p.277.

wealth groups. Not all of KIs questions[14] were all answered by each KI. Approximately 24 KI interviews were held and information were collected on:

1. Changing seasons in a person's lifetime?

2. Decision making for accessing key resources.

3. Changes in local land tenure.

4. Livestock numbers and herd composition where respondents live.

5. Treating livestock diseases.

6. Attitude towards grazing cattle on neighbouring large-scale commercial ranches.

3.6.12 Timeline series

Timeline interviews can be used for a number of different purposes, all which ultimately provide life stories that can be related to their wider historical, social, environmental and political context (Adriansen, 2012). For this study, I collected historic timelines either during the FGs or separately with a small number from the community (Tables 3.7 and 3.8). These timelines and the events calendars they allowed one to create were used to prompt respondents' memories during the HHSs and SSIs. People were asked to think about either recent XCEs that had occurred in the area and/or the number of livestock lost in specific years. To help them remember these events the RAs used the community's historic timeline information to put that year into context. No timeline exercise was carried out at Il Motiok (see Appendix 5[15] for both full timelines).

3.6.13 Participatory mapping

Participatory mapping is an interactive approach that draws on local people's knowledge, enabling participants to work together to create a visual representation of a place. It asks local people to draw maps of where they live and to locate significant places on the map (Bernard, 2006). For this study, I started off the

[14] Appendix 4 – p.278.

[15] Appendix 5 – p.280.

research in the community group ranches by gathering a small number of the community together to draw a map of the group ranch, which included important areas for key resource and notable changes in land tenure. It was also a valuable exercise to me in providing a detailed visual reference of the study site. Figures 3.1 and 3.2 show illustrations of the participatory mapping exercise carried out by residents at Lekiji Village and Il Polei. For Lekiji, they mapped their own village and for Il Polei they mapped where they took their livestock during the 2009 XCE. I re-drew the maps and checked them locally.

3.6.14 Free lists

Free listing or free pile sorts can be used to get respondents to list as many items as they can on subjects, topics or objects. For the purpose of this study, free listing was used to assess the relative importance of different key resources and where they were accessed, the idea being that the more important the key resource the sooner it will be mentioned (Bernard, 2006). This exercise was carried out during FGs in the first study site. A list was generated that ranked the importance of key resource depending how many times it was mentioned (Table 3.9). During the initial FGs it emerged that pastoralists thought of key resources and their use in two ways: key resources for the home and key resources for livestock. Areas where these key resources were collected were found within the study site. However during XCEs key resources (water and pasture) for livestock, mostly for cattle and sheep, would often mean people would search beyond the study site. Table 3.10 summarises the methods used in each of the study sites.

Figure 3.1 Re-drawn illustration of participatory mapping carried out by participants at Lekiji Village.

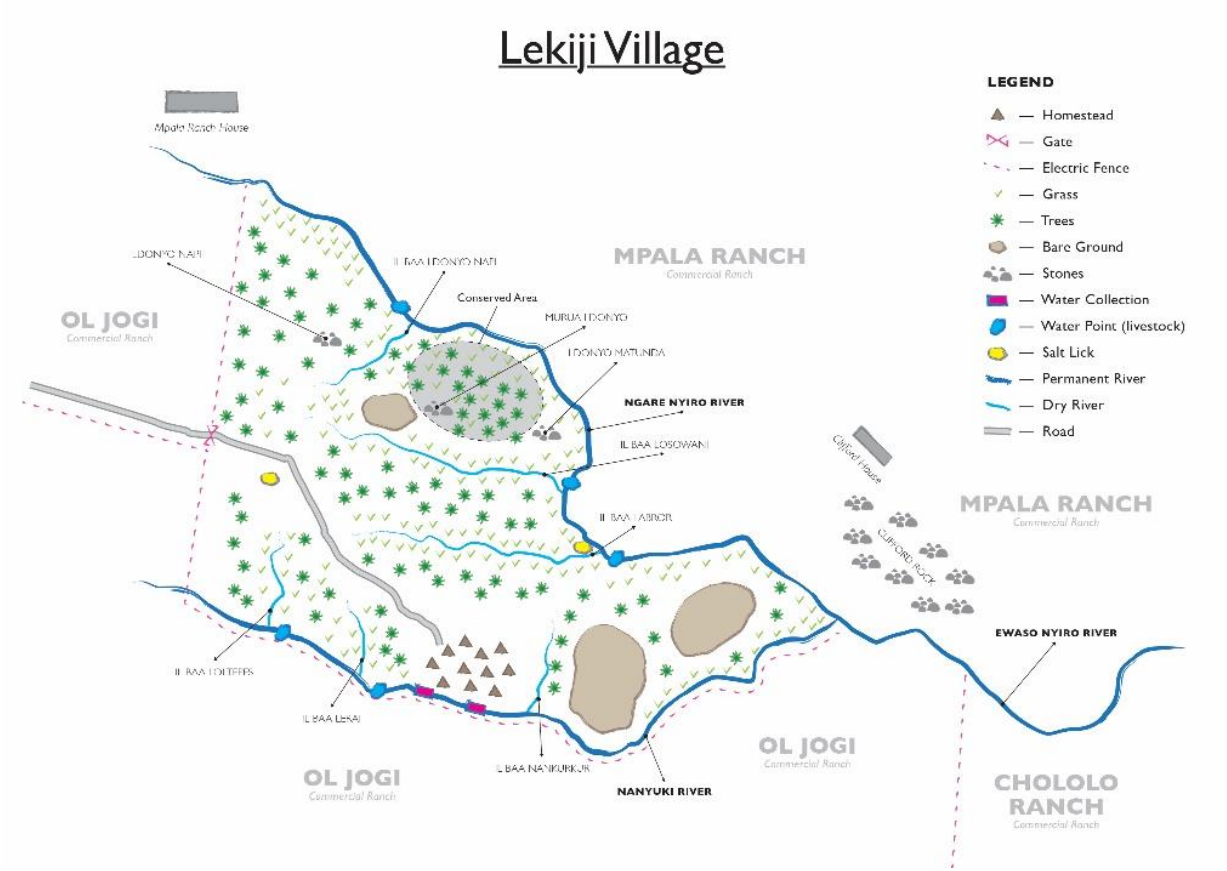


Figure 3.2 Re-drawn illustration of participatory mapping carried out by participants at Il Polei.

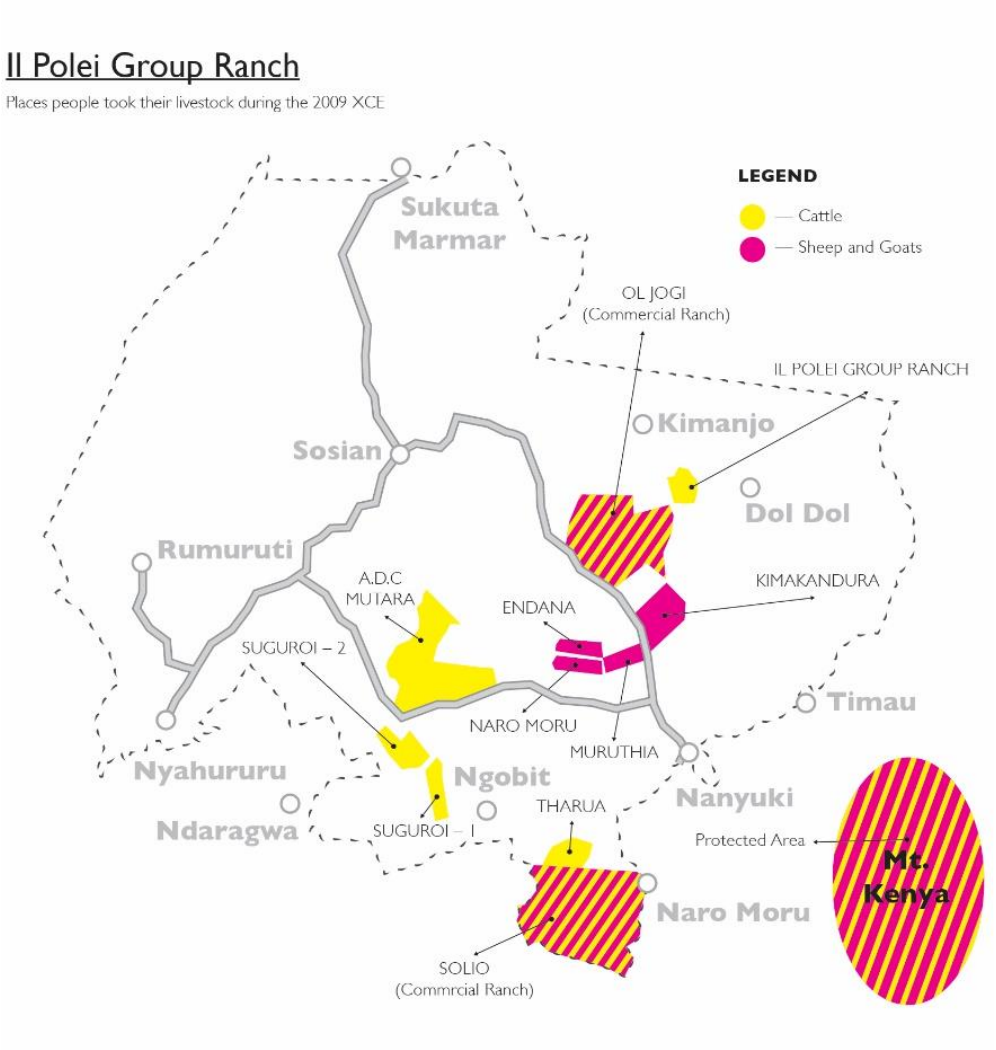


Table 3.10 Free list showing the key resources people use for the home and for livestock.

Rey resources for Livestock	Key resources for the home
Water	Water
Pasture	Firewood
Saltlick	Charcoal
Tree pods and leaves	construction poles
Medicinal plants and trees	beading poles
	roofing poles
	Soil
	Sand
	Stones
	medicinal plants and trees
	tree bark
	Manure

3.6.15 Pebble Distribution Method

The Pebble Distribution Method (PDM) is a scoring exercise for assessing the importance of various elements such as landscape units, ecosystem services, and education and development projects for communities (Sheil & Liswanti, 2006). PDM is also a less direct way to find out about sensitive topics such as income sources. I used PDM in the household questionnaire to collect information on household income for different types of work. The way PDM works is by getting local people to use 100 pebbles (or beans) to indicate importance of something by allocating more pebbles to more important issues/objects. All the 100 pebbles have to be used regardless of the number of issues to get the relative per cents, and therefore its importance. For this study PDM was used to rank the importance of different sources of household income and its relative contribution to the household.

3.7 Large carnivore dataset

3.7.1 Species distribution data

The African wild dog (hereafter wild dog) spatial point data (n=7473) used in Chapter 7 was collected and made available by Prof. Rosie Woodroffe through the Samburu-Laikipia Wild Dog Project (SLWDP), now known as the Kenya Rangelands Wild Dog and Cheetah Project (KRWDCP), established in Laikipia in 2000 and monitors wild dog packs using aerial and ground-based telemetry.

Denning wild dogs were identified (n=37) and excluded from the study because home range sizes differs for denning and non-denning wild dogs (Mbizah et al., 2014).

Methods used to collect and analyse already existing data sets are outlined below and described in more detail in the relevant chapter.

3.7.2 Geographic Information System and Remote sensing data

Geospatial technologies such as Geographic Information System (GIS) and remote sensing (RS) have multiple and diverse uses in different fields requiring spatial representation. Both are fundamental to understanding land use and land tenure distribution (see Figure 2.2: map of Laikipia Disitrict showing different land uses) and are therefore important to this thesis's analysis of mobility as a coping strategy in drought and XCEs. Geographic information on the distribution of wildlife populations forms a basis of information in wildlife management. GIS is increasingly used for mapping wildlife density and distribution derived from ground or aerial survey observations (Butler et al. 1995). GIS can significantly advance the conservation of endangered species because it allows us to define a species' potential distribution (e.g. Hortal et al., 2005), control their populations (e.g. Davies et al., 2005), analyse niche requirements (Peterson et al., 2002), design networks of protected areas (e.g Pearce and Boyce, 2006), and make robust predictions (e.g Hill et al., 2002). In this thesis, GIS and RS were used in Chapter 7 to help identify habitat selection for large carnivores during extreme drought and non-extreme drought years. This involved using 250m x 250m resolution satellite images together with species distribution data to explore changes in behaviour and movement wild dog. The RS data was categorized into five ecogeographical variables (EGVs): Normalized Difference Vegetation Index (NDVI), land use, tree cover, river and roads. Vegetation characteristics are represented by NDVI from 2006-2012, which are divided into extreme drought and non-extreme periods. They were accessed and/or downloaded from a number of freely available different sources (see Table 3.11) and are briefly outlined below, with further details discussed in Chapter 7.

3.7.3 Ecological niche factor analysis (ENFA)

ENFA is a multivariate spatially explicit method that can be used to study the potential distribution of a given focal species (Hirzel et al., 2002). It is a method

Table 3.10 Table showing the source and resolution for the EGVs used in this study.

Ecogeographical variable	Source	Original resolution
Land use	Mpala Research Centre	10m
Rivers	Mpala Research Centre	10m
Roads	Mpala Research Centre	10m
Tree cover	Global Forest Watch http://www.globalforestwatch.org/sources	30m
Normalized Difference Vegetation Index	MODIS www.modis.gsfc.nasa.gov	250m

that builds upon well-established techniques using GIS to explore the relationship between species distributions and ecogeographical variables (EGVs) such as topographical features (Hirzel et al., 2002). The ENFA uses presence-only data and a set of quantitative grid raster maps to describe a species habitat selection. The advantage of ENFA over other logistical regression techniques is that it requires only presence data, rather than presence *and* absence data (Hirzel et al., 2002). Absence data is difficult to obtain for cryptic species such as carnivores because 'absent' may simply be due to not being detected when it is actually present (Hirzel et al., 2002). The ENFA extracts two or more factors that explain a species niche. The first factor marginality conveys the niche position relative to the study area. Specialization factors expresses the niche breadth (Hirzel et al., 2002). ENFA used in this thesis is available as part of the adehabitatHS R package (Calenge, 2011). ENFA is discussed in further detail in Chapter 7.

3.7.4 Data analysis

This thesis makes use an extensive range of analytical tools which includes linear mixed effect models (lme) (Bates et al., 2015), ecological niche factor analysis (ENFA) (Calenge, 2011) and log linear models (Warnes et al., 2005), and are discussed in the relevant Chapters.

Chapter 4 Herd dynamics and household income

4.1 Chapter summary

This chapter looks at everyday life for pastoralists in Laikipia, and in the process, explores herd management by comparing herd structure and dynamics for both drought and non-drought years. One major dimension of herd management, the splitting of herds by species and categories of animal, is explored across all households and then disaggregated by area and wealth for the 2009 XCE. The chapter goes on to look at the use of pastoral livestock products across the seasons and for 2009 XCE. The chapter then puts these pastoral strategies in wider perspective, looking at livelihood income diversification for households for each area and for each wealth ranking.

4.2 Introduction

Rainfall in ASALs is unpredictable in nature and thus makes most of this landscape more suitable to livestock keeping than growing crops, because people can move their herds to exploit spatially or temporally patchy vegetation growth in places where rain has fallen (Galvin, 2009; Homewood, 2008). The life of a herder is accustomed to cyclical conceptions of time rather than linear (Fijn, 2011). Herders are keenly aware of changing seasons and these changes influence how livestock are managed. Herds provide invaluable subsistence products including milk, meat, blood, manure and hides, with milk being the most important from a dietary and nutritional viewpoint (Dahl & Hjort, 1976; Sadler et al., 2009). One of the main livestock production purposes is to produce milk for household consumption (Bekure et al., 1991) providing subsistence for considerably more people per unit area than any other production method in ASALs (Suttie, 2001 in Sadler et al., 2009). By keeping mixed herds, pastoralists can extend the milk supplied by livestock longer (Sadler et al., 2009). Milk is used in a number of ways by the household but the primary decision come down to the allocation between calves and people (Grandin, 1988) that is to say, balancing long term herd growth with day to day subsistence (Sikana et al., 1993). Maasai prefer to consume fresh or soured milk in the home although milk is used to make butter (Nestel, 1989). Milk is also given away or sold (Grandin, 1988). Milk production varies throughout seasons and falls away during the drier months. As one herder put it:

> ‘Animal products reduce in amount and there is not enough for everyone. The calves are not satisfied and I have to find milk to buy because my livestock are not producing enough for the family.’
> *L25, herder, 41*

Also, dependence on milk for subsistence has changed, largely due to a combination of a reduction in grazing areas and an increase in human population, with concomitant decline in numbers of animals per person (Nestel, 1989; see Chapter 6 for TLU/AE in Laikipia compared to other sites). Pastoralists now rely more on agricultural products, which includes sugar, tea, maize, beans, rice and potatoes, to supplement milk intake during the dry season, or (in wealthier households) for dietary variation during the wet season. Poorer households depend on these bought items all year round (Bekure et al., 1991).

For pastoralists, diversifying livelihood activities and dietary intake is a way to cope when keeping fewer livestock as they either have insufficient milk to feed the family, or can do better by selling milk and using the money to buy cheaper foods:

> ‘The area where people live is smaller. People have to do other things now because they keep less livestock. I have a shamba so I plant maize, sukumawiki, beans and cabbage.’
> *IM109, herder, 38*

In exploring the ways in which pastoralists manage their herds during the seasons and in XCEs in Laikipia, this chapter goes some way to answering quantitatively the following research question outlined in Chapter 1: (RQ A) what are the differences in herd management between drought and non-drought periods. The specific aims of the chapter are to explore herd management through seasonal and interannual changes in climate and key resources, and in particular to address the following four research objectives:

1. Compare herd dynamics for drought and non-drought periods

2. Explore the importance of splitting herds in XCEs.

3. Compare seasonal use of pastoral produce and during XCEs.

4. Importance of livestock compared to other sources of household income

4.3 Seasonal weather patterns

East Africa has bimodal rainfall that is divided into wet (long and short rains) and dry seasons and although this is typical, local variations do occur. For example, Laikipia has three rainy seasons as opposed to two (Georgiadis, 2007). According to Laikipia Maasai, Laikipia has four distinct seasons in one year. During five focus group meetings held in Il Polei weather patterns were discussed which the community described in terms of seasonal changes through the year. This brought about the discussion of the Maasai "normal" seasonal cycle particular to that region. Four Maasai seasons were identified: *Olodalu*, *Nkokwa, Lorikine, Oltumuren* (Table 4.1). The discussion made it possible to use this local understanding of changes in climate throughout the year in household survey questions relating to resource and product use. For example, month-by-month details on pastoral livestock products had little meaning for local people. Instead, having understood the way people divide the year into seasons allowed questions to be asked that were meaningful to respondents. Asking people about the weather also established a good way to get people to think about how and when weather patterns changed during their lifetime.

However, one important issue that regularly cropped up during discussions about seasons was how pastoralists had noticed changes to the typical cycle. An important topic was the unreliability of rainfall. Herders differed as to when changes started to occur. However two significant changes all respondents reported was that rain had become more unpredictable and years were drier.

Table 4.1 Table showing the Maasai seasons according to residents in Laikipia.

Season	Months	Description of season
Olodalu	January – March & September	These months are hot and dry with very little or no rain.
Nkokwe	April – May	This is the long rainy season. It is still quite warm and there is plenty of pasture.
Lorikine	June – August	"Lake" rains, which are mostly showers. Temperature is much cooler and can often feel cold at night.
Oltumuren	October – December	These are the short rains with showers starting in October. The temperature is warmer.

"Things started to first change in 1970. Before then it used to rain for most of the year. The dry period would only last for about one month. In 1970 I was a warrior and we could measure the time between dry periods by how many calves were born. Three calves could be delivered by one cow before the next dry season. Now though the dry seasons are longer. You can only count one calf between dry seasons and they are not fully grown healthy and strong to resist drought when the next extreme drought comes. The dry seasons since 1970 have been getting longer and longer. The rains before 1970 were predictable. April-June; July and August; October-December. Now though it can rain in any month. It can rain in January or September, which it never used to because those are always the dry months. Before 1970 the rains were longer and heavy. It could rain all day. Now when it rains it can be for 30 minutes or an hour, and that can be the only rain you get that day. Before 1970 it would rain for many months and the dry season was only a few months. Now the dry seasons last longer and the rainy seasons are short."
Cassey, herder, 55

"Yes, the seasons have changed. During my childhood seasons were predictable. The rains would come three times a year. The dry season was very short and would only last about a month or two. It would rain often and for most of the year. Things started to change when I was a warrior (moran). Things were different after 1964. That's when you could see no rain for a whole year. If it did rain, only the rains at the end of the year would come. Before 1964, when it rained it rained everywhere all over. Now when it rains, it only rains in certain areas and people crowd these areas to get water, pasture and other key resources.
Joseppi, herder, 67

"Before the 1999/2000 drought it used to rain three times a year: April-May, August, November-December. And it would rain everywhere. After this period the rainy season stopped. When it did rain it was not for very long and not everywhere. The rains were only showers and they even came in months you would not normally see rain. The last two years (2011 and 2012) have been like it used to be before the 1999/2000 drought. The rain was not very good for about eight years. Last year (2012) the rains only came in the day in November, where before they would come day and night. Now they stop at about 8pm. Before the 1999/2000 drought we used to get a lot of thunderstorms because the rains were heavy. But we only had one in the last year. We only nearly get one. During 2009-2010, no calves were born. But in the last two years we have had calves born three times. Bulls are not like male goats. If there is not enough pasture to eat they cannot mate with the cows. They are too angry. Before 1999/2000 calves born three times in two years was normal."
Lionel, herder, 67

4.4 Herd management

Herd management can include restocking impoverished clansmen, sharing livestock among patrilineal kin, selling or slaughtering animals (Potkanski, 1994).

Herd dynamics in Laikipia show the difference in management for drought and non-drought years. Table 4.2 shows that more livestock (TLUs) were bought (8%) or born (~30%) during the non-drought year than during the drought year (2.7% and ~14% respectively). The latter equates to approximately 33% more livestock born during non-drought compared to drought years. More livestock were sold (~16%) and slaughtered or consumed (5.5%) during non-drought periods than the drought year (~14% and 4.6% respectively). When livestock are disaggregated by species, more cattle were slaughtered or consumed in the drought year (~2%) compared to the non-drought year (0.6%). Slaughter of goats was similar for drought and non-drought periods but cattle slaughter nearly doubled (~83% increase) during drought.

Customarily the domestic herd is a form of property which involves social rights and obligations, and symbolises social relationships (Gulliver, 1955). Maasai livestock management is centered on individual ownership and control on a day-to-day basis (Potkanski, 1994). However multiple people might have potentially overlapping rights to access the same livestock.

Table 4.2 Herd dynamics for the study area. Numbers of stock kept are given in TLUs but management of livestock is given as a percent of number kept.

Period	**Stock**	**Kept**	**Sold**	**Bought**	**Slaughter/ consume**	**Given as gift**	**Received as gift**	**Born**
		TLUS	%	%	%	%	%	%
2011-	Cattle	1,043	15.6	8.1	0.6	3.2	1.2	34.
2012	Goat	1,527	16.7	8.4	7.0	2.2	1.8	27.
	Sheep	712	16.3	6.7	9.3	2.8	0.3	26.
Total		3,282	16.3	8.0	5.5	3.0	1.2	29.
2009	Cattle	1,867	11.6	2.3	1.9	2.0	1.2	15.
	Goat	1,751	16.6	3.0	6.1	1.9	0.8	13.
	Sheep	973	12.2	2.8	6.9	1.4	1.1	13.
Total		4,591	13.6	2.7	4.6	1.9	1.0	14.

The inclusive nature of Maasai property rights regarding livestock means that the primary owner may have to negotiate with potential joint-owners in extreme circumstances such as drought, disease, livestock raiding or personal illness.

All clan members have the right to negotiate terms, especially extended family members (Potkanski, 1994). The possibilities are very different for poorer as opposed to better off households.

Overall herd dynamics shows clear association with wealth rankings. For the non-drought year. Table 4.3 shows WR1 poorest group D sold, bought, slaughtered or consumed consistently fewer animals than the other wealth groups. They gave away fewer livestock, received fewer livestock as gift and had fewer young born. Similarly WR2 group Poor sold, bought and slaughtered or consumed fewer than other wealth groups. They received fewer livestock and also had fewer young born. Livestock slaughtered or consumed and livestock given away were similar for both WR2 Poor and WR2 Med, and much lower than for Rich group.

During non-drought periods, the richest WR1 group A was most likely and the poorest WR1 group D least likely to sell livestock, buy, slaughter or consume, give as a gift, receive as a gift or have young born (Table 4.3). The poorer groups also gave fewer livestock away and had fewer young born. In WR2, the Rich group was most likely and Poor least likely to sell, buy, receive livestock as a gift or have young born, although numbers slaughtered/consumed and given as gift by Poor were similar to those for group Med.

Table 4.3 Wealth dynamics according to wealth WR1 and WR2 for non-drought period. Numbers are TLUs per household in that wealth group.

WR1	**Kept**	**Sold**	**Bought**	**Slaughtered/ consumed**	**Given as gift**	**Received as gift**	**Born**
A	30.32	4.40	2.42	1.26	1.23	0.18	8.12
B	16.78	3.22	2.03	0.84	0.56	0.32	5.49
C	21.34	3.62	1.34	1.32	0.57	0.37	6.23
D	10.50	1.52	0.76	0.61	0.25	0.16	3.14
Total	*78.94*	*12.76*	*6.55*	*4.03*	*2.61*	*1.06*	*22.98*
WR2							
Rich	41.85	6.69	2.73	1.93	1.50	0.40	11.90
Med	16.92	2.67	1.38	0.76	0.38	0.26	5.05
Poor	14.14	2.34	1.18	0.87	0.44	0.23	4.22
Total	*72.91*	*11.7*	*5.29*	*3.56*	*2.32*	*0.89*	*21.17*

During the 2009 drought, the poorest WR1 group D was least likely and the richest group A most likely to sell livestock, buy, slaughter or consume, give livestock as a gift or have young born (Table 4.4). For WR2, group Poor was less likely to sell

livestock, buy, give as a gift or receive. Numbers slaughtered or consumed were much lower in groups Poor and Med than Rich.

Livestock provide for a variety of non-economic purposes and can pass from one owner to another, for example, through bridewealth. In most pastoralist communities, though less so among Maasai than, say, Turkana, bridewealth offered reflects the wealth of the bridegroom and his kin and the wealthier the future son-in-law the more livestock received for the bride. Livestock transactions are important for a number of different functions, which can include exchanges, gifts and loans (Potkanski, 1994).

Table 4.4 Livestock dynamics according to wealth WR1 and WR2 for drought period. Numbers are TLUs per household in that wealth group.

WR1	**kept**	**sold**	**Bought**	**Slaughtered/ consumed**	**Given as gift**	**Received as gift**	**Born**
A	44.50	5.57	0.89	1.32	0.98	0.11	3.78
B	27.97	4.26	1.01	1.12	0.83	0.51	3.84
C	25.44	4.37	0.64	1.53	0.25	0.18	4.81
D	14.98	2.46	0.39	0.68	0.25	0.19	2.03
Total	*208.92*	*16.66*	*2.93*	*4.65*	*27.06*	*0.99*	*14.46*
WR2							
Rich	86.98	13.28	1.83	2.38	1.99	0.42	9.05
Med	22.43	3.43	0.77	0.96	0.42	0.31	2.22
Poor	17.23	2.74	0.45	0.97	0.28	0.19	3.13
Total	*126.64*	*19.45*	*3.05*	*4.76*	*2.69*	*0.92*	*14.4*

They can be used to (1) establish, maintain or reinforce social relations or (2) to minimise risk optimizes long-term herd survival or maximise gain through herd management strategies. Maasai communities thus differentiate between *lepa*, (livestock loaned for social reasons) and *ronjo*, livestock that are intentionally put to pasture elsewhere (research assistant pers. com.). These two types of transaction are seen to contribute towards livelihood security (Potkanski, 1994). However, such transactions are weakened by increasingly commercial attitudes and practices. Although the division of the family herd may often be a practical rather than social choice, herd management decisions do have important social and ecological consequences.

There are multiple ways in which pastoralists maintain livestock production in response to reduced access to grazing areas due to multiple factors such as changes

in land tenure, privatization, conservation and loss of livestock to drought (McCabe et al., 2010; this Chapter and see also Chapters 1 and 6). Living with seasonal change means that pastoralists have to adopt and modify their strategies throughout the year. The dynamics of herding strategies represent a compromise between the requirements of livestock and social and environmental constraints, as a result of existing land tenure arrangements (Potkanski, 1994), drought (Homewood and Lewis, 1987) and security considerations (McCabe, 2004), amongst other factors, not least negotiated access (Nkedianye et al., 2011). Strategies can include migrating with livestock to areas of pasture and water (see Chapter 5), keeping complementary species-specific herds that make use of the diverse environment, and diversifying household income (Galvin et al., 2004; McCabe et al., 2010; this Chapter). Herd diversification and splitting herds enable a herder to utilize different parts of forage because different livestock species have different feeding niches. Pastoralists in Laikipia negotiated access to neigbouring commercial ranches, as well as avoiding certain areas due to the threat of violence:

> 'We met with the ranch manager to start a good relationship/partners so they could help us.'
> *Cody, male herder, 87*

> 'I used to go to Maralal, Isiolo, Wamba but now I go to Endana, Rumuruti and neighbouring commercial ranches. I changed direction because people there never liked us from Laikipia. They used to raid our cattle. Also today, there is a lot of fighting there so we are scared for our lives.'
> *Larius, male herder, 55*

Livestock dietary requirements largely determine the types of areas where they can be grazed (Coppock et al., 1986). Cattle and sheep rely largely on grass (but also some forbs and browse especially in the dry season), while camels and goats rely mainly on browse (Le Houerou, 1980 in Niamir-Fuller, 1999). However, climate and disease constraints also play a part in where livestock can be grazed. Cattle graze further from the homestead in the dry season and pastoralists employ traditional herding practices such as tracking strategies to identify locations that provide better forage and niche grazing areas (Butt, 2010). Abrupt changes in climate can stress livestock and reduce a herd's natural resistance to endemic diseases in that particular area, which can lead to substantial losses (Potkanski, 1994; see Chapter 6):

> ‘One of the problems at Kimakandura is the cold mornings. The sheep are prone to getting pneumonia there so you have to vaccinate them with injections. I was having to do this every week. I was only injecting the adults.’
> *Jules, male herder, 34*

Excluding livestock from key grazing and other resources on a seasonal or permanent basis and restricting their mobility can reduce their productivity and viability (Homewood, 2008).

4.4.1 Splitting herds

A common and important strategy during drought periods is to split the herd as a way of spreading and reducing risk living in an unpredictable climate (Hesse and MacGregor, 2006). It can result in increased niche specialisation, reduction in competition among livestock for the same vegetation as well as dispersing grazing pressure (Niamir-Fuller, 1999). Some pastoralist communities however only split herds in severely dry periods or in extreme drought times. And those who do not split herds may simply not have enough livestock or enough labour to do so (Niamir-Fuller, 1999). Laikipia herders relied on splitting herds especially during drought:

> Every morning [during drought] I would separate the kids and lambs from the sheep and goats so my sister would look after them. I had about 60 kids and lambs. Then I would go to the bush with the cattle and sheep.
> *Maryl, male herder, 25*

Dividing livestock into separate herds depending on their age, sex, type and productivity is extensively practised in pastoralism (Fratkin, 1986). Some household herds are split into a subsistence herd with one or more fallow herds (Dahl and Hjort, 1976). The Borana in Ethiopia customarily divide management of livestock units typically separating milking cattle with calves and small stock (*worra* herds) from dry and immature stock (*fora* herds). The Fulani of the Inland Delta of the Niger, divide management of livestock into three different units including a transhumance herd made up of sterile and dry cows, heifers, bullocks, oxen, bulls and a few milk cows to feed the herders, a small herd of milch cows, and a core herd of milk cows (Coppock, 1993; Legrosse, 1999; Homewood, 2008).

Milk herds can be further divided to lend cows to friends or relatives (Dahl and Hjort, 1976). Splitting herds allows the age, sex and species-specific needs to be catered for, while exploiting different resources for different feeding ecologies and behaviours (Coppock et al., 1986). During drought, Laikipia pastoralists divide herds up to maximize the forage available for their livestock:

> 'We can split the herd up because there is not enough tree leaves for them to eat in one place. The work is very hard because you have to go far from home to find pasture and tree leaves to feed all your animals.'
> *Charlie, male herder, 32*

4.4.2 A Laikipia herder's year

The lives of herders and their families are organized by the different seasons. Because of the repeating cyclical changes of seasons year in year out, life is managed according to these seasons (Evans-Pritchard, 1940). Different events and activities occur throughout the year according to whether it is the rainy or dry season. This section begins by outlining conditions during the rainy seasons.

In Laikipia there are three rainy seasons: *Nkokwa, Lorikine, Oltumuren* (Table 4.1). During this time herders do not need to travel far from their boma because they are able to access water and pasture nearby in the group ranch: '*This is the time we are resting because our animals are near our homes. Water is not very far away'*. Families are able stay together. Because water and pasture is more plentiful during the rainy seasons cattle are watered daily and sheep and goats usually weekly. The rains that start in April (*Nkokwa*) are the long rains and were usually classed as the first rains of the year in Laikipia:

> 'They used to say that during good years seasons were predictable, especially in the month of April when we were youths. It was known as the first rain of the year.'
> *Bob, male herder, 61*

However, pastoralists have noticed that nowadays rain can fall at any time, even in the drier months at the beginning of the year:

> ‘Before 2000, you would never see any green during January – March because it was the dry season and there was no rain until April. Now there is no dry season as we get showers during those months. That means you can see green every month.’
> *L27, male herder, 42*

In the present study during the rainy season, and only during *Nkokwa,* only the wealthiest herders (WR1 A and WR2 Rich) divided their herds. For example, at Il Polei steers are grazed on Ol Jogi and so are heifers (in separate herds). Cows stayed at home where they could be milked. Sheep and goats also remain at the boma. All other wealth categories did not divide their herds during rainy season. Splitting herds is more important during the dry season but especially in drought times (Sections 4.4.1 and 4.4.3).

Pastoralists in Laikipia included in this study diversified into non-pastoralist activities to supplement livestock income (see Section 4.5 for detail of the contribution of diversification to the household economy, compared to livestock income). During the rainy season, herders have more free time and are able to engage in other businesses. Work is easier during these periods than during the dry months, which means pastoralists have more free time. Herders have more flexibility during the rainy seasons and often take on other work such as growing vegetables or harvesting honey (see Figure 4.1):

> ‘This is the only time I get a chance to do other work like harvesting honey, selling livestock at the market and working in my shamba. Cultivation happens this time because livestock are just around the home. I also get the chance to visit friends.’
> *Icarus, male herder, 55*

> ‘Work becomes easier looking after livestock. Livestock give a lot of products and there is plenty of wild vegetables to collect from the bush. I can do a mobile business for selling miraa to Chololo Ranch, Il Motiok and Kimanjo.’
> *L25, male herder, 41*

> ‘Work comes easily because livestock are close to home. You can do other work like keep the shamba.’
> *L29, male herder, 59*

Figure 4.1 Honey harvested from within Il Motiok Group Ranch.

The rainy seasons are also a time for people to relax and socialise. Senior elders visit friends and family and play *Enkeshui*, while morans are relaxing and singing. It is a time when repairs can be done at home such as mending the fence around the homestead and/or corral as well as fixing the *aji* roof. Livestock are healthy and market prices are good. Many calves are born and there is plenty of milk produced by cows:

> 'The livestock are healthy so taking care of them is easier. You have plenty of milk and they give birth. The young ones will not die because there is plenty of milk.'
> *Jay, male herder, 27*

To keep their animals healthy and productive, herders need to control livestock disease, and the populations of many vectors (ticks, biting flies) and ectoparasites increase during the rains. Regardless of wealth all herders dipped and injected their cattle usually once a month during the rainy seasons, and some would do it twice monthly. Dipping and injecting varied in frequency for sheep and goats and could range from once in a season, once a month or twice monthly in a season and

weekly during the season. Only sheep and goats were dewormed (once a month in the season).

