Let My Cattle Go Thirsty?: Exploring Resource Access and Visualizing the Space-Time Dimensions of Pastoral Mobility in the Kilimanjaro Region of Tanzania

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Eric J. Lovell
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This thesis titled

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by

ERIC J. LOVELL

has been approved for

the Department of Geography

and the College of Arts and Sciences by

Gaurav Sinha

Assistant Professor of Geography

Edna Wangui

Assistant Professor of Geography

Howard Dewald

Interim Dean, College of Arts and Sciences
ABSTRACT

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Pastoralism is one of the most efficient livelihood production systems to cope with the non-equilibrium system that characterizes the semi-arid and arid regions of East Africa. However, Maasai pastoralists occupying the Kilimanjaro region of Tanzania have faced many sociopolitical changes that have interfered with their ability to remain mobile and access resources on a daily basis. As climate change is expected in the form of increased variability and more frequent and prolonged extreme climatic events, such as droughts, these social transformations are placing the Maasai in an uncertain position. This research investigates the changes that have occurred to resource access and mobility among the Maasai over the past 50 years. Using a mixed-methodology, changes in the spatial and temporal dimensions of resource access and mobility are examined. This research then employs a temporally enhanced GIS to geovisualize responses to droughts. Analysis indicates that daily patterns of mobility are constricting due to landscape fragmentation, while the mobility patterns taken in response to extreme climatic events are expanding due to both severity and the opportunities of the 21st century.
Approved: _____________________________________________________________

Gaurav Sinha
Assistant Professor of Geography

Approved: _____________________________________________________________

Edna Wangui
Assistant Professor of Geography
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ACRONYM LIST

AEZ – Agro-ecological Zone

ASAL – Arid and Semi-Arid Lands

CAQDAS – Computer Aided Qualitative Data Analysis Software

GDP – Gross Domestic Product

GIS – Geographic Information System

ICT – Information and Communication Technology

LKCCAP – Local Knowledge and Climate Change Adaptation Project

MLRMP – Maasai Livestock and Range Management Project

NSF – National Science Foundation

PADET – Pastoral Development and Education Trust

PGIS – Participatory Geographic Information Systems

PLE – Pastoralists, Livestock, and the Environment

SPILL – Strategic Plan of the Implementation of the Land Laws

TJFACF – Tanzania/Japan Food Aid Counterpart Fund

TLU – Tropical Livestock Unit

URT – United Republic of Tanzania

USAID – United States Agency for International Development
1.0. INTRODUCTION

Livestock management is an important livelihood practice spanning across all stretches of the globe. In the arid and semi-arid lands (ASAL) of the world, such as parts of East Africa, pastoral practices are one of the most efficient ways of dealing with a very complex landscape that is recognized for its non-equilibrium characteristics, as well as its spatial and temporal heterogeneity. As the maintenance of livestock is dependent upon the ability to access the necessary natural resources, the seasonal and spatial distribution of potable water and sufficient grazing land is of great importance for the future sustainability of pastoralism in the region. In addition to the variable fluctuations of a non-equilibrium rangeland, pressures on resources are amplified as climatic indicators, such as precipitation, are becoming more variable, temperatures are on the rise, and devastating climatic events, such as droughts, are becoming more frequent (Jones and Thornton 2003). Increased climate variability has the potential to alter the ability to access the sufficient resources for those who rely on pastoral practices as rangeland composition and available water resources may be subject to swift physiologic change. In addition to these changes, social processes have forced pastoralists to face additional hardships. Many top-down approaches to scientific inquiry and development practices have not only neglected the importance of livestock herding as an important physical process and a critical form of cultural and social capital, but have also viewed pastoralists as responsible for environmental degradation, and not possessing the correct knowledge and management skills to produce progressive environmental stewardship (Bassett and Zueli 2003; Blaikie and Brookefield 1987). These views of pastoralism have influenced
land tenure policies that are designed for sedentary farming methods and have had an overall bias towards capital-intensive cultivation practices. The formalization of land, promoted by large neoliberal entities such as the World Bank, has greatly impacted those who rely on customary land-use practices to dictate the ability to access necessary resources, such as many mobile pastoral societies in this region (Mwangi 2007; Toulmin and Quan 2000). These concerns have fragmented pastoral resource bases, making it more difficult for herders and livestock to remain mobile and travel across space and time to access necessary resources. Adjustments in both the sociopolitical and the ecological realms are transforming the complex relationships between people, livestock, and the environment (PLE), which in turn is likely to further marginalize those who rely on livestock rearing as their primary livelihood practice. With the intricacy of these adjustments in mind, questions of the complex human-environment (or socio-ecological) system (Blaikie and Brookefield 1987; Turner and Robbins 2008) are sought to further explore the shifts in resource access and mobility occurring among Maasai pastoralists in northern Tanzania.

1.1. Exploring Changes in Resource Access and Pastoral Mobility in Tanzania

This research was conceived to understand what changes are occurring on the ground that have the potential to place pastoralists in a more vulnerable state to cope with increased climate variability. The primary goal was to understand the changes in access and mobility to livestock watering and grazing areas, that have been experienced by Maaasai pastoralists over the past 50 years in Kirya village in the Kilimanjaro region of
northern Tanzania. The research was a part of a project funded by the US National Science Foundation (NSF) for research to be undertaken between 2009 and 2013. This research project, called Local Knowledge and Climate Change Adaptation (LKCCAP) is exploring the social, political, and physical impacts of climate change on the sociogeographic adaptive capacity of livelihoods in the Kilimanjaro region of northern Tanzania\(^1\). LKCCAP study areas occur along four ecological gradients located in four of the six districts within the Kilimanjaro region. Each gradient is composed of three or four villages located at a high (> 1,200 m.), middle (600 – 1,200 m.), and low (< 600 m.) altitudes. Of the four ecological gradients within the LKCCAP study area, one transect, in Mwanga district, was chosen for extensive participatory and community-based research. Kirya village was chosen as the lowland site of the Mwanga District gradient, and also became the study area for this research project (Figure 1). Many of the Maasai of Kirya practice a diverse range of livelihood practices, including cultivation; however, all are still relying heavily on livestock herding. Therefore, this thesis is focused on those who practice livestock herding as a primary livelihood practice as changes in water and grazing access have great impact on these practices (Hobbs et al. 2008; Nori et al. 2008).

\(^{1}\) For more information about LKCCAP: [http://tzclimadapt.ohio.edu/](http://tzclimadapt.ohio.edu/)
Figure 1: LKCCAP Study Area Map.
1.1.1. Research Questions

This study was not necessarily concerned with conducting a detailed resource mapping exercise, but rather with understanding the ‘ground truth’ (Pickles 1995) of what has occurred to pastoral mobility and resource access among the Maasai of Kirya. To do this, explicit mapping of pastoral livelihood spaces and changes in the human-environment interaction were essential for exploring the physical, social, and political dimensions of resource access and mobility. Thus, apart from understanding these issues, another critical component of this research project was to explore how qualitative narratives detailing individuals’ adaptation patterns in space-time can be represented within a temporally enhanced geographic information system (GIS) to reveal and geovisualize interesting changes in the spatiotemporal patterns of livelihood adaptation strategies. To maintain these objectives, this research project was defined and guided by the following research questions:

- **What are the current spatial and seasonal dimensions of watering and grazing access in Kirya?**

This question was posed to identify the locations of livestock watering areas during seasonal variations in Kirya. This question established a spatial understanding of the area and how pastoralists in the region utilize the local resources. Specifically, individuals were asked where they access grazing and watering resources on a daily basis and where they accessed sufficient resources during prolonged periods of dryness and in times of drought.
• What changes have been occurring to watering and grazing resource access in Kirya over the past 50 years?

This research question helped to explore the changes that have occurred or are occurring to the watering and grazing locations identified in the first research question. Fifty years was the chosen range due to the ability to capture narratives that ranged from this array. By understanding past changes that have been experienced, as well as the current trends, a deeper understanding of the local changes experienced in Kirya can be recognized. This line of inquiry helped understand changes in watering or grazing quality and quantity and identify differences between past and current watering and grazing locations and patterns of access.

• How do the Maasai of Kirya adjust their mobility patterns to accommodate changes in watering and grazing?

This question was posed to examine the responses pastoralists have taken to cope with the changes discovered in the previous question. As mobility is a commonly employed strategy that pastoralists use to deal with the spatial and temporal variability of ASALs, this question was conceived to understand how patterns of mobility are changing.

• What benefits might accrue from the representation of Maasai narratives in a temporally enhanced GIS?

There are substantial benefits to qualitative geospatial analysis of narratives. This methodological question was conceived to explore if space-time path analysis can be used and coded to provide tangible benefits through GIS based visualization and
analysis. This question sought to visualize patterns of regional mobility, which are generally very abstract because of their scale and complexity. Additionally, the intention was to test if visualizing lived experiences in a space-time framework helps uncover hidden patterns and uncertainties not easily apparent from qualitative analysis of oral histories.

1.1.2. Mixed-Methods Research Framework

The research questions outlined above mandated a mixed-methods approach be adopted as the primary method of data collection and analysis. Both qualitative and quantitative methods were used for data collection. The various sources of data included surveys conducted in 22 households in Kirya by LKCCAP; four community workshops held in Kirya by LKCCAP; the collection of 15 oral histories; semi-structured interviews; and participatory mapping detailing resource access and change. Oral histories and participatory mapping exercises became the primary source of information for addressing the research questions outlined above. LKCCAP household surveys and community workshops were used as complementary sources of information. These maps and narratives were then geo-coded into a temporally enhanced GIS database for visualizing pastoralists’ past experiences and regional movements in space-time.

As demonstrated in later chapters, this mixed-methodological approach helped both leverage the traditional strengths of a quantitative analysis-oriented GIS and also extend it qualitatively (Cope and Elwood 2009). The specific combination of methods used for this research was inspired more specifically by the developments made by the
Critical GIS research community\(^2\) (Schuurman 2000). Therefore, this research should also be interpreted as making a secondary contribution to the Critical GIS paradigm by combining the strengths of traditionally computational and the newly recognized qualitative analytical capacity of GIS.

1.2. Significance of this Research

Pastoral societies in Africa have faced serious threats to their livelihood and cultural practices. In Kirya, the pressures are no different. Government policies continue to promote land tenure policies, which are not only leading to further conversion of seasonal pastures to farmlands, but are also, fixing spatial boundaries (UNDP 2003). These factors limit pastoralists’ ability to cope with the spatial and temporal heterogeneity that has only recently become a defining characteristic of semi-arid and arid regions across the globe. With climate indicators likely to become more variable and the frequency and duration of extreme climatic events to become more severe, maintaining mobility is both critical to the sustainability of the pastoral livelihood and the most efficiently designed strategy for coping with an overall increase in climate uncertainty (Scoones and Graham 1994). These concerns may paint a bleak picture for pastoral livelihoods but pastoralists have

\(^2\) Spawning from “GIS and Society”, which was established through NCGIA Initiative-19 (1996), “Critical GIS” arose as a sub-discipline of geography in the mid-1990’s from the collective realization that GIS favored only quantitative and positivist representations of space and time (Pickles 1995; Smith 1992). After nearly 15 years of theoretical and practical advancements in several areas of GIScience (Goodchild 1992), researchers have shown how geographic information systems can represent multiple epistemologies and ontologies (Cope and Elwood 2009; Schuurman 2000).
proven resilient, displayed highly adaptive systems, and responded to opportunity as it has emerged during past instances of increased stress (Niamir-Fuller 1999). Therefore, a holistic approach to understanding what is occurring to pastoralists’ ability to remain mobile and access crucial resources can provide insight into how pastoralists will continue to adjust into the 21st century and onward.

1.3. Presentation of this Research

This thesis is organized into eight chapters. In Chapter 2, the current literature on pastoralism in East Africa, issues concerning resource access in East Africa, and the dimensions of pastoral mobility are discussed. This chapter then highlights the two themes of literature that constructed the conceptual framework used in this research. In Chapter 3, the study area of this research is thoroughly discussed, first introducing the Maasai pastoral production system in East Africa. This chapter then focuses on the study area at a national context, but then zooms into the local context to provide an overview of the Kilimanjaro region and the village of Kirya. Chapter 4 provides an overview of the methodological framework used to approach this research and the methods that composed the mixed-methodology. The next chapter, Chapter 5, discusses how the data was analyzed and interpreted for this research, along with an overview of how the qualitative spatiotemporal database was created. Chapter 6 examines the results from fieldwork and data analysis. In Chapter 7, the changing dimensions of resource access and pastoral mobility are summarized into themes and brought into the contemporary
literature on pastoral resource access and mobility. Chapter 8 makes the concluding remarks for this thesis.
2.0. LITERATURE REVIEW

Resource access among pastoralists takes place across a physical, social, and political landscape that is constantly evolving, bringing new opportunities, challenges, and uncertainty to the forefront of each individual resource user. In order to provide context for this research, this chapter is broken down into three sections. Section 2.1 provides an overview of the livelihood production system of pastoralism. This section introduces the focus of this research, as well as present the dynamics of resource access, decision-making, and customary practices commonly employed across ASALs. Section 2.2 discusses the conceptual framework used in this research project that has emerged out of two contemporary themes of literature that explicitly explore pastoral mobility and resource access. This chapter concludes by highlighting the niche that this research is filling by approaching these themes of literature in parallel.