During the dry months (*Olodalu*) work becomes harder for herders as they search for water and pasture within the group ranch. There is no relaxing and socializing is less frequent. Herders who also engage in other business during the rains, stop all such work to concentrate exclusively on taking their livestock to graze:

> 'I have to spend long periods with my livestock to find pasture and make sure they get enough. The mobile miraa business has to stop.'
> *Sammy, male herder, 41*

> 'There is no business being done because people are busy out with their livestock looking for pasture.'
> *Sunny, male herder,* 32

During drought times, herders often will look to obtain other sources of income such as selling hides (traditionally women's business) or harvesting honey:

> 'The people left behind at the end of a drought have no livestock to live on so honey is the main source of income. So we start a new life without animals or just a very small herd. We start building up the herd again with the money from the honey.'
> *IM49, male herder, 35*

Many of the communities have set aside part of the group ranch for wildlife conservation (see Chapter 2), which provides dry season grazing for herders when pasture has been used up elsewhere in the group ranch:

> 'During the dry season people have to move to different areas in their group ranch to look for pasture. During the dry season people use the conservancy to access the grass for grazing livestock. We can do this when all the grass has been used.'
> *Focus group, Il Polei*

This is also a time when herders might seek to access grazing (for a fee) from neighbouring commercial ranches. It was the wealthiest herders that chose to graze

their livestock (steers and Heifers) there during *Olodalu*. In the group ranch, where pasture is harder to find in the group ranch, herders will also cut tree branches for foliage and beat Acacia trees to make the tree pods fall to the ground to feed to the sheep and goats:

> 'When I am out with my livestock, I also use a long stick to beat the pods down from the tree and use my panga to cut the acacias for the goats and sheep. The livestock have to go to Lekiji's conserved area every day now. There is no shade so resting in the bush is difficult.'
> *Tony, male herder, 29*

Livestock were likely to be given medical treatments more frequently during the dry months although how often individual herders carried out such treatments varied. Cattle were usually dipped twice a month or weekly, slightly more than during the wet season. Sheep and goats were likely to be dipped twice a month or monthly, more regularly than in the wet season. Deworming would usually happen once a month for cattle (or not at all) and for sheep and goats. Drugs are widely available to buy in Laikipia from markets, neighbours and the Livestock Marketing Organisation. There has been a vet in Nanyuki since 2000 who provides advice over the phone on how to identify, prevent and cure sick animals. Herders said drugs were expensive but they have little choice in treating their livestock. However, drugs did not always cure a sick animal. Herders said there were a lot of counterfeit and/or out of date drugs in circulation:

> 'Today, everybody carries modern drugs on them so they are very easy to access. You find them at the markets, but also in the bush. These drugs are highly used at the moment to cure all diseases, but sometimes they are not effective. People think that some of the drugs are sold to them when expired or are not really what they say they are.'
> *Manni, male herder, 69*

In Maasai culture, women are typically responsible for processing and the marketing of milk and hides, and using manure in house construction. However, as this study focused on male informants, data from these questions are based on men's understanding of how these products are used in the home as well as

seasonally, allowing us to see how male herders view milk use in the household with the inevitable limitations given these decisions are made by women.

However, season affects the amount of milk pastoralists drink at home, and the amounts directed to other uses. For *Nkokwa*, *Lorikine* and *Oltumuren* rainy seasons, when more milk is being produced, higher proportions of milk are recorded as being given away, sold or processed (with a mean of ~70% milk production consumed at home) while drinking milk at home accounted for ~77% of milk production during the dry season *Olodalu*. Season thus not only affects the amount of milk produced, but also the proportion and amounts of milk given away, used for making butter, or sold (Table 4.5). By comparison during the 2009 XCE milk was mainly consumed (Table 4.5). When 35 respondents who reported not producing any milk during this period are excluded drinking milk at home increases to 94.9%, giving milk away to 3.7% and selling milk 1.4% during 2009 XCE.

As well as the data on livestock transactions (Table 4.4), data were collected on milk, hides and manure production and use from the herds people kept. Variables included drink at home (milk only), make butter (milk only), sell, give, receive and use in the home (hides and manure). All herders interviewed reported having milk throughout the year from their herd kept at home. Most milk produced was consumed at home (Table 4.6: overall mean of ~73% milk production drunk at home).

Table 4.5 Mean percent of milk use seasonally and for XCE 2009.

Season	**Drink**	**Give away**	**Butter**	**Receive**	**Sell**	**Total**
	Mean	Mean	Mean	Mean	Mean	
Olodalu	77.3	13.8	4.5	0.9	3.5	100
Nkokwa	69.0	14.2	10.7	0.7	5.4	100
Lorikine	72.0	13.8	9.4	0.7	4.1	100
Oltumuren	70.2	13.4	10.9	0.6	4.9	100
XCE 2009	77.8	3.0	0.0	0.0	1.2	82
XCE 2009[16]	94.9	3.7	0.0	0.0	1.4	100

[16] Omitting households with no milk production (n=160)

Table 4.6 Overall mean percent of milk use respondents confirmed using across all study sites.

Milk use	Mean percent of milk use
Drink at home	72.1
Give away	13.9
Make butter	8.8
Receive	0.7
Sell	4.5
Total	100

However, this varies between the different rainy seasons:

> 'During the rainy seasons there is plenty of pasture so people don't have to move far from home. In December (in the *Oltumuren* rains) it is a very lively time. There are plenty of calves being born and plenty of milk is produced. During the other rainy seasons (*Nkokwe* and *Olorikine*) the calves are growing, but less milk is being produced. And because livestock are big and fat, sale prices go up.'
> *Focus group, Il Polei*

I interviewed men who were involved in the hide trade, often together with their wives (KI interview data). This was mostly taken up towards the end of an extreme drought years and/or extended dry periods, when many hides are available due to livestock die-off. Some individuals continued to trade in hides after an extreme drought had passed. Selling hides has usually been women's business but more male herders reported taking up a hide business, especially after drought:

> 'It was during this drought (2009) that I started to do hide brokering. I had never done it before but I saw it as another way to get income. I still continue to do it today. I would also buy skins from other people whose animals had died and I would sell them (along with mine) to a bigger broker either at the market or to someone who came looking into the interior of Mt Kenya. With the money I got from hide brokering I was able to extend the small shop my wife runs. Before the drought we only sold sugar but about half way through the drought we started to sell maize flour. My wife still runs the shop today.'
> *Lucky, male herder, 37*

The majority of households in Laikipia primarily sold hides from livestock owned (n=189, 97%). Only 8.2% of households (n=16) made use of them in the home. This was usually for bedding (pers. comm. research assistant). Two households (1.0%) gave their hides away and nobody reported receiving hides in the study areas. Hides were more likely to be used in the home during *Lorikine* (0.9%) and least likely during the *Olodalu* (0.4%).

Traditionally women use manure to plaster or repair houses (Anthony et al., 2013). However, in Laikipia the majority of households (n=173, 88.7%) reported selling manure more than using it for any other purpose. Manure is sold fairly equally across the seasons with the highest (mean ~97%) being sold in the dry and the least in XCE 2009 (mean of 77%). This result could be biased because only males were interviewed. However, a market has emerged in Laikipia, especially for small ruminant manure, largely owing to the increase in smallholder farms in high potential agricultural areas (Anthony et al., 2013). The manure sold throughout the three study sites is largely to buyers from outside the group ranch. Manure is piled up into pyramids to await collection. No manure was reported to be given or received as a gift.

4.4.3 A drought year in the life of a Laikipia herder and family

During drought times, additional forms of livestock management might be adopted. Calves may be slaughtered to reduce stress on their mothers, fodder bought in to feed livestock or branches cut from trees. During the 2009 XCE, any milk produced was consumed at home, not given or sold ((Table 4.6) Blood may be drawn from live male animals and mixed with milk, as milk yields decrease in the dry season (Grandin, 1988). Those who can afford it use improved veterinary care and easier access to buying drugs to help maintain the health of depleted animals exposed to diseases. Households may be forced into distress sales of livestock during drought to afford veterinary drugs for the remaining herd, and also to buy food to feed the household (Letai and Lind, 2013):

> 'Goats were the only source of money I had. I would have to sell them to buy food for my family, pay school fees and leave some money for the children.'
> *Len, male herder, 31*

Male herders are often forced to move far away from home in search of water and pasture for their livestock. Not all livestock will leave though – goats usually remain at the *enkang* with the wife and children. Goats are browsers and can make use of available fodder for longer periods compared to cattle and sheep by browsing dry bushes meaning they can maintain milk yields for longer (Dahl and Hjort, 1976). Livestock losses rise and numbers of livestock kept fall as the drought continues. Many kids and lambs die during the drought because they cannot get enough milk from their mothers. Families don't have enough milk to drink from their animals so they must buy milk or other food. Prices increase but pastoralists are unwilling to sell livestock because livestock prices collapse in drought, with supplies of poor condition animals being offered for sale far outstripping market demand. All but the wealthiest herders are unable to start to replenish their herds until after the drought has passed. As the drought impacts on livelihoods so other sources of temporary income are sought:

> 'Some people will sell charcoal and buy a few goats. More people do it in the drought. But when the drought ends, they will stop charcoal burning. It is a temporary income to get money for food. They do it around their homes.'
> *Sargent, male herder, 33*

Splitting herds, especially in drought, is one of the most important responses to coping with drought and minimising loss by reducing competition between the herds (Niamir-Fuller, 1999). Herd splitting allows the herder to spread risk and maximize use of erratic vegetation growth in ASALs (Niamir-Fuller, 1999). On the whole, more wealthy households were more likely to split than the poorest. However, herd splitting was still an important response for the very poor households (>50%) during the 2009 drought.

The majority of respondents reported splitting their herds. Of 195 herders interviewed, n=123 (~63%) split their herd during the XCE event of 2009. Of those that did split their herd 65 (~53%) were from Il Motiok, 49 (~40%) were from Il Polei and 9 (~7%) were from Lekiji (Table 4.7). The low figure from Lekiji reflects the fact that Lekiji kept significantly fewer cattle than either Il Motiok or Il Polei, that the majority of people living in Lekiji kept only one type of livestock rather than a mixed herd (see Chapter 6), and that they have negotiated year-round

grazing on the neighbouring commercial ranch Ol Jogi for a fee (Chapter 5). Given these circumstances, Lekiji was more likely to *not* split their herds.

Table 4.7 The total number of herders who split their herd. Table figures are from contingency table outputs.

	Total	**Il Motiok**	**Il Polei**	**Lekiji**
total number of respondents who split herd	123	65	49	9
% of all individuals who split herd		52.8	39.8	7.3
Std Residual		2.358	1.142	-4.156
number of respondents who didn't split herd	72	12	17	43
Std Residual		-3.082	-1.493	5.432

Pearson's chi-square test showed a significant association between area and whether or not people split their herd $\chi^2 = 65.36$, $df = 2$, $p = <0.001$. The odds ratio shows Il Motiok respondents 5.41 times and Il Polei 2.88 times more likely to split their herds than not but Lekiji 4.78 times more likely to *not* split herds than to do so.

In this study, cattle and sheep were often split from goats, and the more conservative Il Motiok herders, who retain more customary strategies, were more likely to split their herds than the two other areas. In addition, Il Motiok's location is geographically more isolated than the other two areas and access to markets to sell livestock might be more difficult. Where respondents paid for grazing on the neighbouring commercial ranch, multispecies herds are unavoidably split (as small stock are not allowed to graze on the commercial ranches).

All wealth groups reported splitting their herds although the wealthiest groups were more likely to split their herds further. For example, at Il Polei a herder (WR1 A) divided his herd into four: large cows and calves at Ol Jogi, bulls and heifers at Mt Kenya. Households in poorer wealth group D (WR1) and Poor (WR2) were less likely to split their herds (50% and 59% respectively) compared to other wealth groups in WR1 and WR2 (Tables 4.8 and 4.9).

Table 4.8 WR1: The number of respondents who split herds for each wealth group.

	Wealth ranking WR1			
	A	B	C	D
number of respondents who split herd	17	23	42	41
% of respondents within wealth group who split herd	73.9	63.9	77.8	50.0
Std Residual	0.654	0.061	1.360	-1.491
number of respondents who didn't split	6	13	12	41
Std Residual	-0.855	-0.080	-1.778	1.949

Table 4.9 WR2: The number of respondents who split herds for each wealth group.

	Wealth ranking WR2		
	Rich	Med	Poor
number of respondents who split herd	13	27	83
% of respondents who split herd within wealth group	86.7	69.2	58.9
Std Residual	1.150	0.484	-0.630
number of respondents who didn't split herd	2	12	58
Std Residual	-1.504	-0.632	0.823

There was a significant association for splitting herd in WR1 ($\chi^2 = 12.20$, $df = 3$, $p = 0.007$): WR1 wealth ranks (based on a broad set of criteria, not livestock holdings alone) affects whether you split your herd, but not in a linear way. The odds ratio shows WR1 group C was 3.5 times, group A 2.88 times and group B 1.77 times more likely to split than not, while group D was equally likely to split or not split herds.

WR2: Overall, households in wealth group Poor were less likely to split their herds (59%) compared to other wealth groups in WR2 (Table 4.9). WR2 rankings (based on TLU ownership) show a non-significant but suggestive of trend, with Rich group (87%) more likely to split than Medium (69%) and Poor (59%) groups. All of WR2 groups were more likely to split their herds than not, with the odds ratio group rich splitting their herds 6.5 times higher than not splitting, group medium 2.25 and group poor 1.43 times more likely to split than not.

Communities become more stressed during extreme drought times as families are often separated, which puts enormous pressure on everyone. Children remain behind with their mother to stay in school. When a herder knows he will have to

leave the group ranch in search of water and pasture, he will go first without livestock to survey an area to see if there is any grass there:

> 'I go and survey first the area I want to take my livestock. Then I come back to drive my animals there. I get information on where to go also from people who have visited or live there.'
> *Paul, male herder, 30*

Pastoralists complain that migrating with livestock comes with its challenges. Animals can get sick from being in a new environment and when exposed to new diseases:

> 'You have to move far to find pasture and it is not always suitable. If I go from here (Il Motiok) to say Endana, it is very cold there and my animals will get sick form the cold. Also disease is a big problem. When you are moving with your livestock there are diseases you get on the way.'
> *Jay, male herder, 27*

Because of changes in land tenure and land use very few access routes are available for pastoralists when they migrate from their group ranch. Livestock weaken en route and can die. There is very little herders can do when this happens. The animal is usually left where it dies. Sometimes the skin is removed and sold to a hide broker:

> 'The shoats were dying all along the way to Mt Kenya. The ones that die on the way and in the bush, we just leave them where they are. But the ones that die when we are settled somewhere, we skin them and sell their hides. Money from the hides I sold was not good. There were not enough that died I could skin. And those that I could were not always good to sell. They were covered in parasites such as ticks.'
> *Joseppi, male herder, 70*

> 'Herders feel particularly vulnerable to predation at this time because predators start attacking livestock, especially spotted hyaenas and leopards because all the wildlife [*meaning prey*] have left the area.'
> *Focus group, Il Polei*

Water shortage is one of the main concerns for a herder and his family when there is a drought. This was particularly acute in the 2009 drought. Water levels dropped in the rivers and eventually dried up. This created a feeling of crisis in the community. Women became very strict about how the water was used and told people off for misusing it:

> 'We did not lose as many livestock as other extreme droughts but the main difference was that there was no water. All the water points and rivers dried up. That had not happened before.'
> *Eric, male herder, 42*

> 'Every drop of water needs to be conserved and this can cause anger if water is seen to be wasted. Women have to walk long distances to get water and those that do become really tired. People also stop washing in the rivers.'
> *Focus group, Il Polei*

During drought periods food is scarce in the communities and many people go hungry. Milk yields drop off during this time either because the animal is not able to produce much milk, or because the herd is elsewhere and its milk production not available at home. Fewer herders reported having milk during the XCE 2009, although what milk there was, was mostly consumed at home (~95% for households with any milk production – Table 4.6). However, n=35 (18%) stated no milk was available at home during this time. During this drought, the proportions of milk given away were vanishingly small (mean of 3%) and nobody reported either making butter or receiving milk as a gift (Table 4.6). Given the widespread poverty among Laikipa pastoralists this is likely due to sheer lack of pastoral or other produce; but some see changing social and cultural mores:

> 'In the past before extreme droughts people cared about each other. But now people just care about themselves. This is brought on by the younger generation. There is no more respect and they are not interested in the family like the older generation.'
> *Cassey, male herder, 55*

The poor categories in both wealth rankings reported higher occurrences of having no milk during XCE 2009 (WR1 D n=13, ~7% and WR2 poor n=22, ~11%). Il

Motiok was more likely to report having no milk during XCE 2009 (n=27, ~14%) compared to Il Polei (n=1, 0.5%) and Lekijii (n=7, ~4%).

People said they do not feel healthy during this time. If people do eat, their food is generally porridge made from cereals (maize). Trees such as *Cyphostema, Tinea and Acacia* are used to supplement food for the household. The fruit seeds are boiled and crushed to make a porridge. They are mixed with milk and usually given to children.

> 'People are concerned about starvation during a drought year because there is a lot less food around. During this time, herders are concerned for both their family and livestock. Families suffer shortage of food during a drought, even more so than during a dry season. Meals will often be missed. And if you do eat, it tends to be porridge. Some families are able to make use of the trees in the area to supplement their diet. *Cyphostema* (*Orondo-Olorondo*) fruit seeds are boiled and crushed to make a porridge; *Ehkuee* (same family as *Cyphostema*) is used in the same way. *Tinea* (*Olampirori*) and *Acacia xanthophlea* (*Olerai*) are mixed with milk and given to children. However, all the trees mentioned are now very rare and you have to know where they are to find them during a drought.'
> *Focus group, Il Polei*

> 'During extreme droughts, we bleed the cows to give blood to the children. It doesn't kill the animal. There is a special bow and arrow [arrow head] about ¾" long for the animal.'
> *Dom, male herder, 55*

These communities receive food aid all year round, but especially rely on it during drought times. For the 2009 drought, the Kenya Government provided food items such as ugali flour, maize, beans and fat/oil for everyone as well as water purification tablets. They also provided chocolate, Cerelac and palm nuts for children under five years. Caritas provided food relief for the more vulnerable people such as orphans, single mothers, single father and old people as well as those suffering from HIV and AIDS. Ol Jogi provided clean water to Il Polei and Lekiji. Mpala provided maize and beans to Il Motiok

In the past, Laikipia pastoralists left destitute by drought, disease or conflict resorted to hunting game to eat. Hunting remains a possibility in times of food insecurity, but people are heavily punished if found doing so and wildlife are becoming less common on the group ranches:

‘There is not food in the drought. I would take my dog and I would hunt eland. The eland would try and fight with my dog and would not notice me getting close so it was easy to spear them.’
Lucky, male herder, 60

‘When I used to go hunting I would get everyone together to pray but now people just hide.’
Lucky, male herder, 60

‘People kill/hunt wildlife to eat because they are hungry. However, wildlife leave the group ranch and go to the commercial ranches.’
Focus group, Il Polei

Even when a drought is not happening people are always concerned a drought will come. They look for signs of a drought approaching in and around the environment, as well as watching people and livestock habits change. Herders cited a number of ‘warnings’, which told them an extreme drought was coming. The sky having no clouds and there being a lot of strong winds were common signs for herders. The elders were more likely to refer to celestial and lunar signals: ‘*Only the old men really talk about the stars*’.

‘The first sign is there are no clouds in the sky. This says there is no rain coming. The sun becomes very hot saying that drought is coming. It is very windy, which cleans the environment.’
Jay, male herder, 27

‘The cattle can tell us. Even if there is pasture around and they are satisfied they are restless, as if looking for pasture. And the mothers need to be driven home. They don't come looking for their calves’.
Cassey, Male herder, 55

‘Looking at the stars. An evening star – sometimes it comes sometimes it doesn’t. Not part of the normal evening stars. If it is there it means we are going to get a drought. If the new moon faces south it will be a drought. It normally faces up or north.’
Lucky, male herder, 60

‘Children start playing different games. They start using *Solanum*, which shows migration will happen. And the removal of a cow’s dung when it is sleeping.’
Focus group, Il Polei

4.5 Household income diversification

In addition to livestock keeping, pastoralists also diversify their livelihoods with other sources of incomes such as agriculture, wage labour, petty trade and wildlife based activities (Homewood et al., 2009). Diversification is seen as vital to coping with living in an unpredictable and varying climate (McCabe, 2004; Leslie and McCabe, 2013) and essential to creating alternative development pathways (Sandford, 2013). Livelihood diversification can be driven by push and pull factors whether poverty, risk management or wealth investment (Homewood, 2008). In many cases diversifying is a response to the dwindling opportunities pastoralists face. Opportunities for pastoralists to diversify are often very limited, offering minimal returns (Sandford, 2013). Even though pastoralists are rapidly diversifying into other livelihoods, livestock remain central to the majority of Maasai households currently resident in the rangelands, for both economic and cultural reasons (Homewood et al., 2009; this Chapter; Chapter 5).

In Laikipia, pastoralists diversify their income in ways comparable to other pastoralists in East Africa. Seventy-one different types of paid work were cited in the household surveys and recoded into nine work categories for analysis including livestock (work categories are based on Serneels et al., 2009). Business included work such as small shop, selling petrol, boda-boda[17] operator and charging mobile phones. Wage/salary included hired construction work (roads or houses), sand lorry loader, teaching and watchman. For petty trade category selling charcoal or firewood and selling local brew were included. Laibon[18] was also rolled up into this category (Table 4.10).

The majority of individuals interviewed reported receiving income from livestock (~91% respondents, n=177) (Table 4.10; Figure 4.2). Livestock figures also include pastoral products. This is comparable with Maasai communities in Koyiaki group ranch in the Mara (92%) (Bedelian, 2014), Maasailand (91-100%) (Homewood et al., 2012) and slightly less when compared with households in the peri-urban location of Kitengela (99%) (Nkedianye et al., 2009).

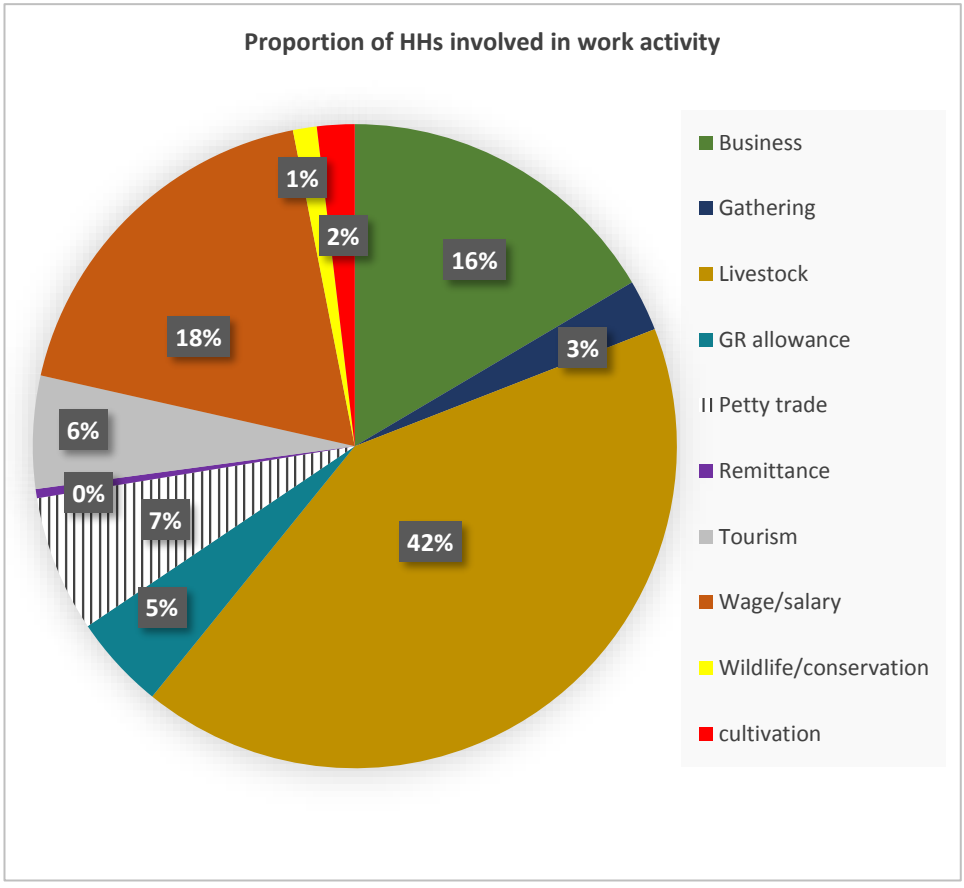
[17] Boda-boda is a motorcycle taxi.

[18] Laibon - The laibon is a ritual figure consulted in the Maasai society as a healer and prophet.

Table 4.10 Different type of work categories carried out by all family members as reported by males interviewed.

Work category	No. of households involved in activity	% of households involved in activity
Business income	70	35.9
Gathering	11	5.6
GR committee allowance	20	10.3
Livestock	177	90.8
Petty trade income	29	14.9
Remittance	2	1.0
Tourism	24	12.3
Wage/salary income	78	40.0
Wildlife/conservation	5	2.6
Cultivation	8	4.1

Figure 4.2 Salience of different work activities, expressed as a percentage of all work records.



Overall and mean contribution to household income received from livestock in this study is lower than found in other studies in Kenya (Bedelian, 2014; Nkedianye et al., 2009; Thompson et al., 2009; 64%: BurnSilver, 2009;) in Kenya and Tanzania (Trench et al., 2009) (Table 4.11). Livestock as an overall contribution to income made up a lower proportion of overall household income compared to other studies. However, in this study livestock and off-land activities were proportionally similar in contributing overall household income. Off-land activities contributed more proportionally to household income than they did in Koyiaki near the Maasai Mara.

Table 4.11 Comparison of % of contribution of overall household income from different activities between to Maasai groups in Kenya: Bedelian 2014; Nkedianye et al., 2009.

% of contribution to overall household income			
Work activity	Laikipia	Maasai Mara	Kitengela
Livestock	42	56	61
Conservation	7	15	3
Off-land	41	14	38
Crops	2	1	<10

Figure 4.2 shows work activities expressed as a percentage of all work records. Livestock was the most common activity reported (42%), followed by wage/salary (18%) and business (16%). Wildlife and conservation accounted for 2% of overall household income. However, for the small proportion of households reported benefiting this way (~3%) it accounts for ~38% mean annual household income. Results might be influenced by sampling schedule, which may not be representative of the whole population in terms of, for example, wealth. There were a number of households that could not be included in the study because the herder worked away from home on a permanent basis due to work.

Mean household income for wildlife/conservation activities was similar to wage/salary and for those households earning from this activity considerably higher than even the highest figures other studies found (Thompson et al., 2009: ~21% cf <5% overall in this multi-site study (Homewood et al., 2009). However, wildlife/conservation accounts for only 3% of work records so the numbers of households and people involved are few. The couple of percent contribute to household earnings from wildlife/conservation averaged across all households are as reported for four out of five multi-site studies in Kenya and Tanzania

(Homewood et al., 2012) and considerably less than for Mara households (Thompson et al., 2009). The three study areas all border large scale commercial ranches (~55,000 acres), which are essentially beef producing ranches engaging in wildlife/conservation/tourism. One of the large-scale ranches, Mpala also engaged in scientific research. Mpala Research Centre, although financially independent from Mpala Ranch, is situated on the original Mpala ranch property. The large-scale ranches employ local residents from neighbouring communities to work the ranch, and the types of jobs undertaken vary in skills required. It is part of the commercial ranches' strategy to employ people from the local community as a way of providing support to a number of neighbouring families, and helping to preserve good relations with the local community. As yet though, wildlife/conservation based income is important for only a small proportion of households.

Total family income in Laikipia was mostly derived from multiple sources (~89%, hh n=174), although ~10% of households received income from livestock alone. ~11% (n=21) cited only one source of income, all bar one of which were livestock based. A teacher (Maasai) in one of the communities said he received no income from the livestock he kept, only from paid teaching work in the local primary school. For this informant, livestock represented an asset and wealth store, not a basis for generating income. Overall, the number of different income sources within a family varied from between 1-6, with a mean of 2.64 and most work people undertook was classed as 'regular' (64%).

However, in some areas livestock production activities have shifted away from subsistence to commercial production. Across Northern Kenya market sales for livestock have increased substantially in the last 25 years. However not all pastoralists profit from the growing opportunities in commercialization (Catley and Aklilu, 2013). Alongside commercial ranches, wealthy pastoralists with large herds mainly benefit from commercialization because they not only have larger herds but are also able to control access over key resources due to their financial and political capital. Loss of access to important key resources such as grazing and water, mineral licks and plant gathering, and/or loss of livestock to drought, disease or raiding increasingly marginalizes a majority of pastoralist people living in ASALs (Homewood, 2008). In these circumstances the poorer pastoralists are often excluded or strain to make payments to access these resources. They can end up exiting pastoralism in these areas altogether, moving to urban areas to find work or becoming reliant on aid agency support (Catley and Aklilu, 2013).

4.5.1 Opportunities for accessing different sources of income

Opportunities to access a range of income activities differed across the three study areas, with Il Polei having most diverse opportunities (n=8). Il Polei borders two large-scale commercial ranches and is located on the main Dol-Dol road leading to the main administrative town for the area (Dol-Dol) and the market town of Nanyuki. Only Il Polei reported income from wildlife/conservation and gathering activities. Lekiji was the only area to report income from remittances. Four out of the nine work activities: Business, livestock, petty trade and wage/salary were income activities reported by all three areas Table 4.12.

Table 4.12 Number of HHs (and percent) involved in work categories that were accessed by all areas.

Work category	**Il Motiok**		**Il Polei**		**Lekiji**	
	n	%	n	%	n	%
Business	37	19	26	13.3	9	4.6
Livestock	76	39	50	25.1	51	26.2
Petty trade	3	1.5	19	9.7	1	0.5
Wage/salary	39	20	49	25.1	31	15.9

Decreases in livestock numbers have a knock-on effect on milk production and food availability. This coupled with increases in drought occurrence and disease is pushing some pastoralists into expanding cultivation as a way of reducing pressure on livestock herds and minimising risk (McCabe et al., 2010). In fact some pastoralists are choosing to abandon livestock husbandry only grow crops. For example, a few pastoralists at Il Motiok are now only growing crops and not keeping livestock:

> 'They (pastoralists) don't keep livestock as a way of life. For example, some people in Il Motiok are just digging [shambas]. They are not keeping livestock now.'
> *Gary, male herder, 67*

4.6 Conclusion

This chapter has presented data collected on pastoralist herd dynamics, the pastoral year and the contribution of pastoral produce to household income. Fewer livestock

were bought, born or given as gifts in 2009 XCE compared to a non-XCE year. Considerably more cattle were slaughtered/consumed in drought than non-drought years. Cattle have been central to Maasai life and are important for economic and social reasons. As drought increases in frequency and severity, two impacts on cattle herds seem to be occurring. 1) Pastoralists will keep fewer cattle because they are not as resilient in drought times compared to sheep and goats (see Chapter 6) and 2) pastoralists will have less time to build up their herds from the small-stock primarily bought to expand and diversify the herd. In addition, pastoralists in Laikipia are keeping fewer livestock because of lack of access to water and grazing due to changes in land tenure and land use (Chapter 5).

Wealthier herders had more livestock transactions and in particular sold more livestock in both drought and non-drought years. Wealthier herders also had more young (livestock) born in non-drought years. The majority of households split livestock during the XCE of 2009. Although the pattern of splitting herds does not show a straightforward relation to wealth rank, the poorest in each of the two wealth ranking systems used here emerged clearly as the least likely to split their herds, and the wealthiest as most likely to do so. Wealthier herders are more likely to keep larger multi-species herds (see Chapter 6) that require splitting to maximize their access to forage. Being wealthier means you are more likely to have more options to hire a herder to look after part of your herd, to be able to pay neighbouring commercial ranches fees for grazing cattle, and to be able to purchase fodder.

Milk is the most important pastoral product (other than live animals sold for meat). The majority of milk produced by herds was consumed at home and drinking (rather than processing) was its preferred use, which is in line with the findings of Behnke and Muthami (2011) on national milk consumption, though this is the perception as reported by male, not female informants. This study confirmed the way milk supply to the household varies immensely between seasons and years owing to seasonal and other environmental factors affecting the production of the lactating herd (Talle, 1990). Although nationally more milk is consumed from cattle than small stock (Behnke and Muthami, 2011), respondents commented on the fact that they now drank more milk from sheep and goats than they used to, owing to the periodic or permanent grazing on commercial ranches for their cattle herds:

> ‘Most people are not drinking cow’s milk because they are all on Ol Jogi. Milk is mainly from sheep and goats. The only cattle you see on Il Polei are for milking for the children.’
> *Manni, male herder, 69*

Milk from livestock is a valuable dietary item and source of food security, and sales of milk can also provide economic flexibility for Maasai women managing the household’s food system (Nkedianye et al., 2009). Not surprisingly, poorer households reported having less milk than wealthier households. Mean sales from milk decreased from an average 4.5% income in the non-drought year to 1.2% in the drought year. Moreover, reduction or loss of milk consumption also occurs because milk yields are lower or non-existent in drought times. Of the three areas, Il Motiok were more likely to report no milk during the XCE. These findings are likely to worsen as drought frequency increases in Kenya. Pastoralist have already noticed that years are getting drier. Longer *Olodalu* seasons will result in less milk being produced. Coupled with fewer livestock owned this will drastically impact on milk availability. Also, cattle grazing away on commercial ranches during drought or as a year-round arrangement reduces milk sales and consumption. Due to the strict security in place on commercial ranches because of wildlife protection against poaching, pastoralist owners of cattle who are paying for grazing on the commercial ranches are generally not allowed access to their own cattle (Chapter 5), though at Lekiji I saw two men every morning cycling to and from Ol Jogi to bring milk to Lekiji from the cattle they had grazing there. This was likely because of the proximity of Lekiji to Ol Jogi and possibly because of the close relationship Lekiji has with Ol Jogi (see Appendix 1[19]).

Milk and its products are culturally important, maintaining social ties (Sadler et al., 2009), and the control and handling of milk and milk products is primarily managed by women (Talle, 1990). In this study more milk was shared (13-14%) than sold (3-5%), reflecting both the lasting social value of milk and its importance in maintaining social networks, and also, perhaps the fact that Il Motiok (with most livestock) was furthest from market outlets. Of the milk produced, a higher proportion was consumed at home during the XCE and *Olodalu* season. During the XCE when the least amount of milk is produced no butter is made, no milk is received, considerably less is given away (proportions given dropped significantly

[19] Appendix 1 – p.265.

to 3% during the 2009 XCE) than recorded in Grandin's (1988) study in Kenya (5%).

Hides and manure sales are traditionally women's business but were important sources of income for the male herder and/or the family overall, especially during drought times. Some male herders who migrated with livestock to find water and pasture tapped into the hide business as a way of getting money to help feed their family. Even once the drought ended many of them said that they have remained in the hide brokering business, and often in partnership with their wife.

Livestock represent the most important single source of income to households in this study. Livestock not only provides access to cash through the sale of animals but also provide milk for subsistence (Bekure et al., 1991). In all of the three study sites people complemented their pastoralist livelihoods by diversifying with a number of different income sources. However, proportional income from livestock was lower in Laikipia than has been reported by other studies of Maasai herders in East Africa. Other income sources reported in this study are consistent with what would normally be expected in pastoralist communities in this part of Africa (Serneels et al., 2009). Although the majority of households reported receiving income from livestock, wage labour (40% respondents, n=78; ~38% mean annual income) and business (36% respondents, n=70; ~25% mean annual income) were also important sources of income for households engaging in these activities. Mean contribution to annual household income from business (25%) is somewhat lower than that Nkedianye et al. (2009) found for business income in the peri-urban site of Kitengela, on the outskirts of Nairobi.

The traditional coping strategies that pastoralists have adopted in response to drought enable them to minimise risk. For example, changes in herd structure (see Chapter 6) is a response to increases in drought because small stock, especially goats are more resilient in drought times. However changes in herd composition may impact pastoral production. In this study milk supplies are likely to be lower than elsewhere, and to decrease further because cattle herds potentially are more likely to graze on commercial ranches as drought frequency increases, and access for milking is difficult; but also because fewer cattle are reportedly being kept, while keeping sheep and goats appears to be increasing in response to drought losses.

As traditional coping strategies are curtailed, their effectiveness may weaken. Impacts on livelihoods from socioecological stresses may become more significant if these processes exacerbate pastoralists' susceptibility to drought. Access to water and pasture becomes ever more problematic for pastoralists, especially during drought times. Drought impacts on livestock holdings can be severe for pastoralist communities living in areas of variable climate and recurrent drought (see Chapter 6). One of the most important strategies pastoralists use in drought times is mobility to manage climate risk and lessen the impacts on livestock. In the next chapter, I look at the main strategies pastoralists used to access water and grazing during the 2009 XCE.

Chapter 5 Chapter mobility

5.1 Chapter summary

This chapter focuses on the main strategies adopted by pastoralist communities in Laikipia to access water and pasture for livestock herds during the 2009 extreme climatic event in Kenya. Traditional coping mechanisms are increasingly constrained by social and political boundaries associated with land fragmentation and alienation. The chapter looks at the new ways households are seeking to adapt to mobility restrictions during drought periods, either moving longer distances through ever harder routes to more hazardous destinations, or making cash payments for access to more local water and pasture on historically Maasai rangelands now under other ownership.

5.2 Introduction

45% of earth's landcover is rangelands and around 78% of this is grazed by a variety of different livestock, predominantly in developing countries (~67%: Reid et al. 2008). The majority of rangelands are extensive grazing lands (91%: Reid et al., 2008), which usually support low human and livestock populations (Niamir-Fuller et al., 2012). They are also areas where wildlife has historically been able to co-exist with livestock production (Reid et al., 2008). Pastoralist communities operate in such arid and semi-arid lands (ASALs) throughout much of Africa. ASALs provide a wide range of ecosystem services for pastoralists, with grazing and water being two of the key resources most important for supporting livestock (Reid et al., 2014). In comparison to other agricultural production systems, extensively grazed livestock production has relatively low levels of inputs (Niamir-Fuller et al., 2012) but because of the highly variable climate regimes that characterise ASALs, pastoralists live with high degrees of risk and uncertainty (Butt, 2011). With an increase in frequency of XCEs, ASAL populations will need to deploy new as well as time-honoured coping strategies.

Pastoralists have successfully used a range of strategies which allow them to exploit unpredictable climates (Homewood, 2008) and manage climate risk (Reid et al., 2014; Davies and Nori, 2008; Chapter 1): such strategies commonly centre on mobility. Livestock mobility may manifest as local or long-distance transhumance and is especially adopted during drought periods (Behnke et al.,

2016; Niamir-Fuller and Turner, 1999) to reduce likelihood of livestock losses (Oba and Lusigi, 1987), both by reducing grazing pressure in any given area and by accessing additional areas, thus increasing the number of livestock that can be sustainably grazed overall (Oba and Lusigi, 1987; Chapter 4). Herd mobility is dictated by a complex interplay of social, economic, political and environmental factors (McCabe, 2004; see Chapter 1).

5.2.1 From communal to privatization of land

Since the start of the colonial period, East Africa has seen a shift from often dominant pastoralism to diversification away from livestock production (Homewood et al., 2009) through a century of severe changes in land tenure. Lands formerly managed communally are increasingly privately owned or leased out by the state to privately managed enterprises, resulting in land subdivision which has decreased the availability of and access to natural resources for mobile pastoralists (Homewood et al., 2009).

Subdivision of land creates borders. Borders that are either strong social boundaries such as tenure or physical boundaries such as fences (Reid et al., 2014). This dissection of land affects communities that rely on shared resource use. The wetter parts of a rangeland are often the first to be lost though exclusion and/or conversion for multiple reasons including resource extraction, damming, settlements and agriculture (Miller, 2015). Loss of access to dry season resources because of land conversion to agriculture, conservation (Homewood, 2008; Brockington, 2005; McCabe, 2003) or urbanization (Behnke, 2008) and the resulting fragmentation of the landscape (Galvin, 2009) affects pastoralists' ability to bounce back from shocks such as drought (Galvin, 2009; Nkedianye et al., 2011). Fragmented rangelands support fewer livestock per hectare because herders and their livestock can no longer move freely to access different vegetation important in grazing in different seasons (Boone and Hobbs, 2004). Climate change coupled with habitat loss and fragmentation jointly present the most serious threat (Chapter 1). These changes are particularly acute in Laikipia, which has seen pastoralists excluded from much of the landscape because of the changes in land tenure since colonial times including, over recent decades, the ongoing intense privatization of land (Chapter 2).

Understanding geographical patterns of livestock mobility in terms of social constraints on movement is critical for understanding how pastoralists adapt,

especially in the face of climate change, with pastoralists creating new ways to cope with these challenges (Reid et al., 2014). This Chapter seeks to understand how Maasai pastoralists in Laikipia respond to extreme climatic events by answering the following questions as first set out in Chapter 1:

1. What are the main coping strategies adopted by pastoralists in Laikipia during XCEs? (RQ C).

2. How do changes in land use and land tenure affect access to water and pasture? (RQ C).

5.3 Land Tenure in Laikipia

Changes in land tenure, especially since the beginning of the 20th century have shaped pastoralism in Laikipia today (Letai and Lind, 2013; Chapter 2). Mobility has decreased significantly, largely due to land conversion, fences and other administrative barriers (Letai and Lind, 2013; Chapter 2). Land privatization and/or sub-division continues to further marginalise pastoralists already living at the margins. With less land available, new types of pastoralism are arising in response to these socio-political changes (Letai and Lind, 2013; this Chapter).

5.3.1 Different land types in Laikipia

Data on where people took their livestock during the 2009 XCE were gathered using questionnaires and semi-structured interviews. It was not possible to visit or georeference the majority of named places to which people reported travelling. The present chapter uses categories based on land tenure and administrative categories rather than spatial or environmental characteristics. This is for three reasons. Firstly, tenure category was an important determinant of land access and use. Secondly, MRC has mapped land in terms of these categories, and were keen to see this classification used to help comparative work. Thirdly, while spatially explicit GIS and remote sensing were important for looking at the distribution patterns of wild dogs for this thesis (Chapter 7) this was dependent on wild dogs being collared. Their GPS data allowed analysis with respect to a remotely sensed GIS spatial framework of habitat types (Chapter 7). GPS data are not available on the historical movements of Laikipia Maasai.

The land types used in this chapter were based on the most current map of Laikipia available from MRC (Figure 5.1), based on official surveys of the different types of land ownership in Laikipia. Key Informants in Il Polei were asked to think about the different types of land tenure in Laikipia and from these group discussions along with the map, eight land categories were classified: 1) large scale commercial ranch (CR), 2) community land (CL), 3) group ranch (GR) (excluding the three study sites), 4) private land (PL), 5) protected area (PA), 6) study site (SS) (the three study sites), 7) trust land (TL) and 8) unclassified (UC) (Table 5.1). Of these eight land types three emerge as the most important destinations for livestock: commercial ranches (CR), community land (CL) and protected area (PA). A list of the names of places visited during 2009 XCE was collated during data collection for the three study sites (Table 5.2). Some respondents reported travelling outside Laikipia to two other Districts: Isiolo and Samburu (not shown on Figure 5.1). A map of the larger Ewaso Ecosystem was also made available by MRC (Figure 5.2), which allowed the two districts to be incorporated into the Figure 5.3. The two maps were merged to create one that represented where people visited during the 2009 XCE (see Figure 5.3), although not all places could be identified on the new map because of not knowing the spatial location.

Table 5.1 The different land uses grouped into land type.

Land type	**Land use**	**Refers to land use on Figure 6.1**
commercial ranch	Large-scale commercial beef ranch often engaging in high-end tourism and/or wildlife	Large-scale ranches
community land	Land respondents were unclear on ownership. They know people are settled on these lands but they also know these are not the title owners. This is land Kenya's Govt. allocated to African farmers after Kenya's independence from the British. This land often has contested	Government settled schemes
protected area	National parks, national reserves.	Mt Kenya (not shown in detail)
group ranch	Other Maasai group ranches (besides the three study sites Il Polei, Il Motiok and Lekiji).	Pastoral areas
private land	Includes wildlife sanctuaries. This land type is often part of a large-scale ranch, engaging in wildlife tourism	Large-scale ranches
study site	Il Polei, Il Motiok & Lekiji.	Pastoral areas
trust land	Government land administered by the land commission.	Government land
unclassified	Areas that respondents were unable to classify. Included 'areas' such as stock roads.	

Figure 5.1 Laikipia County land categories. Mpala Research Centre, 2012.

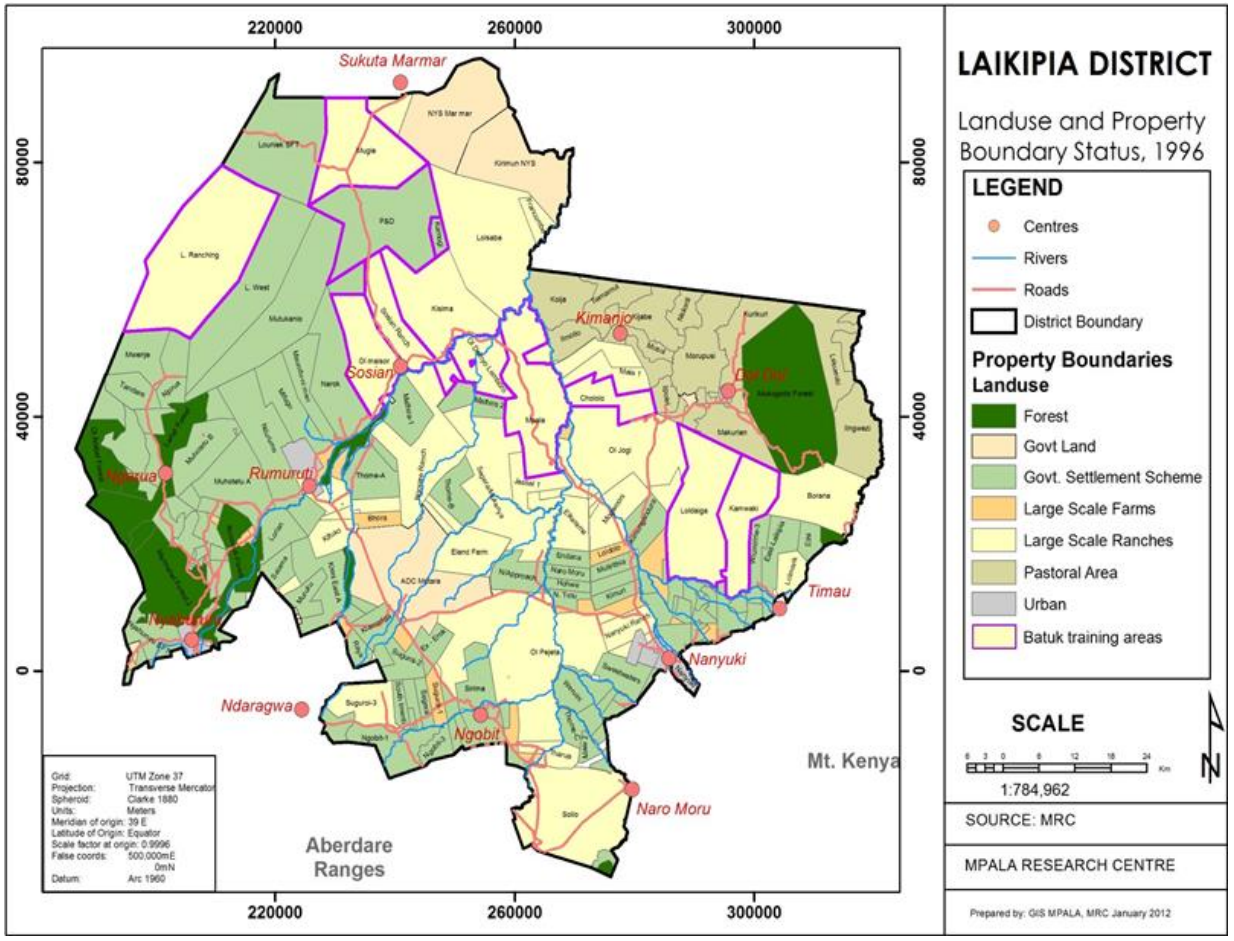
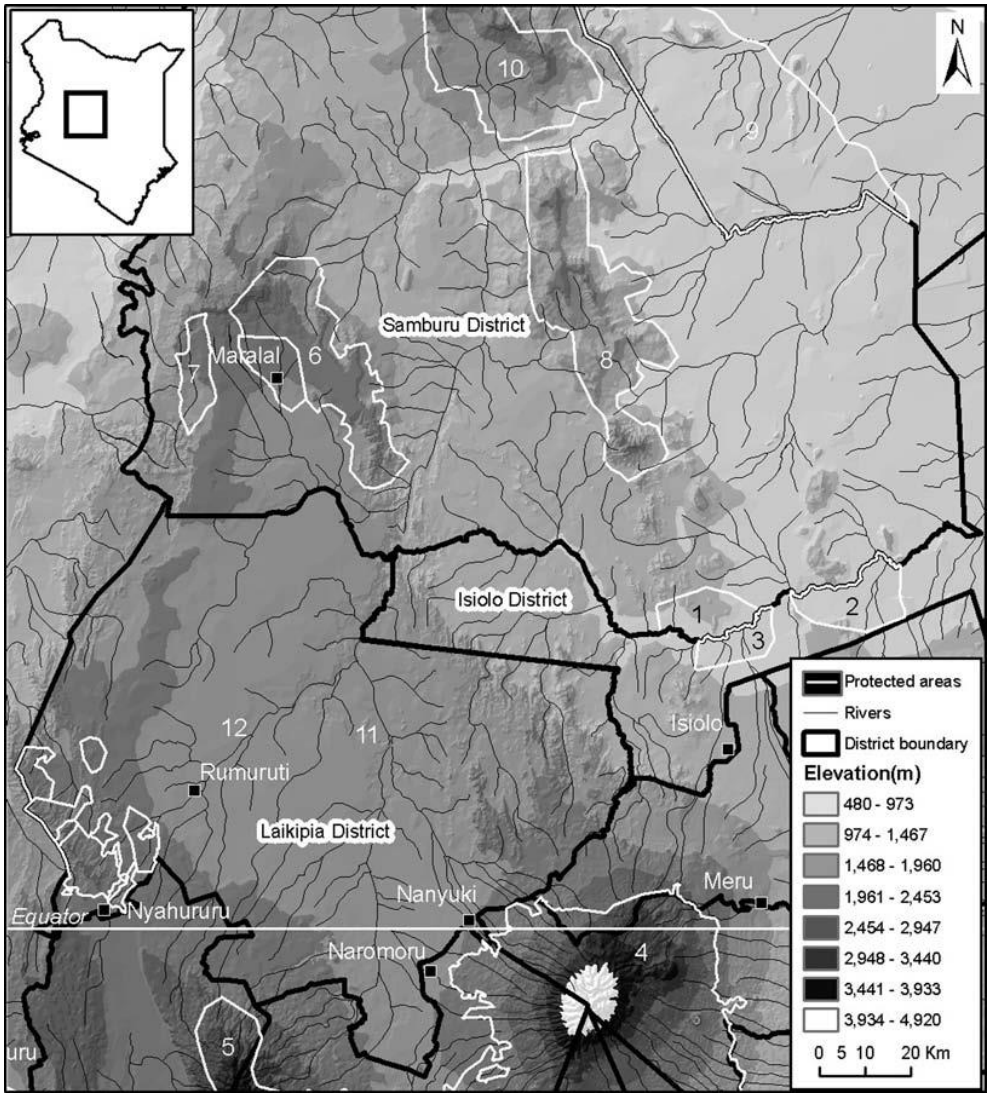


Figure 5.2 Ewaso Ecosystem. The region is bounded to the west by the Rift Valley and in the south by Mt Kenya and the Aberdare Highlands. Protected areas are outlined in white as follows: as follows:1, Samburu National Reserve (NR); 2, Shaba NR; 3, Buffalo Springs NR; 4, Mount Kenya National Park (NP); 5, Aberdare NP; 6, Karisia Hills Forest Reserve (FR); 7, Maralal FR; 8, Matthews Range FR; 9, Loisai NR; 10, Ndoto Mountains FR. Major rivers are as follows: 11, Ewaso Nyiro; 12. Ewaso Narok.
(Taken from Georgiadis, 2011).



5.3.1.1 Commercial ranches

Large-scale commercial ranches in Laikipia provide access to water and pasture to neighbouring community group ranches for a monthly fee charged per head of cattle (Chapter 2). Official access to the commercial ranches was originally offered to pastoralists during drought times on an ad hoc basis from the late 1990s. However, since 2012 Ol Jogi have offered year-round access to Il Polei and Lekiji residents, as well as to other neighbouring group ranches not included in this study.

> 'The commercial ranches next door are our friends again so we can take cattle to graze on the lands. Cattle numbers are low at the moment so Il Polei have not reached their quota, which means all of Il Polei cattle are on Ol Jogi. The only cattle you see on Il Polei are for milking for the children.'
> *Meyoni, male herder, 69*

Ten different CRs were reportedly accessed by pastoralist residents of the three study sites for grazing their cattle, although of the 10 sites seven were only used by a single respondent in this study. They include Mpala Ranch, Ol Jogi Ranch, Lolldaiga Hills Ranch, Chololo Ranch, Chabaa Ranch, Male Ranch, Mamut Ranch, Moamud Ranch, Soit Ngiro Ranch and Tomlinson Farm. The chapter focuses on two commercial ranches Ol Jogi Ranch and Mpala Ranch, which neighbour one or more of the study sites. These CRs gave cattle owners access to water and pasture for a cash fee (see Chapter 2 for details on these two ranches and how they operate).

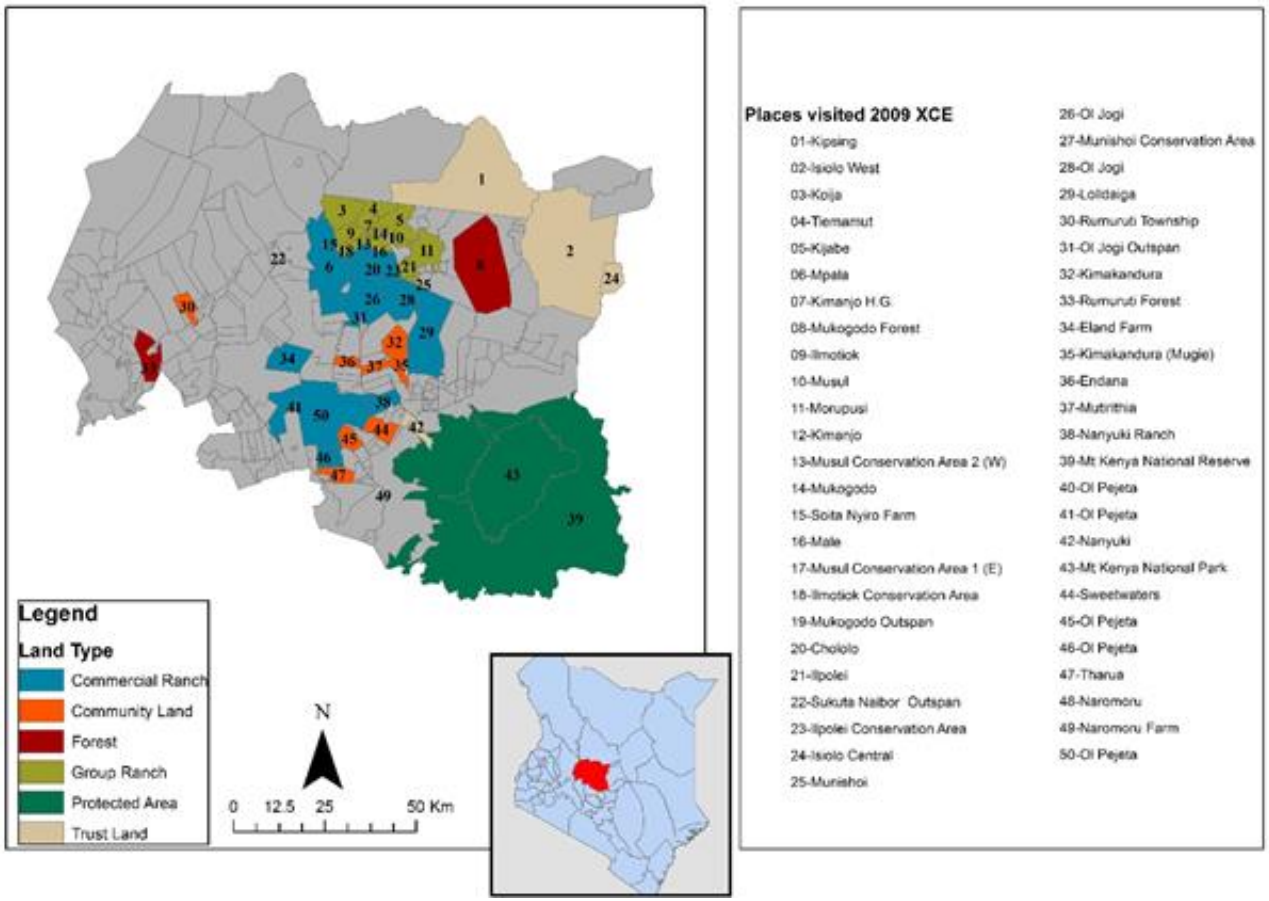
Following on colonial allocation of higher-potential land to settlers, large-scale commercial ranches are located in areas that receive higher rainfall per annum than do GRs. Annual rainfall is around 550-750mm for CRs compared to 400-500mm for the GRs (Georgiadis et al., 2007). ASALs with higher levels of rainfall will stay wetter for longer periods during dry/drought season. These drought resource areas (DRAs) are of considerable value to pastoralists as well as agriculturalists and wildlife (Homewood, 2008; Miller, 2015). In addition, the two main CRs are also pro-wildlife, and are managed for the purpose of supporting wildlife populations. Although these ranches have livestock, cattle numbers are lower than would normally be able to be supported sustainably in these areas. Ol Jogi Ranch operates as a working cattle ranch that also engages in conservation and high-end tourism.

Table 5.2 Names of all the places that pastoralists reported visiting to access pasture and water during 2009 XCE. Where possible, places relate to one of the numbers on Fig 5.3 where information was available. The table is over two pages.

Area	No. Fig. 5.3	Land type
Chabaa Ranch		Commercial Ranch
Chololo	20	Commercial Ranch
Eidaon		Commercial Ranch
Eland Farm	34	Community Land
Endana	36	Community Land
Ereri		Community Land
Ewuaso		Group Ranch
Il Motiok	09, 18	Study Site
Il Polei	21, 23	Study Site
Isiolo	02, 24	Trust Land
Jua Kali		Trust Land
Kamendi		Private Land
Karachiba		Community Land
Kijabe	05	Group Ranch
Kimakandura	32, 35	Community Land
Kimanjo	07, 12	Group Ranch
Kipsing		Trust Land
Koija	03	Group Ranch
Lekiji Village		Study Site
Lolldaiga	29	Commercial Ranch
Loitoktok		Community Land
Male Ranch	16	Commercial Ranch
Mamut Ranch		Commercial Ranch
Moamud Ranch		Commercial Ranch
Moropusi	11	Group Ranch
Moyko		Community Land
Mpala Ranch	06	Commercial Ranch
Mt Kenya	39, 43	Protected Area
Mukogodo	14, 19	Group Ranch
Mukogodo Forest	08	Forest
Munishoi	25, 27	Group Ranch
Musul	10, 13, 17	Group Ranch
Mutirithia	37	Community Land
Nanyuki	42	Trust Land
Nanyuki Ranch	38	Commercial Ranch
Naromoro	48, 49	Trust Land
Ngapolo		Group Ranch
Ol Jogi Ranch	26, 28, 31	Commercial Ranch
Olauraki		Group Ranch
Ol Lentille		Group Ranch
Ol Pejeta	40, 41, 45, 46, 50	Commercial Ranch
Pois		Community Land
Rumuruti	30, 33	Community Land
Rumuruti Forest	33	Forest
Soit Ngiro Ranch	15	Commercial Ranch
Soitoudo		Group Ranch
Stock Road		Unclassified
Sukutan		Community Land
Sweetwaters	44	Community Land
Tharua	47	Community Land
Tiemamut	04	Group Ranch
Tomlinson Farm		Commercial Ranch
Tool		Group Ranch
Tura		Group Ranch

Land use on fig 5.1	Il Motiok	Il Polei	Lekiji
Large Scale Ranches	X		
Large Scale Ranches		X	
Large Scale Ranches	X		
Govt. Settlement Scheme	X	X	
Govt. Settlement Scheme	X	X	X
Govt. Settlement Scheme	X	X	
Pastoral Areas		X	
Pastoral Areas	X	X	
Pastoral Areas		X	
Govt. land	X		
Govt. land	X		
Large Scale Ranches		X	
Govt. Settlement Scheme	X	X	
Pastoral Areas	X		
Govt. Settlement Scheme	X	X	X
Pastoral Areas	X		
Govt. land	X		
Pastoral Areas		X	
Pastoral Areas		X	X
Large Scale Ranches		X	
Govt. Settlement Scheme		X	
Large Scale Ranches		X	
Large Scale Ranches	X		
Large Scale Ranches			X
Pastoral Areas		X	
Govt. Settlement Scheme		X	
Large Scale Ranches	X		X
N/A	X	X	
Pastoral Areas	X	X	
N/A		X	
Pastoral Areas		X	
Pastoral Areas	X	X	
Govt. Settlement Scheme		X	
Govt. land		X	
Large Scale Ranches		X	
Govt. land		X	
Pastoral Areas	X		
Large Scale Ranches	X	X	X
Pastoral Areas		X	
Pastoral Areas	X		
Large Scale Ranches		X	
Govt. Settlement Scheme		X	
Govt. Settlement Scheme	X	X	
N/A	X	X	
Large Scale Ranches	X		
Pastoral Areas			X
N/A	X	X	X
Govt. Settlement Scheme	X		
Govt. Settlement Scheme		X	
Govt. Settlement Scheme		X	
Pastoral Areas		X	
Large Scale Ranches	X		
Pastoral Areas		X	
Pastoral Areas	X		

Figure 5.3 Laikipia District and part of Isiolo and Samburu Districts showing the places where people reported taking their livestock in 2009 XCE. Some place names appear twice or more because they occupy more than one section on the map.



Since 2012, Ol Jogi has been managed "holistically" for the purpose of regenerating and sustaining the rangeland (www.oljogi.org) and is considered as a sustainable resource management model (www.savory.global). "Holistic" rangeland management rests on assumptions which are essentially the opposite to IFD. Livestock are subdivided into multiple herds and concentrated in a single pasture area to produce a high grazing pressure followed by rest periods (Briske et al., 2014). Savory (www.savory.global) argues that intense grazing, manuring and trampling by the cattle can reverse desertification and restore carbon to the soil, which will increase biodiversity and counter climate change in addition to 'greening up the rangelands'. However, there is little or no evidence to suggest that intensive grazing is ecologically more sound than continuous grazing (Briske et al., 2014) or than opportunist tracking of grazing resources practised by less constrained pastoralist herds.

Mpala Ranch is part of the larger MRC and Wildlife Foundation. Although the ranch is managed separately from MRC the area where livestock are is not separated from where conservation and research are carried out on Mpala.

Grazing cattle on CRs is not without its drawbacks. Pastoralists incur financial costs and also lose access to milk for two reasons: 1) pastoralists cannot 'visit' their cattle or get the milk that is produced from their own cows and 2) there are fewer cattle left at home which also impacts on milk yields for the household. The arrangement with CRs is uncertain as it is not based on any long-term official agreements but rather on the decision of the commercial ranch manager, which of course may change as may the terms of the agreement:

> 'There was a limited number put on Ol Jogi (2 cows per person) although some people could have eight on there because some people don't have cattle so you go ask a friend if you could use their quota. But now everyone can put all their animals on there. It changed a couple of years ago. They charge us a lot of money but it is worth it because it keeps our cattle healthy. However, it is not sustainable. Maasai bond with their cattle but now we are separated. We can only visit once a week[20] and only 10 men at that. We cannot milk our cattle or spend time with them. We can pay for herders and they milk the cattle and sell the milk in town or back to us!'
> *Jonathan, male herder, 31*

[20] Visiting cattle once a week was later changed to no visiting at all because of a recent increase in rhino poaching on Ol Jogi.

> ‘This year all our livestock is on Ol Jogi. They are trialling holistic management so they needed all our livestock. The fee we are paying covers the herders, pasture and dipping treatment. Before this we used to pay for our own herders on top, but because of the holistic management programme and the way they are using the herders they are paying for it. They are putting our livestock together in an area and grazing them there for 3 days to 1 week. Then they are moving the cattle to another area, taking the boma with them. The ground left behind has been broken up by the cattle and the manure is a fertilizer for the seeds in the ground. So it should grow back.’
> *Ashley, male herder, 35*

5.3.1.2 Community land

Respondents categorised land allocated to Government settlement schemes (Figure 6.1) as “community land”. They know people who have settled in these areas do not have title deeds to the land. Respondents were unsure who owned the property rights for these places but they saw it as community land because it was the only place you could take your livestock and where people couldn’t ask you to leave:

> ‘After independence in 1963, some of the commercial ranches owned by white people were left vacant. In 1965, people just settled there without buying land or took their livestock there.’
> *Jake, male herder, 75*

> ‘We didn't used to go to Sukutan and Endana because they were privately owned. The group of people left and the Govt decided to give it to the people. So now that is why we can go there today.’
> *Charlie, male herder, 32*

> ‘You could take your livestock anywhere, but now because of the privatization of land you can’t go to those places anymore. The only places you can drive your livestock is to Kimakandura, Endana, Murithia (places respondents classed as community land).’
> *Parker, male herder, 53*

“Community land” in Laikipia was historically trust land before the British excluded the Maasai from the area to make way for white settlement of the highlands (Hughes, 2006). The newly formed independent Kenya Government then sold the “community land” off to Kikuyu farmers. As the majority of land was not

suitable for cultivation these farmers did not settle there but instead used the title deeds to secure bank loans to buy land elsewhere (Chapter 2). Like the group ranches, "community land" receives lower levels of rainfall compared to the CRs. This land has always been, and still is, profoundly important to pastoralists during drought times because "community land" is one of the few land tenure categories, if not the only one, where they can still take their livestock to graze, particularly in drought years.

Initially after the land was subdivided and the plots were sold, relatively few people were resident in the area but over time more and more people, largely pastoralists, settled there. This has largely been because of population pressure and increasing aridity in the Mukugodo group ranches. Some pastoralists decided to stay after grazing their livestock there during drought periods. This was because the pasture was better than back home. Others chose to go and settle there because they had heard pasture there was of good quality in contrast to pasture at their own group ranch.

Also over time, although in more recent years, these lands in Laikipia are being bought up by wealthy private buyers including government officials, politicians, Maasai elites and expatriates, with new patterns of land use emerging (including proliferation of luxury residences) (Letai, 2011). Although the rise in land deals in Laikipia involves a diversity of stakeholders, around 48 individuals control approximately 40.3% of land in Laikipia today (Letai, 2011). Central to the dynamics in Laikipia has been the absentee landlords (Letai, 2011). As more land was seized through non-transparent processes, pastoralists moving to alleviate the pressure on land within group ranches unwittingly became squatters on plots held by absentee landlords, often Kikuyu, (Letai and Lind, 2013). However, absentee landlords are now being identified by former commercial ranchers and persuaded to consolidate and sell this land to meet the rapid growth in demand for land by various foreign stakeholders. The new owners have evicted the pastoralist squatter communities (Letai, 2011). These various converging developments of land and resource expropriation have created significant vulnerability among pastoralists (Letai and Lind, 2013).

Land deals are increasing rapidly and are not usually transparent. For example, the small plots originally owned by Kikuyu farmers settled by former president Kenyatta are now being consolidated into larger plots and sold to mostly expatriates (Letai, 2011). The increase in people settling and the selling off of these

areas have impacted on the pasture available to pastoralists. Respondents regularly reported that the quality and quantity of the pasture over time has changed:

> 'People live in these areas but they never used to so the pasture is not as good as when no one lived there. These changes happened in 1991.'
> *Itales, male herder, 35*

> 'We used to go to Kimakandura, Endana, Mutherethia, Pois & Ereri (places respondents classify as 'community land') but people have bought land there and put up fences so we can no longer use the land for key resources like we used to.'
> *Focus Group, Il Polei*

Under the presidency of Kenyatta's successor Moi, land tensions were further exacerbated. People (largely from the Kalenjin community) who showed support for his regime were again rewarded for their loyalty to the party by being offered sizeable parcels of land in areas such as the Rift Valley. This meant that contested land or land where tenure arrangements were unclear to pastoralists were often put into the 'community land' category. Pastoralists thus continued to graze their livestock on these absentee landowners' lands. However, since the Kenya general elections in 2002 when the Kibaki administration took over, absentee owners began to occupy this land, or to sell or lease it to new occupants. Danger of eviction has been a constant threat to those pastoralists who had chosen to settle there, effectively if unwittingly as squatters (Letai, 2011). One of the most cited grazing refuges visited during the 2009 XCE in this study, Kimakandura, was a source of conflict between pastoralists and new land owners. In 2008, pastoralists living there (since 1980), pulled down fences that restricted access to an important water source as a protest against purchase of the land. Kenyan law states that a person can claim the right of ownership of land if they have lived there for more than 12 years. The pastoralists later went to court claiming ownership of the land because of the length of time they had occupied the land (Letai, 2011): according to reports from local residents at MRC, the case was still pending in 2014.

One high-profile example of changing land tenure and its impacts on pastoralist communities recently has been the sale of Eland Downs (34 on Figure 5.3) to two American-based charities, the Nature Conservancy (TNC) and African Wildlife Foundation (AWF) from a private landowner, ex-president Daniel arap Moi, whose

process of acquiring ownership in the first place remains unclear. TNC and AWF subsequently gifted the land to the Kenya Wildlife Services for a national park, to be called Laikipia National Park. Family homes were burned down across the 17,000acres of land by police who forcibly removed around ~2000 Samburu pastoralists to make way for the creation of Laikipia National Park (http://www.theafricangourmet.com/2014/12/which-is-more-important-people-or-land.html; https://www.theguardian.com/world/2011/dec/14/kenya-samburu-people-evicted-land).

Laikipia boasts that its success in wildlife conservation is based on the fact that the plateau is open for wildlife to roam freely. Positive attitudes toward wildlife emerged in the large-scale ranches in the 1980s (Chapter 2) with tourism seen as an alternative to beef ranching. However, in recent years more fences are being erected restricting both wildlife and pastoralists.

Threat of eviction and an uncertain future hang over residents living in these areas. Communities regularly suffer conflict and tension as people try to secure or access these lands for their livestock, especially in drought times. One respondent reported that there was conflict between those that have settled there and those pastoralists who take their livestock there during the drought. In 2009, conflict occurred in Endana:

> 'They wanted to know why I took my livestock there. We were fighting over pasture. The wazee facilitated a meeting. They took a fine from me and allowed me to stay. '
> *Thom, male herder, 38.*

The recent changes now occurring in Laikipia, especially the changes related to 'community lands' are further restricting pastoralist access to vital drought resource areas. These areas, historically so important to transhumant pastoralists during times of drought, are no longer able to sufficiently support both residents who have settled there and also those moving in during drought in search of water and pasture (Nkedianye et al., 2011). Pastoralists have responded to these changes by moving ever longer distances to try to minimise livestock loss during drought periods. One such distant drought refuge place visited during 2009 XCE was Mt Kenya, the only 'formally' protected area in Laikipia at the time.

5.3.1.3 Protected Area

Pastoralists navigate long distances to travel to Mt Kenya in search of water and grazing, especially during drought times. In Laikipia livestock can be moved ~200km into Mt Kenya or the neighbouring districts of Nyandaru, Eldoret, Nakuru and the Aberdares Range (Ojwang et al., 2010). In 2009 XCE herders were permitted to graze inside the forest during the day. Pastoralists negotiated individual agreements with Kikuyu and Meru small-holders living adjacent to Mt Kenya to kraal their livestock at night (Letai and Lind, 2013).

The Mt Kenya region has become important to pastoralist groups during times of drought. The region is positioned roughly east south-east of the three study sites and is approximately 45km (as the crow flies) or 60km by main road from the Mukogodo region. Migration to Mt Kenya is one of the short-term coping strategies for many pastoralists in the Mukogodo region in search of pasture. During the 2000 XCE, the Kenya government allowed pastoralists to graze their livestock in the Mt Kenya and Aberdare forests, which would otherwise be forbidden (Huho et al., 2011). This intervention has not been without problem (this Chapter).