2.1. Pastoral Livelihoods

ASALs across the globe constitute approximately 32% of the entire land area and approximately 66 percent of Africa’s total land area (Niamir-Fuller 1999, 3). These landscapes are composed of various social and ecological subsystems, which interact in reciprocal ways, constructing human-environment systems and livelihood production systems (Gallopin 2006). In global ASALs, pastoral livelihoods\(^3\) are prevalent as

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\(^3\)Chambers and Conway’s (1992, 6) definition of a livelihood is used here, stating “a livelihood comprises the capabilities, assets (stores, resources, claims, and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global level and in short and long term.”
livestock herding and husbandry are now being acknowledged as the most effective and sustainable means of utilizing landscapes that are seemingly marginal but actually quite viable over both time and across space (Behnke et al. 1993; Scoones and Graham 2004). Pastoralism is a complex livelihood system, which seeks to preserve an optimal balance between natural resources (pasture and water), livestock, and people in variable and uncertain environments (Nori et al. 2008). As defined by Niamir-Fuller (1999, 1), pastoralism is “a mode of production where livestock make up 50 percent or more of the economic portfolio of a small holder”. Across many dryland zones, pastoral societies such as the Sahawi and Touareg of the Sahara; the Fulani and Toubou of the Sahel; the Bedouin and the Kurds of the near East; the Somalis, Borana, and Afar in the Horn of Africa; Tuvans of Central Asia; and the Maasai, Turkana, Pokot, and Samburu of sub-Saharan East Africa, have raised and managed various livestock herds ranging from large stock such as cattle, camels, yaks, and sometimes equine to small stock including sheep, goats (commonly referred to with sheep as “shoats”), pigs, and donkeys (Galaty and Johnson 1990; Nori et al. 2008; Fernandez-Gimenez and Swift 2003). These herd compositions vary across regions. Through the definition proposed by Niamir-Fuller, it can be acknowledged that claims of “pastoralism” as being “pure”, relying only on livestock as a mode of production and dietary staple have been frequently misleading representations of these pastoral societies. This conception has led to misguided colonial perceptions, development practices, and governmental policy planning across global ASAL regions. In fact, pastoralism in Africa takes many façades ranging from nomadic groups which are highly mobile, not relying on an established base of residency, to
transhumant groups which practices more regular movements of their herds between wet and dry season pastures to agro-pastoral groups who base their extensive production systems on sedentary agriculture and more than half on livestock rearing. Many pastoral groups across the globe practice some form of agriculture, as well as supplement their diets with food commodities purchased through trade and sales (Fratkin and Mearns 2003). Therefore, these rather ambiguous boundaries constructed between livelihood practices make it difficult to label who is a “pastoralists” and who is not (Hodgson 2001; Spear and Waller 1993). In the context of this research and the remainder of this chapter, the term “pastoralist” is used loosely to discuss those who rely on livestock herding and some form of livestock mobility as a major livelihood production system.

2.1.1. The Value of Livestock

Livestock play several essential roles in pastoral livelihoods (Niamir-Fuller 1999). Livestock may contribute to an individual’s socioeconomic status, as the numbers of livestock may indicate not only the wealth of an individual, but also the depth of their kinship ties and their ability to survive devastating events such as floods and droughts. Livestock also play a predominant role in food security. Across sub-Saharan Africa, livestock production accounts for approximately 25% of total food production (Homewood and Rogers 1991, 141). Livestock are economic commodities used by herders as a store of wealth (Sperling and Galaty 1990). To many pastoralists, livestock are used to facilitate trade and sales. Practices of destocking and restocking through local market access are a commonly taken strategy as a response to bad years, as markets
provide a means of moving livestock away from areas of resource scarcity (Turner and Williams 2002). For instance, Turner and Williams (2002) found that during a drought-induced decline and subsequent recover period from 1984-1994 in the Sahel region of West Africa, livestock losses were more of a factor of market sales rather than the commonly characterized demography patterns (death and birth rates) associated with such extreme events. Finally, livestock are considered an important form of cultural and social capital, representing the material ties of the moral economy. In the form of loans, dowries, gifts, grain-livestock barters, and entrustments, livestock are used to extend reciprocity amongst other clansmen and ethnic groups, especially after bad production years (Niamir-Fuller 1999). In turn, these acts expand social networks across national and international boundaries, not only with other livestock herders but also establishing socioeconomic relationships with sedentary, less mobile populations (Niamir-Fuller 1999). Historically, trade between these populations has provided the proper dietary needs to be met, diversifying dietary intake and providing a range of proper nutrients (Spear 1997). Practices of livestock herding are not independent production systems, detached from the shifts and swings of the national and international political economy (Bassett 1988). For instance, Bassett (1988) found that although the Ivorian government welcomed Fulani pastoralists into the country for purposes of contributing to national beef production, Senufo farmers challenged livestock development policies as they associated uncompensated crop damage with the deterioration of their standard of living. On the contrary, major economic adjustments such as the implementation of structural adjustment programs (SAP) resulting in increased agricultural production or transitions
from socialist economies to market economies have major implications on the management and governance of pastoral inhabited lands (Fernandez-Gimenez and Swift 2003; Fratkin 2001). The purpose of livestock cannot be simplified to serving one primary purpose or constituting one form of capital. The multi-faceted system of livestock herding serves many purposes to both the pastoralist who owns the livestock and other livelihoods that interact with pastoralists through employment, trade, or other means.

2.1.2. Patchy Resources: Resource Access in Non-Equilibrium Systems

For most pastoral production systems, some form of free or herded access to open pasture and water is crucial for livestock production (Bekure et al 1991; Homewood and Rogers 1991; Niamir-Fuller 1999). Although misunderstood by dominating colonial and post-colonial science and development of the 19th and 20th centuries, ASALs are heterogenic and are characterized by relatively high coefficients of variability, implying that they, along with the resources they possess, vary quite drastically over both space and time. The spatiotemporal dynamics, uncertainty, variability, and normality of major climatic events, such as floods and droughts, characterizing these ecosystems inhibit science from utilizing the principles of equilibrium, where balance and harmony are guided by phenological succession towards climactic characteristics (Behnke et al. 1993). Therefore, these dynamic ecosystems are considered at a state of “non-equilibrium or “disequilibrium” (Behnke et al. 1993). This has spawned an alternative way of thinking about ASALs that is commonly referred to as the “new ecology paradigm” (Scoones
High degrees of variability express an even greater degree of resource ‘patchiness’ as rainfall events are highly intermittent across even a very localized spatial scale; therefore, different areas provide different resources depending upon the time of the year (Scoones and Graham 1994).

In order to facilitate proper resource access on a routine basis, flexible systems of access in the form of communal systems of land and natural resource management have been necessary to enable mobility across these landscapes. Variability across different scales means that pastoralists do not only rely on local variability to dictate where and when sufficient resources can be sought on a daily basis, but also on large-scale variability, in which case long distance livestock movement can be utilized in order to react to the changes in the constantly fluctuating landscape and maintain the necessary stock size for their personal human subsistence (Homewood and Rogers 1991; Niamir-Fuller 1999). The different scales of mobility play a key role in many aspects of the pastoral livelihood and the capability to acquire the proper assets, including: the decision of where an individual or community may establish some form of temporary to permanent residency, how one might access markets or places of trade, what forms of human capital may be available (e.g. education systems, medical centers), what alternative forms of production may be practiced (e.g. cultivation, peri-urban labor), and the timing and the ability to access pasture and watering locations during all times of the year (Homewood and Rogers 1991). Pastoral decision-making is full of complex decisions that lead to these acts of mobility including but not limited to factors such as unpredictable, localized rainfall patterns, disease epidemics, the breakdown of resource
infrastructure (e.g. cattle dips, boreholes), rangeland fires, floods, severe winter storms (dzuds in Mongolia) and (intra/inter-ethnic group) resource conflict and warfare. Dealing with these location specific risks, as well as the spatiotemporal heterogeneity, characterizes these livestock production systems as opportunistic, responding to what Niamir-Fuller and Turner (1999, 20) call “periodic boom and bust”.

2.1.3. Opportunistic Decision-Making and Pastoral Mobility

ASALs are characterized by frequent swings and shifts due to the presences of both perturbations and stresses. For Turner et al. (2003), perturbations are dramatic increases in pressure beyond normal ranges of variability in which systems operate. Perturbations include prolonged droughts, range fires, flash floods and other events with quick onset (Gallopin 2006). Stresses are continuous pressures with slow but consistent onset, commonly within the range of normal variability (Turner et al. 2003). These may range from soil degradation, inconsistent grazing pressures, reducing rainfall regimes, or other progressive events (Gallopin 2006; Turner et al. 2003). Even with the frequency of these major disturbances, these environments are still highly productive. With high productivity levels varying across space and time, the facilitation of migratory livestock management practices is encouraged to utilize areas of new and variable growth, as well as reduce the natural degree of uncertainty that is manifested within these systems (Homewood and Rogers 1991). Pastoralists who inhabit these rangelands have devised preventative practices of dealing with the constantly-lingering risk and localized uncertainty through practices such as the daily resource monitoring, constant
renegotiation of access rights, and flexible natural resource management systems. These means of skirting risk has led much literature to characterize pastoralists as “risk-adverse” (Niamir-Fuller 1999, 274). Strategies for reducing risk reflect the multidimensional complexities of the decision-making process that pastoralists have to make on a daily basis in order to sustain their production goals such as year round milk and meat supply, enough stock to generate appropriate income, stock used to build social capital (reciprocity), and the herd accumulation for long-term survival and social success (Burkure et al. 1991). McCabe (2004) highlights that access to palatable forage and potable water for livestock are critically important factors that dictate when and where a herder and his/her livestock may be located at any given time. Fernandez-Gimenez (2002) found that Mongolian herders typically spend the summer months living in close proximity to natural water sources, while, during the winter, springs and snowmelt are common water sources. However, access to these resources is a very complex, multifaceted equation that is not as cut and dry as merely relying on the spatial and temporal availability, but is tied to numerous physical (e.g. seasonal changes of water and pasture, disease epidemics, localized drought), social (e.g. inter or intra-clan conflict, ceremonies and periodic social gatherings), economical (e.g. communal herding practices, drawing water for wells, paying access fees for resources), and political (e.g. government corruption, land tenure policies, resource regulation and privatization, infrastructure breakdowns, neighbor relations, market locations) variables that intertwine themselves into the ability to gain access to particular natural resources of interest (McCabe 2004; Homewood and Rogers 1991; Niamir-Fuller 1999). To deal with these
variables on a day-to-day basis, pastoralists seek opportunistic strategies to convert seasonally varying and scarce vegetation patches into calories and protein for later human consumption (Fratkin and Mearns 2003). Butt et al. (2009, 311) classifies these strategies as either socioeconomic or socioecological strategies used to cope with changes in the local environment. Socioeconomic strategies are strategies that a household may employ which involves turning towards economic incentives and opportunities as a response to a growing need for an increase in economic capital. Pastoral households may seek alternative sources of incomes through peri-urban and urban migrations. Another socioeconomic strategy may be the fluctuation of rangeland stocking rates (Homewood and Rogers 1991). During good years, when resources are relatively abundant, herd numbers may exceed subsistence levels in order to assure survival in dry periods, especially in drought. During prolonged dry periods, when resources may be more difficult to come by, herders may reduce their livestock numbers in compensation for cash through available markets and trade, such as previously discussed (Bekure et al. 1991; Butt et al. 2009; Brockington 2001; Turner and Williams 2002). Another socioeconomic strategy taken by pastoral households is the diversification of herd composition. During recovery times from extreme perturbations, mixtures of livestock species are important because small stock typically have higher survival rates, allowing pastoralists to maintain subsistence at the required level, until the numbers of large stock can be increased to their appropriate levels (Bekure et al 1991; Niamir-Fuller and Turner 1999). Socioecological strategies are strategies that may be employed which rely on deep familiarity and complex ecological knowledge of the local ecology, meteorological
parameters, and abiotic factors to adapt to ecological changes. Ecological tracking is a commonly executed technique that involves the advancement of scouts prior to acts of mobility in order to scope out suitable grazing and water resources and return to communicate their locations. Ecological tracking involves constant tracking of ecological observations of both social and physical factors that may influence acts of mobility. Goldman (2007) explores the depth of local ecological knowledge that facilitates such methods of ecological tracking while exploring the use of Maasai knowledge to understand wildebeest behavior in northern Tanzania. Goldman explains that when “…the ilmurran [warrior age grade] are sent to check on the pasture where the wildebeest have gone...if they find that enough fresh grass has grown, they will take their cattle to that pasture area” (Goldman 2007, 321). These opportunistic strategies taken by individual pastoralists in response to variability help maintain daily grazing orbits, or what is commonly referred to as micro-mobility (Butt et al. 2009, Niamir-Fuller 1999).

Whenever local environmental variability results in increased stress in the form of resource quantities and qualities reductions that push subsistence levels to their limits or during perturbation events, pastoralists may employ the same socioeconomic and socioecological opportunistic strategies. However, to reduce higher stock losses and increased vulnerability, pastoralists commonly employ additional social and ecological strategies such as herd splitting, moving to other locations by joining other households, pool labor between members of the household and with other herders, and moving their livestock long distances, breaching the local spatial extent and moving in search of stable grazing and watering locations (Behnke et al. 1993; Butt et al. 2009; McCabe 2004;
Niamir-Fuller 1999). For instance, Fernandez-Gimenez and Swift (2003) note that in Mongolia, it is common to split livestock herds by breeds, taking small stock and equine breeds to designated pastures to fatten and build their nutrient storage, while mature cattle herds are taken elsewhere. Similar methods are employed across the East African rangeland, where small stock may remain close to the household and herded by younger children, while mature stock are taken to distant pasture reserves (Bekure et al.1991; Homewood and Rogers 1991). Seasonal movements outside the local area are frequently referred to as patterns of macro-mobility (Niamir-Fuller 1999) and typically provoke greater energy expenditures from a herders’ livestock population. For example, Omosa (2005, 11) found that northern Kenyan pastoralists traveled an average of 8.2 km. per day to access watering holes in the wet season, while averages increased to 19 km. in the dry season. Similarly, Homewood and Rogers (1991, 160) found that during a Maasai herd’s typical active grazing day, walking (as opposed to actively grazing) may be as low as 1.7 hours during the wet season but may increase up to 7.8 hours during drought conditions. To cut down on these additional expenditures, many herder’s may opt for alternative solutions such as grazing in protected areas (PA), such as national parks; graze close to where they can access water for their livestock; moving livestock to different locations during the dry season; and varying the days of livestock watering from one day to every second day (Bekure et al. 1991; Butt et al. 2009; Homewood and Rogers 1991; Western and Finch 1986). Coppolillo (2000) suggests that in many cases, there is a stronger relationship between pastoral movement and distance from water rather than between grazing resources because the need for water may drive herders farther and in different
directions than if they were motivated predominantly by grazing. Therefore resources cannot be treated mutually exclusive, and inappropriate decisions or exclusions from critical resource areas may pin the access to essential sources against one another. Complex management systems are necessary to make fundamental resource-related decisions.