5.4 Results and discussion

5.4.1 Land types used

Of the eight different land types categorised three were of particular importance in strategies for coping with XCEs: commercial ranch (CR), 'community land' (CL) and protected area (PA): this Chapter focuses on the results for these three land types. CL (48.7% respondents) and CR (41.5%) were clearly the two most important for Laikipia pastoralists during the 2009 XCE, with 15.4% respondents reportedly using PAs (Mt Kenya) (Table 5.3).

The three study sites used the three main land types in rather different ways. Il Motiok used CR and CL equally with fewer people reportedly using PA. Il Motiok is more remotely positioned than Il Polei and therefore the initial migration of cattle would be more difficult compared to Il Polei whose group ranch was next to the main road into town [Nanyuki]. Il Polei reported using CL more than CR or PA. As with Il Polei, Lekiji reportedly used CL more than CR, although the difference between them was not large. Lekiji did not report using PA. That said,

Lekiji's use of CL and CR were considerably lower than both Il Motiok and Il Polei (~61-75%), likely due to Lekiji having a different demographic, social and economic make-up, as well as different herd ownership with residents keeping many fewer cattle and livestock overall (Chapter 2).

Table 5.3 Land type used during 2009 XCE for (1) all livestock species: total number of households across the three study sites. Numbers in brackets after land type show how many places were recorded as being used within each land type (Figure 5.1); (2) Number of cattle owners accessing the three different land types.

Land type	**Land code**	**No. of HH (n=195)**	**% of HHs**	**Total no. of cattle owners accessing land for cattle**	**% of cattle owners using land type**
commercial ranch (10)	CR	81	41.5%	81	62.3%
community land (11)	CL	95	48.7%	52	40%
protected area (1)	PA	30	15.4%	25	19.2%

Table 5.4 Figures from contingency tables show the total number of households that used each land type. Percentage values are calculated as per cent of the pooled total 195 households.

Land type	**Il Motiok (n=77)**		**Il Polei (n=66)**		**Lekiji (n=52)**	
	total no. of HHs		total no. of HHs		total no. of HHs	
CR (cattle only)	43	55.8%	28	42.4%	11	21.1%
CL	43	55.8%	40	60.6%	12	23.1%
PA	13	16.9%	17	25.8%	0	

5.4.2 Paid access to large-scale commercial ranches

Of 195 respondents interviewed across the three study sites 130 (66.7%) reported keeping cattle with n=81 (62.3% of cattle owners) paying to graze on CRs (Table 5.3). During the 2009 XCE more cattle were grazed on commercial ranches than on any other land type (CL = 40% of cattle owners and PA = 19.2% of cattle owners) (excluding the place they resided), showing the importance of this land type to cattle owners in the region. Table 5.4 shows use of commercial ranches compared to other land types for grazing cattle.

Approximately one fifth (20.8%) of CRs in Laikipia sold access to water and pasture during the 2009 XCE, although two of the CRs dominated sale of access to

study site pastoralists. This was largely because they are direct neighbours of the three study sites, often employing individuals from the neighbouring group ranches and therefore having closer links with the community. Ol Jogi sold access to water and pasture to residents at Il Polei (n=23 respondents) and Lekiji (n=11) and Mpala sold access to residents at Il Motiok (n=39) (see Figure 5.3 to see location of Mpala and Ol Jogi to the three study sites).

It is clear that CRs have come to represent a valuable option for many of the neighbouring pastoralist communities to maintain access to key resources in times of drought (Miller, 2015). Those pastoralists who were interviewed said they were happy with the current arrangement that they have with the CRs:

> 'We have a good friendship with our commercial ranch neighbours who give us pasture for our livestock so there is no need to go anywhere else.'
> *Aristotle, male herd owner (age 68) 2.2.13*

> 'In 2004 we started to take our cattle to the commercial ranches. We met with the ranch manager to start a good relationship so they could help us.'
> *Satre, male herd owner (age 54) 13.10.13*

5.4.3 Migration during 2009 XCE

Overall, migration was an important mechanism for coping during the 2009 drought with 151 respondents (77.4%) reportedly migrating from their group ranch with all or part of their herd. Il Motiok and Il Polei both reported high numbers and percentages of households migrating (n=69 or 89.6% of those living in Il Motiok; 57 or 86.4% of those living in Il Polei). By contrast Lekiji with fewer livestock holdings overall reported fewer households as migrating (25 or 48.1%). Overall, two thirds of all households (n=125 (64.1%), of total n=195) migrated with their cattle; half also took sheep (n=98 or 50.3%) and around one-third their goats (n=62 or 31.8%).

Travelling to Mt Kenya with single-species or mixed herds in search of water and pasture has been a recent development for Laikipia pastoralists, reported in this study as first undertaken in the 2000 XCE. XCE 2009 was only the second time pastoralists had migrated to Mt Kenya, as one individual recalls:

> ‘People lost a lot, if not all their livestock. The rains did not come for a long time so people had to go to Mt Kenya because there was no pasture left for the livestock to eat. We went for the first time in 2000. Everybody made their own decision. It is a personal choice not a group decision whether to go to Mt Kenya. People knew already there would be pasture because it is a state forest and the pasture is therefore conserved.’
> *Dylan, male herd owner, 33*

Though mobility is a traditional drought management response (Niamir-Fuller, 1999), people can still lose large numbers of livestock in the process of moving them (McCabe, 1987; Homewood and Lewis, 1987; Nkedianye et al., 2011; Chapter 4). Pastoralists face many challenges when moving herds, such as exposure to disease and raiding, as well as climate shocks. More stock losses can occur when livestock are moved over considerable distances (Homewood and Lewis, 1987).

The importance of CL Kimakandura as a staging post and drought refuge en route to Mt Kenya emerges strongly in people’s narrative of the journey they undertook during the 2009 drought:

> ‘The journey to Kimakandura was congested with other herders and their livestock making the same journey. The reason the route was so crowded was because everybody had to travel in the same direction because of the two electric fences [on Ol Jogi], steering people one way. The route was very narrow and there was no pasture along the way so a lot of livestock died on this part of the journey.’
> *Frank, male herder, 50*

When pastoralists arrived with their herds they found Mt Kenya had abundant pasture. However, livestock were exposed to a much colder climate there than they were used to. By the time they arrived the livestock were weakened from the long journey and were therefore vulnerable to this change in climate. It is now well documented that weakened livestock readily die of hypothermia (McCabe, 1987). In addition, diseases such as pneumonia also took their toll. Consequently, most pastoralists who had made the journey found their livestock dying both on the road and in even greater numbers once they arrived. As one individual recalls:

> ‘But it [Mt Kenya] does not stop your animals from dying. People who live by Mt Kenya have healthy livestock, but those of us who have migrated there, our animals are weak and dying. There are leaves at Mt Kenya that satisfy your livestock but in the morning they are dead. Mt Kenya is very cold and livestock get sick and die from pneumonia.’
> *Bob, male herder, 56*

5.4.4 Influence of wealth on land used

This study’s data on pastoralists’ selection of land type used did not show any significant association with wealth rankings (WR1 or WR2). This contrasts with Goldman & Riosema’s (2013) findings that for Tanzanian Maasai wealth was an important factor in who accessed what land type and in particular determined who could pay to access forage. Both study sites are characterised as ASALs and both are experiencing fragmentation. However, large scale commercial ranches dominate Laikipia unlike Monduli and Longido in Tanzania. Among Laikipia respondents asked whether or not they used CR, nearly two-thirds (~62%) of cattle owners confirmed they did. Further research would be needed to establish how many cattle were involved and for how long cattle were kept on CR. Such data might show a differential between wealth groups, which does not emerge from the present study’s analysis of CR use by wealth rank. However, it is clear that wealthier households are likely to approach poorer ones to negotiate making use of any unused quota:

> ‘Some people only have a few cattle so you go ask a friend if you could use some of their quota.’
> *Johnny, male herder, 31*

5.5 Conclusion

This chapter presents data collected on pastoralist mobility and the land types accessed during the 2009 XCE in Kenya. The 44 different places identified by respondents were categorised into eight different land types. Not all land types were used equally by pastoralists in the three study sites.

This study supports the view that mobility remains an important coping strategy during times of drought (Niamir-Fuller, 1999). Of the 195 households interviewed

151 (77.4%) left their group ranch (including putting cattle on neighbouring commercial ranches) in search of water and graze.

"Community land", commercial ranches and protected area were the three main land types accessed during the 2009 drought and analysis showed there was a strong association for these land types. Commercial ranch and "community land" were used considerably more than other land types, including protected area. However, access to commercial ranches is negotiable for cattle herds only.

Protected areas represent the third most accessed land in this study (although only accessed by Il Motiok and Il Polei, as all Lekiji cattle are pastured on Ol Jogi CR). Migrating to Mt Kenya was again a new option for Laikipia pastoralists, who had only accessed the region once before during the 2000 XCE. A higher proportion of cattle herders from Il Polei went to Mt Kenya than from the other study sites, perhaps linked to the fewer possibilities for access to CR land. More respondents at Il Motiok accessed Mpala than respondents at Il Polei accessed Ol Jogi.

Pastoralists' selection of land type used did not show any significant association with wealth rankings, but this contrasts with Goldman & Riosema (2013)'s finding for Tanzanian Maasai that wealth was an important factor in who accessed what land type. Both study sites are characterised as ASALs and both are experiencing fragmentation although Laikipia main land use is large-scale commercial ranches. In the present study, herders' responses to the 2009 drought might not be differentiated according to wealth because the data did not pick up on the numbers of livestock any individual herder grazes on a commercial ranch, or how long the individual animal stayed there.

Respondents in all three study sites reported paying cash to access water and pasture from commercial ranches, with the majority of cattle owners using this type of new 'mobility'. Paying to access commercial ranches was a new addition to the suite of coping mechanism employed by Laikipia pastoralists during recent drought times, and accounts for all Lekiji cattle on a year-round basis.

As pastoralists become increasingly limited in accessing important key resource areas during drought periods, new drought-coping strategies emerge. Data presented in this chapter show that one recently evolved strategy is to pay cash to access water and pasture from privately owned land. The arrangement is often to access land historically managed through Maasai common property resource systems but now outside of Maasai control. Obtaining exclusive or shared rights to

access private pasture involves paying a landowner for the rights to graze livestock on their land (cf. Goldman and Riosema, 2013). Such arrangements can be made either with new institutions (such as paying large-scale commercial beef ranches, often owned by expatriates) or through renegotiating historical institutions that have been modified, such as the arrangements agreed with the farmers in the River Njoro Watershed, Kenya (once Ogiek hunter gatherers), who charge a fee to individual Maasai herders to access crop residues and holding grounds for their livestock (Willy and Chiuri, 2010). Pastoralists thus pay for access to private pasture in both Tanzania (Goldman and Riosema, 2013) and Kenya (present study; Willy and Chiuri, 2010). This relationship is purely economic and has been seen as not very common in the recent past (BurnSilver and Mwangi, 2007), but it became prominent in Laikipia cattle owners' strategies in XCE 2009.

41.5% of respondents across the three study sites reported paying cash to access water and pasture from commercial ranches. This arrangement is for cattle only (62.3% of cattle owners). The large-scale commercial ranches, largely owned by expatriates or elite Kenyans, dominate land use immediately south of the community group ranches (Lekiji is enclosed by commercial ranches) and on average receive more rainfall. Therefore, commercial ranches are more agroecologically favoured in terms of resources and hence more productive than the community group ranches, especially into the dry season.

Community land accessed in this study included areas that were known to be contested. Ownership for land in Kenya is bitterly contested and highly emotive. For example, smallholdings of absentee landlords are occupied by pastoralists who have settled there as squatters, and by herders who migrate to these areas during extreme droughts. Land ownership in one such place, Kimakandura, which was one of the drought refuge areas respondents accessed during the 2009 XCEs, is currently being legally challenged by the pastoralists that live there. In Kimakandura, former absentee landowners' farms have been consolidated and sold to a foreign investor but the long-term occupants are unwilling to move.

As land acquisitions continue to gain pace in ASALs so does land alienation from the poorer communities living there (Fairhead et al., 2012). The Kimakandura case brings home how drought refuge areas are being lost to outside investors through past (and non-transparent) state-mediated land grab by outside investors as the culmination of past non-transparent land grants and land deals. Furthermore, Laikipia is well known for its wildlife and conservation (Georgiadis et al., 2007),

and areas connected with conservation often see increases in the cost of buying land to levels well beyond the means of poorer land users (Armsworth et al., 2006).

Protected Areas such as Mt Kenya mostly encompass dry season grazing reserves and drought refuges with permanent water and dry season forage (Butt, 2011; Miller, 2015). These areas become incredibly important to both livestock and wildlife during extreme drought times though accessing the region does not come without its problems. In the case of Mt Kenya the risk and cost to pastoralists is compounded by the altitude and extreme environmental conditions. Cold weather and disease impacting on livestock already weakened by poor nutrition and exhaustion were responsible for the majority of livestock deaths once pastoralists arrived at Mt Kenya. However, other studies looking at different Maasai communities moving to different destinations (Baringo for Il Chamus; Athi River for Kajiado Maasai) concur that more livestock losses are likely to occur when herds are forced to migrate in drought (Homewood and Lewis, 1987; Nkedianye et al., 2011).

In Laikipia, access to key resources in drought times is not a straightforward response to environmental conditions. Pastoralists' movements to access water and graze are therefore not often simply dictated by spatio-temporal availability of forage and water as may be expected both theoretically and in less contested ASALs. Access is constrained by social and political constraints carved out by different property rights. Changes in land use and land tenure mean pastoralists do not own the land rights that would allow access. Today people access water and pasture not because they are responding to highly variable rainfall or the environment but due to socio-political changes and constraints which dominate decisions over access, resulting in a diminishing choice for some users, such as pastoralists, while benefitting other users.

Ideal free distribution's (IFD) premise is that all users have unrestricted and equal access. This is simply not the case for Laikipia's pastoralists. Pastoralists are so constrained today that they cannot operate according to IFD, which lived experience as well as theory predicts would still underpin optimal grazing in Laikpia (see first quote). Although livestock populations are widespread throughout Laikipia District fewer numbers are found in areas with important key resources, such as large scale commercial ranches. Institutional rules that govern land tenure can promote or restrict resource matching (Behnke et al., 2016). In the case of Laikipia, pastoralists are restricted and unable to access key resources

freely in response to climatic variability. This contrasts with wildlife populations. For example, wildlife biomass increased in Laikipia by 7.5% (Ogutu et al., 2016). Burchell's Zebra (*Equus quagga burchelli*) is a widely distributed grazing herbivore and the most numerous Laikipia species after livestock (Hillman Smith et al., 2016). Numbers have increased since surveying began in 1977 (96.6% see Ogutu et al., 2016) and appear relatively stable over the last 30 years (Hillman Smith et al., 2016). They are found in larger numbers on large scale commercial ranches. These commercial ranches cover ~48% of Laikipia Plateau and are often managed for the benefit of, and to support, wildlife populations and conservation efforts (Chapter 2).

Pastoralist herders are adapting to restriction on mobility in Laikipia by moving longer distances and/or paying for water and graze from neighbouring land owners through non-Maasai agreements. However, neither of these two very important strategies for herders in 2009 XCE offer long-term security.

As the scale of movement has changed for many pastoralists, including those living in Laikipia, pastoralists must identify new ways to respond to existing circumstances. More distant drought refuges such as Mt Kenya pose serious political, social, economic and logistical problems for herders as well as physical problems for herds. Using the CRs to graze cattle, albeit for a cash fee, has been one newly adopted strategy to tackle changing options. However, not all livestock species are allowed to graze on the commercial ranches. As the trend for keeping increased number of small livestock continues, accessing key resources on lands beyond their group ranch during drought times remains a vital coping strategy for Laikipia's pastoralists.

Paying for access to the commercial ranches requires renegotiation each year and/or each drought period, and it is for cattle only. Therefore, this is not a long-term agreement or guarantee. The relationship is dependent on the Commercial Ranch Manager and the group ranch. In addition, all cattle grazing away from home mean that households lose potential income from milk sales, loss of subsistence living, as well as less sharing potential and negotiating use. It also means the bond between herder and herd is lost. So this is perhaps not so much a successful adaptation as a suite of only moderately successful coping strategies. Alongside this, there are changes in the structure of herds being kept in Laikipia (Ogutu et al., 2016; Chapter 6), which has seen relative increase in number of sheep and goats being kept, decline in proportions of cattle.

Today, Laikipia pastoralists occupy less than 10% of Laikipia plateau, a fraction of the area they controlled 200 years ago. Changes in land use and land tenure have seen pastoralists being 'squeezed' out of accessing key resources in Laikipia (Letai and Lind, 2013). Pastoralists often occupy land on the sufferance of others, rather than having legal rights to be there. As communal lands are increasingly privatised, so options for mobility decrease (BurnSilver and Mwangi, 2007). As seen in Laikipia.

Laikipia is approaching an endpoint for mobile pastoralism. Though CRs offer grazing for payment, herder concerns around lack of access to their cattle and lack of milk, as well as costs and quotas, prohibitive for some show this arrangement is not ideal and potentially even unsustainable. Though both social and environmental constraints affect Laikipia pastoralists, the social constraints have increasingly drastic effects on their lives limiting the ability to bounce back from periods of extreme drought.

As institutions in ASALs continue to change and further restrict pastoralists' movement, climate change is likely to exacerbate this already constrained situation. Climate change is particularly potent when mixed with habitat loss and fragmentation (Chapter 1). This chapter has investigated how people have managed extreme drought in Laikipia by identifying the main coping mechanisms people used to access water and pasture in response to the 2009 XCE. By exploring the main land use types accessed, this chapter goes some way to answering the following questions first outlined in Chapter 1 and earlier in this Chapter identifying the main land types used by pastoralists during XCEs and showing how changes in land use, land tenure and fragmentation affect access to important dry season/drought resources.

More generally, this thesis' findings bear out other work suggesting land in Laikipia has increasingly become a focus for investment by international investors and/or local elites, including pastoralists (Letai and Lind, 2013). Pastoralist communities' loss of key resources results in fewer available places for herders to take their livestock during drought times. Exclusion from key resources that are outside the control of a group ranch also impacts on traditional customary forms of reciprocal arrangements. The erosion of customary safety nets has undermined mobility and flexibility as borders have become more rigid (Letai and Lind, 2013). In the next chapter, I explore the impacts of two XCEs on livestock holdings (2000

and 2009) and compare these losses to livestock losses in non-drought years. I also look at whether location or a person's wealth affects the numbers of livestock lost.

Chapter 6 Chapter livestock loss

6.1 Chapter summary

This chapter aims to explore impacts of extreme climatic events (XCE) by looking at the patterns of livestock loss associated with both XCE and non-XCE years. The chapter begins by looking at the total tropical livestock units (TLUs) kept for two XCE years and two non-XCE year and their distribution by wealth and area. Patterns of livestock loss by wealth, species and cause of death are explored for each location and results are presented as a percent of total TLUs owned. This information establishes the importance of livestock to people in Laikipia and the impacts of XCEs on livestock holdings, and the most important factors driving livestock losses in XCE and non-XCE years.

As expected more livestock are lost in drought years compared to non-drought years in north eastern Laikipia. Droughts in Kenya are becoming more frequent and their impacts more severe for those communities, such as pastoralists, dependent on natural resources. Drought in recent years in Kenya (such as the 2009 XCE) has seen more livestock (and wildlife for that matter) die than previous droughts, although, in terms of rainfall deficit, the 2009 drought was not considered the worst drought in recent times. Socio-political changes happening on the ground are impacting on how pastoralists can mitigate the effects of drought on livestock losses. Changes in land tenure, habitat fragmentation and loss, human population increase, and constraints on access to important key resources are weakening the coping strategies pastoralists depend on during drought times.

6.2 Introduction

Pastoralists living in ASALs experience periodic XCEs (Oba and Lusigi, 1987), although the intensity, duration and spatial extent of these events vary from one area and year to another (IPCC, 2014). Pastoralists have lived with the pressures of drought for millennia (Catley et al., 2013) and pastoralist groups across sub-Saharan Africa, Central Asia and elsewhere have evolved suites of adaptive and coping mechanisms based on mobile livestock systems, which can remain productive in unpredictable ASAL climates (Galvin, 2009; Fratkin, 2001; see also Chapters 4 and 5).

Although, in terms of total precipitation, recent droughts may be no more acute than previous ones, impacts on households and communities today are more severe than before. The 2009 drought was considered the worst drought in Kenya for 60 years, even though total annual rainfall was higher in 2009 (864.4mm) compared to 2000 drought (792.4mm) (Figure 6.1) (Ogutu et al., 2016). With climatic change, droughts may become more frequent and severe in meteorological terms, while people's coping strategies become increasingly constrained, meaning that impacts are more serious and recovery from them is harder (Eriksen et al., 2013).

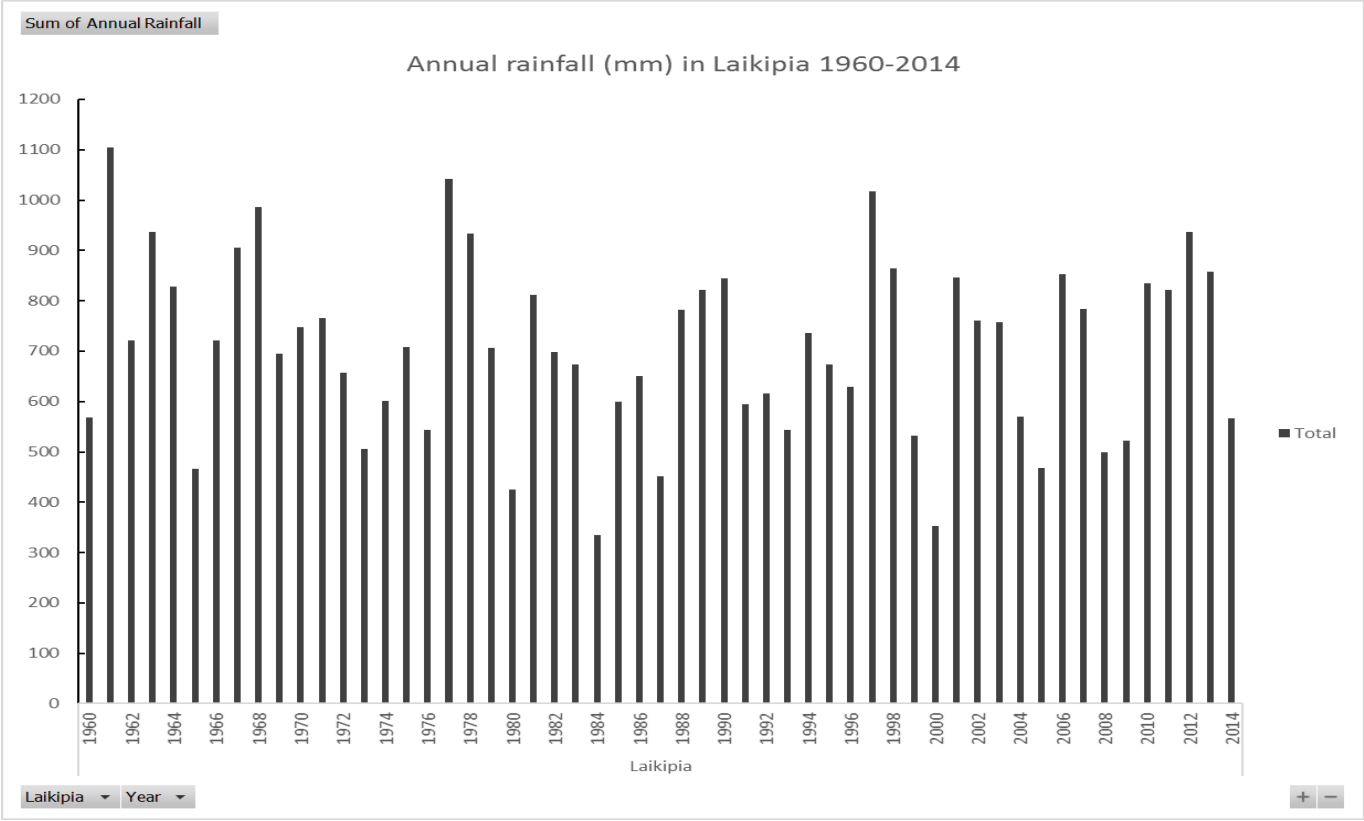
6.2.1 Definition of drought

Meteorological droughts are defined in terms of scale of rainfall deficit (compared to a long-term average rainfall/precipitation) and length of deficit period. Such criteria are region specific because different societies have different land use and livestock management options (Homewood, 2008). In East Africa, drought is usually associated with the failure of seasonal rains (Lyon and DeWitt, 2012). Changes in the El Niño-Southern Oscillation (ENSO) events are known to influence rainfall variability in Africa (Boko et al., 2007). For example, since the 1970s the drying of the Sahel region in Africa has been linked to changes in the interannual rainfall scales caused by ENSO (Christensen et al., 2007). And in recent decades, ENSO has been linked to severe droughts in southern Africa (Fauchereau et al., 2003) and extremes of both rainfall and drought in East Africa (Boko et al., 2007).

6.2.2 Impacts of drought

Drought affects all economic sectors and is considered among the costliest of natural hazards (AghaKouchak, 2015). Between 2008-2011, Kenya's economy lost an estimated KSH1.2 trillion due to the effects of drought (IBLI, 2015). Market prices for livestock drop because of the loss of condition in the animal. Prices for livestock fluctuate more during drought that during non-drought periods (Little and McPeak, 2006). Alongside reduction in livestock productivity (McCabe, 1987) droughts also impact directly on human well-being (IPCC, 2014) and environmental services through long lasting water shortages (Gies et al., 2014) and crop losses, mass displacement (Wilhite et al., 2005) increasing deaths among livestock and wildlife (Shieraw et al., 2014) and in worse cases among humans too (IPCC, 1997). Some authors suggest a causal relationship between increases in extreme

Figure 6.1 Graph showing rainfall (mm) in Laikipia derived from the GeoCLIM software tool developed by the USGS FEWS NET for USAID PREPARED project which blends station rainfall data with satellite rainfall data (from Ogutu et al., 2016).



climatic events and in civil conflict incidence at a regional and global level (Burke et al., 2009; Maystadt and Ecker, 2014). Current conflict in Laikipia is in part attributed to impacts of drought (http://www.the-star.co.ke/news/2016/11/10/laikipia-locals-raise-concerns-over-violence_c1452865). Livestock mortality is widely held to be the most serious economic risk Laikipia pastoralists face as most households' income is largely derived from livestock (Chantarat et al., 2012; Chapter 4).

In ASALs, the loss of livestock is expected to be greatest in drought times (Galvin et al., 2007; this Chapter). Cattle are particularly affected by drought whereas sheep and goats (as well as camels and donkeys) may fare better during drought (Ogutu et al., 2016; this Chapter). In addition, weakened livestock suffer more acutely from disease during drought (Little, 1992), especially adult females and calves (McCabe, 1987). And even when a drought episode has ended with the return of rains, nutritionally stressed livestock often suffer mortality because of the colder temperature (McCabe, 1987; Chapter 5).

Predation does not kill as many livestock as starvation and/or disease, but heir impact is particularly exacerbated by drought when so many animals are being lost to other causes. When predation does occur it frequently causes severe tension for pastoralists because of the anxiety of dealing with a dangerous animal as well as suffering loss of income. The presence of large predators, and the perception of conflict that herders experience living with the threat of attack can often lead to negative attitudes toward predator species of conservation interest (Sillero-Zubiri and Laurenson, 2001).

Large carnivores are likely to respond to XCEs by altering movement and behaviour, thus bringing them into contact more often with livestock herds (see Chapter 7). Lions (*Panthera leo*) were found to have expanded their territories into new areas during the period following the 2009 drought in Kenya; for example, lions moved into communal group ranches adjacent to Amboseli National Park (Tuqa et al., 2014; Dolrenry, 2013), increasing the potential for conflict to occur. The rise in attacks on livestock at a time when pastoralists have suffered tremendous losses already, and where those livestock which remain are weakened and vulnerable, often elicits an escalation in retaliatory killing of carnivores (Frank et al., 2005).

Direct impacts of drought on pastoralist communities through lack of water and grazing are further compounded by socio-political factors such as land loss and fragmentation, caused by underlying factors often originating far from rangelands and driving local causes (Galvin et al., 2007; Reid et al., 2004; Chapter 5). They can include demographic, economic, institutional, policy, climatic and biological factors. Social issues such as changes in property rights are seen to impact on rangelands the most (Reid et al., 2004; Chapter 5).

6.2.3 Livestock herds

Keeping at least a minimum herd size is integral to subsistence pastoralism. Dahl and Hjort (1976) estimated that subsistence milk-based pastoralism needs approximately 4.5-4.7 TLUs per person, though the ratio depends on the local context and associated characteristics of herd performance, terms of trade, and contributions from alternative activities. Broadly speaking, below this figure, pastoralists need to diversify their production to provide enough food for the family through changing seasons and years. Keeping fewer animals increases pastoralist vulnerability to the effects of drought (Cabot Venton et al., 2012). The poor are particularly affected as by definition these families do not own large numbers of livestock. Wealthier pastoralists can survive a drought because of their larger herds (Fratkin and Roth, 2005). However, the number of households classed as 'poor' – owning insufficient herds to feed their family – can double after a drought (Fratkin and Roth, 2005). Herders living in more remote areas potentially face higher risks from drought because they are less likely to diversify household activities than those herders living closer to town (see Chapter 4; this Chapter).

Keeping large herds has customarily been one of the central coping strategy pastoralists use to alleviate the effects of drought. Large herds are kept to ensure enough animals survive a severe drought or epidemic outbreak, so there are enough animals to rebuild the herd after the event (McPeak, 2005; Dahl and Hjort, 1976). To minimize the risk of loss, large herds would be divided with some herds going to distant grazing (Grandin, 1991) or spread amongst family and stock friends (Dahl and Hjort, 1976; Nkedianye et al., 2011). Today, pastoralist social institutions and established informal political systems of distributing livestock between areas and among networks are weakening because of changes in the landscape (Goldman and Riosema, 2013; Nkedianye et al., 2011; see also Chapter 5) as well as social and economic changes to communities. Keeping large herds

also enabled the herder to restock from their own animals when necessary (Lind et al., 2016) as well as using livestock transfers to strengthen relations.

Keeping mixed herds has a number of benefits for all pastoralists: different livestock species utilise different parts of the forage, have different breeding and milking cycles (Dahl and Hjort, 1976; Fratkin, 1991), resistance to drought (Kashaye et al., 1998; Ouma, 2011) and disease (Fratkin, 1991). Among Maasai pastoralists, cattle have long been central to their culture as well as their economy and are a sign of wealth that also embodies an expression of good judgement, carrying high social standing and respect (Spear and Waller, 1993). But now there is a widespread shift towards keeping small stock (Ogutu et al., 2016; this Chapter).

6.2.3.1 Importance of cattle to Maasai communities

Cattle have been central to pastoralist communities and represent more than just an economic commodity. They have customarily been considered more important in terms of prestige and status compared with sheep and goats (Cronk, 1991). Maximising the potential of a herd has wide-reaching social implications for the herder and his community because they are embedded in social relations (Broch-Due, 1999; Cronk, 1991). They are significant in terms are providing the means to establish strong networks through relations of reciprocity with other herders (Broch-Due, 1999). The more livestock you have the more transactions and exchanges are likely to occur. Depending on social ties can be particularly important during times of hardship, such as drought (Broch-Due, 1999). They also hold great importance in ritual and ceremony. For example, they symbolise the bond between a groom and his bride's family when bridewealth payment is received at the marriages of daughters (Cronk, 1991; Ferguson, 1985). Increasingly these social relations are expressed through small stock, however modest by comparison to cattle. Changes in herd dynamics as a response to drought will impact on social relations and potentially change the cultural importance of cattle.

This Chapter will look at the impacts of extreme climatic events on livestock holdings in East Africa rangelands by answering the following question: what are the impacts of extreme climatic events on livestock holdings for Laikipia pastoralists? (RQ D), and in particular address the following research objectives:

1. Identify patterns of and trends in livestock holdings.

2. Compare livestock loss for drought and non-drought years.
3. Evaluate if wealth and area affect numbers of livestock lost.
4. Compare the main causes of livestock loss and assess whether HWC patterns differ for drought and non-drought years and across species by modelling causes of livestock loss and focusing down on predation and it impacts on livestock in relation to drought.

6.3 Results and discussion

6.3.1 Livestock owned

This section looks at the number of livestock kept by each household in all the study sites immediately prior to XCE years 2000 and 2009, and non-XCE years 2011 and 2012. Three main types of livestock were kept in the study areas: cattle, goats and sheep. Camels were owned by very few people and only in small numbers (n=215 TLUs or 1.4% of total TLUs kept during the four years studied) and are not considered further here. Recall data were collected on the numbers of cattle, goats and sheep owned immediately prior to major drought events in 2000 and 2009 and then on numbers lost in those droughts. Data were collected on current holdings and losses for non-XCE years observed at the time of the study during 2011 and 2012 for comparison. Relatively low figures from 2012 reflect the way pastoralists were still recovering in terms of herd size from the 2009 XCE (Table 6.1 and Table 6.2).

In 2012, the number of livestock owned varied across the three study sites, with small stock making up the majority (~63% TLUs). The larger group ranch Il Motiok owned more livestock (TLUs) overall than Il Polei or Lekiji. The mean number of TLU/AE was the same for Il Motiok and Il Polei, but lower for Lekiji village (Table 6.2).

Table 6.3 shows the difference in mean livestock holdings (mean TLUs per household and per AE) by wealth rank, of both WR1 (based on local perceptions of wealth ranks) and WR2 (wealth ranks based on livestock holdings only).

In 2012, households in the richest wealth rank on average own around an order of magnitude more livestock per adult equivalent than households in the poorest category (Table 6.3). In this study, the total number of livestock owned has

decreased across the three study sites since 2000. At the time of this study the livestock population was still recovering from the 2009 drought, and showing signs of ongoing recovery with livestock TLUs higher in 2012 than 2011 (see Table 6.1), but livestock numbers owned across the three study sites were nonetheless ~37% lower than since pre-drought 2000.

Table 6.1 Tropical livestock units (TLUs) owned by sample households (n=195) across the three areas. For drought years (2000 and 2009) numbers represent recall data on livestock owned pre-drought. For non-drought numbers (2011 and 2012) represent data collected at time of study.

	Pre-drought (recall)	**Pre-drought (recall)**	**Post-drought (recovery observed)**	**Post-drought (recovery observed)**
Livestock	2000	2009	2011	2012
Cattle	3594	1803	694	879
Goat	1658	1931	902	1038
Sheep	1102	1036	351	434

Table 6.2 Total number of households (HHs), TLUs per HH and per adult equivalent (AE) for each study site (2012 data).

	Il Motiok	**Il Polei**	**Lekiji Village**
Total HHs	77	66	52
TLU per HH	15.1	11.2	8.7
TLU per AE	3.2	3.2	2.5

Table 6.3 Number of households (HHs), mean TLUs per HH and mean TLUs per AE in 2012 for each wealth group.

WR1	**A**	**B**	**C**	**D**
Total HHs	22	37	54	82
TLU per HH	39.4	13.1	11.6	4.5
TLU per AE	10.9	3.2	2.6	1.2

WR2	Rich	Med	Poor
Total HHs	15	39	141
TLU per HH	52.1	15.5	6.8
TLU per AE	14.1	4.5	1.6

Cattle herds have decreased the most (~76%) followed by sheep (~60%) and goats (~37%) since 2000. A decline in cattle numbers, albeit significantly less (~25%)

was also reported by Ogutu et al. (2016) across all of Kenya (including Laikipia), but not for the Laikipia region exclusively. However, Ogutu et al. (2016) did not report a decline in small stock which this study found. For example, in Laikipia, sheep and goats increased by 259.6% from 1977 to 2016 whereas cattle only increased by 7.3% (Ogutu et al., 2016). One reason for this might be the difference in spatial scales of the different studies. The DRSRS aerial data used by Ogutu et al. (2016) is broad-scale covering the whole of Kenya (and for all of Laikipia) including small-holder and large commercial ranches. This study focused on recording livestock kept by subsistence pastoralists using fine-scale local data collection, in three study areas collectively accounting for <1% of Laikipia District (9,666km^2).

Ogutu et al., (2016) reported there has been an increase in livestock numbers owing to increases in sheep, goats, camels and donkeys, but that livestock biomass overall has decreased. Reasons for this include species' differential drought responses and favourable market prices for small stock (in Kenya). The composition of livestock herds is changing in response to increases in extreme drought conditions.