2.1.4. Customary Land-Use Systems

Most ASALs have been communally governed by what Galvin (2009, 188) calls *de jure* or *de facto* systems that allow for the movement of livestock herds and opportunistic strategies to be evoked. These customary systems of land tenure are generally characterized by permeable social and spatial boundaries and are location specific to provide individual herd owners a degree of territorial security in times of localized disease epidemics or drought occurrences (Toulmin and Quan 2000; Homewood et al. 2004). In many pastoral societies, these systems of land and resource management are devised, regulated, and decided upon by a council of male elders. Customary systems of land use are largely dependent on tight social networks that may revolve around clans, age-sets, stock friendship relations, marriage ties, and others to maintain access to sufficient resources (Homewood et al. 2004; Seno and Shaw 2002). Niamir-Fuller and Turner (1999, 35) provide an insightful overview of pastoral social traits that create a particular ‘sense of community’ including: the sense that they must share a *common* future; the capacity to develop mutual trust; the capacity to communicate with one another; and a set of shared norms that can be seen as social capital.
In practice, customary systems typically involve communal regulation, where higher-potential areas with more consistent forage and rainfall are subject to greater exclusivity (Sperling and Galaty 1990). Bekure et al. (1991) indicates that Maasai communities in southern Kenya commonly divide land into residential and grazing areas, where semi-permanent or permanent homesteads are erected near permanent watering locations. Grazing rights and user rights within close proximity to the residential zones are generally well recognized, but with the increase in distance, user rights may become more fluid to act as a buffer to cope with the spatial and temporal variability that may dictate where herds may require access. Access to areas outside an individual’s locality is generally open to negotiations based on political alliances that may be established through intermarriage, family/clan relations, patron-client relations, relations with traditional authorities or acts of reciprocity such as gift giving (Homewood et al. 2004; Seno and Shaw 2002; Odgaard 1999). In the case of water access, many customary systems have had a tendency of regulating water sources a bit more vigilantly. During wetter seasons when sufficient water amounts are present, water may be found in streams, surface pools, and river, but in drier periods, water resources are generally confined to more permanent sources, such as large rivers or manmade infrastructure. Fernandez-Gimenez (2002) found that although wells may not be regulated during the rainy summer months among pastoralists in Mongolia’s desert-steppe, their use is typically confined to the dry spring, fall, and winter months. Control over water resources are not typically entirely exclusive, as visiting herders are frequently granted permission
by community authorities upon request, but they may demand slightly higher reciprocal or financial payment (Hodgson 2001).

2.1.4.1. The Erosion of Customary Land-Use Systems

These customary systems of land-use have provided pastoralists with the necessary flexibility needed to access sufficient resources on a daily basis. However, developmental, governmental, and scientific misconceptions and interests have eroded these systems through privatization, contemporary policies promoting cultivation or what Mark Moritz (2006) calls “farmer bias”, and land formalization. This in turn has increased the state of vulnerability experienced by pastoralists. Vulnerability is defined as the likelihood that an individual or group will be exposed to and potentially adversely impacted by particular circumstances (Cutter 2001). Turner et al. (2003, 8074) defines vulnerability as “the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation or stress/stressor”. Past interventions and attempts at development have exposed pastoralists to greater risks, inhibiting their ability to rely on flexible coping mechanisms of mobility and impervious social and physical boundaries (Fratkin and Mearns 2003). Currently, the (re)popularization of formal land tenure has introduced the idea that land formalization “carries with it the mark of civilized progress” (Musembi 2007, 1462). Odgaard (1999, 72) considers contemporary concerns of land formalization to be a ‘double safeguard’ where “the formalization of customary rights is sought, while the social legitimization of “formal” rights is also pursued.” The work of Peruvian economist, Hernando de Soto, has
been an instrumental factor in influencing these current practices. De Soto argues that poor inhabitants in developing countries have failed to reap the benefits from the capitalist system because they lack formal protection, therefore land cannot be used as collateral to support investment and their production systems cannot generate sufficient capital (Musembi, 2007; Mwangi 2007). In order to allow for these inhabitants to benefit from capitalism, it is assumed that webs of informal norms should be transitioned toward formal land titling, as it is believed that “formal title breathes life into dead assets and transforms them into capital” (Musembi 2007, 1458). Further privatization of land greatly impacts pastoral livelihoods as clear spatial and social boundaries that were traditionally based on flexibility are limiting how pastoralists can respond to the spatial and temporal heterogeneity of ASALs (Fratkin and Mearns 2003; Homewood et al. 2004; Mwangi 2007). Pressures that have reduced the flexibility that pastoralists rely on are not new to pastoral areas across the globe but have came in the form of pastoral development projects, conservation initiatives, and political strategies that have sought “order” across these non-equilibrium systems. Most of these external interventions have resulted in failure.

2.1.5. Failed Interventions and “Received Wisdom”

Across ASALs, pastoralists have been at the tail end of many development failures, triggered during the dawn of colonialism and carried through contemporary misconceptions by decision-makers, Western science, conservation practitioners, and local resource services (Behnke et al. 1993; Behnke and Graham 1994; Hodgson 1999;
Hodgson 2001; Homewood and Rogers 1991; Homewood et al. 2004; Leach and Mearns 1996; Niamir-Fuller 1999; Nori and Davies 2007; Nori et al. 2008). Leach and Mearns (1996, 3) label the coming of such interventions to have spawned from forms of “received wisdom”, which have obscured the plurality of other possible understandings of environmental values and causal inducers of environmental change. The roots of both colonial and post-colonial development attempts have been deeply imbedded in Western values and the economic policies and political interests of governments (Brockington and Homewood 1996; Fratkin and Mearns 2003). They tended to focus less on the understanding of ecological processes and short-term environmental variability of the African rangeland and more on the commodification of the African rangeland and assuming the landscape’s ecological carrying capacity for domestic livestock. With shifts from ecological concerns to economic ones, perceptions of pastoralists also transitioned from “rugged pastoralists” to “uneconomic loafers” that were backwards, irrational, short-sighted, and above all, initiators of environmental degradation, overstocking and overgrazing dryland regions well beyond their assumed ecological carrying capacity, spawning what Homewood and Rogers (1991) call a “major ecological argument” (Blaikie and Brookefield 1987; Fratkin and Mearns 2003; Hodgson 2001; Niamir-Fuller and Turner 1999). One of the most influential volumes of inspiration for this mode of thinking about pastoral practices grew out of Garrett Hardin (1968)’s *The Tragedy of the Commons*. Fratkin and Mearns (2003) quote Hardin’s piece stating:
“The tragedy of the commons develops in this way. Picture a pasture open to all. It is to be expected that each herdsman will try to keep as many cattle as possible on the commons…As a rational being, each herdsman seeks to maximize his gain…The rational herdsman concludes that the only sensible course for him to pursue is to add another animal…and another; and another…but this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system, which compels him to increase his herd without a limit – in a world that is limited. Ruin is the destination towards which all men rush each pursuing his own interests in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to it all.” (Hardin 1968: 1244) derived from Fratkin and Mearns (2003)

Hardin’s (1968) thesis disseminates the view of pastoralists as ignorant in their way and possessing little to no ecological knowledge of the rangeland characteristics. This view not only ignored the complex strategies that herders induce to cope with the spatial and temporal variability of these regions but also assumes the successive characteristics of an ecosystem at equilibrium can be applied to dryland regions. However skewed this view may be, Hardin’s (1968) thesis was very influential on formalizing development projects and conservation initiatives in pastoral areas. To these interventions, pastoral practices of mobility were viewed as unreasonable acts that limited capital investments in livestock production, as it was assumed that pastoralists were interested in producing cash profit
rather than relying on livestock as a form of subsistence and could greatly contribute to countries’ livestock sector (Homewood and Rogers 1991).

Upon the arrival of colonial administration to many ASALs, customary land management, which had been vital aspects to sustainable pastoral production, quickly deteriorated. Sperling and Galaty (1990) discuss the difference between traditional and administratively conceived land tenure systems as they define two primary land concepts: *territory*, which “denotes land in an objective sense…defined by the jurisdiction of the state through an administrative hierarchy of location, division, and subdivision”; and *domain*, which is the “range of customary control, loosely as a sphere of influence” (Sperling and Galaty 1990, 78). With Sperling and Galaty’s concept in mind, transitions presented an overall loss of “domain” and a gain in “territory”. The delineation in the perceived value of land transcended through policies and pushes for revenue generation, political control, and economic development, and land conservation (Mwangi 2007; Neumann 1998). Rather than acknowledging land as holding a particular value to specific ways of life, a factor in establishing cultural identities, and an employer of various gender and age roles, colonial administrations viewed land and natural resources as primary materials for all people to compete over (Kajembe et al. 2003). Lands that were assumed to be unoccupied due to flexible management were quickly taken under control, and placed under more productive, income generating cultivation schemes. Further measures were taken to preserve what Neumann (1998) calls the “Edenic” value of land, which resulted in the establishments of land reserves and national parks, and thus the displacement of those who live within their boundaries.
Even after independence in many pastoral occupied countries, pastoral mobility and tenure were considered obstacles to pastoral development, therefore interventions with the backing of large entities such as USAID and the World Bank sought Western management models (Chapter 3) focusing on two aspects: 1) sedentarization through medical, veterinary, and extension services, or forced settlement and 2) relocation of tenure rights through nationalization and/or privatization (Hodgson 1999; Nori et al. 2008). Hodgson (2001, 118) considers the process of pastoral development to have placed pastoralists in a “double bind” where the concept of the “pure pastoralist” was used to appropriate more productive regions for cultivation and discourage pastoralists from farming, perpetuating their dependence on pastoral production. The shortfalls of pastoral development efforts have been due to development planners’ poor understanding of: pastoral objectives, ASAL ecosystems, the functions of pastoral production systems, pastoral productivity relative to the environment, and the economics of animal husbandry systems (Waters-Bayer and Bayer 1994). Attempts of pastoral development have had a tendency to ignore what worked and what did not work in past development strategies. This “historical amnesia” (Hodgson 2001, 11) has resulted in pastoralists not only being worse off than before the implementation of “development”, but has also produced false hopes and major skepticism from pastoral societies towards government and development interventions.
2.1.6. Climate Change and Pastoralism

Pastoral vulnerability to increased climatic variability is less of a function of reduced resources than it is the result of previous land tenure and development approaches that have decreased pastoralist’s ability to respond to changes through regional and transnational mobility and trade, as well as continued exclusion from participation in decision and policy-making processes (Nori et al. 2008). According to the 2007 Assessment Report by the Intergovernmental Panel on Climate Change (IPCC), if trends in greenhouse gas (GHG) emissions do not cease, global temperatures may rise between 1.4°C and 5.8°C by 2100 (IPCC 2007). These changes result in increased climate variability, which can be broadly classified as (Nori and Davis 2007; Nori et al. 2008): changing rainfall patterns, with increased variability and declining water balances; spatial and temporal biodiversity shifts; changes in wind patterns; more frequent extreme climatic events (floods and droughts); and changes in the oscillations of recurrent events (El Niño, tropical cyclones, heat waves).

These changes represent increased likelihood of both stresses and perturbations, resulting in an overall increase in climate variability. In East Africa, analysis assumes that some parts of the region may experience increased drying, with considerable reductions in the length of the growing season, while other areas may experience increased precipitation, extending the length of growing seasons (Agrawala et al. 2003; Galvin et al. 2004). As it can be understood through such assessment, the degree of uncertainty is increased as already variable ASALs may become more irregular across time and space, decreasing the ability to predict upcoming events. Research has shown
that many rural livelihoods that rely on seasonally reoccurring rainfall events to guide cultivation and herding practices are heavily dependent on the ability to predict the timing and the expected amount of rainfall (Luseno et al. 2003). As climate forecasting and early warning systems (EWS) are continuously evolving, building the capacity to adapt in proactive means, their coarse spatial and temporal resolutions are extremely limiting (Luseno et al. 2003). Therefore, more variability in climatic indicators is likely to have major influence on all rural livelihoods in ASAL regions.

2.1.7. Natural Resource Conflict and Climate Change

Although not uniform across the entire African continent, climate scenarios indicate that 75-250 million by 2020s and 350-600 million people by 2050 may be at risk for increased water stress across Africa (IPCC 2007, 10). With increased stress on human-environmental systems, increased climate change and variability may lead to greater natural resource conflict, particularly over water, at both transnational scales (e.g. water management of the Nile) and local scales (e.g. herder-farmer conflicts). Climate change has the potential for tightening the regulation of resources, resulting in not only potential reductions in physical availability, but increased social and political tension surrounding these resources. As expressed by Turner (2004), much literature, especially within the area of resource management, has taken the “resource scarcity” approach when consulting conflict over natural resources. Turner (2004, 879) argues that most “resource conflicts” are commonly conflicts also over “other things” that often hold a moral or personal connection, more “dear” to an individual livelihood than ephemeral or
permanent natural resources. Therefore, vulnerability to increased climate variability is less a function of declining resources but rather an increase in micro-scale changes (driven by both local and global scales) that may result in moral wrongs or greater factors that influence the inability to access sufficient resources (Nori et al. 2008; Turner 2004). Omosa (2005) highlights that conflict for marginalized groups, such as pastoralists, is not a biophysically produced output of troubled resource availability, but rather a means of addressing injustices and inequalities in water resource distribution. Conflict becomes an inherent struggle for social reform, as it is interwoven in social, economic, environmental, and political discourse (Omosa 2005, 12). Herder-farmer conflicts are also a response to issues of governance and government corruption, as Benjaminsen et al. (2009) shows in the Sahel region of West Africa. Potential conflicts over natural resources pose great concern towards the physical health and social justice of populations and have the potential to lead to additional population shifts through in and out migrations and displacements. An exodus of knowledge, cultural wealth, and overall place-based identity succumbs from these displacements, potentially instigating further moral dilemmas (Wisner 2010). The rather progressive onset of climate change and its multifaceted links to social transformation have the potential to exacerbate resource problems as “conflicts are less likely to be ‘in-the-moment’ struggles over a particular resource patch and more likely to resemble strategic contests to maintain resource access over the longer-term” (Turner 2004, 877).
2.1.8. Pastoral Adaptation

As briefly discussed earlier, ASALs experience both biophysical and social perturbations and stresses that induce substantial changes in human-environment systems (Behnke et al. 1993; Gallopin 2006; Turner et al. 2003). The ability to respond to such pressures that are altering the system’s current state towards a more secure one is important to its sustainability. Numerous definitions of adaptation can be found across climate change literature (Smit and Wandel 2006). As defined by IPCC’s Third Assessment Report, adaptation is the “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates, harms, or exploits beneficial opportunities” (IPCC 2001). Similarly, Smit et al. (2000, 225) refers to adaptation as “adjustments in ecological-socio-economic systems in response to actual or expected climatic stimuli, their effects, or impacts”. Pielke (1998, 159) define adaptation as the “adjustments in individual groups and institutional behavior in order to reduce society’s vulnerability to climate.” Through multiple definitions, it can be claimed that adaptation across multiple scales may work in order to moderate the adverse effects of impending consequences, such as climate change, through a wide range of actions that target to reduce the degree of vulnerability (Fussel and Klein 2006; Smit and Wandel 2006). As pastoral practices of resource access have developed from dealing with the “boom and busts” (Niamir-Fuller and Turner 1999, 20) of ASALs, pastoral livelihoods have utilized these actions through various techniques such as small and large scale mobility, stock regulation, and ecological tracking as highlighted above. Therefore, pastoralism should be seen as an emblematic livelihood system that has been capable of
coping with ecological scarcity, social transformations, and environmental variability (Nori and Davies 2007; Nori, Taylor, and Sensi 2008). Diversification of livelihood strategies is one means of dealing with high degrees of uncertainty. Across East African ASALs, research has shown that pastoralists managed to diversify their livelihood practices from livestock-based economies through numerous ways such as livestock sales, small business, trade, waged labor, and cultivation, as they have come to realize that herding is no longer a viable economic enterprise without other forms of economic support (Coast 2002; Hodgson 2001; McCabe 2003).

Adaptation and diversification strategies are now a core element of pastoral societies in East Africa. McCabe (2003, 109) claims that a sustainable livelihood for pastoralists are based on “a diversified economy with livestock at its core, but supplemented by cultivation and other possible sources of income”. However, diversification and other adaptation strategies are not merely dependent upon picking up a hoe and beginning to cultivate. As indicated by Eriksen and Lind (2009), adaptation is a political process that is driven by factors emerging from the global to the local scale. These acts ultimately lead towards social stratification, as they are reliant upon a wealth of enablers and inhibitors including education, the financial capital to invest, and land tenure. Nori et al. (2008, 15) affirms that social stratification and economic differentiation among pastoral societies is changing resource management in pastoral areas and disrupting traditional social networks, which are damaging the capacity of these communities to adapt to the impacts of climate change.
Development practitioners, scientists, and decision-makers are, as Nori et al. (2008) put it, “browsing on fences” as to where pastoral communities stand in the face of increased uncertainty. In one sense, pastoral livelihoods are seen as highly adaptive systems that cope well with ecological and social transformations. They are also acknowledged as good custodians, living in harmony with wildlife and utilizing livelihood practices that make the most efficient use of rangelands (Goldman 2003; Goldman 2007; Nori and Davies 2007; Nori et al. 2008). On the other hand, pastoral groups are frequently acknowledges as “canaries in the coalmine”, doomed to fall victim to increased natural resource shortages (Nori and Davies 2007).

2.2. The Conceptual Framework of this Research

In so far, this chapter has introduced the complex livestock production system of pastoralism by providing an overview of both the livelihood system and the coinciding mechanisms of production, (non)technical knowledge systems, and complex decision-making. Along with this, several factors that have disrupted or have the potential to disrupt pastoral mobility and resource access across all ASALs have been discussed, as well as the means by which pastoralists are adapting to these changes. The literature used thus far has spawned from numerous approaches that have sought further understanding of the different realms pastoralism including the culture and identity of the pastoral production system (Anderson and Broch-Due 1999; Galaty and Johnson 1990; Spear and Waller 1993; McCabe 2003), the gendered dimensions of pastoral societies (Brockington 2001; Hodgson 2001; Wangui 2008), and the shifting tenure, land rights, and concerns
over resource access that have occurred across ASALs (Brockington 2002; Fernandez-Gimenez 2002; Galvin et al. 2008; Niamir-Fuller 1999; Homewood and Rogers 1991). In short, all of this literature and more has extensively documented the complex socio-ecological relationship between people, livestock, and the environment. Even as these bodies of literature differ in their focus, they all have a tendency to refer back to the role of mobility as a central component to the pastoral household, and through their individualized lenses, document its cultural, gendered, and structural dimensions and shifts. This section draws upon two themes of literature that have approached pastoral mobility and resource access even more head on. These two themes are mobility literature and fragmentation literature. These themes are often rooted in the theoretical frameworks of political ecology to some degree and tend to view mobility as the most sustainable means of coping with a non-equilibrium system, a quintessential process in daily access to resources, and as Bassett and Zimmerer (2004, 102) call it, “… a classic cultural-ecologic theme”. In doing so, they have positioned pastoral mobility and resource access at the center of their focus to seek more explicit understanding of the changes that are occurring to the relationship between PLE. Although these frameworks share similar core principles, when examined simultaneously, diverging characteristics are recognizable. This research project used the parallels and disconnects between these two themes of literature to construct a conceptual framework to follow. This section introduces both of these research themes (Section 2.2.1 and Section 2.2.2) and then

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4 The phrase political ecology, as defined by Blaikie and Brookfield (1987), “combines the concerns of ecology and a broadly defined political economy. Together this encompasses the constantly shifting dialect between society and land-based resource, and also within class and groups within itself (Blaikie and Brookfield 1987,17)
details their benefits and drawbacks (Section 2.2.3). By presenting how the benefits of the two frameworks can be maximized and drawbacks can be minimized, a hybrid model is brought forth to indicate the niche of this research (Section 2.2.4).

2.2.1. Mobility Literature

The first research framework that has taken a strong precedence in studies of PLE consists of research that explicitly focuses on the patterns of mobility taken by pastoralists and livestock herds across the rangeland. This theme acknowledges the practical aspects of mobility, and typically positions it within a broader framework (e.g. new ecology paradigm, landscape degradation). In doing so, it establishes the patterns of mobility an entities in themselves (Adriansen and Nielsen 2002; Adriansen and Nielsen 2005; Butt et al. 2009; Butt 2010; Coppolillo 2000; Moritz et al. 2010; Turner and Hiernaux 2002). Research that falls under this umbrella frequently employs quantitative GIS/GPS techniques to explore the spatial and temporal dimensions of patterns of micromobility. For instance, Coppolillo (2000) used GPS devices to map and examine the factors affecting the spatial patterns of daily herding among Sukuma agropastoralists in the Rukwa Valley of southwestern Tanzania. Although these approaches frequently employ rigorous statistically or computationally costly methods, qualitative, local knowledge sets are occasionally used in parallel in the form of herder accounts (Turner and Hiernaux 2002) or ethnographic methods (Moritz et al. 2010). For instance, Turner and Hiernaux (2002) utilized non-Cartesian herder narratives of daily grazing and resource extraction practices with an empirically driven GIS-based regression model to
map fine-scale livestock activities across in the Sahel region of West Africa. Approaches that utilize these technologies are frequently not only concerned with advancing the knowledge surrounding patterns of mobility, crop-livestock interactions, and herding strategies but are also strongly interested in making methodological contributions to studies of PLE (Adriansen and Nielsen 2002; Butt et al. 2009; Butt 2010; Moritz et al. 2010).

2.2.2. Fragmentation Literature

The second body of literature that shares a common focus on pastoral mobility and resource access tends to more explicitly focus on the dynamics of the social, political, and physical landscape. This framework frequently assesses how the fragmentation of the landscape and critical pastoral resource bases inhibits both the patterns of mobility and how this loss of mobility affects the individual livelihood system (Boone 2007; Burnsilver et al. 2002; Galvin et al. 2008; Galvin 2009; Hobbs et al. 2008). In fragmentation literature, the term “fragmentation” refers the partitioning of the biophysical system into spatially isolated, smaller parcels that is typically induced by changes in the socio-ecological system such as population growth (Homewood et al. 2001), globalization (Casciarri 2009), conservation (Brockington 2002; Neumann 1998) and land tenure reform (Fernandez-Gimenez 2002). This partitioning results in a loss of connectivity to critical pastoral resource bases; however this loss of connectivity does not always occur in a uniform fashion. Research has found that depending on the situation, several different forms of fragmentation exist that can hinder resource access. Hobbs et
al. (2008, 777) provides several different forms of fragmentation including the decoupling and the dissection of the landscape.

2.2.2.1. Type of Landscape Fragmentation

A coupled landscape permits the travel across it to go uninhibited, allowing for individuals to move freely from one end to the other. On the other hand, the decoupling of a landscape occurs when changes in the system, result in the partitioning of a landscape and a loss of connectivity (Galvin et al. 2008; Hobbs et al. 2008). In terms of herd mobility to and from resource points, a decoupled landscape may be characterized by habitat transformations that render access to critical resources unsuccessful. These changes may include a shift in the physical dimensions of the access corridor, the resource quality and quantity changes from being palatable to being unpalatable, or the consequences of using the corridor or resources may result in negative social implications such as social conflict or monetary fines (Galvin et al. 2008).

Hobbs et al. (2008, 777-778) defines the second type of fragmentation, landscape dissection, as the creation of physical barriers such as stone walls, fences, natural features; social barriers in the form of social sanctions or land tenure policies; or administrative barriers such as the demarcation of national boundaries that limit mobility. The dissection of the landscape is frequently in reference to the use of barriers in order to detain or exclude those from accessing a more spatially extensive resource, such as pasture, conservation land, or farm plots; however, small, localized resources, such as watering points and wells are sometimes surrounded by such barriers (Hobbs and Boone
2004). Whatever the resource may be, the primary purpose of these barriers is always the same, which is to regulate access (Hobbs and Boone 2004)

2.2.2.2. Methods Approach in Fragmentation Literature

No matter the type of fragmentation that occurs, research that takes this approach has a tendency of taking a more livelihoods-oriented approach, addressing the implications of landscape fragmentation on the pastoral livelihood and how fragmentation it is both a product and causal agent of socio-economic stratification and changes in land-use practices (Burnsilver et al. 2008). For instance, while discussing the global pastoral system, Galvin (2009) associated fragmentation and climate change to be two major causes of transitioning livelihoods, as the flexibility that has enabled mobility and resource access has become more rigid. Similarly to the mobility literature, quantitative GIS-based modeling approaches are frequently utilized to calculate fragmentation indices and landscape ‘patchiness’. For instance, Boone (2007) used an integrative ecosystem model to explore livestock population sensitivity to landscape fragmentation. In another study, Burnsilver et al. (2002) utilized multiple remote sensing methods, GIS analysis, and a household economic survey to quantify ecological heterogeneity of pastoral landscapes and identify the scales of pastoral resource use. Since work on fragmentation borrows many concepts from landscape ecology, its scale of observation is typically coarser than work within mobility literature, providing a means to look at a slightly broader system of interactions.
Both bodies of literature have unique benefits. However, with these benefits have come limitations and drawbacks to each of these frameworks. Benefits accrue in mobility literature from the positioning of mobility as the central concept. By addressing mobility as an entity in itself, tangible and empirical patterns emerge across rangelands, upon which theories of change can be applied to assess both small and large-scale changes that have occurred. For instance, by using GPS-enabled cattle collars, Butt (2010) found unusually high frequencies of grazing in the early morning within close proximity to households, which were later, found to coincide with night grazing systems that are seasonally enacted. However, drawbacks are associated with these measures as the explicit focus on the spatial and temporal dimensions of mobility result in fixed spatial and temporal scales (Butt et al. 2009). Literature within this body has tended to focus on patterns of micro-mobility, as patterns of macro-mobility would result in coarse spatial and temporal scale data that is computationally and analytically troublesome. These methods are rather limited to assessing mobility within the confines of local herding strategies taken during dry and wet season variations, and therefore, are typically unable to capture the strategies taken to cope with extreme climatic events.

The benefits of fragmentation literature lie in the fallbacks of mobility literature. This is the ability of analyzing influential factors that are nested in various scales. For instance, Burnsilver et al. (2008) found that drivers of landscape fragmentation in southern Kenya were a result of both distal factors that originated outside the system (e.g. pastoral policies, rising human populations) and proximate drivers that arose from the
interaction of systematic functions (e.g. changes in settlement patterns, livelihood diversification). However, when compared with the mobility literature, the main drawback of fragmentation literature is in the fact that even though coarser spatial and temporal scales can be analyzed, the inability to make mobility tangible makes mobility more of a construct than a complex process that occurs in an explicit pattern. This does not necessarily provide spatially explicit understandings to fully emerge, creating a certain degree of vagueness in what is meant by “mobility”.

A drawback of these research frameworks, with the exception of some work (Turner and Hiernaux 2002; Adriansen and Nielsen 2002), is the lack of the incorporation of the knowledge of the herders, who are obviously in the best position to discuss changes in mobility and resource access. Some researchers have acknowledged the depth of pastoralists’ knowledge and even utilized it in parallel with scientific knowledge (Bollig and Shulte 1999; Goldman 2007; Luseno et al. 2003; Oba and Kaitira 2006). Oba and Kaitira (2006) illustrated how herder’s knowledge of grazing lands could be used to classify and assess the changing state of grazing landscapes. Since both mobility and fragmentation literature is concerned with complex land-use practices, incorporating additional forms of knowledge and the personal experiences of mobility and resource access in correspondence with scientific knowledge will elicit an even greater understanding of the interactions between PLE.
2.2.4. A Call for a Hybrid Approach

As benefits and drawbacks exist in both frameworks, integrating the two may provide a more insightful and holistic way of capturing both concerns over resource access (Research Question 1 and Research Question 2), and how mobility patterns have changed (Research Question 3). This integration would allow for the benefits of the two frameworks to be maximized, that is, making the concept of mobility tangible and enhancing the ability to jump scales of analysis and theorization, while minimizing the drawbacks. This would also provide a means of addressing both mobility patterns in the context of daily access and the patterns of macro-mobility, elicited during extreme climatic events. Since these events, especially in regards to drought, are “a part of [Africa’s] climate, and not apart from it” (Glantz 1987, 38), this means that a more encapsulating understanding of the changes that are occurring across pastoral inhabited regions is elicited. Furthermore, by addressing the drawbacks that both of these frameworks have tended to assume and incorporate herder narratives as a companion to the technical geospatial aspect of these frameworks, a more grounded understanding of these changes can be obtained. This research employs this hybrid model in order to maintain the same principles and approaches of these two bodies of literature, while maximizing the benefits of both and incorporating the narratives of those who are in the best position to discuss changes in resource access and mobility.
3.0. STUDY AREA

This chapter describes the study area for this research. The first section begins with a description of the East African country of Tanzania to place it into a global context. The next section, Section 3.2, provides an overview of the most widely dispersed pastoral society in Tanzania, the Maasai, who are the focus for this research. This section includes the economic activities and social structure that is common amongst Maasai societies. In the following section, Section 3.3, the impacts of colonialism on the Maasai is discussed. Since this research is particularly focused on resource access and pastoral mobility, this discussion will primarily address how colonial powers transformed access to critical pastoral resources and land-use in Tanzania. Following in chronological order, Section 3.4 provides a background of post-colonial land policies and development schemes that have impacted pastoral resource access in across Tanzania’s ASALs. The final section, Section 3.5, draws more explicitly on the focused study area, starting with the Kilimanjaro region and eventually scaling down to the village of Kirya.