In addition to reasons cited for the decline of livestock populations (human population increase, changes in land use, increased competition for and declining availability of water resources, subdivision and privatisation of land, which restricts seasonal movement and conservation initiatives (Thornton, 2010), aridification and rising temperatures are having a negative effect on tall grasses favoured by cattle (Ogutu et al., 2016). Thus, the changes pastoralists are making in the structure of herds are in part a response to the increase in frequency and intensity of droughts (Ogutu et al., 2016) whose effects are exacerbated by multiple interacting social, political and tenurial factors undermining established coping strategies.

Overall reduction in both the long and short rains, increases in spatial and temporal variability of precipitation as well the increase in daily temperatures has had a positive effect on the short grasses favoured by sheep and goats and browse preferred by goats and camels (Peden, 1987). In addition, small stock are less vulnerable to drought and populations are able to recover more quickly (Ouma, 2011). Cattle's longer gestation periods, and changes in vegetation to swards that are less suitable for cattle, are some of the reasons cited for the decline in their numbers in Kenya (Ogutu et al., 2016). The coupled effect of climate change and

socio-economic and political changes in Laikipia may increasingly make keeping small stock more favourable than cattle for pastoralist communities.

6.3.1.1 Livestock ownership among Laikipia Maasai

Livestock holdings (TLU/HH or TLU/AE) appear lower than those found by other recent studies of pastoralists in Kenya (Amboseli: BurnSilver, 2009; Mara: Thompson et al., 2009; Longido: Trench et al., 2009; Kitengela: Nkedianye et al 2009) (Table 6.4). The TLUs per AE for this study are also lower than Dahl and Hjort's (1976) estimated minimum herd size for subsistence, as well as for other studies of Maasai pastoralist communities (Table 6.4). ~90% of households that formed part of this study reported diversifying into other economic activities (see Chapter 4). Livestock holdings TLU/HH are in part low because the overwhelming majority of households in the present study were essentially living as nuclear families rather than in extended *Olmarei*, a trend increasingly widely observed among Kenya Maasai (Coast 2002; Talle, 1988; Chapter 3*).* However, in addition, Laikipia pastoralists today were largely derived from *Iltorrobo* hunter-gatherers dispossessed and impoverished (see Chapter 2) who had been relegated to the most arid part of Laikipia with the lowest productive potential, leading to low TLU/AE. Nonetheless, livestock still make the most important contribution in terms of household income for the majority of households included in this study (see Chapter 4).

The percentage for diversifying was noticeably higher when compared to other rural Maasai communities in Kenya (see Bedelian, 2014: Mara 11-61%; BurnSilver, 2009: Amboseli 32-70%; Trench et al., 2009: Longido 4-80%). Higher diversification is an inescapable necessary for pastoralist households with lower numbers of livestock. As pastoral ranges decrease, and numbers of livestock per capita reduce, they need to rely more on non-livestock sources of income for their livelihoods (Homewood et al., 2009).

6.3.1.2 Changes in herds composition

In Maasai communities, cattle have historically been by far the most important species of livestock. Maasai are known as "people of cattle" and cattle have been integral for several important cultural purposes (Galaty. 1982). Even so, this may be changing in Laikipia and more widely.

Table 6.4 Total number TLUs per adult equivalent (AE) compared across studies.

Area	TLU per AE	Source
Laikipia		
Il Motiok	3.2	this study
Il Polei	3.2	this study
Lekiji Village	2.5	this study
Amboseli		
Osilalei	5.4	BurnSilver 2009
Eselenkei	7.0	BurnSilver 2009
Lenkism	6.1	BurnSilver 2009
North Imbirikani	6.8	BurnSilver 2009
South Imbirikani	4.3	BurnSilver 2009
Emeshenani	8.7	BurnSilver 2009
Kitengela	7.2	Nkedianye et al 2009
Maasai Mara	13.0	Thompson et al 2009
Longido (TZ)		
Elerai	4.2	Trench et al 2009
Ngereyani	6.4	Trench et al 2009

Considerably fewer cattle were owned in the three study sites in all years compared to the pre-drought 2000 baseline year. Interviewees and informants stated that many people now kept fewer cattle and more goats because of the severe losses they experienced in the 2000 XCE. As two respondents recalled:

> "In the past people used to keep many cattle but not many sheep and goats. Today there are many sheep and goats and only a few cattle. People didn't choose to keep sheep and goats over cattle. It just naturally happened. Drought is the biggest killer and it will kill all your cattle but not all your sheep and goats. They are more drought resistant. Therefore, sheep and goat herds grew naturally because they did not die and could multiply. Cattle herds are difficult to grow, especially as extreme droughts come more often. They die and there is not enough pasture around to build up the herd. That is why today there are smaller cattle numbers and larger sheep and goat herds."
> *Jose, male herder, 56*

> "When I was a boy (in the 1950s) there were many cattle and few sheep and goats. For example, in 10 homesteads all had big numbers of cattle but only 2 of them kept a few sheep and goats. That's because there were few extreme droughts to kill them [cattle]. Not many people kept sheep and goats because they could not see the benefit of them. Even if you

> wanted to eat meat, you slaughtered a cow. After 1973[21], sheep and goats grew to big numbers as everyone started to keep them. Now, everybody keeps sheep and goats and no-one ever really slaughters cows any more. People keep bigger sheep and goat herds than cattle these days. Some people even choose not to own cattle because they are not drought tolerant and extreme droughts come too quickly to build up cattle numbers. People noticed that goats were more resilient in comparison to cattle so choose to keep these more now. I think this change has come about because of extreme droughts being more frequent."
> *Pedro, male herder, 76*

In Laikipia's Mukogodo Division, herds are changing from being cattle-dominated to sheep and goat-dominated (Huho and Kosonei, 2013; Ogutu et al., 2016). The majority of household herd numbers in Laikipia (~70-80%) are made up of sheep and goats (Huho and Kosonei, 2013), a higher proportion than recorded in this study. The increase in keeping small stock has been for three main reasons: 1) small stock are more resilient to droughts, 2) reproduction rates are higher in small stock and 3) small stock are easier to convert to cash during drought (Huho and Kosonei, 2013). The shift from cattle to small stock is seen across Kenya (aerial census data: Ogutu et al., 2016) and sub-Saharan Africa generally (Toutain et al., 2010; Aklilu and Catley, 2010). Small stock can reproduce more quickly dropping two kids or lambs in 12 months (McCabe, 1987) and have long been a way for the poorest to re-establish diminished herds (Dahl and Hjort, 1976; Homewood, 2008):

> "There were large numbers of livestock and few people when I was young because there was free land for grazing and there were no diseases to kill livestock. Everybody kept cattle but only a few people kept sheep and goats. Today, there are more people but people have fewer livestock than they used to. All people keep sheep and goats today and some people don't keep cattle".
> *Joey, male herder, 58*

Elsewhere in Kenya, the rise in the number of small stock kept has also been driven by quite different reasons: favourable market prices and also partly for reasons of ease of management in an increasingly fragmented landscape.

[21] Kenya experienced a major drought episode in 1973/74 (Hillman & Hillman, 1977).

"People used to keep more cows and fewer goats. The environment was good so you could keep many cows. The land was not divided so you could take your livestock to good places for pasture. Now at those good places, you must request to take your cattle there or else they will die because there is no pasture at home. People changed to keeping more goats because they are easier to manage. They don't need much whereas cows are harder to keep. People liked keeping cows because there was plenty of pasture but now goats are better to have because of the droughts and dry months".
Jimmy, male herder, 27

All respondents also said that there are more small stock today, especially goats. Some respondents reported the change occurring after an XCE:

"People in Lekiji used to have a lot of cattle but now much fewer people keep cattle. People even used to keep many camels here. When we had many cattle, there were less goats around. Many people lost a lot of cattle in the 1999/2000 drought. After that people chose to keep goats instead of cattle. Fewer sheep are kept in comparison to goats and it's always been like that".
Kevin, male herder, 32

Younger herders are more likely to sell livestock compared to older herders. Younger herders see livestock more from a business standpoint, whereas older herders' main reasons for selling are for meeting subsistence costs:

"Younger people will sell their livestock if a drought is coming but the older people will not because livestock is their status and a cultural symbol. Younger people see livestock more as a business so do not mind selling their livestock if a drought comes. They will just replace them when the drought passes. But the elders will not sell them even if they know a drought is coming. There is an age divide between the younger and older men in how they think of their livestock".
Barry, male herder, 29

"So younger men are willing, and will sell their livestock and put the money in the bank to minimise their losses. Then they will use that money to restock after the drought. Elders think it is wrong to sell animals – that's not what animals are for. They keep hold of their livestock and go and find pasture and hope they will survive the drought. The elders remember droughts from years ago and feel that they did not lose that many animals in those droughts. So although they lose a lot now, they still hope they won't and it will be like the old days, where

most of the animals survived".
Richard, male herder, 31

6.3.2 Livestock losses

Overall patterns of livestock loss by area, wealth, species and reasons for loss are presented throughout this Chapter in terms of TLUs. Livestock losses disaggregated by area are presented as TLU/AE. Livestock losses are given as a percentage lost of the numbers of that livestock species owned. These analyses then culminate with mixed effects models exploring the relative importance of these different factors in determining patterns of livestock loss. The discussion puts into perspective the differences between sites in patterns of livestock loss by wealth, by site, by species and by cause of death, relating these patterns to site, species and household specific conditions, and to comparative findings from the literature.

6.3.2.1 Overall livestock loss

For the four specific years on which this study focuses (drought years 2000 and 2009 and non-drought years 2011 and 2012), a total of 7,103 TLUs were reported lost by respondents in the sample. Of all livestock owned, 46.1% were lost during the years for which data (both recall and observational) were collected. As expected, considerably more livestock were lost during drought years: 63% and 58% TLUs in 2000 and 2009 respectively. Losses for non-drought years were 7.8% overall; 9.5% and 6.5% TLUs for 2011 and 2012 respectively (Table 6.5). Mean total stock losses per household were 34.7 TLUs for drought years and 1.7 TLUs for non-drought years. As expected, total livestock loss was significantly associated with drought ($f = 158.4$, $df = 1$, $p = <0.001$), making the figures for losses overall consistently very close to those for drought losses (Tables 6.5 through 6.8).

Table 6.5 TLUs lost as % of TLUs for that species kept.

Livestock	**2000**	**2009**	**2011**	**2012**
	% TLUs lost	% TLUs lost	% TLUs lost	% TLUs lost
Cattle	74.9	62.7	4.9	2.7
Goat	37.1	46.2	11.9	9.0
Sheep	62.8	71.6	12.2	8.4
Total	63.0	58.0	9.5	6.5

Drought losses in this study were similar to those found in other studies on drought losses in Kenya. Livestock losses in Kitengela reached ~43% TLUs (all species) in the 2005/2006 drought (less severe than 2000 and 2009 XCEs), although three other areas included in the study (Amboseli, Mara and Simanjiro) suffered fewer livestock losses during the same period (14-30% of livestock owned) (Nkedianye et al., 2011). However, losses reported by recall data in this study for the 2009 XCE were lower (~58% TLU) than the 70-90% of livestock reportedly lost across Kenya for that period (see Huho and Kosonei, 2013). Reasons for lower figures could be 1) livestock numbers were already severely depleted in Laikipia by the 2000 XCE, and had not yet recovered (see Table 6.1) so losses might be expected to be proportionally lower in 2009 XCE and 2) recalling losses can be difficult for some individuals, especially estimating numbers of small stock compared to cattle numbers lost. In addition, when small stock die in large numbers, herders often stop counting the losses (McCabe, 1987; Chapter 3). Cattle on the other hand are likely to be more clearly remembered.

Table 6.5 shows that proportionally more cattle were lost in 2000 XCE (75%) than in 2009 XCE (63%). This is likely to be for two reasons. Firstly, the numbers of cattle kept in the run up to the drought of 2009 were around half the numbers recorded for pre-drought 2000 (Table 6.1). Twenty key informants were asked about changes in livestock numbers and composition during their own lifetime. Each one said there were far more cattle when they were a small boy than there are today. Secondly, 2009 XCE was the first-time herders could access water and grazing by paying the neighbouring commercial ranches:

> "We could start putting out livestock on Commercial Ranches in 2008 (Ol Jogi and Mpala Ranches). It is just cattle, no sheep or goats are allowed. All of Lekiji can put up to 120 cattle on Ol Jogi. We don't have more than that so they are all on Ol Jogi now".
> *Kevin, male herder, 32*

The effects of the emerging strategy of cattle herders paying for grazing on the neighbouring commercial ranches during the 2009 XCE is likely to have made a major difference (Chapter 5), going some way to make up for the loss of access through land fragmentation, tenure changes and fencing (Jimmy's quote p.174 this Chapter).

6.3.3 Livestock losses by area, wealth species and reason

6.3.3.1 Area

Patterns of drought stock loss varied with area and species (Table 6.6). Overall cattle losses were highest in Il Motiok and Il Polei (where higher numbers of cattle were owned than at Lekiji but with less possibility for purchasing access to commercial ranches). What cattle were owned at Lekiji were all on the neighbouring commercial ranch (Chapter 5). Goat losses were highest in Lekiji and sheep losses were highest in Il Motiok (although very similar at Il Polei).

Table 6.6 Livestock losses for each study site, expressed as a % of all TLUs owned in that study site.

Area	% loss of livestock at each study site	Overall % TLUs lost	Non drought % TLUs lost	Drought % TLUs lost
Il Motiok	total livestock owned Il Motiok	51.4	1.9	50.9
Il Polei	total livestock owned Il Polei	34.9	1.9	33.3
Lekiji	total livestock owned Lekiji	37.2	4.0	33.2

All areas lost more livestock during drought years than non-drought years, but nonetheless location was an important determinant of livestock loss (see Table 6.6) and perhaps of the larger number of livestock lost in Il Motiok overall. Il Motiok lost ~51% of TLUs owned compared to Il Polei (~35% TLUs) and Lekiji (~ 37% TLUs) (Table 6.6), dictated by patterns of loss during drought. Fewer livestock were lost in Il Polei and Lekiji both overall and specifically during drought. Both communities live near main roads and households were more diversified than at Il Motiok (Chapter 4) perhaps opening up alternatives (eg. sale of livestock; purchase of fodder). In non-drought years Lekiji lost around twice as much (4%) as Il Motiok (~2%) and Il Polei (~2%) (see Table 6.6). Lekiji is <1000 acres in size and is surrounded by large scale commercial ranches, both of which have 'hard' borders and do not allow grazing of small stock on their land. By contrast Il Motiok and Il Polei would be able to negotiate access with neighbouring Group Ranches in Mukogodo through social ties within and across the different communities. Lekiji's community includes many families that have been displaced and/or are herders not originally from Laikipia (see Chapter 2).

6.3.3.2 Wealth

Wealth was also a major determinant with the wealthiest losing proportionally the fewest TLU. In WR1 (wealth rank from multiple dimensions) group A lost fewer TLUs both overall and during XCEs (~36% TLUs owned in group A were lost, as against 45-53% TLUs owned for the three other groups B, C and D in WR1). Similarly, in WR2 (wealth rank by TLU/AE), the Rich group reported fewer losses (40% of livestock owned in group Rich) though livestock losses for the Medium and Poor group are similar (49% and 48% overall respectively).

In WR1 the best-off group A lost fewer TLUs than did the less well-off groups (though this effect is not confirmed as significant by the linear mixed effects model set out in the following section of this Chapter). In WR2, the wealthiest group Rich also lost fewer livestock compared to the other groups, a finding confirmed as significant by the LME ($P<0.05$) for the poorest group (see Table 6.16). Losses are concentrated among the poorer households for a whole range of interlocking reasons, both social and economic. As livestock are used for social purposes (eg. loans, bride wealth and gifts), keeping larger herds can build more social alliances through transferring livestock to friends and family (Oba and Lusigi, 1987).

Table 6.7 Total livestock losses (TLUs) for each wealth category expressed as a percent of the number of TLUs in each wealth category

Wealth	**% loss of livestock**	**Overall % TLUs lost**	**Non-drought % TLUs lost**	**Drought % TLUs lost**
WR1				
A	of total livestock owned in A	35.6	5.4	55.8
B	of total livestock owned in B	53.3	8.2	69.3
C	of total livestock owned in C	45.4	9.1	58.8
D	of total livestock owned in D	51.1	10.8	59.8
WR2				
Rich	of total livestock owned in Rich	40.3	3.9	58.5
Med	of total livestock owned in Med	48.8	8.2	66.2
Poor	of total livestock owned in Poor	47.9	10.7	59.1

Poorer pastoralists with fewer livestock also have less purchasing power (Oba, 2001b). This constrains options in drought, particularly cash-based strategies such as purchasing fodder or access to grazing (see Chapter 5). Access to markets may become even more constrained and poorer herders may be less able to sell their

livestock before the animals die, losing even this action of last resort to salvage something from drought losses.

6.3.3.3 Species

Species are not all equally affected. More cattle are lost both overall and during drought periods. Fewer goats are lost both overall and during drought periods. Similar proportions of goat and sheep TLUs were lost for non-drought years (around 10% of goats and sheep owned: Table 6.8).

Table 6.8 Total number of livestock losses (TLUs) for each species.

Livestock species	% loss	Overall % TLUs lost	Non-drought % TLUs lost	Drought % TLUs lost
Cattle	of total cattle owned	55.7	3.7	70.9
Goats	of total goats owned	30.9	10.3	42.0
Sheep	of total sheep owned	51.8	10.1	67.1

However, when 2000 and 2009 XCEs are separated it shows that cattle losses were around 16% lower in 2009 compared to cattle losses in 2000 drought. Goat and sheep losses increased in the 2009 drought compared to the 2000 drought by ~20% and ~12% respectively (Table 6.9).

Table 6.9 Number of livestock losses (TLUs) for each drought separated.

Livestock species	% loss	2000 drought % TLUs lost	2009 drought % TLUs lost
Cattle	of total cattle owned	74.9	62.7
Goats	of total goats owned	37.1	46.2
Sheep	of total sheep owned	62.8	71.6

6.3.3.4 Reason for loss

Starvation accounted for the majority of TLUs lost (~35% of TLUs owned being lost to starvation, both overall and during XCEs). The second main cause of death was disease (responsible for ~8% losses both overall and during XCEs). Predation accounted for the loss of only a small proportion: around 1% TLUs owned, both overall and during XCEs (Table 6.10).

Table 6.10 Total number of livestock losses (TLUs) for each reason responsible for livestock deaths.

Reason for stock loss	% loss	Overall % TLUs lost	Non-drought % TLUs lost	Drought % TLUs lost
Starvation	of total livestock owned	34.5	0.05	34.7
Disease	of total livestock owned	8.9	1.4	7.5
Predation	of total livestock owned	1.1	0.5	1.2
Accident	of total livestock owned	0.2	0.1	0.04
Raiding	of total livestock owned	0.1	0.01	0.1
Other	of total livestock owned	0.4	0.1	0.3

6.3.4 Losses disaggregated by area and by wealth

6.3.4.1 Il Motiok

Il Motiok Group Ranch is the largest of the three study sites in size of land area and number of households. It also kept more livestock overall than the other two study sites. It borders three commercial ranches (Mpala Ranch, Soita Nyiro Ranch Mukogodo Ranch) and two group ranches (Koija and Tiemamut). It is more remote than either Il Polei or Lekiji; and is not positioned on a main road. Il Motiok sits between two main rivers – Ewaso Nyiro River (permanent) and Losupukiai River (seasonal). Crop cultivation started around 2007 and is concentrated along the Ewaso Nyiro River but harvests were unreliable due to poor rainfall. Around 10% of the group ranch has been set aside for wildlife conservation through the help of Mpala Ranch.

In Il Motiok the richest WR1 group A reported considerably fewer losses overall of livestock owned and during non-drought years (~39% TLU owned/AE). Groups B, C and D all reported heavier proportional losses (45-60% TLU/AE): Table 6.11). However, during drought the two richer WR1 groups A and B lost proportionally more than the two poorest C and D groups (Table 6.11). Similar results were obtained for WR2. While Il Motiok had fewer losses in the Rich group (~48% TLU owned /AE) both overall and during non-XCEs, during drought the Poor group lost proportionally fewer livestock (62% TLU/AE) than Rich and Medium groups (72% and 66% respectively) (Table 6.11). This may have been because the poorer had very few livestock to start with.

Table 6.11 Loss of livestock (TLU/AE) at Il Motiok for each wealth group.

Wealth WR1	**% loss of all livestock owned at Il Motiok**	**Overall lost % TLUs/AE**	**Non-drought lost % TLUs/AE**	**Drought lost % TLUs/AE**
A	total livestock owned Il Motiok	39.4	6.1	66.8
B	total livestock owned Il Motiok	59.8	8.6	73.3
C	total livestock owned Il Motiok	45.4	8.5	58.1
D	total livestock owned Il Motiok	54.0	10.8	63.1
WR2				
Rich	total livestock owned Il Motiok	47.6	5.0	71.7
Med	total livestock owned Il Motiok	50.3	8.4	65.6
Poor	total livestock owned Il Motiok	54.4	13.7	61.6

6.3.4.2 Il Polei

Il Polei is a little more than half the size in land area (5,000 acres) than Il Motiok. It is located on the main Dol-Dol road from Nanyuki (~40kms away) going towards Dol-Dol. It borders two large scale commercial ranches (Ol Jogi and Chololo) and three group ranches (Munichoi, Murupusi and Makaurian) and has access to the Ewaso Nyiro River. The 'centre' of Il Polei is shared with Munichoi, which is also situated on the same main road. Although I interviewed residents that were from Il Polei, the centre had a mixture of herders and families from the two group ranches equally.

Il Polei's position on the main road made access to the local livestock markets (Dol-Dol and Kimanjo) and market town of Nanyuki easier than Il Motiok.

At Il Polei, livestock losses in WR1 group A were also fewer for overall and non-drought years (27% and 4% TLUs owned/AE respectively) compared to groups B, C and D (Table 6.12). For WR2 group Rich reported fewer losses for overall (27% TLUs owned at Il Polei/AE), non-drought (3%) and drought years (40%) (Table 6.12).

6.3.4.3 Lekiji

Lekiji is the smallest of the three study sites (~1000 acres). It is not a group ranch but a stretch of land between two large commercial ranches at the junction between the Ewaso Nyiro and Nanyuki Rivers, a site considered an important wildlife corridor. People first settled here in the 1960s after Kenya's independence.

Table 6.12 Loss of livestock (TLU per adult equivalent) at Il Polei for each wealth group.

Wealth WR1	% loss of livestock Il Polei	Overall lost % TLUs/AE	Non-drought lost % TLUs/AE	Drought lost % TLUs/AE
A	total livestock owned Il Polei	27.1	4.1	43.5
B	total livestock owned Il Polei	48.1	4.4	76.7
C	total livestock owned Il Polei	42.9	8.9	55.2
D	total livestock owned Il Polei	38.8	12.3	43.7
WR2				
Rich	total livestock owned Il Polei	26.6	2.9	39.9
Med	total livestock owned Il Polei	52.9	4.6	63.8
Poor	total livestock owned Il Polei	35.9	9.0	53.0

They were originally labourers for a white Kenya farmer who occupied the land and gifted it to them when he left for Britain. However, since 1996 there have been many eviction attempts, often ending in violence.

The community here was notably poorer than either Il Polei or Il Motiok and have fewer government facilities. Ol Jogi and Mpala both were investing in schools in Lekiji and sponsoring several children.

The pattern of loss at Lekiji with respect to WR1 wealth categories was again mixed, with most losses reported for the least well off (WR1 D) in Lekiji. Local perceptions of wealth allowed for four categories A-D, but WR2 ranks (allocated according to TLUs owned) placed no households in group Rich. WR2 wealth ranks at Lekiji showed livestock losses concentrated in group Poor both overall and during XCEs (41-60% TLU owned/AE) compared to Medium (29-53% TLU owned/AE lost: Table 6.13).

Table 6.13 Loss of livestock (TLU per adult equivalent) at Lekiji for each wealth group.

Wealth WR1	% loss of livestock Lekiji	Overall lost % TLUs/AE	Non-drought lost % TLUs/AE	Drought lost % TLUs/AE
A	total livestock owned Lekiji	36.6	13.8	59.2
B	total livestock owned Lekiji	29.0	10.6	46.9
C	total livestock owned Lekiji	34.5	8.6	58.6
D	total livestock owned Lekiji	48.0	9.6	65.2
WR2				
Rich	total livestock owned Lekiji	No HHs in Rich group		
Med	total livestock owned Lekiji	29.2	13.3	53.0
Poor	total livestock owned Lekiji	41.0	9.4	60.1

6.3.5 Overall losses of livestock with drought and non-drought interactions

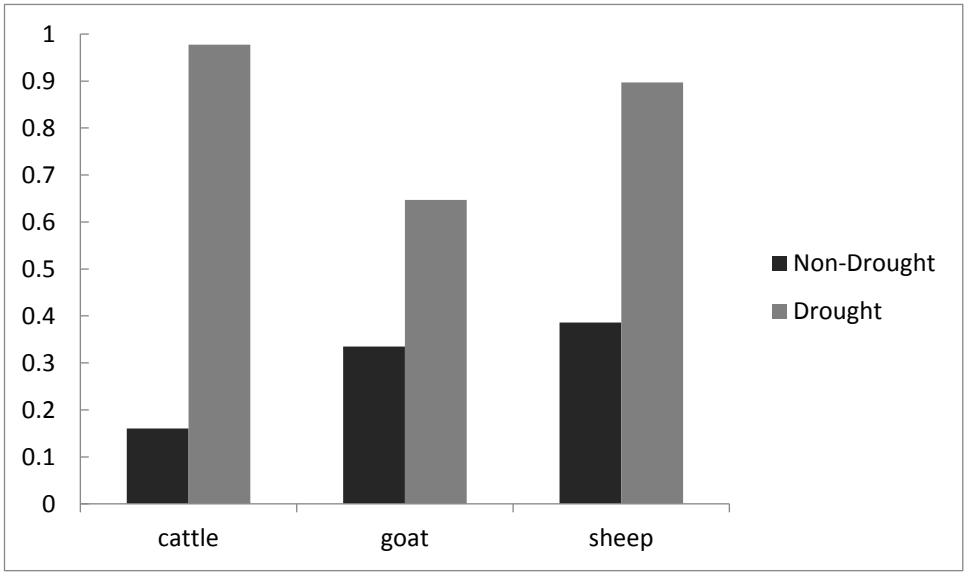
Table 6.14 shows the results from the final linear mixed effects models (A and B) exploring and pulling together overall livestock loss in drought and non-drought years (LME). Data were transformed before analysis to ensure normality (see Chapter 3). Model A uses WR1 wealth ranks based on local criteria. Model B uses WR2 wealth ranks according to relative livestock holdings TLU/AE. In both models, livestock losses during drought years were significantly higher than losses during non-drought years.

Table 6.14 Results from LME model investigating reported total livestock losses during drought and non-drought years. Model selection was performed using Akaike's information criterion (AIC), with lower scores indicating a better model. Confounding factors such as village, household head age and education level of HH head were excluded from the model because they produced higher AIC scores. The best fit model is shown, and includes drought and non-drought years, livestock species, wealth, area and the interaction between livestock and drought/non-drought years. Household ID was the random effect. The two models depict the two different wealth rankings used in this study. Model A fits the WR1 variable and model B fits the WR2 variable.

Dependent	**Parameters**	**Value**	**s.e.**	***t*-value**	***p*-value**
A					
Total livestock loss = TLU/AE	Intercept	1.011	0.041	24.414	0.0000
	Drought	-0.801	0.033	-24.020	0.0000
	Goat	-0.324	0.029	-11.156	0.0000
	Sheep	-0.080	0.031	-2.613	0.0095
	Il Polei	-0.645	0.026	-2.468	0.0145
	Lekiji	-0.041	0.030	-1.359	0.1759
	Drought x goat	0.495	0.042	11.792	0.0000
	Drought x sheep	0.297	0.045	6.609	0.0000
	WR1 B	0.019	0.041	0.047	0.6385
	WR1 C	-0.024	0.038	-0.619	0.5363
	WR1 D	-0.021	0.037	-0.572	0.5678
B					
Total livestock loss = TLU/AE	Intercept	0.929	0.045	20.724	0.0000
	Drought	-0.799	0.033	-23.937	0.0000
	Goat	-0.327	0.029	-11.256	0.0000
	Sheep	-0.083	0.031	-2.685	0.0075
	Il Polei	-0.616	0.025	-2.426	0.0163
	Lekiji	-0.045	0.030	-1.475	0.1420
	Drought/ x goat	0.494	0.042	11.752	0.0000
	Drought/ x sheep	0.299	0.045	6.636	0.0000
	WR2 med	0.061	0.045	1.337	0.1830
	WR2 poor	0.083	0.040	2.034	0.0434

In addition, significant interactions between drought and livestock type shows that there is a non-linear impact of drought on cattle, goat and sheep losses. Losses of cattle during drought years were disproportionately high compared with non-drought years, whereas losses of goats during drought years were disproportionately low compared with non-drought years (Figure 6.2). Thus, droughts were associated with much higher proportional loss of cattle than small stock, particularly goats.

Figure 6.2 Graph shows livestock loss for drought and non-drought years using transformed data as in the analysis (see Chapter 3).



Area was also important in both models. Livestock losses in Lekiji did not significantly differ from losses in Il Motiok but losses in Il Polei were significantly lower. Wealth based on local criteria (WR1) was not significantly associated with level of livestock losses in Model A. However, in Model B wealth ranking (based on livestock kept) did play a role, and the poorest group was associated with significantly more livestock losses than the richest group ($p<0.05$).

Table 6.15 shows the results from the final linear mixed effects models (C and D) exploring livestock losses to predation in drought and non-drought years. In both models, livestock losses to predation during drought are significantly higher than losses during non-drought ($p<0.05$), although the differences are less marked than those observed for total losses. Sheep and goat losses were significantly different

compared to cattle losses: more sheep and goats were lost to predation than cattle ($p<0.001$). However, livestock loss to predation was not associated with wealth, using either the WR1 or WR2 wealth ranking system.

Table 6.15 Results from LME model investigating reported livestock losses to predation during drought and non-drought years. Model selection was performed using Akaike's information criterion (AIC), with lower scores indicating a better model. Confounding factors such as area, village, household head age and education of HH head were excluded from the model because they produced higher AIC scores. The best fit model is shown and includes drought and non-drought years, livestock type and wealth. Household ID was the random effect. The two models depict the two different wealth rankings used in the study: Model C fits the WR1 variable and model D fits the WR2 variable.

Dependent	**Parameters**	**Value**	**s.e.**	***t*-value**	***p*-value**
C					
Total stock loss to predation = TLU/AE	Intercept	0.035	0.211	1.666	0.0964
	Drought	0.0277	0.011	2.479	0.0135
	Goat	0.050	0.0136	3.653	0.0003
	Sheep	0.069	0.014	4.698	0.0000
	WR1 B	-0.011	0.024	-0.455	0.6493
	WR1 C	-0.013	0.022	-0.611	0.5421
	WR1 D	-0.013	0.021	-0.629	0.5300
D					
Total stock loss to predation = TLU/AE	Intercept	0.33	0.244	1.365	0.1729
	Drought	0.028	0.011	2.506	0.0125
	Goat	0.049	0.014	3.592	0.0004
	Sheep	0.068	0.015	4.683	0.0000
	WR2 Med	-0.021	0.026	-0.796	0.4266
	WR2 Poor	-0.006	0.023	-0.264	0.7917

6.4 Conclusion

Laikipia pastoralists now have lower numbers of livestock per HH/AE than other studies in Kenya. This is likely because Laikipia pastoralists were impoverished to begin with and have historically kept lower numbers of livestock compared to other Maasai pastoralists. This derives from their mixed origins from hunter-gatherers *il-torrobo* merging with Maasai pastoralist survivors of 19th century war and disease to constitute Mukogodo Maasai (see Chapter 2).

The number of livestock kept by Laikipia pastoralists today is lower than numbers kept in pre-drought 2000. This study showed cattle numbers had dropped considerably (~76%). The smallest drop was in goats (~37%). The decrease in

cattle numbers kept in this study is considerably more than Ogutu et al., (2016) found (~25%) in their national level study of aerial census data, which includes livestock owned by large scale commercial ranches and people not engaged in subsistence pastoralism. The present study collected data at the local level at a finer scale from the three study sites jointly making up <1% of the total area of Laikipia District. The DRSRS aerial survey, although systematic, might not pick up the differentiated changes occurring in Maasai and other pastoralist communities disaggregated within the Laikipia landscape overall.

Small stock made up the majority of herds kept in this study (~63%). According to the DRSRS data there has been an increase of ~259% in small stock kept in Laikipia since surveys began (1977) (Ogutu et al., 2016). One of the main reasons respondents reported keeping more small stock was because they were more likely to survive a drought compared to cattle, continuing the pattern of pastoralist response and adaptation to drought over millennia to help minimise loss of livestock in highly variable climatic conditions.

The first DRSRS aerial survey data collection followed some of the worst drought years on record for sub-Saharan Africa (see Nyandega, 1990). Many pastoralists had already lost livestock during this period (Fratkin, 2007). In Laikipia annual rainfall for 1976 (544.3mm) was similar to annual rainfall in 2009 (521.4mm) (see Fig 6.1). Similarly, Laikipia Wildlife Forum's (LWF) aerial surveys, which have been systematically surveying Laikipia since 1985, began in a year following one of the worst droughts in recent history (with 1984 still known as the 'big' drought). Figure 6.1 shows 1984 had the lowest annual rainfall for the 54-year period covered by records (335.5mm). For both DRSRS and LWF series, livestock numbers in Laikipia started from an exceptionally low baseline.

Laikipia has seen rapid changes in land use and land tenure (Letai and Lind, 2013; Chapter 5) which negatively impacts subsistence pastoralism in the region. Land fragmentation results in the loss of access to important key resources (Galvin et al., 2007; Chapter 5). Laikipia pastoralists now occupy ~7% of the land area they once controlled (Letai and Lind, 2013). Since the adjudication of communal rangelands in the 1970s, pastoralists in Laikipia have become increasingly sedentary. That means they usually keep smaller herds and need to diversify more to meet household demands (BurnSilver, 2009), as found in this study (see Chapter 4; this Chapter).

Considerably more livestock were lost during XCE than in non-XCE years. Losses in this study were of the same order as for other studies on drought losses in Kenya. However, losses reported by recall data in this study for the 2009 XCE were lower (~58% TLU) than the 70-90% reportedly lost across Kenya for that period (see Huho and Kosonei, 2014). Reasons for these lower figures could be in part methodological: recalling losses can be difficult for some individuals, especially estimating numbers of small stock (Chapter 3). When small stock die in large numbers, herders often stop counting the losses (McCabe, 1987). However, cattle losses tend to be well remembered.

Patterns of loss vary with area, wealth and species. Livestock losses were highest in Il Motiok both overall (~51%) and during drought (~51%). Cattle losses were highest in Il Motiok both overall and in drought years. Il Motiok kept more livestock than either Il Polei or Lekiji and it is also the study site most remote in location. Il Polei and Lekiji had the option to put all their cattle on Ol Jogi Ranch whereas Mpala Ranch offer Il Motiok paid access for a limited number per household during drought times. Households in Il Polei and Lekiji were more diversified than Il Motiok (Chapter 4), largely owing to their position on main roads to Nanyuki market town making alternative options possible.

Overall, wealthier households lost less livestock than poorer ones. However, this differed between study sites. Il Polei wealthiest groups (WR1 A and WR2 Rich) lost the least livestock for overall (~27%), drought (~43%) and non-drought (~4%). Il Motiok wealthiest groups (WR1 A and WR2 Rich) lost the least livestock for overall (~39%) and non-drought (~6%) whereas medium wealth groups lost more than either richest or poorest in drought times (~60% and ~50% respectively). Il Motiok is more remote than Il Polei and paying for grazing on the neighbouring commercial ranch may have been an option only available to the wealthier group because of the costs involved. In Lekiji the poorest groups (WR1 D and WR2 Poor) lost most livestock both overall (48%) and during drought (~62%). They lost less during non-drought years, likely because the poorer groups keep so few livestock at Lekiji in the first place.

Wealthier households have larger herds and can sell livestock to pay for private pasture and fodder. They are also likely to have stronger social networks so can rely on these ties during times of hardship. Goldman and Riosema (2013) see pastoralists better able to adapt and lose less livestock if they have the right entitlement bundles to effectively cope with drought. All the study sites had the

opportunity to pay for grazing in the 2009 drought but not all herders would have been in a position to benefit equally. This study asked a binary question relating to paying for grazing – yes or no. It did not capture the number of cattle that were grazed from each household or the length of time each individual animal was kept on the commercial ranch nor total amounts paid. Further investigation, especially given that this is a new adaptive response to drought, would make more clear who really gains from paying for grazing during drought times.

Losses differed for different species with more cattle being lost overall (~56%) and during drought times (~71%). Cattle are less drought tolerant than small stock. Small stock are also easier to convert to cash than cattle, with trade in small stock more resilient while market prices plummet for cattle in drought (see Chapter 4), meaning it is possible that more small stock could be sold off before they were likely to die. More cattle died than either sheep or goats in part because they are the herds most likely to be moved long distances. Nutritionally severely stressed animals may be further weakened because of the physical difficulties of increasingly long and problematic treks to drought refuges (Chapter 5). Upland destinations may have cold and wet conditions which readily kill livestock weakened by drought (cf. McCabe, 1987). Furthermore, livestock may be exposed to new diseases for which they have no prior immunological experience. During the drought in Kenya 1979-1981, 65% of cattle died from contagious bovine pleuropneumonia (CBP), which accounted for more losses than did starvation during this period (McCabe, 1987). In the present study, CBP was said by one KI to be responsible for most deaths among livestock people took to drought refuge grazing on Mt Kenya (see Chapter 5).

Starvation reportedly killed more livestock than other factors overall (~35%) and during drought (~35%). Disease was the second most cited reason for livestock dying during drought years. However, differentiating losses between starvation and disease is complex as the two work in synergy. This is because when an animal is starving it will die from a disease it would normally weather if it were in better condition (Oba, 2001a). Disease was reported to kill more livestock during non-drought years (1.4%).

However comparing losses for the two drought years (2000 and 2009) independently, there was a drop in cattle losses of ~16%. I would attribute this to two reasons: firstly, less cattle were kept overall prior to 2009 drought compared to 2000 and secondly the communities had the option to pay for graze from the

neighbouring commercial ranches in 2009 XCE. Likewise, there was an increase in small stock losses from 2000 to 2009 of ~20% for goats and ~12% for sheep.

During non-drought years, more small stock are likely to die. Cattle at Il Polei and Lekiji are now able to graze on Ol Jogi all year round. And Laikipia pastoralists are keeping more small stock owing to their relatively stronger tolerance to drought. However, increase in small stock losses will rise as pastoralists continue to grow these herds.

There was a slight increase reported in livestock loss to predation during XCEs compared to non-XCEs, confirmed as significant in the linear mixed effects models exploring predation. Even so, losses in this study to predation (1.2%) were fewer compared to losses reported in Turkana during the 1979-1981 drought (3%) (McCabe, 1987). Small stock are more likely to be predated than cattle. Cattle numbers overall are fewer in number than sheep and goats and are herded by male herders. Small stock are usually herded by women and children and because of their size are often seen as being easier for predators to pick off (Frank et al., 2005). In addition, cattle could also graze on neighbouring commercial ranches during drought, herded by men selected from the group ranch to tend to the cattle during the day and night. On the commercial ranches, cattle are kept in strong metal mobile bomas during the night – considerably more secure than the bomas on the group ranch.

Predation does not kill as many livestock, nor is it as widespread as starvation and disease in Laikipia. Nonetheless, stock losses to predators are considerable in terms of impacts on livelihoods and the potential threats of revenge killings of local carnivore populations (Frank et al., 2005). Losses of livestock to predators in this study (overall ~1%) was of an order comparable to research findings by Frank, (1998) (0.7% for cattle and 1.4% for small stock). However, the trend in both the present study, and in McCabe's (1987) work in Turkana was for more livestock lost to predation during drought compared to non-drought. This challenges Frank's finding that predation losses are greater in non-drought 'normal' periods, rather than in XCEs. Though its impact on livestock herds was minimal in comparison to starvation and disease, the linear mixed effects models show predation did increase significantly during XCEs, exacerbating conditions for pastoralists battling to maintain herds. This suggests that an increase in frequency of XCEs will likely result in the increase for potential conflict between large carnivores and livestock to occur. This has significant implications for our understanding of HWC.

HWC affects many people globally and involves various types of conflict between humans and wildlife (see Chapter 1). Chapter 5 looked at the land types used by pastoralists and the constraints on accessing water and pasture during the 2009 extreme drought. This chapter identified the main reason for livestock loss for drought and non-drought years: starvation being the primary cause of death. Starvation occurs when there is not enough pasture and water for livestock to survive. Disease transmission between livestock and wildlife has often been managed by pastoralists avoiding areas with a high risk of disease challenge, spatially and temporally and/or by PAs excluding livestock (du Toit et al., 2017). The direct impacts of predation on livestock are substantial for pastoralist households (this Chapter) and well documented (see Treves and Karanth, 2003; Distefano, 2005; Aryal et al., 2014). The next chapter begins by outlining the main three conflicts identified by pastoralist communities in ASALs generally and Laikipia in particular: grazing competition, disease and predation (du Toit et al., 2017). It begins by identifying the species involved and whether individuals think there are more wildlife today than used to be. It then goes on to look more specifically at a large carnivore's range use and how this will likely alter during extreme drought years, focusing in particular on African wild dog as a case study for which suitable data could be accessed. Carnivore habitat selection will likely be influenced in part by prey species availability, which is a key driver of carnivore ecology (Durant et al., 1988). Although the study was originally designed to explore HWC between pastoralists and lions around Amboseli (see Chapter 1 and Chapter 2) the unavoidable relocation to Laikipia initially promised access to DRSRS census data on all mammal species $\geq$10kg, including prey species and all large carnivores. When it eventually became apparent that I would not be able access the DRSRS data in a useable format, I secured an opportunity to use African wild dog GPS/VHS point data collected during 2001-2012 DATES. The next chapter first looks at Laikipia pastoralists perceptions of HWC, and then compares African wild dog habitat selection during drought and non-drought years, providing an insight on 1) the potential for livestock predation to increase and 2) areas where livestock and prey species will likely overlap, and drawing together the wildlife and people strands of this thesis.

Chapter 7 Human-wildlife conflict: impacts and implications of extreme climatic events on large carnivore habitat selection

7.1 Chapter summary

The chapter begins by looking at perceptions of HWC according to the pastoralist communities in Laikipia. It explores the different types of HWC pastoralists perceive as commonly occurring on their Group Ranches, and the wildlife species involved. It then goes on to examine in more detail how XCEs impact on large carnivore habitat selection in the Ewaso Ecosystem in North Central Kenya, (including Laikipia), using as case study the distribution of endangered large carnivore species, African wild dog, and the implications for overlap, conflict and/or competition with pastoralists. An overview of the status and current global threats to large carnivore populations is presented and the importance of large carnivores in ecosystems is explored in more detail. Then it introduces the focal species, African wild dog. A detailed account is given of the data and methodology used to perform the analysis.

Pastoralists perceive grazing competition, predation and disease to be the main causes of HWC. Importantly, pastoralists reported that livestock predation was more likely to occur in the dry season and during XCEs (also see Chapter 6). Focusing down on wild dogs the results indicate these are widely distributed throughout the region in both XCE and non-XCE periods, and slightly more so during XCEs. They select very particular habitats for both XCE and non-XCE periods, meaning they are highly specialized.

7.2 Introduction

Potential for HWC might likely increase during XCEs, impacting on pastoralists' livelihoods as well as threatening wildlife species of conservation importance. XCEs are predicted to increase in frequency and severity in East Africa (Chapter 1), and are expected to impact and alter ecosystems and certainly make already existing socio-political problems worse.

Changes in land tenure and land use as well as habitat loss and fragmentation in ASALs have resulted in fewer areas for pastoralists to access important key

resources (Chapters 1 and 5). In addition, more land is increasingly changing from communal to private. Increases in human population have led to increases in the overall livestock population in Kenya (Ogutu et al., 2016). In areas where conservation initiatives are present and land is managed in a way to promote biodiversity, increases in wildlife populations can also occur (Distefano, 2005).

In the context of changes in land tenure and land use, increases in the overlap of use in fewer areas puts people and wildlife in situations that might potentially cause conflict to increase (Mariki et al., 2015; Graham, 2006). The socio-political constraints on pastoralists in Laikipia (Chapter 1 and 5) potentially creating or intensifying HWC are likely to be exacerbated by increases in XCEs. Understanding the main causes of HWC in a given area is important because conflict is often site specific (Distefano, 2005). And although HWC between pastoralists and wildlife is usually dominated by livestock predation, other types of conflict, due to fewer areas available to access key resources, coupled with changes in climate, are likely to increase. For example, climate change effects on infectious diseases, particularly vector-borne diseases and emerging diseases could alter the prevalence, distribution and intensity (Gallana et al., 2013).

7.2.1 Perceptions of human-wildlife conflict

Pastoralists were asked to identify wildlife species that they thought were present on their Group Ranch and say whether they were a species of conflict[22]. Thirty-four different species of mammalian wildlife were identified across the three study sites (Il Polei identified n=30, Il Motiok identified n=30, Lekiji identified n=34) either through household surveys or through focus groups. Thirty-eight independent reports were collected, of which four are from focus groups made up of five people; all conducted at Il Polei. Twenty-two households were interviewed at Il Motiok and 12 households at Lekji. Some species (hare (*Lepus microtis*), Hippopotamus (*Hippopotamus amphibious*), hyrax (Procaviidae) and tortoise (*Stigmochelys pardalis*)) were only identified by one household (Lekiji). Of the 34 species identified 30 were perceived as a cause of HWC with pastoralist communities (Table 7.1). Thirty-eight different types of conflicts were identified and classified into seven different HWC categories: grazing competition, livestock

[22] See Appendix 2: question 11.

predation, disease transmission, crop raiding, attacks on people, invasive plants and destroying beehives.

Table 7.1 Wildlife species identified by pastoralists as present on their Group Ranches.

Wildlife species	No. respondents who ID species present on GR	No. respondents who perceive species to cause conflict on GR	% respondents who perceive species to cause conflict on GR
Aardvark	20	9	45.0
Baboon	37	32	86.5
Buffalo	24	22	91.7
Bushbuck	15	3	20.0
Cheetah	28	28	100
Dik dik	38	6	15.8
Duiker	22	4	18.2
Eland	28	7	25.0
Elephant	38	38	100
Gerenuk	25	5	20.0
Giraffe	27	8	29.6
Grant's gazelle	29	7	24.1
Grevy's zebra	37	31	83.8
Hare	1	0	0
Hartebeest	11	0	0
Hippo	1	1	100
Honey badger	36	34	94.4
Hyrax	1	0	0
Impala	20	1	5.0
Jackal	38	38	100
Kudu	6	1	16.7
Leopard	38	38	100
Lion	26	26	100
Oryx	12	2	16.7
Plains zebra	27	23	85.2
Spotted hyaena	38	38	100
Steinbuck	20	6	30.0
Striped hyaena	38	36	94.7
Thompson's gazelle	26	6	23.1
Tortoise	1	0	0
Vervet monkey	38	19	50.0
Warthog	27	8	29.6
Waterbuck	23	6	26.1
Wild dog	37	24	64.9

Grazing competition, predation and disease transmission were also the top three problems pastoralists associated with local wildlife populations. More wildlife species were cited as a problem for grazing competition (21) compared with predation (11) and disease transmission (9) (Table 7.2) Only two species – elephant (*Loxodonta africana*) and buffalo (*Syncerus caffer*) fell into all three HWC categories of predation, grazing competition and disease transmission (Table 7.2).

Table 7.2 Three main types of conflict identified by pastoralists occurring on their Group Ranch.

No. of times wildlife species cited as species of conflict		**No. of times wildlife species cited as species of conflict**		**No. of times wildlife species cited as species of conflict**	
Predation		**Grazing**		**Disease**	
Jackal	38	Elephant	32	Grevy's zebra	15
Leopard	38	Grevy's zebra	29	Plains zebra	6
Spotted hyaena	37	Plains zebra	23	Buffalo	3
Striped hyaena	36	Buffalo	13	Eland	1
Cheetah	30	Duiker	13	Elephant	1
Lion	26	Aardvark	8	Hippo	1
Wild dog	24	Giraffe	8	Impala	1
Baboon	9	Eland	7	Kudu	1
Honey badger	8	Grant's gazelle	7	Warthog	1
Elephant	4	Warthog	7		
Buffalo	1	Dik dik	6		
		Steinbuck	6		
		Thompson's gazelle	6		
		Waterbuck	6		
		Gerenuk	5		
		Bushbuck	3		
		Vervet monkey	3		
		Oryx	2		
		Baboon	1		
		Hippo	1		
		Impala	1		

These were the three main reasons cited by most respondents when asked about the biggest threats to livestock today:

> 'I have some challenges today. The main problems are disease, predators and starvation (through lack of grazing). The diseases today that are a problem are ECF, foot and mouth, ticks and lung disease. The predators that are a big problem are leopards and hyaenas [spotted]. Even elephants kill my livestock.'
> *HH52 herder, 69*

> 'Before about 20 years ago there were few diseases. In cattle, the only thing was Foot and Mouth. In sheep and goats, it was red intestine disease. These diseases came as an outbreak so the Government would send vets to deal with it. Nowadays we have a lot of diseases – lung diseases, red intestine, ECF (in cows), parasites like fleas, lice and ticks (cows and goats – especially in the dry season). These diseases are everywhere. It is because there are more wild animals today.'
> *L126 Herder, 67*

> 'When I was in my young life there were no diseases such as lipis, lungs disease (in goats) and mporot (dry ducts in cows). These, as well as ticks,

were brought to livestock by wild animals.'
Miliko, herder, 60

Included in the 11 different species perceived as livestock predators were all five large carnivores present in Africa (Table 7.2). All those interviewed (100%) reported conflict with all large carnivores apart from African wild dog, which fewer people saw as a species of conflict (64.9%) (Table 7.1). Respondents were asked if there were more or less large carnivores present today than there were 10 years ago (Table 7.3). Overwhelmingly respondents perceived there to be more large carnivores around today than previously, apart from lions.

Table 7.3 Table showing percent of respondents that thought there were more large carnivore species today than 10 years ago.

Large carnivore species	**More species today than 10 years ago (%)**
Cheetah	78.6
Leopard	81.6
Lion	41.7
Spotted hyaena	86.8
Wild dog	86.5

Nine species were seen as a problem for transmitting disease to livestock. In all cases respondents identified ticks as the agent of disease transmission (Table 7.2) (see quote from Herder L126 above).

Habitat and dietary overlap are usually seen as the main causes for grazing competition (Georgiadis et al., 2007). Twenty-one species were identified as causing competition for grazing with herders' livestock (Table 7.2). One of the reasons given was there is more wildlife around today. Some pastoralists felt that this is because: '*a lot of land is set aside as conservation for wildlife [in Laikipia]*'.

'Before people could go anywhere and so it meant that people would use all areas. But now we are a group ranch we have a conservancy area that is for wildlife. You can only use it when we have exhausted the pasture in our group ranch.'
Noddy, herder, 70

'Before they made all the Commercial Ranches conservancies there was no problem [getting pasture]. This was about 30 years ago. Before then

you could take your livestock anywhere.'
Sirius, Male herder, 58

'One problem is that the conservancy stops access to land beyond it so you cannot use land the other side of the conservancy. Other Group Ranches also have conservancies, which means people cannot access land beyond another Group Ranch's conservation area.'
Focus Group, Il Polei

When HWC conflict is compared across the different seasons respondents are more likely to say predation and grazing competition are more of a problem during the dry season and drought years. Disease was equally reported as a problem across all seasons. However, Lekiji were more to likely to say disease was the main problem is the dry season.

The next section of this chapter looks specifically at how large carnivores in general, and African wild dogs in particular use the landscape during drought and non-drought years, and what the implications might be for HWC between pastoralists and large carnivore species of conservation importance, as climate change increases the frequency and severity of extreme drought (Chapter 1). Human carnivore conflict (HCC) because of livestock predation has been a key contributor to the decline in numbers of carnivore species (Treves and Karanth, 2003; this thesis, Chapter 1). Vulnerable communities living adjacent to protected areas or pro-wildlife managed areas suffer livestock losses that inflict economic costs on them (Distefano, 2005). Tensions rise and pastoralists can, and do, respond with retaliation killings, threatening important local carnivore populations (Frank et al., 2005).

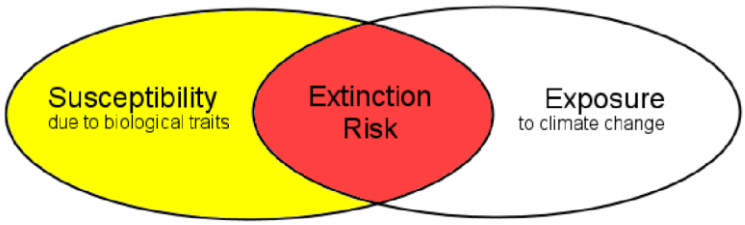
Despite African wild dogs not being seen locally as the most significant predator (nor implicated in disease transmission/grazing competition) they are seen as a species of conflict, with 24 out of 37 respondents (Table 7.1) reporting wild dogs responsible for causing HCC/livestock predation. HCC has been a major reason for the species decline in Africa (Woodroffe and Ginsberg, 1999) although in Laikipia levels of African wild dog predation on livestock has been low (Woodroffe et al., 2005c). I use them here to explore the implications of XCEs for predator species more generally, for these reason: 1) The African wild dogs point data was originally to be used in tandem with the DRSRS data (aerial survey data of mammals >10kg; see Chapter 1 and 3). This would have allowed to collect data on

all large carnivores, prey species, grazing competitors and disease reservoirs. But it eventually became clear I could not have access to these data in a form I could use for disaggregated spatial analysis; 2) African wild dogs are one of the world most endangered carnivores (Woodroffe, 2001; this chapter). They are persecuted by farmers because they kill livestock; 3) The African wild dog data gives level of data permitting detailed spatial analysis through XCE and non-XCE years.

7.3 Impacts of climate change on wildlife species

Climate change is a significant and accelerating threat that is likely to be a major factor in species extinction in the 21st century (Foden et al., 2013) and is seen as one of the drivers which is most difficult to reverse (Mace et al., 2005). Changes in climate are projected to increase species extinction rates further (Foden et al., 2013) (Figure 7.1), both directly and indirectly although not all species will be affected equally (Mace et al., 2005). Restricted habitat availability, reduced mobility and/or living in small or isolated populations are all cited as reasons that increase wildlife species vulnerability to changes in climate (Mace et al., 2005; Foden et al., 2008). Already vulnerable species such as large carnivores will likely be affected most (see Chapter 1; Section 7.3.1 below). Other studies however see wide ranging species more likely to adapt able to changes in climate owing to their ability to shift ranges. Populations are already changing geographical distributions in response to climate change (Hoffmann and Sgrò, 2011).

Figure 7.1 Increased risk of extinction for species possessing certain biological traits that make them more prone to changes, and which live in areas where change in climate will be felt the most (from Foden et al., 2008).



7.3.1 Importance of large carnivores in ecosystem resilience

Large carnivore populations are globally threatened and have suffered huge declines in population numbers and geographic ranges (Ripple et al., 2014). For example, 61% of the largest carnivore species[23] are listed as vulnerable, endangered or critically endangered according to the IUCN Red List (IUCN, 2015; Ripple et al., 2014). Seventy-seven percent of these threatened species are experiencing ongoing population declines (Ripple et al., 2014). This has wider implications as they play important roles in the healthy functioning ecosystems of ecosystems (Ripple et al., 2014; see also Chapter 1).

The impacts of climate change will be more severe when it works in tandem with other well-established stressors, in particular habitat loss (Root et al., 2003), exacerbating existing pressures on species (Chapter 1). Large carnivores can positively influence the resilience of an ecosystem's response to global processes such as climate change by enhancing ecosystem functions and buffering climate change effects in a variety of ways (Ripple et al., 2014). These can involve long interactive chains with wide-ranging impacts on connected systems (Estes et al., 2011) which may include strengthening ecosystem carbon storage by improving plant growth through herbivore suppression (Ripple and Beschta., 2012), biodiversity enrichment, restoration of riparian habitats through reducing stream bank erosion (Beschta and Ripple, 2012), altering tree communities due to prey species responding to predator risk (Ford et al., 2015) as well as helping reduce disease prevalence by reducing ungulate prey populations (Packer et al., 2003). However, these outcomes from top-down processes will also be influenced by a number of bottom-up processes such as resource availability, habitat quality and the intricacy of carnivore assemblages (Ritchie & Johnson, 2009).

The rest of this chapter examines the impacts of XCEs on large carnivore movement and behavior, adopting Ecological Niche Factor Analysis (ENFA) as an approach which uses a multifactorial analysis to determine niche selectivity based on observed presence in relation to a range of key ecogeographical variable (EGVs). The point of choosing ENFA is that it allows quantification of selectivity in a relatively simple manner (Hirzel et al., 2002). Further details of this method are discussed below in the Section 7.5.

[23] The 31 largest carnivore species are found in five families: Canidae, Felidae, Mustelidae, Ursidae and Hyaenidae (Ripple et al., 2014).

In the sections that follow, I explore the influence XCEs have on wild dog species and habitat selection during XCE and non-XCE periods. In order to answer the following research questions outlined in Chapter 1: (1) what are the impacts of XCEs on large carnivore movement and behaviour and (2) how does large carnivore habitat selection differ between XCE and non-XCE years? The habitat selectivity parameters generated by ENFA, marginality and tolerance (see Section 7.5.1), are used to test the following hypotheses: (i) large carnivores become less selective during XCEs and (ii) show some level of specialization through the following predictions:

1. Marginality will decrease during XCEs as I expect large carnivores in general and wild dogs in particular to be less selective in habitat relative to the reference set of EGVs.
2. Tolerance will increase during XCEs as I expect large carnivores in general and wild dogs in particular to be more widely distributed in the range of EGVs.

During XCEs, I would expect large carnivores to be more widely dispersed than during non-XCEs periods (see Chapter 5). And because of predator-prey dynamics, I would expect to find them closer to water sources during XCEs than compared to non-XCEs periods.

7.4 African wild dog

The African wild dog, *Lycaon pictus*, also known as the cape hunting dog or painted hunting dog is the largest member of canidae extant in Africa (Figure 7.2). Their scientific name translates as 'painted wolf' and refers to the patchwork of brown, black and white that is unique to each individual's coat (Creel and Creel, 2002). They are listed as Endangered[24] and are one of the most endangered carnivores in Africa (IUCN, 2015).

Wild dog populations were once distributed throughout sub-Saharan Africa (Woodroffe & Ginsberg, 1999; Fanshawe et al., 1991), but today inhabit approximately 7% of their former range in East Africa (Durant, 2007).

[24] Endangered - A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see IUCN Red List, 2015).

Figure 7.2 Pack of African Wild Dogs in Laikipia.

Wild dog populations have undergone major declines as human populations have increased and they now mainly reside in and around protected areas (PAs) (Creel et al., 2004). Wild dogs are resident in approximately 13% of their historic range and are considered extirpated from much of their historical range (including recoverable, unrecoverable and connecting range), although this figure is likely to be greatly underestimated (Durant, 2007). Outside PAs these reduced populations are exposed to habitat loss, alongside deliberate or accidental killing by people and disease (Woodroffe et al., 2004).

Wild dogs are obligate cooperative breeders and are territorial (Fuller et al., 1992). Their diet consists almost entirely of mammal prey species ranging from small hares (*Lepus spp*.) to adult zebras (*Equus burchelli*) (Creel and Creel, 2002). Large prey, sometimes up to 120% of their own body weight, can be taken because wild dogs are cooperative hunters (Woodroffe, 2010; Creel and Creel, 1995). In this study area diet primarily consists of dikdiks *Madoqua spp*., (70% of prey biomass) and impala (*Aepyceros melampus*) (11% of prey biomass), although livestock are occasionally taken (Woodroffe et al., 2005c, 2007). Wild dog population densities are relatively low when compared to sympatric large carnivores (Creel et al., 2004) and home ranges are correspondingly larger than would be expected for a species with their metabolic requirements (Woodroffe, 2010; Creel and Creel, 1996).

Home range estimates vary in size across different study sites, for example in the Serengeti they were documented at around 1,500-2,000km^2 (Creel and Creel, 2002) and in Kruger National Park they averaged 537km^2 (Mills and Gorman, 1997).

7.5 Methods

For this analysis, I use wild dog distribution data collected in the Ewaso ecosystem, North Central Kenya, which covers an area of approximately 40,000km^2 (as defined by Georgiadis, 2011) including Laikipia and incorporates all or part of nine Kenyan Districts[25] (Figure 7.3) to investigate their habitat selection during XCE and non-XCE years. Wild dogs usually live in low densities because of their wide ranging behaviour. This also means they range extensively outside protected areas, which exposes them to human activities, thus potentially causing conflict to occur. Species that range widely are more likely to disappear from fragmented habitats (Woodroffe, 2010). Habitat fragmentation and persecution are seen as severe threats to wild dog populations (Woodroffe and Ginsberg, 1999). Thus, wild dog response will provide information in terms of mitigating potential future conflict with humans in periods of XCEs.

There are multiple land use systems in the region and most of the area is not formally protected (Chapter 2). The wild dog spatial data used in this chapter were collected 2006-2012 by the KRWDCP, then known as the Samburu-Laikipia Wild Dog Project (SLWDP). The georeferenced presence-only points represent wild dog locations recorded by Global Positioning Position (GPS) collars (Posrec-300, Televilt, Lindesberg, Sweden) and VHF radio collars (Telonics, Mesa, AZ, USA), as well as sighting data, collected using hand held GPS units made available by the Northern Rangelands Trust (NRT). At least one wild dog per pack was fitted with a GPS collar and/or VHF radio collar. For the VHF radio collars, aerial telemetry data was collected once a week around 07:30-08:30, during wild dogs' hunting period when they are likely to be more active. Location accuracy was~200m. For GPS collars, location data were either collected at 06:00, 08:00, 10:00, 13:00, 16:00, 18:00 and 20:00h or at -5:00, 06:00, 07:00, 18:00, 20:00 and 00:00h. On average, GPS collars stored data for 106 days, which gave~433 locations per collar. The aerial radio collar data indicated that wild dog mean home range size for each pack in Laikipia was calculated as 278km^2 (using 100% minimum convex

[25] Laikipia, Samburu, Isiolo, Meru, Meru North, Meru South, Embnu, Kirinyaga and Nyeri.

polygons) or 423km^2 (using 50% and 95% fixed kernel density) (based on data collected between 2001-2009) (see Woodroffe, 2010).

Data were divided into drought year (October 2008-September 2009) and non-drought (October 2006-September 2008 and October 2009-September 2012). The start of year is based on seasonal not calendar dates and uses the start of the short rains (October-December). During the SSIs with pastoralist communities they often talked about the failing short rains in 2008 (October-December) which identified the start of the extreme drought in 2009 (Chapter 4).

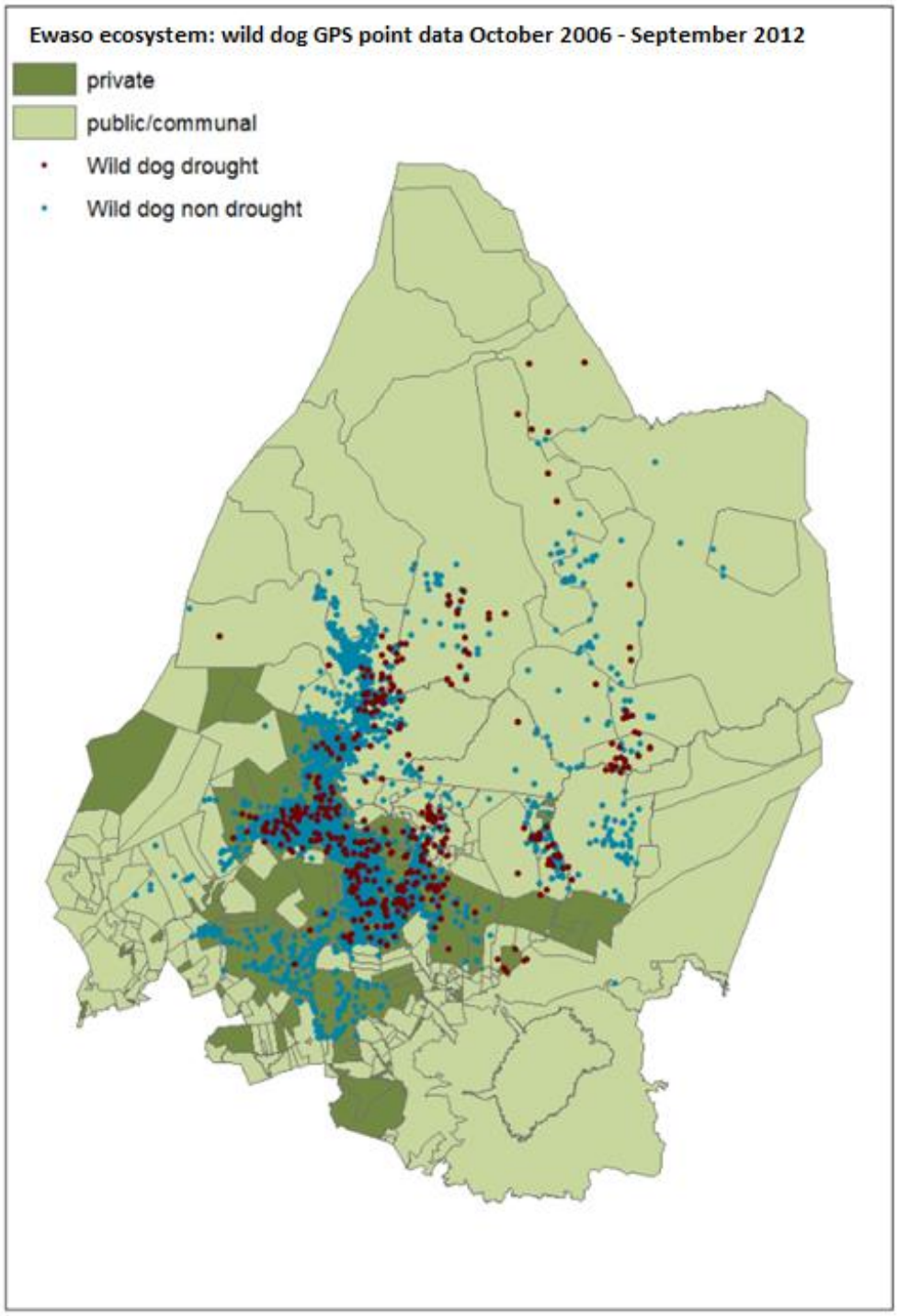
The main method used for analysis in this chapter is species distribution modelling (SDM). Recent advances in spatial analysis potentially allow us to define the parameters for species habitat selection based on where species occur (Durant et al., 2010), and where absence data is not available (Hirzel et al., 2002). Ecological Niche Factor Analysis (ENFA) uses a number of factors to determine habitat suitability for a species using presence-only data with reference to a range of EGVs (Durant et al., 2010; Pettorelli et al., 2009).

7.5.1 Ecogeographical Variables

The specific EGVs chosen for this study were selected because of their potential influence on wild dog distribution. Large carnivore habitat selection is usually based on the distribution of prey species throughout the landscape (Schaller, 1972). Prey species habitat selection is influenced by a suite of biotic and abiotic factors, largely determined by a trade-off between vegetation quality and predator avoidance (Riginos & Grace, 2008). In total, five EGVs were considered: land use (private or public/communal[26]), rivers, roads, tree cover and Normalized Difference Vegetation Index (NDVI). Elevation was originally included in the analysis. However, one wild dog GPS point data was recorded high up on Mt Kenya, skewing the data. Re-analysis excluding this data point would be worthwhile for further investigation of African wild dog habitat selection because elevation is considered to be a potential influence on a carnivore's habitat (Durant et al., 2010). The shared resolution for the maps used in the analysis was set at 250m x 250m. This was determined by the NDVI resolution used because of multiple data download from MODIS as well as processing time.

[26] Public/communal land in this study includes the following land types classified in Chapter 5: community land, group ranch, study site, trust land and unclassified.

Figure 7.3 Map showing Ewaso Ecosystem and wild dog point data for drought (October 2008-September 2009) and non-drought years (October 2006-September 2008 & October 2009-September 2012).



Before carrying out the ENFA a square root transformation was performed on non-symmetric continuous EGVs (excluding land use which is categorical) and a PCA

was performed on the EGVs to give appropriate weights and transformation to the data. The details of the EGVs selected are discussed below.

7.5.1.1 Land type

Land type was divided into two groups: privately owned land and public/communal (Table 7.4). Dividing land this way links into land type categorizes identified by pastoralists living in Lakipia (see Chapter 5). As land tenure and land use impact on where pastoralists can take their livestock herds during drought (Chapter 5) provides a relationship on how people, livestock and wildlife use the landscape. The land use shape file was provided by Mpala Research Centre (MRC) and converted to a GIS raster Geotiff file using QGIS software (QGIS Development Team).

Table 7.4 The two groups of land use created for the ENFA analysis.

Private	**Public/communal**
Forest reserves	Community group ranches
National parks	Community conservation area
Private wildlife sanctuary	Settlements
Rhino sanctuary	Trust land
Urban settlements	Government land
Cmmercial ranches	Unclassified

7.5.1.2 Normalized Difference Vegetation Index

NDVI is an index based on remotely sensed data which is available at medium to high resolution with global coverage for both spatial and temporal scales. It is a powerful tool using simple numerical indicators to assess the spatio-temporal changes in green vegetation (Pettorelli, 2013). It provides valuable information on productivity, distribution and dynamics of vegetation allowing a range of assessments to be made, which include climatic disasters, while offering the means to monitor habitat changes such as degradation and fragmentation (Pettorelli, 2013).

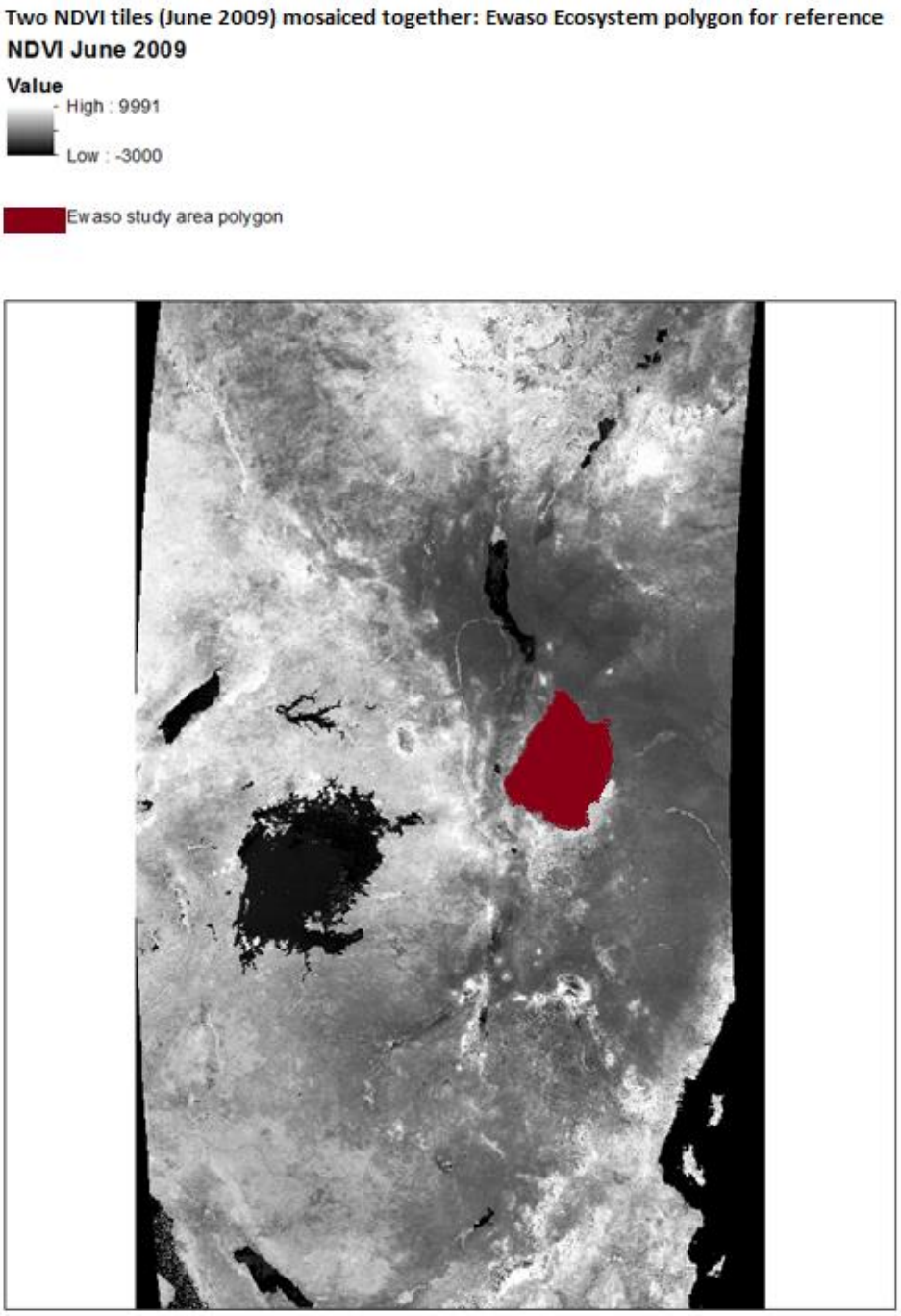
The NDVI used in this study was from the National Aeronautics and Space Administration's (NASA) MODerate-resolution Imaging Spectroradiometer (MODIS) (www.modis.gsfc.nasa.gov), specifically, MOD13Q1, 250m x 250m

resolution at 16 day intervals. Image tiles selected were from the second half of each month for consistency, apart from August 2008. Data from MODIS for the second half of August was corrupt so the first half was used here. Two image tiles (www.modis.gsfc.nasa.gov) (Figure 7.4) from each month were included in the analysis to cover the Ewaso region. NDVI was downloaded and processed using ModisDownload (www.r-gis.net) and MODIS Reprojection Tool (MRT) (https://lpdaac.usgs.gov) within the R environment (R Development Core Team, 2015). ModisDownload downloads a series of images in a specific date or a date range and in individual tile(s). ModisDownload then uses MRT software to mosaic the downloaded images if more than one tile is selected. It then re-projects the image tile(s) to a specified coordinate system. Finally it can convert the source image format, in this case hierarchical data format (HDF) to other ones such as Geotiff. For this analysis data was converted to Geotiff and the coordinate system used was Universal Transverse Mercator (UTM). Data were visualised and plotted using the R packages raster (Hijmans, 2015) and rgdal (Kiett et al., 2011).