3.1. National Context: United Republic of Tanzania

The East African country of Tanzania emerged as a nation in 1964, after achieving independence from Britain in 1961. Today, Tanzania is the home to a population of approximately 46.6 million people including the semi-autonomous region of Zanzibar (World Factbook, 2011). With the major coastal islands of Mafia, Pemba, and Zanzibar, Tanzania’s total land area covers 945,000 km$^2$, sharing a border with Burundi (451 km.), the Democratic Republic of Congo (459 km.), Kenya (769 km.),
Malawi (475 km.), Mozambique (756 km.), Rwanda (217 km.), Uganda (396 km.), and Zambia (338 km.), as well as a coastline spanning 1,424 km. along the Indian Ocean that forms most of the eastern border of Tanzania (Figure 2) (Agrawala 2003; World Factbook 2011). A central plateau, coastal plains, and highland regions located in the north and south characterize the terrain of Tanzania (Agrawala 2003). The total area of Tanzania includes several large bodies of water including approximately one half of Lake Victoria, the world’s second largest freshwater body, located in the northwest; Lake Tanganyika, the world’s second deepest freshwater body, in the west; and Lake Nyasa in the southwest (World Factbook 2011).
3.1.1. National Context: Physical Characteristics

The country’s elevation ranges from sea level to the glaciated peak of Mount Kilimanjaro at 5,895 m., which is the highest peak in the continent of Africa. The climate of Tanzania varies with its vast land area, ranging from tropical along the coast to temperate in the highlands (World Factbook 2011). Depending on location, the average
temperatures range between 17°C and 28°C. As the geography of the country varies substantially, rainfall patterns are largely determined by altitude. Precipitation in Tanzania is primarily governed by two rainfall regimes. In the northeastern, northwestern, and northern regions, which encapsulate the study area of this research, bimodal rainfall characteristics in the form of long rains (Masika) between March-May and short rains (Vuli) between October-December. In the southern, central, westerns, and southeastern regions of the country, a unimodal rainfall pattern is common, with most of the precipitation occurring between December-April (Agrawala 2003). Tanzania is not immune to natural disasters. In fact, floods and droughts occur frequently in the country. However, these disasters cannot be defined in purely physical terms, as their severity is dependent upon not only rainfall totals and timing but also the social and political characteristics of the disaster zones (Eriksen and Lind 2009).

3.1.2. National Context: Economic Sector

In terms of per capita income, Tanzania is one of the world’s poorest countries. The GDP per capita for Tanzania is approximately US $1,500 (2010 estimate), ranking it 202 amongst the 229 countries of the world (World Factbook 2011). According to the 2011 estimation, the current population growth rate for Tanzania is approximately 2% with an average life expectancy of 53.38 years (World Factbook 2011). With an overwhelming proportion of the population residing in rural areas (76.9%), Tanzania’s economy is heavily dependent on agriculture, which accounts for more than 40% of the country’s GDP, 85% of the country’s exports, and employs approximately 60% of the
work force (FAO 2005; World Factbook 2011). Primary products generated in Tanzania
include coffee, sisal, tea, cotton, maize, cassava, bananas, and livestock (cattle, sheep,
and goats) (World Factbook 2011). Cultivated land accounts for approximately 5% 
(51,000 km.$^2$) of Tanzania’s surface area, while much of the other arable land (100,000
km.$^2$) is frequently used as pasture. Of these agricultural products, livestock is a very
important sector to Tanzania’s economy (URT 2011b). Making up approximately 30% of
the agricultural GDP, Tanzania currently ranks third in Africa in terms of its cattle (17.37
million; 2002 estimation) and sheep and goats (shoats) (15,839 million; 2002 estimation)
populations after Ethiopia and Sudan (FAO 2005). Tourism is another booming sector
within the Tanzanian economy, with recording earnings of over US $500 million
annually (URT 2011a). Of the total surface area (945,000 km.$^2$), 23% (220,000 km.$^2$) is
allocated to reserved land including national parks (42,000 km.$^2$), game reserves (77,000
km.$^2$), and forest reserves (101,000 km.$^2$). These protected areas bring hundreds of
thousands of tourists to Tanzania every year, yet have compromised resource access in
these regions as they are constitute two processes, (1) the forced removal of people from
their homes; and (2) economic displacement as the exclusion of people from particular
areas has impacted the pursuit of a livelihood (West et al. 2006).

3.2. Maasai Pastoralism

Livelihood production systems in Tanzania vary with location. Amongst these
production systems, pastoral and agro-pastoral production systems are practiced by
approximately 10% of the total population (Sendalo 2009). The Maasai are the most
abundant and well recognized of these pastoral populations in Tanzania. Originally inhabiting regions of southern Sudan, Maa-speakers expanded downward through the East African Rift Valley to eventually inhabit the region between Lake Turkana in northern Kenya to the Maasai Steppe of central Tanzania. This region is known as Maasailand (Spear and Waller 1993).

3.2.1. The Maasai Economy

The Maasai economy has been largely encompassed by livestock subsistence, however much research has identified the fact that Maasai were originally agro-pastoralists, cultivating such crops as sorghum and millet (Spear and Waller 1993). Overtime, specialized skills in livestock rearing developed, bringing about the commonly assumed link between the system of pastoral production and the identity of the Maasai (Hodgson 1999, 2001; Spear and Waller 1993). This has led to the view of Maasai as being prototypical pastoralists, relying solely on livestock as their only production system. This view has continued to impact the Maasai despite the evidence dating back over a half century, which has documented Maasai diversification into cultivation (Hodgson 1999). Hodgson (1999, 232) references a 1974 USAID census administered in north-central Tanzania that found that almost half of the households within the study area were cultivating in addition to livestock husbandry. Similarly, Coast (2002) found that 88% of the Maasai households within the Ngorongoro Crater Area were actively cultivating as a means to meet necessary subsistence. In addition to cultivation, Maasai men have turned towards waged labor through working as security, becoming paid herdsmen, and peri-urban and urban migrations to more populated market centers (Talle
In his work detailing the economic opportunities of Maasai women around Mkomazi Game Reserve, Brockington (2001) found that women, especially in areas that provide greater economic freedom, were diversifying their livelihood practices, and extending their production systems through the sale of milk that was previously provided to the household. In addition to milk sales, Maasai women can be frequently found in market areas, selling medicines, herbs, and crafts. As many Maasai households have diversified their production systems, expanding into cultivation and waged labor, livestock husbandry still remains a high priority across many Maasai households. The importance of livestock in Maasai households is recognizable in many of the Maasai articulations of poverty, which have not necessarily placed material wealth in the locus of what defines poverty, but the lack of cattle and failure to maintain livestock husbandry as the defining factor (Anderson and Broch-Due 1999).

3.2.2. Maasai Gender Roles and Economic Activities

Like many other pastoral societies, Maasai are commonly referred to as being egalitarian societies, placing emphasis on the use of livestock as a critical form of social capital. However, more recent scholars challenged this premise, recognizing that the pastoral system intrinsically results in social stratification and economic differentiation among pastoralists, including the Maasai (Anderson and Broch-Due 1999; Brockington 2001; Lesorogol 2003). This process has become even more evident where the forces of modernity have led to private land and resource ownership (Lesorogol 2003). Additionally, scholars have contested the frequently acknowledged identity of Maasai as
being a patriarchal society, claiming that men’s dominance over political and economic decision-making is a colonial construct that emerged through the male-oriented colonial interactions that occurred during the formation of the state (Brockington 2001; Hodgson 2001). However this may be, gender does define the spheres of decision-making and economic roles for Maasai households. Women’s economic activities typically take place within close proximity to the household and range from milk production, caring for the children, reproduction, and keeping up with the homestead (boma) (Brockington 2001; Hodgson 1999; Wangui 2008). Maasai women’s central role with milk production has even been documented to grant significant decision-making power within the household (Wangui 2008). Men’s economic activities typically revolve around livestock decision-making and managing community affairs (Hodgson 1999; Brockington 2001). Although these gender roles may appear to be mutually exclusive, quite a bit of overlap exists, which is ultimately dependent on the context of each individual household. For instance, Wangui (2008) found that many Maasai women in southern Kenya were actually more involved with livestock activities in the rainy season, while males maintained the livestock herds in the dry season and in times of extreme disturbances that drove them outward. Economic activities and roles are dependent on gender; however, age and seniority further dictate the individual’s capacity of involvement within each economic activity.
3.2.3. Maasai Social Order: Age-Sets and Age Grade System

In Maasai society, both age sets and age grades are the fundamental characteristics of social order (Spear and Waller 1993). Males are divided up into age sets that extend over about 15 years, while women do not get placed in specific age sets but gain seniority in social class as they progress up age grades (Bekure et al. 1991; Spencer 1993). Spencer (1993, 140) best describes the model of the Maasai social order as a metaphor of a climber ascending a ladder. In this metaphor, the climber represents the age sets, progressing through time to reach different rungs, or age groups. The most simplistic model of this social order is broken up into three age grades for men: uncircumcised herdboys (ilaiyok), circumcised young males (murran or moran), and junior and senior elders; and two age grades for women: unmarried girls and wives and widows (Spencer 1993; Wangui 2008). As an individual progresses through this system, he/she gains both political and moral seniority, or what Spencer (1993) illustrates as taking steps towards being Maasai.

From around the age of six to ten years old, herdboys begin learning the requirements of livestock rearing and herding the household’s smallstock and calves. As they gain trust and age, they begin herding mature cattle. This is usually around the age of eleven (Bekure et al. 1991). During this time, young boys herd to their allotted capacity and engulf themselves in aspirations of their own murranhood, or what is imagined at this time of their lives as the “heart of the Maasai identity” (Spencer 1993, 150). The transition into murranhood comes with the traditional process and “rites of
passage” ceremony. This process is most commonly associated with the circumcision of the young boy.

Murran are probably the most emblematic figure of Maasai identity. Murran, which is frequently referred to as part of the the warrior stage, play several roles in the household and community, but their most recognized role revolves around the protection of the livestock herd and their community (Hodgson 1999). This means that in times of extreme disturbances, it is usually the murran who are the primary herders who accompany the livestock herd on large-scale migrations that extend beyond the daily grazing orbit. At the time of initiation, murran tend to see themselves as having become the quintessential identity of Maasai (Spear and Waller 1993). During murranhood, a unity develops, which closely bonds the individuals within the murran age grade and the larger age set. This carries with them into the next age grade, elderhood, which occurs when the individual marries or as the next age set promotes to the murran age grade (Spencer 1993).

To the herdboys age grade, murranhood is the epitome of Maasai culture. Likewise, members of the murran age grade place an enormous emphasis on the belief that the murran age grade is the emblem of Maasai culture. However, to elders, murranhood is acknowledged as a mere step towards becoming the superior identity of Maasai, or what Spencer (1993, 151) calls the “guardians of Maasai culture”. During this time, the unity that was inherited during murranhood is maintained. This unity is engaged in community concerns and becomes the primary governing body in regards to community-based decision making. However, during times when resources become
limited and in the event of a large-scale disturbance, the social group becomes individualized and decisions to cope are made at the household level (Spencer 1993). Spencer (1993, 151) calls this “a shift away from a purely Maasai ideal towards a pragmatic concern for their pastoralism: from group-indulgence to self-indulgence.”

These social systems have sustained through many changes; however, since the advent of colonialism, social structures and livelihoods have experienced a nuance of change.

3.3. Colonial History and Maasai Pastoralism

Colonial presence in East Africa had major implications for all inhabitants, regardless of their production system. For many pastoralists, who occupied these lands, the drawing of political boundaries had many detrimental impacts on customary land tenure systems and mobile practices. Those occupying Maasailand were faced a sudden dilemma as a political boundary separating British Kenya from German Tanganyika emerged in 1885 (Fratkin 1997). The colonial splitting of the region cut pastoralists off from their traditional transhumance routes, leading to an inability to access the resources of interests in times of need. As both British and German occupied lands of Kenya and Tanganyika, their defining of land tenure was a way to reorder the communal structures of these communities, further amplifying the power held over individuals (Boone 2007). Colonial presences tended to approach the concept of land ownership ‘tabula rasa’, dissolving the basic communal units of society and freezing pastoralists to the land areas they occupied at the time of colonial conquest (Boone 2007, Niamir-Fuller 1999).
On top of the continental-scale rinderpest epidemic in the late nineteenth century, conquest by European powers initiated a whole series of changes to pastoral resource access (Niamir-Fuller and Turner 1999). The formal declaration of Kenya as a British colony occurred in 1920. During this time, all land occupied within the British territory was then owned by the imperial power, or referred to as ‘Crown Land’. Initially, this land was only granted as private estates for white settlers, however, in 1938, Britain drew a distinction between ‘Crown Land’ and native lands (Toulmin and Quan 2000). Although still technically owned by the “Crown”, native land titles were held in trust by the British and provided to those who actually occupied land. In Tanganyika, German power assumed ownership of all land unless documentation proved otherwise. Since formalized documentation was not a priority for those who relied on traditional land systems, this meant that most of the land was taken out of customary rights. Upon Britain’s exchange of power over Tanganyika after the First World War, all land, occupied and unoccupied, was considered public lands, open to all (Toulmin and Quan 2000).

In the eyes of the colonial power, occupancy of the land had to maintained at all times. In order to obtain their levels of power over the land and people, the British imposed the use of indirect rule in 1926 (Spear 1997). British indirect rule was established through the use of “traditional” leaders, selected by British. These ‘native authorities’ (Spear 1997, 111) were used as a median between the colonial power and the occupants to the land and were responsible for settling disputes at the local level, as well as collecting taxes, enforcing local ordinances, and finding state labor. Leaders in the position of indirect rule were commonly chosen from sedentary populations, thus were
typically bias towards the land-use practices, conflicts, and land ownership rights of the sedentary farmer, throwing the social order of the area, as well as the power relations of pastoralists. ‘Native authorities’ quickly became engulfed in self-power, establishing themselves as the wealthiest and most powerful men in their societies. These became an issue as the power gained by colonial rule went directly into supporting their patronage networks (Spear 1997).

3.3.1. Colonialism and the Expansion of the Agriculture Sector

These political dimensions began to dominate in the locations where the colonial powers felt they could retain the most power. In Tanganyika, a focus on the expansion of agriculture was primary to colonial rule. The colonial powers of Tanganyika saw the opportunity to build the export production of the territory, especially through the push for ‘beverage’ crops, such as coffee, which was introduced in 1902 by German missionaries (Spear 1997). Agricultural expansion in the region further fragmented pastoral resource access as cultivation encroached areas one time used for dry or wet season pasture. In the Usambara Mountains of northern Tanganyika, German settlers found themselves very interested in the cool and fertile highlands. From this area, settlers quickly moved towards the northwest, into the Mount Kilimanjaro and Mount Meru regions, where they settled across and alienated “unoccupied land”. Tom Spear (1997) discusses the beginning of cultivation and land restriction in the Mount Meru region in which an “iron ring” of alienated land was established as cultivation took over the lower segments of the slope, while a government-established forest reserve limited settlement and land-use
moving upward on the slopes. Settlers were forced to inhabit lower lands around the base of the mountains, as there was little unoccupied land available in the highland regions (Spear 1997). As peasants found themselves being pressured by the colonial regimes into more productive cultivation, they pushed to increase agricultural yields by finding new approaches such as planting pastures with annual crop production, extending crops such as bananas into areas that were previously used for annual crops, therefore pushing annual crops into areas utilized for grazing, and diversifying crop types to meet the patterns of the market. Land that was once free from cultivation shortly came under intensive pressures. To produce more crops, farmers were also decreasing the amount of time between fallow periods, which were commonly used by pastoralists as areas of grazing. As cultivation spread across the region, areas of local pasture soon became completely taken over by cultivation. In the plains, a reduction of the quantity of pasture quickly eroded the quality of available pasture as an increase in cultivation constraints pushed more and more pastoralists into the same areas. In order to counteract the demise of open pasture, many pastoralists reduced their stock in order to meet the available resources and even went to the extent of hand-feeding livestock in order to reduce their need to gain access to necessary resources (Spear 1997). As active herders were not able to graze in vacant pasture, many remained within their home area. An increase in murran presence at home transitioned social relations between family members and friends local resource competition and contestation of their patrimony led to the further fragmentations of village lands into smaller holdings. An increase in individualization of property placed
eminent measures of the moral economy of pastoral households, as both inter and intra
conflicts emerged (Spear 1997).

3.3.2. Agricultural Gains in the Form of Social Marginalization

Being seen as unproductive users of land, pastoralists were commonly assumed to
be backwards, unsuccessful, and somewhat of a lower form of production than
agriculture by German and British colonizers (Raikes 1975). As imperial forces
continued to alienate land across Tanganyika, their negative connotation towards the
Maasai was expressed through myths of aggressive, predatory people who attacked and
murder their neighbors (Rigby 1992). These Western narratives were common across
throughout colonial times as they were a means of further exploiting Maasai land to turn
into more “productive” forms of cultivation. While discussing the earliest British efforts
to alienate pastoral claims, Rigby (1992) paraphrases the memoirs of Charles Hobley, a
district officer of Maasailand in 1905, reflecting on then Commissioner of the East
African Protectorate, Sir Charles Eliot, claiming:

“Eliot saw that the time would come when the Masai tribe would have to be
confined to definite limits. He also held the belief that the land on each side of the
stretch of seventy miles of the railway in or near the Rift Valley [i.e., in
Maasailand] was of considerable productive value if properly farmed. His vision
had come true, for the southern half of this section of the Rift Valley now holds
many valuable stock farms, and the northern half is an area of maize. In addition,
the Masai are no worse off than they were twenty years ago.” -Charles Hobley, 1929 (Cited in Rigby 1992, 19)

As the Maasai were seen as shiftless, ‘primitive’, obstructions that limited production, their practices were also thought of as antithetical to productive land practices, therefore destroying the landscape in their path (Niamir-Fuller and Turner 1999). In order to deal with these assumingly negative outcomes of pastoralism, colonial rule imposed limits to their ability to access necessary resources, not only through tighter regulation but also through incentives to practice more sedentary ways of life. Once pastoralists were settled, their movement across the landscape could be easier to regulate, which populations could also be medically treated, schooled, and taxed by government officials with agricultural backgrounds (Niamir-Fuller and Turner 1999). Although the British assumed environmental problems were stemming from the cattle herds, the Maasai interpreted recent environment shifts and degradation as a consequence from land limitations, cause from the delimitation of fiat boundaries imposed during colonization (Campbell 1993). British also pushed Maasai and other pastoral societies into economic production of their livestock. Educating and pushing pastoralists to utilize markets was a means to regulate the size of cattle origins, therefore reduce the impacts of the mobile communities. In Kenya, these mechanisms of control came about in the form of the Swynnerton Plan of 1954, which established the first group ranching schemes in the Kajiado and Narok districts (Homewood and Rogers 1991; Mwangi 2007). In Tanzania,
similar ranching schemes were attempted, however their occurrence at the same time as the nation’s political shift towards socialism conflicted with their implementation.

3.4. Post-Colonialism and Maasai Pastoralism

Upon Tanzania’s independence in 1961, many political shifts occurred, transforming land tenure and land-use practices, the most significant of these being the post-independence shift towards self-reliance in the form of socialism. The transformation to self-dependence placed a large emphasis on the role of the rural sector, as agriculture was the primary production system. In order to place more focus on personal growth, Tanzania began to reduce the reliance on export-dominated structures and push for peasant production systems (Raikes 1975). In his thorough overview of Ujamaa policies in Tanzania, Goran Hyden (1980, 101) identifies eight major objects of Ujamaa including: (1) establishment of self-governing communities; (2) better use of rural labor; (3) taking advantage of economy of scale to increase production; (4) dissemination of new values; (5) avoidance of exploitation; (6) increasing the standard of living of the peasants; (7) mobilization of people for national defense by using villages as para-military organizations; and (8) facilitation of national planning. These elements created the Ujamaa policies adopted by Julius Nyerere through the Arusha Declaration of 1967. Ujamaa embarked on a process of resettlement, which placed a stronger emphasis on equitable distribution of the country’s wealth and basic needs rather than on development (Campbell et al. 2004). The notion of ‘commanding heights of the economy’ was fundamental to the Arusha Declaration, which basically called for a
complete halt in the accumulation of private wealth by government and party officials (Hyden 1980). Using basic social services as incentives, resettlement into rural villages was designed to boost the rural production sector and rural development. Julius Neyere’s pamphlet called “Socialism and Rural Development” was based on three primary assumptions: (a) respect – place and rights of all other family members must be recognized; (b) common property – the basic necessities of one person must be accepted as property of other family members; (c) obligations to work – family members and guest must work when needed in order to possess the right to eat and share shelter (Hyden, 1980, 98). The concepts of Ujamaa strongly focused on building a community from within, as positive reinforcement of these relationships was key to positive rural production.

People who refused to move into Ujamaa villages were portrayed as backwards, furthering the negative reputation that many Maasai had already inherited. The complexity of the highland landscapes and the lack of available land made it difficult for Ujamaa villages to be formulated; therefore, they typically spread across lowland regions. In many cases Maasai residing in the regions were pressured to move into these villages. In order to meet the requirements of the Ujamaa policies, Coast (2002) indicates that many Maasai multi-household structures (enkangs) split to disperse across several Ujamaa villages. This allowed them to spread their relationships across the government assigned villages, resulting in the ability to continue to access seasonal resources (Coast 2002). Many people who inhabited the highland moved towards lowland regions in order to gain access to the basic public services offered by Ujamaa policies. This increased
cultivation in these regions and promoted the use of irrigation systems, which in turn greatly affected wildlife corridors and natural vegetation (Mbonile et al. 2003, Campbell et al. 2004). The passing of the Village Act of 1975 mixed Ujamaa villages, land tenure and communal plots, but as land was not necessarily allocated based on agricultural production, serious degradation occurred to the resources. Although Ujamaa had rearranged the traditional settlements of Tanzania, Homewood and Rogers (1991) state that other than formulating the single-family household, the impacts of Ujamaa were mostly cosmetic for pastoralists.

3.4.1. Pastoral Development: Maasai Livestock and Range Management Project

In addition to the cosmetic transformations that were sweeping the country, many pastoral development projects were being carried out at this time. These projects primarily emerged as a means of modernizing the livestock sector, as it was seen as a lucrative way of increasing state revenue (Hodgson 1999; Homewood and Rogers 1991). In 1964, a pilot ranching association called Komolonik was instated across a 220,000-acre region of Maasailand near the town of Monduli (Hodgson 1999). Komolonik contained several infrastructure developments such as roads, watering points, cattle dips, but due to the government’s lack of maintenance and negative view towards the Maasai, skepticism from the Maasai grew towards the government’s scheme. However so, Komolonik became a foundation for a much larger project that sought further commercialization of the livestock industry. The Maasai Livestock and Range Management Project (MLRMP) was a series of projects that occurred from 1969 to
1979 in Tanzania with the primary goal to “assist the Government of Tanzania to achieve its objective of self-sufficiency and an exportable surplus to earn foreign exchange in the livestock sector” (Utah, 1976, 5 cited in Hodgson 1999, 228-229). The project was first initiated with funds of approximately US $10 million, but what later increased to US $23 million when complete (Homewood and Rogers 1991). With substantial financial backing and the goal of exploiting the livestock sector in mind, MLRMP was interested in boosting the productivity of the Maasai’s livestock through education, veterinary services, and the introduction of exotic breeds of cattle (Hodgson 1999). The project was strongly received by the Maasai, but yet again, the government’s inability to fulfill promises made, as well as their inability to maintain the introduced infrastructure, led to the complete failure of the ten year project. Similar to other pastoral development projects elsewhere, government officials quickly turned towards blaming the perceived unwillingness and negative attitudes of the Maasai, ignoring the lack of Maasai participation in the planning and implementation of the plan (Hodgson 1999). Hodgson (1999, 232) argues that the failure of MLRMP was not due to the fact that the Maasai were unwilling to participate, but was defined prior the projects planning and implementation and therefore, due to the “formulation of the plan itself”. To paraphrase Hodgson (1999, 225), it is not the Maasai who have remained stubborn in their own ways and resisting change, but it has been the image of the Maasai that has remained fixed and distilled within a view of traditionalism and ‘primitivism’.
3.4.2. Contemporary Land Tenure and Decentralization in Tanzania

Combined with the Land Act of 1975 (the establishment of Ujamaa villages), the Local Government Act of 1982 allocated all the power over all village land concerns to the village council, which is a democratically elected body chosen by the village. A major drawback to this policy however was the fact that it did not possess any written guarantee of rights of ownership, and since the land was still in possession by the government, rights over land could be terminated if the government found the reason to benefit the nation. The Agricultural Policy of 1983 was set in place however as a means of reducing the insecurity by allocating land, with the capability to sublease to individuals, to the villages. A major fallback of this act came as leasing ignored the traditional land tenure systems that were already set in place, ultimately leading to the further expansion of cultivation and the fragmentation of pastoralist’s access to important resource bases (Mbonile et al. 2004).

As continuous acts arose, the role of the village in land conflicts emerged as the primary mediator. Land tenure policy after land tenure policy placed the majority of the power in the arms of the village council, which was frequently composed of educated, sedentary villagers. The Village Land Act and Land Act of 1999, or what is frequently referred to together as the “New Land Acts” are the most current land tenure policies implemented in Tanzania. The acts define land ownership based on three categories, including village land, reserved land (conservation areas, national parks, forest reserves), and general land (Kajembe et al. 2003; Sendalo 2009). The primary purpose of the Village Land Act of 1999 was to devolve power to the local administration so that all
land matters are carried out “by the village, at the village, for the village” (Toulmin and Quan 2000, 280). One of the principle components of the New Land Acts was to provide a means of registering land that already holds ownership by existing customary rights (Sendalo 2009). In theory, this process provides landowners with certificate of ownership, however it has been claimed that this process is a top-down bureaucratically process that is carried out at the village level. This makes it very difficult for those not tied directly to council members, which are frequently underprivileged groups, such as women and poor pastoralists, to obtain formal land titles (Sendalo 2009). Although the allocation of village affairs to the village council has improved relations and security for women, urban ‘squatters’, and pastoralists, the failure of the government to release its ownership of the land has disappointed many. Even as land issues have been designated to the local, practices of pastoralism are still considered to be second tier. This concept can still be seen in that fact that when land is unoccupied and unutilized for agricultural purpose, pastoralists generally have been able to use village public lands. However as soon as there is any opportunity to push land use towards large-scale agricultural expansion, the pastoralists must move (Odgaard 1999).

Recent legislation has created even more impediments for pastoralists in Tanzania. The Strategic Plan for the Implementation of Land Laws (SPILL) emerged in 2005 to reassert the measures of the New Land Acts and place additional emphasis on transitioning land-use techniques from traditional forms of agriculture and livestock production to more modern agricultural techniques and animal husbandry (Sendalo 2009). Sendalo (2009, 6) highlights several of the concerns towards pastoralism
mentioned in SPILL including pastoralism’s inability to address poverty due to its low productivity levels, the role of pastoralism in degrading large plots of land, pastoralist’s frequent invasions of established farms, and the inability to control livestock diseases, which restrain the government’s ability to export meat, milk, and livestock. Due to its most recent implementation, a thorough understanding of the impacts of SPILL is still uncertain.

3.5. Sub-National Context: Kilimanjaro Region

The Kilimanjaro region of Tanzania is located in north central Tanzania, straddling the international administrative boundary with Kenya. The region covers 13,209 km$^2$, or 1.4%, of Tanzania’s entire mainland area, which makes Kilimanjaro the smallest region of mainland Tanzania (URT 2002). Six administrative districts make up the Kilimanjaro region including, Hai, Moshi Rural, Moshi Urban, Mwanga, Rombo, and Same, which are then divided into 121 wards, and 449 villages (URT 2002). According to the United Republic of Tanzania 2002 Census, the population of the Kilimanjaro region was estimated at just over two million, of which 75% live in rural areas. In the region, especially in the rural areas, agriculture is the dominant production system, with livestock keeping being the second most widespread economic activity (URT 2002). In fact, the region contains the highest number of improved dairy cattle in Tanzania, holding more than half of nation’s entire population (Ikeno 2007).