7.5.1.3 Other Ecogeographical Variables

As prey species are influenced by the presence, and/or absence of water, rivers would likely influence how wild dogs use the landscape, especially during drought. The rivers included for this analysis were classified as non-perennial/intermittent/fluctuation or perennial/permanent. Rivers were more densely distributed in the south. A road network for the area was obtained from MRC of which main roads (primary and secondary routes) were selected for the analysis. Roads were more concentrated in the south west and middle part of the study region. Both rivers and roads shapefiles were converted to raster and Euclidean distance was calculated using ArcGIS (distance to feature). Tree cover (30m resolution) was extracted from Global Forest Watch Data (www.globalforestwatch.org). The data were generated using multispectral satellite imagery from the Landsat 7 Thematic mapper plus (ETM+) sensor. Tree cover is classified as all vegetation taller than 5m in height with per cent of tree cover characterized as tree canopy coverage of the land surface. Tree cover can include natural forest or plantations (Hansen et al., 2013). Eight Landsat image tiles were downloaded, mosaiced together, resolution converted to 250m and re-projected in ArcGIS 10.2.1.

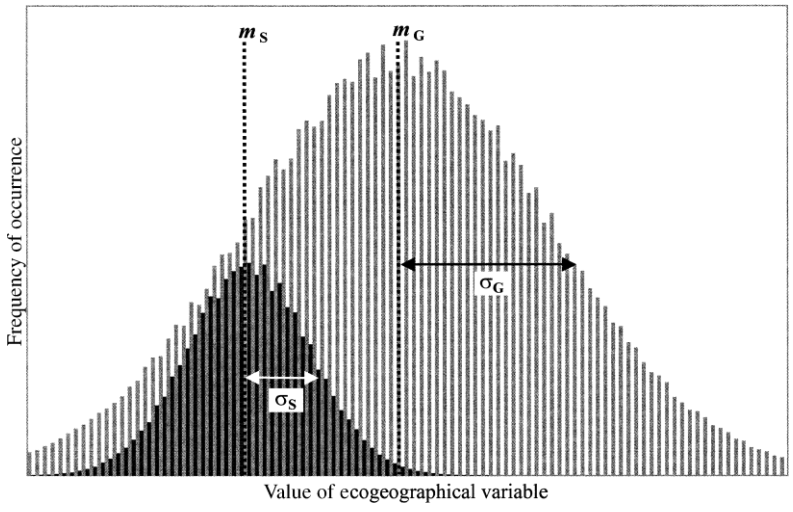
Figure 7.4 Example of two NDVI tiles (from June 2009). These tiles are mosaiced together and a polygon, used to define the study area, is overlaid across the two tiles to crop them to the size and shape of the study area. Two tiles from each month (period October 2006 September 2009) were used in the analysis. The solid dark red polygon represents the Ewaso ecosystem used in this chapter.



7.5.2 Data analysis and definitions

ENFA was used to explore habitat selection of wild dog for drought and non-drought years. ENFA uses a factor analysis technique (Hirzel et al., 2002) using presence-only observation data to summarize the environmental factors that foster species distribution (Durant et al., 2010; Pettorelli et al., 2009). The underlying theory of ENFA is to compare the distributions of EGVs between the points where wild dogs are recorded against the background distribution of EGVs across the whole study area (Pettorelli et al., 2009). Species with strong habitat selection are expected to be non-randomly distributed in relation to EGVs (Hirzel et al., 2002). ENFA uses a factor analysis to aggregate information for a species into two uncorrelated indices, 'marginality' and 'specialization'. Marginality can be seen as the first factor and contains the majority of information (Hirzel et al., 2002). It maximizes the difference between the environments used on average by the species and the environments available in the study area. Specialization is an aggregate of the remaining factors and maximizes the ratio between of the ecological variances of available environments and the variance of environments used by a species (Pettorelli et al., 2009) (see Figure 7.5). Tolerance is defined as the inverse of specialization (Durant et al., 2010; Hirzel et al., 2002). A global marginality factor near to one means a species lives in a very particular habitat comparative to the reference set, whereas tolerance varies from zero (highly specialised species) to one (highly generalized species) (Durant et al., 2010; Hirzel et al., 2006).

Figure 7.5 The distribution of the focal species on any ecogeographical variable (black bars) may differ from that of the whole set of cells (grey bars) with respect to its mean ($m_S \pm m_G$), thus allowing marginality to be defined. It may also differ with respect to standard deviations ($s_S \pm s_G$), thus allowing specialization to be defined (Hirzel et al., 2002).



ENFA is similar to a Principal Component Analysis (PCA) although it assesses the position of the habitat within the environment based on two previously determined components (Basille et al., 2009). Data from the ENFA can be used to produce maps showing suitable habitat available (Figure 7.6).

To test the strength of the model a randomization test was performed. The test is carried out by simulating a random distribution of species occurrence in the pixels of a map. At each step of the randomization procedure the test randomly allocates the sum of the nk occurrences s (where nk is the sum of the occurrence vector (wild dog points) of the object of class ENFA) in the Ik pixels of the focus area (where Ik is the length of this occurrence vector). At each step of the procedure, the first eigenvalue of the ENFA performed on the randomised data set is recomputed. This value provides a criterion to test the model fit of the ENFA analysis (Calenge, 2005). The simulated *p* for both models was $p = 0.001$ indicating the models are robust and that the ENFA model explains a significant proportion of the variance in wild dog distribution.

Data preparation for the ENFA was carried out using Excel, QGIS, ArcGIS 10.2.1, ModisDownload, Modis Re-projection Tool (MRT) and R 3.1.2 (R Development Core Team, 2015). Data analysis was carried out using the R package adehabitatHS (Calenge, 2011).

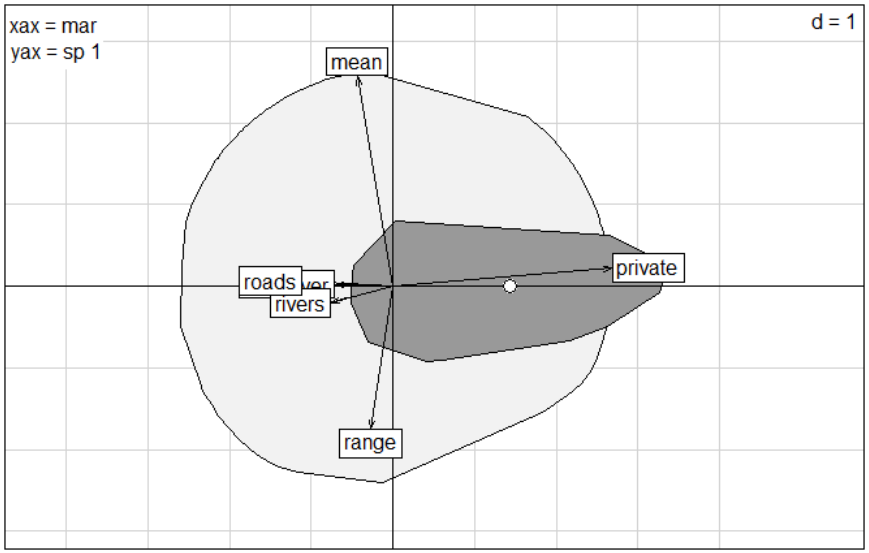
7.6 Results

The results of the ENFA are presented in Table 7.5. The number of point data used in the analysis was n=7473 pooled across drought (n=826) and non-drought (n=6647). According to the ENFA wild dog habitat selectivity differs for extreme drought and non-extreme years. Two factors were retained for both cases using the broken-stick heuristics (Jackson, 1993) for the five EGVs totalling 93% for extreme drought and 100% for non-drought periods.

Marginality for wild dogs is high for both XCE and non-XCE periods, which means they live in very different habitats compared to the global mean. Wild dogs live in a very particular habitat for both periods although during extreme drought they are less selective than during non-drought (2.054 and 4.243 respectively). Tolerance score for wild dogs is high [which means it is] and similar to the global standard deviation.

Figure 7.6 Habitat suitability maps from the ENFA analysis for drought (A) and non-drought (B) periods. The light grey areas indicate the habitat available, while the dark grey areas show the actual habitat used.

A



B

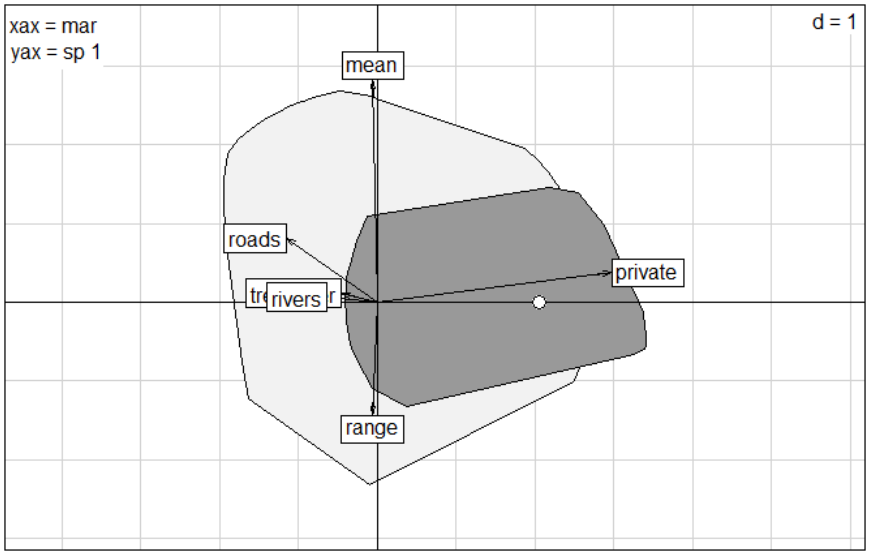


Table 7.5 Coefficients of the ecogeographical variables for wild dog. *N* indicates the number of locations were wild dogs were recorded.

Ecogeographical variable	**Drought (n=826)**		**Non-drought (n=6647)**	
	Factor 1 marginality	Factor 2 specialization	Factor 1 marginality	Factor 2 specialization
Mean NDVI	-0.140	0.823	-0.018	0.860
Range NDVI	-0.086	-0.560	-0.018	-0.437
Tree cover	-0.229	0.008	-0.140	0.034
Distance to rivers	-0.245	-0.064	-0.195	0.019
Distance to roads	-0.354	0.022	-0.352	0.247
Private land use	0.857	0.071	0.904	0.114
Ratio variance explained by marginality (factor 1)	0.731		0.849	
Ratio variance explained by first axis of specialization (factor 2)	5.573		6.991	
% explained by marginality (factor 1)	34.2		35.0	
Marginality	2.054		4.243	
Tolerance	0.65		0.62	

Two factors were retained using the broken-stick heuristics explaining 93% of drought information and 99% of non-drought information. ENFA – Ecological Niche Factor Analysis.

This indicates that wild dogs are widely distributed in the study area across both drought and non-drought periods although tolerance was slightly higher during drought (0.65) than non-drought (0.62). There was a negative association with distance to rivers for both drought (-0.245) and non-drought (-0.195), suggesting that wild dogs were found closer to rivers than on average, with this association stronger for drought. There was a negative association with distance to roads, which was similar for both drought and non-drought (-0.354 and -0.352 respectively) indicating that wild dogs are likely to be found closer to roads irrespective of drought.

Wild dogs were negatively associated with tree cover for both drought and non-drought with a stronger evidence of avoidance in drought (-0.229) than non-drought periods (-0.140) meaning they preferred open land, which in ASALs could include thick bush rather than tall cover, comprising of 100% canopy cover. Wild dogs emerge as strongly associated with privately owned land compared to non-

privately owned land for both drought and non-drought. However, the association is stronger during non-drought than for drought periods (0.904 and 0.857 respectively). Privately owned land, such as large-scale commercial ranches and private wildlife sanctuaries are more likely located in dry resource areas and often support large numbers of prey species. Wildlife dogs are also less likely to be persecuted than on communal lands. Although marginality was markedly higher during non-drought periods, the percentage of variance in the ENFA explained by marginality was similar 34.2% for drought and 35% for non-drought.

7.7 Discussion

Results for this chapter present the first case where the impacts of extreme climatic events on large carnivore habitat selection are explored. The ENFA provided information on habitat selectivity during extreme drought and non-drought periods across the Ewaso region. This analysis demonstrated strong evidence that wild dogs select for habitat different to the global mean for both XCE and non-XCE periods. Furthermore, the aggregate statistics generated by the analysis provided support for both research hypotheses – that these large carnivores become less selective during XCEs and that they show some level of specialization. There was clear evidence for both of the predictions for wild dogs: (i) marginality did decrease during XCEs and (ii) tolerance did increase during XCEs, albeit to a lesser extent. This analysis indicates there is a trend for wild dogs to become less selective during XCEs across the range of EGVs used in this analysis.

Although there was a considerable number of wild dog locations for the whole period, the majority were collected in the non-drought period (n=6647) compared to the extreme drought (n=826). This was owing to data collected for one XCE year and data collated from five non-drought years. XCEs are rare and thus it is difficult to schedule to collect data during these periods. However, the model validation for both XCE and non-XCE was robust.

The analysis ascertained wild dogs are highly selective for habitat in both drought and non-drought periods. Marginalities were higher than 1 for both periods, suggesting the mean EGVs where they were found differ significantly from the mean EGVs across the region. This means they live in marginal habitats and are likely to be fairly specialized. Although tolerance scores were <1, indicating wild dogs are relatively specialized, the tolerance score was closer to one than zero for

both drought (0.65) and non-drought (0.62) periods. This signifies they are not narrowly distributed compared to the reference set of EGVs.

Wild dogs are wide ranging species that will likely shift throughout the EGVs that have been used in this analysis. Moreover, since re-colonising the region wild dog packs have naturally shifted their home ranges in a west to east direction across the region as the population has increased (Woodroffe, 2010). Wild dogs will tend to avoid areas with high prey densities favoured by other carnivore species, especially lions and spotted hyaenas (Creel & Creel, 1996). Habitat avoidance because of interspecific competition between large carnivores may influence distribution more than direct determinants of habitat selection (Durant, 1998, 2000). Observed differences in habitat use may also be attributed to behavioural traits such as hunting rather than actively avoiding other large carnivore species (Broekhuis et al., 2013). Not only are they potentially limited by their interactions with other carnivores but they are strongly affected by human activities (Woodroffe et al., 2004).

Data used in the analysis were from radiotracking and visual sightings. Collar data are less likely to be biased, with visual sighting data likely to be influenced by habitat type because carnivores are easier to observe in open habitats than ones with thick bush cover. However, the biases are likely to be consistent between XCE and non-XCE years meaning the comparison between these periods is valid, even if there may be some biases in the data. Wild dogs are considered a highly visible and gregarious species (Rasmussen, 1999). Wild dogs have been reported to be attracted to roads with low levels of activity as they act good routes for hunting and ease of travel (Woodroffe, 2010). The equally strong association with distance to roads for both drought and non-drought supports this. Wild dogs also have higher rates of traffic mortality compared with other species (Woodroffe, 2010), which might be linked to their greater use of roads.

Studies have shown that wild dogs appear to inhabit a variety of habitats from short to medium grasslands in the Eastern part of Kruger National Park (Ginsberg et al., 1995), bushy areas close to rivers in Laikipia (Woodroffe, 2010) or closed bush and hilly woodland habitats in Southern Africa (Mills and Gorman, 1997). In this study wild dogs were negatively associated with densely vegetated areas and preferred areas with decreased net productivity for both drought and non-drought periods, corroborating other studies in Africa. For example in South Africa, wild dogs selected areas that were resource poor throughout the year. Wild dogs also

selected for open land cover types for both wet and dry seasons and only selected for closed riverine areas in the dry season (Vanak et al., 2013). Wild dog presence data used in the analysis excluded denning packs, which are more likely to be found in dense vegetation as a strategy to avoid detection from other large carnivores that pose a threat to pups (Creel and Creel, 2002).

Wild dogs preferred private land rather than public/communal land for both drought and non-drought periods. This land type has higher numbers of wild prey species (Kinnaird and O'Brien, 2012) and low human densities (Woodroffe, 2010). The association was less strong for the XCE period, suggesting wild dogs are more likely to be found on communal land during XCEs, increasing the potential for conflict with pastoralists.

Wild dog distribution is related to distance to river sources, with packs being found closer to river sources (Woodroffe, 2010) and this study validates the importance of water availability in habitat selection for wild dogs. This association was strongest in the XCE period, which might be linked to wild higher prey abundance found near the fewer water sources remaining in drought. Riparian areas stay productive longer in drought periods. In addition, pastoralists are more likely to be mobile during XCEs searching for water and pasture with their livestock and thus increases likelihood of conflict as productive areas decrease.

The impacts of climate change will be most severe on species when it interacts with other threats, most notable habitat loss/fragmentation (Root et al., 2003). The impacts of habitat loss/fragmentation as well as changes in land use/cover are known to be the main drivers of biodiversity loss (Mace et al., 2005). The ability for species to distribute into new areas that are suitable in terms of climate is dependent on intact contiguous habitat (Fordham et al., 2013). Frequent shifts in the distribution and abundance of different species due to climate change have already occurred (Thomas et al., 2004; Thomas, 2011). However, whole biomes do not move intact and in concert with regional shifts in climate patterns (Welch, 2005). Thus habitat loss/fragmentation will impede the potential for species dispersal into future areas of distribution (Thomas et al., 2004).

Protected areas have long been considered the cornerstone of global conservation in protecting wildlife populations (Craigie et al., 2010). They are also seen as natural solutions to mitigating the impacts of climate change on species (IUCN, 2012). Models of species range shifts due to climate change have explored the role

PAs have in conserving species (Root and Schneider, 1995) and have shown that PAs can be effective in responding to climate induced range shifts (Hannah, 2008). However, PAs in Africa have not effectively mitigated human-induced threats to large mammal species, as there has been a continent-wide decline in wildlife abundance since their creation (Craigie et al., 2010).

Current conservation efforts to mitigate climate change impacts may be inadequate to support some species (Fordham et al., 2013). For example, large carnivores are often wide ranging and require extensive areas to persist (Gittleman and Purvis, 1998). A study looking at the impacts of climate change on the endangered Iberian Lynx (*Lynx pardinus*) show that predicted changes in climate will rapidly and severely reduce lynx abundance and probably lead to extinction within the next 50 years. This is because there may not be sufficient range movement for Iberian lynx to naturally adapt in response to the velocity of environmental change now forecast (Fordham et al., 2013). Habitat loss and fragmentation and/or land conversion have already impacted on the processes that underlie lynx dispersal and establishment, largely through the restriction of connectivity caused by anthropogenic modifications. Climate change could thus have the potential to raise extinction rates in the near future (Thomas et al., 2004).

However, the impacts of climate change do not work on individual species alone (Walther, 2010), and not all species will be affected equally either temporally or spatially (Mace et al., 2005). Some of the changes already happening include changes in the timing of reproduction in animals, changes in migration patterns and changes in the severity of disease outbreaks (Perrings, 2010). Species are connected through interactions at the same tropic level as well as through the whole trophic structure (Van der Putten et al., 2010). Reorganisation of communities may have considerable impacts the way species interact, which could have consequences for the functioning of ecosystems (Walther, 2010). There could be a shift in dominant species within communities as well as the creation of non-analogue communities (Walther, 2003). A recent study highlighted the potential vulnerability of existing ecosystems to invasive species, even under moderate scenarios of climate change (Thomas and Ohlemuller, 2010). *Opuntia stricta* (var *stricta*) is listed in the top 100 list of the world's worst plant and animal invaders (IUCN/SSG, 2009; Strum et al., 2015). Invasions across the globe include Australia, the Mediterranean region, South Africa and North Africa (Strum e al.,

2015). This invasive species is spreading across Laikipia due to land use changes in the area (Strum et al., 2015) (see Figures 7.7 and 7.8).

In addition, climate change can also move ecosystems irreversibly from one state to another when crossing critical thresholds (Barnosky et al., 2012).

Climate change will exacerbate environmental and human pressures already impacting on large carnivores. Changes in geographic range and distributions might result in species not being able to keep pace with suitable climate zones in which they would disperse. The division of contiguous land, largely through privatisation, results in habitat loss and fragmentation, which are significant drivers of wildlife decline (Norton-Griffiths and Said, 2010). Coupled with climate change they pose a greater threat to large carnivores, which conservation strategies might fail to mitigate.

Figure 7.7 *Opuntia Stricta* in Il Polei

Figure 7.8 Image of *Opuntia Stricta* in Il Polei.

During the 2009 XCE wild dogs were more likely to use communal/public land. This land forms an important land use choice for pastoralists during XCEs. ~50% of respondents in this study reported accessing community land during the 2009 XCE, considerably more than other land types apart from commercial ranches (~42% - Chapter 5). In fact, during the 2009 drought more pastoralists moved further through the landscape so they could access water and pasture at Mt Kenya. En route to Mt Kenya the majority of pastoralists stayed on land categorized as communal land. Around two thirds of pastoralists interviewed said that they split their herds to be able to find water and pasture outside their group ranch. As droughts are expected to become more frequent, pastoralists will likely make this trip more often, exposing them to potentially more conflict with large predators. This is particularly relevant to small stock, which were more likely to be predated during the 2009 drought than cattle (Table 6.14: Chapter 6). As seen across Kenya, and also in this study (Chapter 6), livestock composition for pastoralists is changing, with a preference for keeping more small stock and less cattle than they once previously did. This was largely cited because they were more able to survive a drought, especially goats. And as this study confirmed this (less goats were lost than cattle or sheep: Chapter 6), the likelihood is that pastoralists in Laikipia will

move more frequently to communal land and PAs due to the increase in frequency of drought, and in doing so will herd larger flocks of sheep and goats.

The change in African wild dog habitat selection during XCEs could lead to increase in HWC between pastoralists and large carnivores in Laikipia and indeed Chapter 6 and Section 7.2.1 of this chapter show such an increase of HWC observed during XCEs in present study. This is also important from a conservation standpoint, as wild dogs are listed as endangered by the IUCN Red List (IUCN, 2012), having already lost much of their range.

Furthermore, wild dogs were more likely to be found near water sources during XCEs. Although this study is not able to present data on prey species movement in drought years, is expected that the influence of them on wild dogs is assumed, based on the literature (see Schaller, 1972; Riginos & Grace, 2008; Lima, 1998). Areas where water and pasture are present longer in a drought season are often located on dry season grazing areas, many of which are located on commercial ranches in Laikipia, as well as Mt Kenya. Prey species distribution and abundance are correlated with primary productivity (NDVI) across broad scales (Sandom et al., 2013). However, interactions between prey and predators also influence habitat selection (see Riginos and Grace, 2008). The commercial ranches and PAs (two land uses that were important to pastoralists during the 2009 XCE (Chapter 5)) formed an important part of the private land category for this chapter.

ASAL systems have highly variable climates. Accessing key resources in the landscape has been pivotal to humans, livestock and wildlife. Soft boundaries where people and wildlife are relatively free to move have hardened (Reid, 2012) meaning that people, livestock and/or wildlife movements are restricted. This has largely been driven by changes in land use and land tenure, which cause habitat loss and fragmentation of once contiguous land. When people, livestock and wildlife occupy smaller areas, the potential for HWC to occur is exacerbated. The three main sources of conflict for pastoralists in this study was grazing competition, livestock predation and disease transmission. The suite of coping and adaptive mechanism that pastoralists adopted to manage these conflicts are no longer as effective as they once were. The socio-political factors that impact on ASALs are intensified by climate change. Climate change is particularly potent when mixed with habitat loss. And with a growing human population and ever smaller areas to access, demand on key resources is greater than ever. This combination of fewer areas to access, restriction on movement and changes in

climate, in an environment with already unreliable rainfall, is setting up a situation in which HWC will increase and 'coexistence' between people and wildlife, who have lived together for millennia, will disappear. The division of land in Laikipia, has impacted on wildlife populations in that area. The last DRSRS data reported a decline in wildlife numbers for giraffe, Grant's gazelle, Thompson's gazelle, eland, hartebeest – see Ogutu et al., (2016) for full list – while biomass for livestock has remained constraint (Ogutu et al., 2016). These findings have questioned the efficacy of conservation policies (such as creating PAs). And although there are socio-political drivers, including increase in human population impacting on wildlife species, Laikpia is essentially not an 'open landscape', which ultimately affects where people, livestock *and* wildlife can move.

Chapter 8 Prospects for coexistence of people and wildlife in East African rangelands in face of extreme climatic events.

Extreme climatic events (XCEs) are predicted to increase in frequency and severity with climate change. This thesis has investigated the impacts of extreme climatic events, especially that of the severe 2009 drought, on pastoralist livelihoods and large carnivore habitat selection in Laikipia, Kenya, and the implications for human-wildlife conflict (HWC), in the context of ongoing socio-economic and political change, land use intensification, and landscape fragmentation. The findings of individual data chapters are considered with respect to the wider literature in each of the preceding chapter discussions. In this concluding chapter, I draw together the main results of this study and their potential relevance to the wider field of the impacts of climate change on people and wildlife.

Socio-ecological systems (SES) provide a wide range of ecosystem services for both people and wildlife (Reid et al., 2014). Within arid and semi-arid land (ASAL) SESs, connectivity ensures social, economic, ecological resilience, while fragmentation undermines it. A linked SES can experience shocks, such as extreme drought, and still retain the capacity to function, but loss of a functional ecological connection in ASALs is likely to reduce livestock productivity and dynamics as well as landscape condition (Boone and Hobbs, 2004), while habitat loss and fragmentation continue to present a threat to many wildlife species (Vié et al., 2009). Adding climate change impacts, such as increase in temperature, increase in the frequency and severity of drought and changes in vegetation structure into this scenario of fragmenting ASALs will likely pose new challenges for their people and wildlife. Rainfall is expected to become ever more patchy and unpredictable (Platts et al., 2014b), which will likely lead to increased pressure on fewer key forage resources that are distributed ever more unevenly in a fragmented landscape. Even in equatorial Africa, where this study site is located, predicted heavier rainfall will be off-set by rises in temperature that will increase evapo-transpiration (Jones and Thornton, 2003). Increase in competition and overlap in resource use between people and wildlife have the potential to increase HWC, a major issue in wildlife conservation, with serious impacts on people and livelihoods (Woodroffe et al., 2005).

Figure 1.1 summarises these factors, identified in this thesis as impacting on pastoralists and wildlife, in particular large carnivores. The combination of socio-

political factors and climate change, in this case its particular expression through an increase in extreme droughts, are predicted to create an escalation in HWC, for reasons explored in this thesis and summarised below.

The preceding chapters demonstrate that XCEs do impact on the pastoralist livelihoods by causing much more substantial livestock losses during these periods than compared to non-drought years, with knock-on effects on milk availability (Chapter 4) and livestock sales (Chapter 6). Original data gathered and analysed for this thesis showed that increases in livestock predation ensued in extreme drought years (Chapter 6). This thesis also shows that pastoralists are having to work harder to try to mitigate livestock losses by migrating further distances, and/or by paying cash to access water and pasture during drought periods. Analysis of the causes of livestock loss showed that while the overhelming majority died of starvation, and some from associated disease, there is also an increase in losses to predation during drought (challenging earlier findings by Frank et al., 2005).

This thesis has also developed a carnivore case study to explore predator behaviour during extreme climatic events (Chapter 7). The case study species, African wild dogs, were revealed as more likely to use communal land in XCE years, which is the land type that most livestock (in terms of numbers) were taken to find water and pasture during XCEs (given commercial ranches only permit cattle to graze for cash payment, and often impose quotas) (Chapter 5). In addition, African wild dogs were more likely to be found near rivers during extreme drought periods. Riparian areas are particularly attractive to large carnivores, especially during the dry season and drought (Schuette et al., 2013). These "wetlands in dry lands" areas are also pivotal for pastoralists and livestock during the dry season and in drought because they maintain forage production longer into the onset of dry conditions than do other parts of the landscape. These findings suggest that in spatial terms alone, regardless of other factors, pastoralists are more likely to be exposed to potential increase in conflict with African wild dogs during extreme drought years (Chapter 7), and possibly (by extension) to other large carnivores as well. The implications are serious not only for pastoralists and their herds, but for large carnivore conservation in general and for African wild dog in particular.

Pastoralism and wildlife in ASALs

Two-thirds of sub-Saharan Africa south are arid and semi-arid land (ASAL)

ecosystems which receive too little rainfall for rain-fed agriculture to be reliable for a subsistence living. ASALs are dynamic SES that have been shaped by multiple users sharing key resources through common property resource management (CPRM). This reciprocal arrangement allowed access to different parts of the landscape in response to environmental changes. Mobile pastoralism has evolved in ASALs as an economically and ecologically effective land use in these systems (Galvin et al., 2001). Recurrent cycles of droughts are particular features of ASALs, and pastoralists have adapted to living in the highly variable climate through using a suite of coping mechanisms managing the interrelationships between landscape, livelihoods and institutions (Fratkin et al., 1994). Pastoralists in this study used a suite of traditional coping mechanisms during extreme drought years, such as moving livestock and splitting herds. However, more pastoralists are becoming sedentarized due to changes in land use and land tenure (Homewood et al., 2009). Loss of mobility can increase vulnerability to stresses and shocks such as extreme drought (McPeak and Little, 2005). And livestock losses can increase for those pastoralist communities that increasingly become more sedentarized (McPeak and Little, 2005). Lamprey and Reid (2004) found that sedentarization leads to increases in HWC. Conclusions from a 50-year study found that the pastoral/wildlife system in the Maasai Mara is likely to collapse unless mobility for both livestock and wildlife can be maintained (Lamprey and Reid, 2004). Pastoralists in this study responded to the lack of mobility by adopting a new short-term strategy of cash payment for pasture from neighbouring commercial ranches. However, the sustainability of this agreement could possibly be thwarted by continuing political violence and insecurity over land use and land tenure, especially in Laikipia (Cattle Barons: https://www.slideshare.net/starwebmaster/is-laikipia-slipping-into-longterm-anarchy).

Land use policies in ASALs

This thesis reports that historical western ideas around managing ASALs and the policies applied since colonial times are still very present today, and continue to influence future management and policy of ASALs. Although not formally protected, Laikipia does define borders/boundaries by using fences to exclude livestock and/or wildlife. The idea that land could be managed sustainably through customary common property resource systems was discounted because of the assumption that this would ultimately lead to degradation of the environment (Hardin, 1968). The debate still continues today despite a widespread body of

literature demonstrating that flexible and opportunistic tracking of resources is an economically and ecologically effective way to manage ASALs. Despite being seen as 'open' access such flexible and mobile use of spatiotemporally patchy resources is in fact subject to rules agreed between different local users as customary common property resource management (Behnke et al., 2016; Reid et al., 2014). In place of flexible, socially and spatially fuzzy customary CPR systems, present-day orthodoxy seeks to impose privatization to individuals, group or corporate owners, with or without an added layer of new forms of community-based management.

The division of land and the subsequent privatization has had a dramatic impact on pastoralist communities and wildlife alike. Subdivision alters access to water and pasture (BurnSilver and Mwangi, 2007). Privatization is pushed as a more economically productive way to manage land although political ecology analyses show this often leads to accumulation by dispossession, with an imbalance in the share of resources whereby marginalized communities, such as pastoralists, usually lose out (Robbins, 2004). Socio-political factors driving changes in land use and land tenure, with subsequent habitat loss and fragmentation, have been far more pervasive threats to ecosystems than climate change alone (Mace et al., 2005). In addition, habitat loss has been the main cause of species and populations range decline (Mace et al., 2005).

Land grabbing by foreign investors and national or international elites is widespread across the global south, but especially apparent in Africa (Zoomers, 2010). Social elites, private companies and foreign countries capturing resources is resulting in the exclusion of local communities, often poor and dependent on those natural resources as part of their livelihood. The rapid socio-political changes occurring in ASALs are widely feared to lessen pastoralists' ability to respond effectively to environmental shocks and stresses (Goldman and Riosema, 2013), especially in the context of extreme drought (Galvin, 2009). Ideal Free Distribution (IFD) theory predicts that free movement of animals will allow them to match their distribution to that of resources in that area (Behnke et al., 2016) as a direct response to environmental conditions. But pastoralists are increasingly unable to respond to the environment as they once did in terms of resource matching (Behnke et al., 2016). Socio-political drivers have always shaped pastoralists' use and access of resources, such as where they can take their livestock, but exclusion is now reaching new, unmanageable extremes, as well as increasingly constraining

wildlife ranging behaviour. In this study, pastoralists' access to forage was largely based on where they were 'allowed' to take their livestock rather than where they knew pasture would be (Chapter 5). "Community Land" was one such place pastoralists travelled to with their livestock. However, many of the pastoralists reported that although they knew there would be little, if any, good grazing there, it was the only place that people could not ask them to leave. This land was contested land and many of the people that have settled there do not have title deeds.

Well-documented ecological studies show that ecologically continuous landscapes support larger numbers of animals than do fragmented ones (Boone et al., 2005; Boone and Hobbs, 2004). Contiguous landscapes are needed to maintain ecological processes that enable wide ranging species to respond to long-term environmental transitions such as climate change (Fordham et al., 2013). Habitat loss and fragmentation with loss of mobility are equally problematic for pastoralist herds. The broadly free movement of people and wildlife that prevailed in ASALs for millennia, meant that overlapping of resource use could be managed effectively to limit conflict. More overlap in resource use means that it is harder to control potential conflicts that may otherwise occur. The loss of spatial resource variability for pastoralists and wildlife inevitably reduces their ability to buffer and cope with changing resource availability due to increase in extreme droughts. Barriers, such as fences, may reduce landscape connectivity, leading to substantial ecological and economic impacts (Okin et al., 2009; Boone and Hobbs, 2004). As climate change impacts on ecosystem services, the importance of mobility and in a connected landscape becomes increasingly important (Woodroffe et al., 2014). And as human populations and consumption increases, pressures intensify to develop the more productive parts of ASALs (those parts containing key resources of water and vegetation) to meet those demands (Reid et al., 2014). In addition, fragmented landscapes require greater inputs by pastoralists to off-set the effects of climate change (Galvin, 2009) and impacts on livelihood security will increase vulnerability for pastoralist communities (Thornton and Gerber, 2010).