With one of Africa’s most recognized geographic features, Mount Kilimanjaro, located in the northernmost extent of the region, elevation and precipitation varies across
the region; therefore, the agricultural systems that occupy different zones differ considerably. The region is comprised of four agro-ecological zones including the Kilimanjaro Mountain Peak Zone, the Highland Zone, the Intermediate Zone, and the Lowland Plains Zone (URT 2002). The Highlands Zone, which is also frequently referred to as the Coffee Zone, receives approximately 1,000-1,800 mm. of rainfall annually and is characterized by its immense biodiversity and complex cultivated landscapes. This zone is composed of the North and South Pare Mountains, which are two of the 13 blocks of the Eastern Arc Mountains, a chain of ancient crystalline Precambrian mountains that extend from Taita Hills of Kenya to the Udzungwa Mountains of Tanzania (Burgess et al. 2007). This zone has historically been home to the Pare ethnic group who has cultivated coffee and bananas, as well as beans, maize, and other crops in the area’s rich volcanic soils (Ikeno 2007). The Intermediate Zone occupies the area between 900 and 1,100 m. altitude and receives approximately 800 to 1,250 mm. of rainfall annual. The Chagga people have historically inhabited this zone. The Chagga were traditionally livestock keepers who have over time, transitioned towards prosperous cultivators, cultivating coffee, bananas, maize, beans, and other crops (Moore 1986). The Lowland Plains Zone, characterizes the lands below 900 m. of the Kilimanjaro region receives approximately 700 to 900 mm. of rainfall annually. Crops such as maize, cotton, rice, sorghum, cassava, and pigeon pea are common to this zone; however, livestock keeping is the most sustainable production in this zone due to its spatial and temporal heterogeneity and uncertainty common to dryland regions (Chapter 2). Cultivation has become more popular in this zone as the implementation of irrigation systems has redirected water
coming from the highlands, towards the cultivated areas (URT 2002). Maasai pastoralists commonly reside in this zone, however like all of the zones, populations are rather heterogeneous, with individuals of all ethnic origins inhabiting this zone.

3.5.1. Sub-National Context: Mwanga District

Mwanga district is the second most southern district within the Kilimanjaro district. With an area 2,698 km.², Mwanga is the third largest district within the region. The population is approximately 115,145 (2002 Census), which is split between 121 wards and 62 different villages (URT 2002). Similarly to the region as a whole, Mwanga district is a composed of a high degree of variation as the North Pare Mountains run down the center of Mwanga district, defining the three agro-ecological zones previously mentioned. The North Pare Mountains also segment the lowland plains zone into two regions, the “West Plains” lying between the Pare escarpment and Manyara Region and the “East Plains”, located between the Pare Mountains and the international administrative boundary shared with Kenya (Ikeno 2007). Just to the west of the Pare Mountains, the major roadway, B1, connects the capital of the Kilimanjaro region, Moshi, to Dar es Salaam, Tanzania’s most populated urban area. This highway is economically important for those who inhabit Mwanga district, however the district has a road density of .19 kms/km.² (road length per km.²), which ranks it the second lowest next to Mwanga. This factor in addition to the population distribution make Mwanga the most rural district within the Kilimanjaro region (URT 2002)(Figure 3).
As Mwanga contains all three agro-ecological zones, its agriculture products vary; however unlike the region as a whole, Mwanga produces the least coffee amongst the six districts of the Kilimanjaro region. Of the various produce that is cultivated in the district, maize and bananas are estimated to cover 75% of the total land area under cultivation (URT 2002). Mwanga district is estimated to have a total of 71,258 heads of cattle (13% of the regional total), 37,936 heads of sheep (10% of the regional total), 27,409 heads of sheep (9% of the regional total), and 108 heads of pigs (1% of the regional total). A high percentage of these populations can be found within the “East” and “West” Plains of Mwanga district.

3.5.2. Sub-National Context: Kirya Village

Kirya is a village located in the southwestern corner of the “East Plains” area of Mwanga (Figure 3). To the west of Kirya is Manyara district, containing the plains of Simanjiro, a commonly recognized pastoral area of Tanzania. Between Kirya and Simanjiro lies the Ruvu or Pangani River. Runoff from Mount Kilimanjaro contributes to approximately 60% of the water that runs into the Ruvu River, providing an estimated 3.7 million inhabitants with water and arable land up and downstream of Kirya (IUCN 2003). In addition to supplying the necessary resources for livelihoods, the Ruvu River is also a source of hydroelectric power for Tanzania. Nyumba ya Mungu (House of God) is a man-made reservoir that was installed just north of Kirya village in 1965 for the purposes of flood control, hydro-electric power, and irrigation (Bailey 1978). With a
maximum surface area of 180 km. Nyumba ya Mungu is the largest reservoir system in the Kilimanjaro region, supplying approximately 80 megawatts (Mws.) of hydroelectricity to the country (URT 2002). In addition to supplying hydroelectric power, Nyumba ya Mungu has become a primary source of fisheries for many livelihoods in the region, since its initial stocking of 28,509 tons of fish in 1970 (IUCN 2003).

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5 The Ruvu River and the Kikuletwa River meet at Nyumba Ya Mungu to form the Pangani River (Bailey 1978), however the names, Ruvu and Pangani, were used synonymously during fieldwork. For purposes of consistency in this thesis the river is noted as the Ruvu River.
Figure 3: Map of the Study Area: Kirya Village, Mwanga District.
The village of Kirya falls into the lowland plains agro-ecological zone, as it receives less than 900 mm. of rainfall annually. The 1,378 strong population of Kirya (2002 Census estimate), draws from several ethnic groups including Maasai, Chagga, and Pare (URT 2002). Livestock keeping is a primary productive system by many inhabitants of Kirya and it contains approximately 4,853 heads of cattle, 3,198 heads of goats, and 2,317 heads of sheep, ranking it the fifth highest livestock population in the Mwanga district (Agriculture and Livestock Census). The village’s population is further dissected amongst three subvillages, including Emangulai B, Emangulai A, and Kirya subvillage. Several Maasai households can be found in each subvillage, however the largest community can be found in Emangulai A and Emanguali B. For the sake of this thesis, the study area is referred to as the village of Kirya. However, when necessary, the subvillage name is referenced in order to bring slightly more specificity to the topic of discussion.
4.0. METHODOLOGY

This chapter provides an overview of the research methodology for this research. In Section 4.1, the methodological framework is presented to discuss the approach carried throughout the entire research process. In the next section, Section 4.2, a more in-depth discussion of the mixed-methodology as applied in the field is presented. This section will also compare and contrast the differences between a mixed-methodology and a participatory-GIS (PGIS) methodology, not to exaggerate the difference but to highlight how these two approaches correlate. Section 4.3 will provide a thorough overview of each of the field methods used in the mixed-methodology including project-based household survey, community workshops, participatory mapping, oral histories, and semi-structured interviews. In the final section, Section 4.4, the limitations of these field methods is discussed.

4.1. Methodological Framework

In this chapter, the methodological framework that was developed for formalizing the research questions, interacting with individuals, collecting data in the field, analyzing the collected data, and theorizing the results is discussed in detail. Donna Haraway’s (1991) “situated knowledge” concept aptly conveys the spirit of the methodological framework developed for this research. It was important to give primacy to the knowledge of those who are in the most suited position to understand what is occurring to resource access and mobility. The concept of situated knowledge has become one of the most useful means of contesting universalist or reductionist forms of knowledge, whose
one language has been enforced as the standard for all conversations (Haraway 1998, 580). Haraway argues that ideologies of scientific knowledge should be perceived as a “god trick of seeing everything from nowhere” (Haraway 1991, Hay 2005). She proposes that objectivity should be situated in the position of the knower; therefore, the production of knowledge is situated around an individual’s history, cultural, and individualism. Hence, for this research, complex relationships, non-quantifiable properties, unprivileged ontologies, and fluid narratives of herders in Kirya are explored to examine the situations that produce the knowledge of these herders and how these ‘knowledge spaces’ (Turnbull 2000) are changing (Cope and Elwood 2009, 31). Local, or in this case “Maasai”, knowledge is not discussed in order to embellish over the differences between local knowledge and “scientific” knowledge, but because the knowledge of the local inhabitance should be seen as an alternative and equally “valid” knowledge system that is rooted in the historical, cultural, and moral positionality of the observed “knowledge space” (Goldman 2007; Turnbull 2000). These knowledge systems are the only available systems capable of assessing the social, political, and physical components (or situations) that construct the complex relationship between nature and society at such fine scales of observation: the individual and the local.

The interaction with and ability to access these local knowledge systems must take a very reflexive route not only to account for the historical, cultural, and moral positionality of the local knowledge system and its production, but also to similarly situate the researcher’s own knowledge system. As an mtafiti (researcher), mwanafunzi (student), mzungu (white person), kijana (young man), and an mgeni (guest) who spoke
very little KiSwahili in the field (let alone any Maa!), critical self-reflexivity was constantly obligatory for me throughout this research. Uncertainty and unfamiliarity was, and always is, present prior to developing a research agenda, conducting field research, and analyzing and theorizing the results, as the researcher’s knowledge is always ‘situated’ and ‘partial’ (Goldman 2007). Therefore, to decentralize my own positionality in this research, and allow the knowledge and experience of those who interact with the local environment on a daily basis to emerge and drive this research, a grounded theory approach was taken in order to “give priority to developing rather than to verifying analytical propositions” (Emerson et al. 1995, 143). Theoretical construction through grounded theory lies in the iterative process of data collection, coding, categorization, comparison, and analysis in order to construct knowledge that is ‘grounded’ in empirical data and able to conceptually analyze various social worlds (Knigge and Cope 2009, 96; Burck 2005, 9). **Fluidity** is a key component of grounded theory that provides a means of remaining dynamic, enabling emerging themes, which may have been suppressed through other approaches, to take precedent and allows adaptive modes of observation and learning to emerge spontaneously during this research.

4.2. Mixed-Methodology

Grounded theory is commonly implemented using a suite of varying qualitative methods, including in-depth interviews, oral histories, participant observation, photography, participatory mapping and more in order to explore the depth of ‘partial’ and ‘situated’ knowledge. Multiple methods allow for a variety of theoretical
"discoveries" to emerge as the researcher compares across the different datasets (Emerson et al. 1995). Experiential knowledge, represented and collected through qualitative methods, does not necessarily need to stand alone, polarized against research that takes a more quantitative route. Quantitative methods can be used in collaboration with grounded theory to create a hybrid epistemology to explain “for particular purposes and in specific circumstances” (Elwood and Cope 2009, 5). This unity of methods is frequently referred to as a mixed-methodology that has gained popularity within social science as a means of greatly expanding the explanatory power of research (Elwood and Cope 2009). In this research, employing a mixed-methodology allowed not just a holistic combination of qualitative and quantitative methods but also provided alternative methods for eliciting individual and community level local knowledge. By working at both the individual and community scales of knowledge, the mixed-methodology also allowed cross-referencing and verification of information collected opportunistically from the various sources. Thus, the mixed methodology is not just about the collaboration of quantitative and qualitative methods to merely bring “scientific rigor” to qualitatively-derived data, but to also merge scales of observation, construct both community and individual dialogues, explore the presence of multiple truths, and triangulate between data to consider the incongruence that may be present.

4.2.1. The Identity of this Mixed-Methodology

Knigge and Cope claim that when employing a mixed-methods approach, it is often helpful to have some sort of ‘glue’ to bind different methods of a mixed-
methodology together (2009, 95). The ‘glue’ in the case of this research is geographic information. Geographers are constantly seeking to understand the influence and production of space and place across multiple scales. Understanding how one relays geographic information can help facilitate a better understanding of how one utilizes their surroundings as well as conceives of changes to these specific spaces. As previously noted, both epistemological and ontological investigations of these places/spaces have been dominated by scientific knowledge systems. Geographic information of these places/spaces that is disseminated, represented, and visualized has also fallen victim to the same overpowering system, marginalizing those that are commonly oppressed. These are frequently local communities and individuals. A GIS is a suite of methods and applications that can be used for storing, managing, analyzing, and representing geographic information, while also producing and negotiating geographic knowledge through analysis and representation of spatial data (Elwood and Cope 2009, 3). Initially criticized for the portrayal of geographic information as a single dimension of truth, the inability to be value neutral, and the potential for exclusion and disempowerment, a re-evaluation in the way of thinking about GIS has spurred careful adoption even by critical geographers and social scientists (Craig et al. 2002; Cope and Elwood 2009; Weiner and Harris 1999; Pickles 1995; Schuurman 2000). More holistic approaches with dealing with the collection of geographic information are now being taken to recognize knowledge as partial and situated and represent unprivileged ontologies and epistemologies (Elwood and Cope 2009; Kwan and Ding 2008).
One such means of tackling these knowledge representations has been through the emergence of participatory GIS (PGIS). PGIS is an approach that has emerged out of the convergence of GIS and participatory rural appraisal (PRA) methods of sustainable development (Craig et al. 2002). Participatory GIS is a spatial decision-making tool, which utilizes the technology of GIS as a medium to meet the needs and capabilities of communities facing a variety of community-based geographic concerns (Abbot et al. 1998, Tripathi and Bhattarya 2004). Drawing on the diverse experience of individuals, PGIS emphasizes the collection stage rather than the analysis stage of traditional GIS applications. It seeks the inclusion of multiple truths and diverse perceptions of space and place for the production of GIS data and spatial decision-making (Abbot et al. 1998). PGIS approaches also place an emphasis on the dissemination of information collected in the field back to the individual participants, policy-makers, planners, and decision-makers. Multimedia technologies are frequently used in PGIS methodologies as tools for visualization, simulation, communication, and exploration. Interactive methods such as the use of hyperlinks and the incorporation of videos or photographs have become mediums for PGIS practitioners to better understand spatial phenomena and facilitate communication between participants, decision-makers, and community-based organizations (Ott and Swiaczny 2001).

Some components of this research methodology discussed in this thesis may appear to stem from a PGIS methodology. In fact, it can even be claimed that the methodology used for the formalization of the research plan, the approach taken in the field, and the emphasis on the dissemination of cartographic outputs constitutes a “PGIS
methodology”. Conventional PGIS approaches have generated their own sets of hypotheses, produced knowledge, and elicited new kinds of questions derived from its original intensions to seek further questions of political ecology, but have rarely taken steps further into exploring the geographic dimensions of situated knowledge. For this research, PGIS was a field data collection method but not an analytical framework. The analytical framework used for exploring the knowledge of livestock herders in this research should be interpreted from the mixed-methodology perspective.

4.3 Research Methods

Fieldwork for this research occurred between June 17, 2010 and August 26, 2010. In this section, a detailed description of each of the methods taken in the field is provided. An important first step was to identify the types of data that could help answer each of the research questions (Table 1).