Wildlife conservation

Narratives around protecting the environment have long been built on the idea that certain users should be excluded. National Parks and Reserves in Kenya are located on dry season grazing areas and do not incorporate wet season ranges that are important to many large herbivore migratory species (Western et al., 2009a). Yet

these Protected Areas, based on exclusion as the cornerstone of western philosophy regarding how best to protect wildlife, have failed spectacularly in Kenya on a country-wide level (Ogutu et al., 2016). These efforts to conserve wildlife can alter ecological systems as well as giving increased access to some users but not others, triggering a cascade of socio-political as well as ecological impacts. A prominent example of exclusion was discussed in Chapter 1, outlining the eviction of pastoralists from Eland Downs in Laikipia, which was an important dry season grazing area for pastoralist herds. The removal of the pastoralists from Eland Downs was to create Laikipia's first National Park. The loss of socio-economic potential as well as their homes inevitably provoke strong tensions in the community and certainly create resentment of wildlife and PAs (Western and Gichohi, 1993). This seems to go against the recent conservation orthodoxy whereby initiatives purport to be based on the increasingly widespread understanding that without local community support, any attempts to protect and sustain viable wildlife populations will fail (see Holmes, 2013). And some species of wildlife prefer to graze around pastoralists settlements so are likely to prefer grazing outside PAs (Reid, 2012). Moreover, excluding pastoralists from dry season areas such as where PAs are located increases their vulnerability to impacts of drought (Reid et al., 2014).

Human wildlife conflict

Human-wildlife conflict (HWC) significantly impacts on humans and their livelihoods and is strongly associated with declines in wildlife populations (Woodroffe et al., 2005b). HWC is seen as an increasingly significant obstacle both to conservation of threatened wildlife species (Madden, 2008). However, HWC can often be framed in the context of human-human conflict (HHC), where conflicts occur between different stakeholders over how to manage wildlife and wildlife threats (Peterson et al., 2010). In the case of Laikipia, very wealthy landowners manage their land to promote wildlife populations (Chapter 2). These properties are often located adjacent to pastoralist group ranches. The increased interface between wildlife and pastoralists because of constrained mobility and restricted access is likely to increase human-livestock-wildlife interactions. This study found that for pastoralists, in contrast to ranch owners, wildlife populations are perceived as problematic and a cause of HWC, primarily because of grazing competition, livestock predation or disease transmission between people and wildlife (Chapter 7, this study; Graham et al., 2005). The vast majority of pastoralists I spoke with said

there were more wildlife species present today than in the past. In addition, many of the group ranches in the area, including the three study sites, were all encouraged to set aside part of their group ranch for the purpose of conserving wildlife, again increasing the risk of interaction between human-livestock-wildlife. Livestock can graze in the conservancies during the dry season and drought, otherwise livestock are excluded. So although not a hard boundary such as electric fences are, conservancies can be considered 'soft' boundaries whereby movement in and out of this area is less 'controlled'. Nonetheless movement is still restricted within the conservancy area and beyond.

The land type used by pastoralists in this study (Chapter 5) and the behavioural changes the large carnivores show during XCEs, may contribute to greater spatial overlap in resource use during times of extreme drought than has customarily been the case. This exacerbates every dimension of HWC: grazing competition between wild and domestic herbivores; transmission of disease between wildlife and livestock; and livestock losses to predation. Coupled with climate change, these threats are potentially devastating to large carnivore populations (Root et al., 2003) and pastoralism alike (Homewood in Leslie and McCabe, 2013).

Grazing interactions: Pastoralists and wildlife land use have shaped resource heterogeneity in the ASALs: for example, the way pastoralists corral their livestock overnight creates nutrient hot spots (in some cases called glades), which linger in the landscape for decades or longer and provide above average levels of forage for wild herbivores (Fynn et al., 2015). Comparable stripping and redistribution of nutrients by the action of wildlife was identified some time back for wildebeest grazers in the Serengeti (McNaughton 1988, McNaughton et al 1990). In such landscapes, pastoralist livestock and wildlife not only co-exist but may facilitate one another. For example, wildlife density for certain species may be higher when there were intermediate densities of livestock (Ogutu et al., 2016). In addition, under some systems of conservation, livestock are given access to protected areas during drought: the PAs thus act as a drought grazing reserve for wildlife and livestock alike; such cases are strongly appreciated by pastoralists. Examples include Enduimet and Lake Natron Wildlife Management Areas in Tanzania. However, as less space is available for livestock and wildlife to coexist, fewer patches of forage are available to access. Increase in spatial and temporal overlap means that livestock and wildlife graze in the same area more often, possibly exposing pastoralists to increases in HWC. In CPRM, responding to resource

availability meant livestock and wildlife would not necessarily share the same forage in a shared habitat (Butt and Turner, 2012). But changes in access, climate and vegetation structure may likely alter the level of interaction between people and wildlife further, causing them to overlap more often in scarcer parts of the landscape. The significance is that fewer animals can be supported in a fragmented system and as a consequence grazing pressure can intensify in those areas, causing a depletion in forage (Reid et al., 2014).

Disease interactions: All the pastoralists I interviewed reported that disease had increased dramatically in their life time, specifically citing increase in the number of diseases and the frequency in which they occurred (Chapter 6). Many pastoralists thought that the increase in livestock diseases was due to more wildlife present in the area today than in previous years. Ogutu et al. (2016) does report that Laikipia has seen an increase in certain wildlife species such as Grey's zebra, Burchells zebra, buffalo and elephants. This perception could also be due to wildlife and pastoralist livestock being increasingly forced to overlap spatially and temporally. Disease is identified as a key factor in hampering pastoralist livestock production (Homewood et al., 2006b).

Certain types of disease are likely to worsen for as climate changes. Infectious diseases which are sensitive to changes in climate related environmental variables, such as vector-borne diseases and those which have an external phase in their life cycle, are susceptible to climate change impacts (Gallana et al., 2013). Climate change is thus expected to impact disease prevalence, distribution and intensity, especially vector-borne and emerging diseases (Gallana et al., 2013). Restriction on movement, for both wildlife and livestock means the interface between wildlife and people is likely to exacerbate the challenges that climate change will bring.

Livestock predation and co-existence with carnivores: Large carnivores have coexisted with people for millennia (Woodroffe et al., 2005a) and till continue to do so today. For example, Laikipia supports an intact large carnivore community: lion, leopard, cheetah and spotted hyaena have persisted in the region despite extensive human population growth and use of the landscape. African wild dogs recolonised Laikipia District spontaneously in 2000 (Woodroffe, 2011; Ogada, 2003). However, HWC is a serious threat to many endangered species, and large carnivores (Distefano, 2005) are no exception. Although carnivores do impact on pastoralists livelihoods and security it is also the perceived threat that provokes such strong responses. This study showed that predation by large carnivores

increased during XCE years (Chapter 6); a period when pastoralists and livestock herds are more likely to be mobile accessing water and pasture. In this thesis, GPS data on African wild dogs showed they were more likely to use private land types such as commercial ranches during XCEs than they would do in non-drought years, which would be expected, given there are more prey species on private land in Laikipia than communal land (Kinnaird and O'Brien, 2012). However, an unexpected finding of this thesis has been that African wild dogs were also more likely to use communal or community land during XCEs years than they would do during normal years. This has particular implications for HWC and may underpin the way Laikipia livestock, especially sheep and goats, showed higher predation losses during drought, in contrast to earlier findings by Frank (2005).

Conclusion

The socio-political policies in place that determine how ASALs are managed do not take into account the current impacts of climate change, let alone the future projections, on people and wildlife and the increase need for mobility to be able to adapt and respond to increase in extreme droughts. Shifts in ecosystems, the availability of resource access and the increasing exclusion of resources due to resource capture by changes in land use and land tenure will continue to challenge humans and wildlife coexistence; with which climate change will add further complexity to the scenario. And although pastoralists are adapting to the changes in climate as this thesis has demonstrated, some of the strategies adopted seem to represent either expensive options not open to poorer households, or unfavourable choices that lead to livestock losses despite enormous physical, logistical and financial efforts to sustain the herds. Unless state and private landowners fund the will to facilitate better and more equitable ways of managing pastoralist livestock alongside wildlife, there is a strong likelihood that Laikipia will lose one or both.

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Appendix 1

Transcription of interview with Mike Littlewood, Mpala Ranch Manager

27.1.13

ML: The title I have seen to…Mrs Hansen. This map shows land from about 1950.

CA: So Lekiji Village as we know it today was originally Crown Land.

ML: Yes, I can't be sure of that but it looks that way.

CA: So Lekiji was never part of Ol Jogi?

ML: No. What actually happened was that, I can get a photostat of that for you?

CA: Thank you. That would be great.

ML: What's his name…Raymond Hook together with, this is Webb yeah.

CA: What year is this map actually?

ML: 1954. The material is probably 1950 for it to be printed in 1954. Ol Jogi…there was this Italian called Monzimo (Spelling?) over the horizon and bought these properties from KW Bastard, all that over there, ok. Who owns this…Raymond Hook…and I'm not sure who that is…and made it into Ol Jogi.

CA: How we know Ol Jogi today?

ML: How we know Ol Jogi today. But there was more added at a later date to Ol Jogi. But there was an agreement. The agreement was Raymond Hook, who was a funny old character, a naturalist, who for instance imported quapu (what was the exotic animal?) into this country, all these different funny animals.

CA: Just for pleasure, personal pleasure?

ML: No he thought he was going to make a fortune out of them. There were zebroids, then there were nutria, which escaped and became a big problem here. Now he, he owned…Hook here, Bastard there, he sold and went to the UK. He died. Actually his son sold it. Ok? Raymond Hook now became a bit…they didn't know that to do with him. So it was decided that Raymond Hook could live on this bit of land here.

CA: Once he sold all his larger lands that he owned?

ML: Yes. And that he could live on this little bit here with his people. Only for his life. Once he died that was it.

CA: Did it become Crown Land?

ML: No no, it became part of the bigger Ol Jogi. Because Raymond Hook has sold everything to Ol Jogi and Ol Jogi will let him stay there for his whole life. But then he died. Now, down here was a little piece of land, 1000 acres, owned by a Mrs Gasson.

CA: This name here.

ML: No.

CA: Oh another Gasson?

ML: Another Gasson. What does that say?

CA: Oh Gosh…erm…H…

MPS: A R C S… No Hansen.

ML: Mrs Hansen. So Mrs Hansen sold her bit of land to Bunny Allen who was a sort of gypsy.

CA: Right. Bunny Allen didn't have any land in that particular part of Laikipia then?

ML: Bunny Allen…also owned where Cery Glenn is here then Maurice Randall bought. Or owned. Ok? So Bunny Allen bought this and that.

CA: So that from Mrs Hansen, and that from somebody else.

ML: Maurice Randall.

CA: Was Mrs Hansen living there? Did she have a house there?

ML: I'm not sure whether she had a house there. Yes, I think so. But her husband worked in Nanyuki.

CA: Ok right.

ML: Ok then, but Raymond Hook was a man who…he had, sort of, lots of…people…6 Boran, Rendile, erm people who he sort of lived with.

CA: What, people that worked for him?

ML: Yes. And the girls probably helped a little bit in the house. And there is story of kids. His grandson who you saw the other day…so now he's dead [Raymond Hook]. Hook is dead…as this settlement here, opposite Mpala House over there, the agreement is with Hazel Holmes.

CA: Who's Hazel Holmes?
ML: Hazel Holmes is still in Nanyuki, she is in her 80's and she has a farm here.

CA: So what's the Hook name there for?
ML: She's a Hook. And he's got a white wife up here old Raymond Hook, so the day comes to move this lot, these 6, and it was about 6.

CA: 6 people?

ML: 6 people and their families. And their sheep and their goats.

CA: So all their livestoc

ML: Everything out to Hook. They are there, opposite Mpala House.

CA: Arhh, this one…Hook's smaller property here. So where is Mrs Hansen at this point?

ML: Mrs Hansen has sold the place to Bunny Allen.

CA: But Bunny Allen hasn't done anything with it.

ML: Bunny Allen is a hunter and he's got a house down here. So Bunny Allen says to the squatters, the 6 of them, to get on the lorry to come up here. The manager of Ol Jogi, the new manager (name?) of Ol Jogi realized what they were going to do so he thought, well I better do something.

CA: Why did he think he needed to do something?

ML: Because he thought they would come back.

CA: Right

ML: They would receive their money or whatever gratuity it was and so he bulldozed all their houses down.

CA: The new manager of Ol Jogi?
ML: Yeah. But he didn't burn anything. If he had burned anything he would have been in all sorts of shit. All he did was just knock everything down. So they went to see Bunny Allen and said listen Allen [the 6 families]. The name of the guy was Karollai (spelling?)

CA: Karollai. One of the 6 guys. He was like their leader?

ML: It may have been 4 guys actually. Karollai said, listen, I will look after this place for you. And Bunny, he's also got a place in Lamu, and he's a gypsy and he's also a great womanizer himself. Ok. So and he does safaris out of here. I can remember going there when there were large, huge erm quantities of yellow fever trees.

CA: What year would this have been?

ML: 60's. Late 60's. And we had a safari up here and the client wanted a party and they went to Nairobi pick up the girls and brought them there.

CA: For who? Bunny Allen?

ML: No, no. Bunny Allen's out of it. Anton his son. Anyhow, so, it's now Bunny Allen's. Bunny Allen then sells both properties to Mohamed Ismail and Bernard Hinger, who…Bernard Hinger is the commissioner of police in Kenya.

CA: Yeah, ok.

ML: Sold both properties to him

CA: So what properties are sold to Ismail if both properties are sold to Hinger?
ML: Both are sold to Ismail and Hinger.

CA: Oh so Hinger buys this property up here and Ismail buys these two…

ML: No no, Ismail buys this property.

CA: Oh, Hansen's old property.

ML: So the pair of them, the partnership has that and that.

CA: What year would this have been about?
ML: In the 70's…we are going to sell. They sell it to Mtaytu (not sure of the name?) as a buying company.

CA: What, set up from the government?
ML: No. Set up from…just set up. There were lots buying companies at that stage.

CA: I've recently read that there were a lot of buying companies set up by the government.

ML: Yes.

CA: But this is one bought by them.

ML: No. Anyhow…the surveyors actually came here when I was Mpala before.

CA: When would that have been?
ML: 1980-87. And they erm, surveyed that property.

CA: What we know as Lekiji today?

ML: What we know as Lekiji today.

CA: So, why did they survey it?
ML: To sell and settle it with people. To settle with the shareholder of Mtaytu (spelling?).

CA: Mtaytu? Who are these?
ML: Thompson's Fall group.

CA: Thompson's Falls group. Ok. So the land buying company bought it for people to settle on it.

ML: The land buying company bought it…yep.

CA: And that was in 1980-87 period?
ML: Yes. Then Ol Jogi wanted to buy it. Ol Jogi…the idea was, for Ol Jogi to move them from there so they wouldn't be near the Ol Jogi house over there, and they wouldn't be near Mpala they would be moved to somewhere over here. WK Bastard. Here. Ok? That never happened. Nigel Trent got the sack.

CA: Who's Nigel Trent?
ML: The present owner of Lekiji. He ratted on the…

CA: So Nigel Trent is the present owner of Lekiji. So when did he buy that? From the land company?
ML: Yes.

CA: Arhh, ok, we haven't talked about that.

ML: He bought it from the land company about that time. When he left…about 1990. Ol Jogi was going to buy it, he ratted on them…Ol Jogi, and bought it himself.

CA: So he was nothing to do with Ol Jogi, an individual, a private buyer.

ML: He used to be the manager of Ol Jogi.

CA: Used to be the manager of Ol Jogi. Ok. But he left Ol Jogi before he bought Lekiji?

ML: Yes. So he had been fighting a legal case ever since.

CA: Ever since

ML: Now, why is it, why is it still in court all these years after?

CA: I think most land cases…

ML: No because it started…the first land case on this issue was taken to court within 7 years of Hook dying.

CA: When did Hook die? In the 50's, 60's
ML: 60…(thinking)

CA: Independence was 63

ML: 71, 72

CA: 1971/72

ML: Yeah. So now that is how this settlement ever started there. There were either 4 or 6 families and they were all Hooks people.

CA: They were all people that worked for him?
ML: No...to be fair to the people of Ol Jogi a lot of those girls were more than workers. Raymond had an extraordinary situation.

CA: In what way?
ML: Extraordinary individual. Lots of girls. Black girls. Brown girls. That used to help him in his daily jobs. So now the government is going to buy that. Although…today I was talking to Cery Glenn. Cery now lives here. Ok?

CA: In one of Bunny Allen's old properties?
ML: She bought part of that. And I think we…I think it's been valued at KSH360,000 per acre.

CA: And how big is Lekiji?
ML: 1000 acres. But that is an outrageous amount. If he got 50 per acre he'd be bloody lucky.

MPS: KSH50,000 per acre?
ML: Yes.

MPS: That's how much land is worth?
CA: That land?
ML: Why, is that a lot?
MPS: No, that's nothing.

ML: Ok that's what that is worth and he'd be bloody lucky to get it.

CA: So…

ML: Have I made myself clear?
CA: Well when I play back the recording, I'll let you know. And I'm probably

going to have a lot of questions. So I hope you are free this week and next week. Erm you say that the government are going to buy it.

ML: Yes, because when…now we have a thing, this new government to settle all IDPs. There is no point in them moving a load of IDPS and a new lot being created here so they may as well buy for the people.

CA: Because they are going to go somewhere else and have the same problem happen all over again.

ML: And there will be a battle there and someone will be shot. Like last time. A chap was shot.

CA: This is what I am interested in. So you say it started off with 4 or 6 families. How has a diverse group of people come to live there? It's so diverse there.

ML: People just got hold of Korollai and said listen I want to come and live there and there's some money.

CA: Ok so although it started off with 4 or 6 guys and their families…

ML: More families came

CA: Sooner rather later?

ML: Families are still coming

CA: Yeah, ok.

MPS: So whom was the government buying the land from?
CA: Yeah, that's my next question. You say they are going to buy it
ML: From Nigel Trent

CA: Ok, so although it's been contested in court a long time…does he have the deeds?

ML: Nigel has the deeds

CA: Ok so he does have the title deeds for it?

ML: Yeah. Nigel will be 80. He has a couple of sons

Appendix 2

Household Survey
Date: **GR:** **House ID no:** **Start time:** **End time:**
Interviewer: Claudia Amphlett & RA name **Interviewee:** **Interviewee code:**

1. Who lives in your household?

ID	Name	Sex	Relation to HH head	Age	How long in village	Highest education level	Mother tongue	Most important activities in terms of income for HH	Most important work activities in terms of time spent doing that activity (not for children)
1								1 2 3	1 2 3
2								1 2 3	1 2 3
3								1 2 3	1 2 3
4								1 2 3	1 2 3

Questions on key resources

2. Where do you currently go to use/access key resources not related to livestock, within Il Polei and outside Il Polei?

Resource	Area	Since what year?	Do you use/access it all year?	How long (hrs) to walk from home? (leave & arrive)

Questions about Livestock

3. Where do you currently take your livestock herds to access key resources during average/good years?

Herd (cattle, goats, sheep)	Place/name/location where you take your livestock	For which key resource	Months

4. Can you tell me where you took your livestock during these extreme drought years?

(Say which ones they are and the political/social point of interest occurring at the time). Please start with the most recent one.

Extreme drought year	Herd	Place/name/location where you take your livestock	For which key resource	Months
2008/2009 (Census)	Cattle			
	Goats			
	Sheep			
1999/2000	Cattle			
	Goats			
	Sheep			

5. Tell me about the livestock you lost during the extreme droughts we have talked about, starting with the most recent extreme drought.

Probe for starvation, disease, raiding, predation, accident, unknown etc

Extreme drought year	Herd	No. of livestock kept	Total number died	What were the reasons for loss?	How many for each reason?
2008/2009	Cattle				
	Goats				
	Sheep				
1999/2000	Cattle				
	Goats				
	Sheep				

6. Can you tell me about the livestock that have entered or left your herd over the (a) last year* & (b) during the last extreme drought **

** Starting from month of first interview & count back & include the last 12 months.*

*** From the last rains August 2008 to first rains October 2009*

Last 12 months	Species	Kept	Sold	Bought	Slaughtered / consumed	Given as gift	Received as gift	Born

During 2008/2009 drought	Species	Kept	Sold	Bought	Slaughtered / consumed	Given as gift	Received as gift	Born

7. Can you tell me about the products other than meat, you get from your livestock? (*Use beans to show amount for each product*)

drink = D; make butter = B; sell = S; give = G receive = R; home = H

Season	Milk					Manure				Hides				Butter			
	D	M	S	G	R	H	S	G	R	H	S	G	R	H	S	G	R
Olodalu (Jan-Mar + Sep)																	
Nkokwa (Apr-Jun)																	
Lorikine (Jul-Aug)																	
Oltumuren (Oct-Dec)																	
Drought (2009)																	

9. How many livestock did you lose in 2011 and 2012?

Extreme drought year	Herd	No. of livestock kept	Total number died	What were the reasons for loss?	How many for each reason?
2011	Cattle				
	Goats				
	Sheep				
2012	Cattle				
	Goats				
	Sheep				

Questions on other activities

10. Does anyone in your household have any other income sources other than from livestock?

Use PDM to show how much income the household receives from each activity

Activity	Who does this?	Home or away	Is it regular or occasional	Proportion this activity contributes toward household income

Questions about wildlife species present in your area.

11. Please tell me what wild animals you have present in and around your group ranch. Can you tell me if any of them cause any problems?

Name	Present (yes, no, don't know)	Are the more or less today than 10 year ago	Are the more or less today than in your lifetime	Does this animal cause any problems	What is the problem caused

Appendix 3

Focus group questions[27]

1. Questions about seasons

a. Tell me about the different seasons here and how they change. (Use each month and say what the weather is like).

b. Tell me about how your work changes through the seasons? What do you do and when do you do it? (questions about livelihoods and structure it according to seasons)

c. Can you tell me about the major extreme droughts you can remember occurring in this area? Let people go back as far as they want. And how would you grade the severity of the individual extreme droughts, using a scale of 1-5 where 5 is the most severe and 1 is the least?

d. Can you tell me about the changes people had to make during extreme droughts years since 1999?

e. Do you know of any warning systems in place to inform the community of extreme drought?

f. What help is available for the community during extreme droughts? (from govt, NGOs, community, clan, family etc)

2. Questions about resources

a. Tell me about the key resources you use and where you get them from. Can you rank them in order of importance?

b. Tell me about significant changes in land tenure that have occurred in this area that you can remember and how this has affected your access to key resources. (Use the community map drawn in Q2a&b. Also use official government land records & land registry maps etc to help with the discussion & demarcating out changes).

c. Have these land tenure changes affected where you take your livestock? (Get the community to show on the map where they no longer access key resources because of changes in land tenure).

[27] These questions were used as SSI at Il Motiok and Lekiji.

3. Question about places go with their livestock

3a. Tell me about the places people take their livestock for grazing during the dry & rainy seasons. (Use the community map to show the areas that are important for grazing livestock).

3b. Can you tell me about the places you take your livestock to during extreme drought?

3c. Can you tell me if in some areas people are more likely to suffer from livestock losses? (Use PM to show the areas that people perceive are at risk from predators). Do these areas change during XCES?

4. Questions about livestock losses

a. Tell me about the losses of livestock people suffer from. What are the main reasons for livestock losses? (Prompt for starvation, disease, raiding predation, accident etc)

b. Do these reasons for losses change depending on season? (dry, rainy and extreme drought)

5. Questions about conflict resolution

a. Did any particular problems/conflicts emerge during the last extreme droughts we have just discussed?

b. Why did they arise?

c. How did people resolve them?

Appendix 4

Key Informant Questions

Q1. Have the pattern of seasons changed at all in your lifetime?

Q2. When accessing KRs outside of the group ranch, how do you decide where to go?

Q3. What do you think is the biggest threat to livestock today?

Q4. What have changes in land tenure brought for you and your livestock?

Q5. Have livestock numbers and structure changed in your lifetime?

Q6. Have livestock diseases changed & how do you treat the diseases?

Q7. What are the problems brought on by XCEs?

Q8. Why do you think the 1999/2000 & 2008/2009 extreme droughts were worse than other extreme droughts in recent years?

Q9. Today, you can take your cattle on commercial ranches. Has it always been like this?

Appendix 5

Timeline and the event calendar created by Il Polei and Lekiji Village. The full list of events mentioned as salient is set out, giving a feel for life in the village.

Il Polei timeline event calendar.

Year	Positive	Negative
2000	Ol Jogi allowed all Il Polei livestock to graze on their ranch Government provided relief food (rice, beans, fat, oil, soya, porridge flour) Ol Jogi provided relief aid Rains come October = seen as very good rains	Drought Shoat prices dropped A lot of livestock died Degradation (due to strong winds) Children dropped out of school because of no money A few male household heads went to Mt Kenya = lost all livestock en route or while there
2001	Good rains Fewer livestock = grazing for all	
2002	Govt relief food National elections went well Rains came in November	Drought (not as bad as 2000) Only 2 cattle per household allowed to graze on Ol Jogi Prices of livestock dropped
2003	Clear separation of resources between Il Polei & Munichoi group ranch Il Polei get ownership of resources (sand, conservation area) and money accrued from them Il Polei started to sell sand for a whole month (Jan, May, Sept) No drought so there was pasture for livestock, apart from end of year	Death of MUNIPOL (Munichoi & Il Polei) Conflict over resources (sand) between the two GRs More conflict because of breach of agreement Drought started in Nov after little rain Il Polei community was denied plots of land at the centre because of disagreement. Members have to buy plots
2004	Livestock got access to pasture because of invading commercial ranches (apart from Ol Jogi) Il Polei rebuilt 4 classes for the primary school (using money from sand extraction) Start of paying contributions toward people's hospital bills (using sand money) Restocking herds of old men's herd with shoats who have lost livestock because of drought (sand money). Then other people according to hierarchy. Employment of 2 nursery teachers at 2 nurseries at Soitoitashe Ranch and Il Polei (using sand money)	Drought (not as bad as 2000 but worse than 2002) Conflict between group ranch, government & commercial ranches Children & women left at home Men & leader left with livestock for Mt Kenya No govt relief food Livestock prices dropped Food price increased No water in rivers (*due to increase in sand extraction?)*
2005	Good pasture until Nov	Drought started at end of year in Nov

	Il Polei started youth, women & old men groups Prices of sand went up Prices of livestock very good	
2006	Il Polei initiated a bursary scheme for primary & secondary children to help parents pay for school fees Ol Jogi gave grazing access for 2 cattle per household	Drought = rain didn't come until Dec Male household heads migrated to Mt Kenya Lots of cattle & shoats died Livestock prices went down Food prices went up Charcoal extraction for people outside Il Polei
2007	Good year for grass and grazing National elections went well	
2008	Peace within Il Polei GR election done	Some tension between members of Il Polei because of change in group ranch committee members Drought begins after last rains in Aug
2009	Govt supplied water Ol Jogi supplied water Ol Jogi supplied flour to the most poor families Govt food relief food CARITAS for poor families GR bursaries (youth, woman & old men) continued 2 cattle per household went to Ol Jogi	Extreme drought 80% of livestock lost Livestock prices went down Water level went down Wildlife die = dik dik, elephant & baboon Trees & plants were not providing flowers or seeds Many GR members went to Mt Kenya
2010	Rained throughout year Livestock prices went up Plenty of milk Increase in sand so business brought more money in Plenty of pasture for livestock	
2011	Rained throughout year Livestock prices went up Plenty of milk Increase in sand so business brought more money in to community Plenty of pasture for livestock Cattle moved onto Ol Jogi as Ol Jogi start a holistic livestock management programme Il Polei start holistic livestock management programme to rehabilitate the land	Foot & mouth disease Arrival NEMA (National Environmental Management Authority) at Il Polei and want to know about the sand extraction business – who's involved, where, when, how the money is spent etc NEMA to conduct an Environmental Impact Assessment on sand extraction business
2012	Il Polei continue with holistic management programme Plenty of rain Plenty of pasture Lots of water in luggas Lots of sand	Foot & Mouth continues

Lekiji timeline and event calendar.

Year	Events people remember from that year
2000	An extreme drought with no rain; livestock migrated to different areas; community lost a lot of livestock, especially cattle; families return home with nothing after migrating; the was cattle rustling at Kipsing and Dol-Dol; the land was red and bare; trees looked dry and had no leaves; Government supplies yellow corn, beans, cooking fat and pulses; USAID donated food; people that lost all their animals cut down trees for burning charcoal; People were sick a lot with the flu and an eye disease.
2001	After the long drought the community slaughter and had thanks giving to God for the rain; Normal rains return; Water from Nanyuki river was so forceful it created big gullies at the riverside An old man was speared by a young man in the thigh and died – the younger man died later through an arrow injury; British Army bought all our chickens for KSH1,000 each; A group of youths in our community decided to dig terraces and plant grass in the bare land
2002	Election year so this year saw a lot of chaos. (Kibaki elected). One of the word?? A representative was almost burned by the community. Ol Jogi build a cattle cell on the other side of the river to impound our livestock for 2 days if we are caught grazing in Ol Jogi. Government introduced 'Food for Work' programmes, which includes digging luggas. A high number of youth are circumcised. Female Genital Mutilaton was prohibited by the Government as a way of stopping girls being circumcised. One of the key main elders of the community, who had been our chief since we arrived in Lekiji in 1952 died. Was the longest serving chief. A small girl about 5 years old was killed by bees as she was fetching firewood. An unknown dog from outside the village that was affected by rabies bites & eats all the small puppies in Lekiji.
2003	Lekiji Primary school was upgraded from a class 4 school to a class 8 school. 3 new teachers were employed by the Government. Cattle raiders attack the village & took almost 200 goats & a cow. The cow was recovered the same night but the goats got lost and were predated on by hyaenas. Rainfall was normal. Many goats give birth premature but nobody knows why. Outbreak of an ear infection in people, which was reported to the ministry of health. Ministry of heal visits Lekiji and urges the community to start using pit latrines instead of the buses around the village. Mpala donated storage tanks, pipes & pump machine for the school to access water from the river. Otherwise, the children were taking a lot of time out of school to collect water from the river. Mpala build 2 new classrooms.
2004	A dry year. Government donated relief food.

	Lekiji Primary school overall score was high at the division level. Lekiji community was not allowed to entre Ol Jogi. Livestock suffered from lung disease Lekiji women are interviewed by a British lawyer with regards to the case of rape against them by the Gurkha Regiment of the British Army. 10 men were paid compensation by the British Army because of injuries caused by landmines. Outbreak of bird flu, which killed most of the chickens at the village.
2005	Mini drought from Jan – April. Water level in the river is low. People with livestock take them to neighbouring ranches at night illegally. Police anti-stocking Unit arrests the livestock owners and take them to Naibor. Relations with Ol Jogi are not good. A lot of arguing. 1 man arrested by Ol Jogi commercial ranch security for fetching firewood. He is taken to Nanyuki. First time to see sniffer dogs from Ol Jogi tracking for poachers who had escaped through Lekiji. Drunken woman beats a drunk man very seriously injuring him for not paying for the local brew. It is reported to the BATUK (British Army Training Unit Kenya) in the area and he is airlifted to Nanyuki hospital by British helicopter. First donkey at Lekiji bought from Ol Jogi.
2006	Normal year for weather. Livestock were OK. There was not enough food to eat because no relief food was given out. Robbers broke into the kiosk & took everything. 3 of them were killed by Naibor Police after Lekiji community called the police and followed their tracks. Drunken man stabs 3 young men. He is arrested later. 2 men admitted to hospital after taking illegal brew and methanol together. People start to use corrugated tin for their roofs instead of thatching grass. Lunar eclipse Some people bought camels for the first time. *Acacia brevispica* begins to disappear. The trees started drying up and there are none to be found in Lekiji now. (Also happened in parts of Ol Jogi)
2007	Polling station was built for the first time in the school Many goats died of lung disease Many visitors came from Ewaso, Il Motiok & Kimanjo on their way to Endana to migrate with their livestock. They stay in Lekiji overnight & bring disease with them as well as eating all the pasture. Many sheep die from unidentified 'grass' Lekiji community complain to the Government after farmers in Mt Kenya block the river water and divert to their shambas (farms). The Nanyuki River run slower and is lower. Outbreak of smallpox Rabies in domestic dogs. Rabid spotted hyaena broke into chicken boma & killed 20 chickens. Locusts come in swarms & destroy the shambas, grass & trees. Sand harvest site found underground where 2 rivers meet Big campaign for general election. Many aspirants visited Lekiji for the election in December. Mpala give Lekiji a big bull on Christmas eve. Lekiji primary school announce best in the environment in the division. People in the community complain of pain in the joints. A women's group is formed – farming, beads & poultry.

2008	Dry year Jackals were dying of a disease. Village dogs vaccinated against rabies (Rosie Woodroffe's project). Outbreak of Rift Valley Fever on livestock. The Government stopped all sale of livestock in the Rift Valley Province. Chicken prices went up to KSH1000. 300% increase on normal prices. An insect named after Nairobi spread its bacteria (Nairobi fly) Livestock were migrated to Mlimatatu, Sweetwaters & Endana to search for pasture Some people lost their livestock mostly after the cattle feed on polythene bags. Most people feed on the acacia ballanite (seeds). Cook for 12 hrs before you can eat. Because we are so hungry. Malaria outbreak because of the stagnant water. Some pupils dropped out of school. Forced to search for food because they are so hungry. Plenty of fish but they were not sweet like they normally are. Some women took divorce. This year was higher than normal. Most families lost most of their livestock. Elephants die especially individuals aged 7 years & below. Food prices increased. There was a shortage of food from the markets.
2009	heavy rainfall on 15th April Rex Taylor (Mpala trustee) scholarship started. 2 pupils are sponsored every year – 1 boy & 1 girl. Mfariji CFC (Christian Fund for Children) & NGOs sponsor school – 50 pupils Changing of age groups In Moolo to Il Mopio. This is done every 10 years. Outbreak of bird flu. Chickens die rapidly. People treat their chickens with aloe herbs. Bees migrated to Mt. Kenya A boy drowned in the Nanyuki River Mt Kenya burned due to smoking the bees out & the Nanyuki River turned black. Could use it for 2 weeks. A member of Lekiji was injured by a black rhino while on his way to Lekiji. Most of the acacia trees alongside the rivers died because of a certain insect than burrowed in them. A member of the community was injured by the British Army when one of their vehicles overturned while he was in the car. Outbreak of TB 5 members of Lekiji were hired by the British troops as guards Community complain of be bitten by fleas at their homes (especially at night). Between September 2008 & April 2009, impala came from around the village into the village. People caught them & slaughtered them for over a month. People ate very well. There was nothing else to eat.
2010	Mini drought between June and September. Strong winds in October for 2 days. Few livestock due to hunger & less grass. The Nanyuki River dried up for the first time Fish died Goats crossing the river were caught by Ol Jogi security & confiscated. The goats were sold to the workers at Ol Jogi. Wind blows 3 houses & 2 classrooms down Well-wishers from Nanyuki built a Mosque. First one in the village.

	CDF added 1 block to the class. Thyphoid outbreak due to stagnant water. 7 people died Ol Jogi put up an electric fence between the boundaries of Ol Jogi & Lekiji. Government distributed relief food Government introduced & distributed medicine through the mobile clinic for the first time. Youth harvested sand from the river & stream
2011	High amount of rainfall – mini el nino Destocking of livestock by the Government. The Government bought our livestock & slaughtered it for the community to have. The meat was shared out between everybody. This was free. Bumper harvest for subsistence farmers Honey harvest was the high A shooting star was seen passing by. Employment for Lekiji youth to Mpala was the highest (17). There was a solar eclipse in mid-June A leopard was a menace in the village. Reduction in the number of dogs, cats & goats. 2 girls were selected to join a National School for the first time. Local youth from Lekiji was recruited as a police officer Young girl died after a tress fell on her NEMA came to measure river volume for the first time
2012	Community election held for chairperson, committees & youth leader School committee elected School elected a new head teacher Livestock was healthy. Numbers increased. All cattle went at graze at Ol Jogi commercial ranch All camels were sold because of opuntia cactus. They eat it and it makes them sick & kills them. Outbreak of malaria Goats are attacked by leopard at night even more than normal. 30 domestic dogs are taken by the leopard & killed. An elephant kills a 19 year old young man. The elephant also destroys the shambas. Geographical boundaries change for Laikipia. A new District is added – Laikipia North. A new constituency is added and a new District Centre is added. Expect MP