The first research question was intended to explore the local land-use practices of contemporary herders in Kirya. This includes understanding the spatial distribution of watering and grazing resources in the wet and dry season, as well as in times of extreme disturbances, such as floods, droughts, and disease outbreaks. To explore these locations, the collection of spatially referenced GPS points and personal narratives about each location were essential. The second research question was conceived to explore individual experiences with resource change; therefore local narratives of changing resource access, as well as personal observations were important to address these changes. Since change is dependent on the ability to compare past resource use to
contemporary resource use, interviews with both active livestock herders and past livestock herders took place. Also, constructing a timeline of climatic events was important for understanding and contextualizing how climate extremes are experienced and interpreted in Kirya; therefore community workshops with community members of Kirya were held to obtain such information. The third research question related to individual herding strategies and changes in mobility patterns. To explore changes in these patterns, in-depth interviews and participatory mapping exercises were utilized. Finally, the fourth research question was posed to understand how spatially referenced local knowledge can be represented. This question was geared toward understanding how oral histories can be analyzed and visualized in a digital geographic environment to provide insights not available through conventional analysis.
Table 1

Research Methods and Data Requirements

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Data Required</th>
<th>Method(s)</th>
<th>Data Sources</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What are the current spatial and seasonal dimensions of watering and grazing access in Kirya?</strong></td>
<td>Personal narratives about the locations of resource areas during different seasonal variations Georeferenced field locations to map these resources</td>
<td>Semi-structured interviews/participant observations Participatory mapping exercises Oral drought response histories</td>
<td>Past Herders Contemporary Herders</td>
<td>Qualitative coding Content analysis Cartographic production</td>
</tr>
<tr>
<td><strong>What changes have been occurring to watering and grazing resource access in Kirya over the past 50 years?</strong></td>
<td>A timeline of experienced change that has occurred to the environment of Kirya over the past century An understanding of the issues that are currently experienced by herders Personal observations</td>
<td>Community workshops Semi-structured interviews/participant observations Participatory mapping exercises Oral drought response histories Focused interviews</td>
<td>Past Herders Contemporary Herders Village executives and Extension Agencies</td>
<td>Qualitative coding Content analysis Cartographic production</td>
</tr>
<tr>
<td><strong>How do the Maasai of Kirya adjust their mobility patterns to accommodate changes in watering and grazing?</strong></td>
<td>Personal narratives addressing changes that have occurred to herding strategies</td>
<td>Oral histories of drought response Participatory mapping</td>
<td>Past Herders Contemporary Herders</td>
<td>Cartographic production</td>
</tr>
<tr>
<td><strong>What benefits might accrue from the representation of Maasai narratives in a temporally enhanced GIS?</strong></td>
<td>Spatial and temporal dimensions of past drought response Personal narratives of drought response</td>
<td>Oral drought response histories Participatory mapping Time-space geodatabase management</td>
<td>Past Herders Contemporary Herders</td>
<td>Space-time path representation in GIS</td>
</tr>
</tbody>
</table>
4.3.1. Household Survey

Household surveys were administered across the Kilimanjaro region by other LKCCAP personnel before personal arrival to the region. The household survey provided data on a range of critical livelihood activities. In addition to conventional livelihoods-focused variables (e.g. household demographics, livelihood practices), the household survey was also used to collect data reflecting the perceptions and responses of households to local, regional, and global environmental change. The household survey questionnaire also included an ethno-linguistic section pertaining to the range of terms that are currently diffusing into KiSwahili from English language discourses on climate change. Previous research and scoping by LKCCAP personnel in 2007 and 2009 ensured that the survey adequately captured the contemporary elements of adaptive capacity. In total, the LKCCAP team administered 600 household surveys. In the village of Kirya, 40 household surveys were administered. Twenty-two of these were administered to households who identified themselves as Maasai. A random number generator was used as the sampling technique for the survey. Although the household survey administered in Kirya contained a wealth of information relative to household’s adaptive capacity, only selected questions were utilized in this research. Specifically, survey questions pertaining to household demographics, extreme climatic events, and changes experienced in Kirya were fundamental for providing a general descriptive window to address intra-household information in Kirya.
4.3.2. LKCCAP Community Workshops

Before imposing an assumed concern about water and grazing related issues to the local community in Kirya, it was crucial to understand the community’s primary concerns through community workshops. These workshops focused on first eliciting and later ranking of livelihood related problems of major concern to village residents. Three workshops with men, women, and elders were arranged in each of the LKCCAP villages along the intensive gradient in Mwanga district. The men and women were requested to participate in different workshops to obtain a gendered perspective on the relative importance of major problems faced by villagers. The workshops with elders were designed to establish a historical perspective on extreme climatic events. Both male and female elders were encouraged to participate equally in this workshop. These workshops were conducted as part of LKCCAP’s participatory research methodology. In Kirya, community workshops were held in both Emangulai A and Emangulai B subvillages. Community workshops were scheduled and facilitated by the Emangulai A and Emangulai B subvillage chairs. The LKCCAP team gave the subvillage chair several days to organize community members for each of the three sessions. The workshops were held in an enclosed community structure in Emangulai A and a classroom at the school in the Emangulai B subvillage. During the workshops, only the community members of the focused gendered workshops were asked to attend. For each of the six workshops (three each in Emangulai A and B), the LKCCAP field coordinator led the discussion in KiSwahili. In Emanguali B, many participants only spoke Maa. To overcome this language barrier, a male interpreter was present to translate the
presentation into Maa. Before the workshops, the interpreter was briefed on the intention of the meeting and asked to act as merely a translator during the women’s and elders’ meetings, but to speak freely like other participants during the men’s workshop. Because of the language barrier, the male interpreter, along with a couple of male LKCCAP team members had to be present in all of the workshops, including the women’s workshop.

Approximately 15 women attended the women’s workshop, while approximately 12 men attended the men’s workshop. The number of participants fluctuated as several participants would step out of the classroom to return slightly later. In the problem ranking workshops, the participants were encouraged to focus on the problems and concerns that affect the entire community, and to not dwell on individual worries. The LKCCAP field coordinator facilitated the discussion, using index cards and markers to write the concerns acknowledged by the participants. After writing the concern, the field coordinator showed the card to the participants to confirm that it was written properly. Once the card was validated, it was taped to the chalkboard located at the front of the room. Once the workshop hit the saturation point (Hay 2005, 122) with no new problems being cited, the field coordinator re-examined the previously stated issues with the community. Following the re-examination, the field coordinator then began by asking the participants to rank the village concerns according to the severity of the concern amongst itself and in comparison with the other stated problems. The problem cards were rearranged on the chalkboard from order of most severe (at the top) to the least severe (at the bottom). During this time, the LKCCAP team continued the discussion until all participants had an equal opportunity to voice their opinion on the ranking of the problem
amongst the other stated problems. Participants were free to move the problem cards around if they were not satisfied with the ranks of all the stated problems. Problems perceived to be of similar severity were ranked at the same level (i.e. placed in the same row).

After all problems were ranked, the field coordinator reassessed the problem rankings with the community members, present at the meeting, and then identified problems from the top three rows and discussed one by one how the community responded to those problems. These responses were then organized and written on the chalkboard. Upon completion of the exercise, the LKCCAP team photographed the complete problem rankings and responses.

The elders’ workshop had a slightly different thematic focus: extreme climatic events and the consequent stresses experienced in the village. To obtain participants for this workshop, similar sampling methods were used as discussed above. Before the workshop, several large pieces of sketch paper were taped horizontally to the chalkboard. The LKCCAP field coordinator led the discussion in KiSwahili. In Emangulai B, the Maa interpreter translated back and forth from KiSwahili to Maa. Participants were asked which elder was the oldest and around what year he/she was born. The field coordinator wrote the year on the far left end of the sketch paper, along with the year at time of the workshops (2010) at the far right end to establish a base timeline for the available timeframe of the participants. With a base timeline established, the field coordinator elicited conversations revolving around various climatic events that took place within the community members’ lifetimes. If the participants missed a key climatic event, and the
field coordinator was aware of it already through prior feedback from community members, a measured effort was made to lead the participants to talk about the event either indirectly by leading them to talk about the relevant timeframe, or directly by bringing up the event. Once the conversation reached saturation, the field coordinator started discussing each individual event, placing a “severity marker” above or below the drawn timeline. Event codes or brief descriptions were documented on the timeline. Once all of the extreme events were examined individually, the field coordinator requested participants to discuss and compare the impact of and community response to the three most severe events. Finally, the coordinator and other LKCCAP team members discussed with participants the potential strategies for adapting to future climatic events. Similar to the former community workshops, the LKCCAP team photographed the timeline and the response sheets, leaving the paper copies for the community.

4.3.3. Participatory Mapping Exercises and Field Mapping

Several community concerns became evident from the community workshops held in Kirya and other villages. To follow-up on these concerns in Kirya, and to look for answers to the proposed research questions, participatory mapping exercises were undertaken to complement data from the household surveys and community workshops. Participatory mapping can be done in as simple a fashion as using the ground as the canvas and natural materials, such as sticks and rocks as drawing material. Typically, however, participatory mapping involves the use of pencils or crayons to draw on blank sheets of paper. Another approach is to provide a laminated basemap (topographic or
imagery map) on which participants could draw symbols to spatialize components of their narratives. A more sophisticated format developed by Giacomo Rambaldi (Corbett and Rambaldi 2009) is to work with local community members to produce a three-dimensional topographic map at the scale (i.e., 1:5,000 or 1:10,000 scale) and then evoke community members to use material such as threads and pushpins to dynamically interact and visualize their collective narratives on the three-dimension rendition. The narratives can be oriented towards one or more important community issues, while the three-dimensional map acts as a facilitating medium for explore those issues from a geographic perspective. Regardless of the method of mapping, participating mapping are enlightening for both the participants and the researchers. Participatory mapping creates shared knowledge, and encourages a semi-structured collaborative discussion and analysis of community-oriented concerns such as land tenure, lack of specific resources, or issues of resource access (Craig et al. 2002; Chambers 2006; Hay 2005).

4.3.3.1. The Selection of Participants

For this research, it was important to elicit narratives that would reveal long-term changes that are being observed in the area. Thus, eliciting narratives from both the present and past generations of herders was important. As mentioned in Chapter 3, the Maasai social system is based on age grades and age sets, where household males are typically involved with livestock herding from a very young age (Bekure et al 1991; Spear and Waller 1993). Thus, most elders in the community were livestock herders during their youth. Instead of trying to elicit information on change directly through
conversations with only elders, it was decided that it would be better to infer the perceived changes in resource access indirectly by comparing the narratives of present-day and past herders.

Two focus groups were, therefore, identified for these exercises. The first group included junior and senior elders who no longer herded cattle. Elders were encouraged to talk only about their herding experiences in the past. For this research, this group was considered the Past Herder focus group\(^6\). The second group consisted of contemporary, active herdsmen who were all around the murran age grade and who could provide the best source of information about current uses of resources and mobility patterns in accessing these resources. This focus group is referred to Contemporary Herder focus group\(^6\) in the rest of this thesis. The desired information on the changes experienced by the Maasai herders was to be inferred by comparing the accounts and maps of the two groups.

4.3.3.2. Participatory Mapping with Maasai Herders

Arrangements for the mapping exercises were made during the final community workshop in Emangulai B subvillage. Because close connections were already established with subvillage executives and several community members, snowball sampling was used to collect participants for each exercise. Snowball sampling is the process of establishing a connection with a person(s) in the community, then having them

\(^{6}\) Capital letters in “Past Herders” and “Contemporary Herders” are used when discussing the focus groups, while lower case letters are used when discussing social groups outside of the context of the methodology.
aid you in approaching other valuable participants (Miles and Huberman 1994). Initially, enlarged and laminated 1:50,000 scale topographic maps were brought into the field to provide a base for map for the participatory mapping exercises. However, the scale of the community problems that emerged in the previous community workshops necessitated a pre-test to assess the usefulness of the 1:50,000 scale maps. Participatory mapping is more about the process rather than the final cartographic output, and the base map is merely intended to complement the spoken narratives and link the cartographic spatial scales with the scales of personal narratives. During the final community workshop in Emangulai B, several 1:50,000 scale maps were taped to the chalkboard. As community members, both past and contemporary herders interacted with the map, it became clear that a map scale of 1:50,000 was too small to allow any meaningful discussion at the local level.

To overcome this dilemma, what the researcher has deemed “MacGyver cartography” was employed by utilizing the available resources to facilitate useful mapping techniques. During a visit to the Kirya village office prior to the community workshops, a photograph of a community-produced village sketch map was acquired since it was not possible to transport the map beyond the village for photocopying (Figure 4B). A portable digital projector that was fortunately brought to the field by the LKCCAP team was used to project the photograph of the village map onto sketch paper taped on the wall, and all features and the legend displayed within the projected map were manually traced. Clear packing tape was then used to laminate the reproduced map so that
wet-erase markers could be used to draw freely on the reproduced village map (Figure 4B).

Figure 4(A, B): The Village Map (A) Redrawn for the Participatory Mapping Exercise (B).

As stated in Chapter 3, elders are typically the authoritarian figure within the community; therefore, it was decided to begin the participatory mapping exercises with the Past Herder focus group, followed by the Contemporary Herder focus group. Although the two focus groups were from different generations, the context and approach of each mapping exercise was identical. In both exercises, the LKCCAP field coordinator acted as an interpreter to translate questions asked in English into KiSwahili. A
designated interpreter to translate KiSwahili into Maa for the benefit of the participants only speaking Maa was also chosen before starting the community workshops.

Participants were first briefed on the community workshops held only a few days earlier by the LKCCAP project personnel. This helped to situate the mapping exercise in the context of the LKCCAP research project, which the community was already comfortable with. This was essential for gaining the trust of the community and also ensured that the community did not perceive the mapping exercise as an independent activity. Participants were then asked to carefully examine the map and were handed wet-erase markers to add important features of the village they saw missing, and create an enhanced map legend indicating the various symbols used to represent the missing features. A series of questions revolving around seasonal resource access were administered to explore the spatial and temporal dimensions of resource access. Once saturation was reached, the map was re-examined by the participants, allowing for any corrections to take place. The participatory mapping exercises were photographed and audio recorded with the permission from the participants. Additionally, the Contemporary Herder’s mapping exercise was video recorded with participants’ permission. When the exercises were complete, the map was photographed and wiped clean for reuse.

While two workshops with Past and Contemporary Herder focus groups were held in the school in Emangulai B, a third short participatory mapping exercise was arranged at Staff, a Maasai community in the northern extent of Emanguali B. This exercise involved only men around the murran age grade (Contemporary Herder focus group). Using a similar question format, the third mapping exercise validated the
comments provided by the earlier Contemporary Herder mapping exercise. Upon completion of the Staff participatory mapping exercise, the maps were photographed for later analysis. Five members in the Past Herder focus group and 11 members of the Contemporary Herder focus group participated in these three participatory mapping exercises. These numbers fluctuated as several individuals would come and go during the exercise.

4.3.3.4. Georeferencing Map Features

Post completion of the participatory mapping exercises, field points corresponding to features discussed in the mapping exercises were geocoded using a GPS so that the sketch maps could be georeferenced later in a GIS, albeit approximately given the non-cartometric nature of the map. A Garmin e-Trex H GPS receiver unit was used for field mapping of features. The unit has an error specification of 5-10 meters, which was more than satisfactory for georeferencing a sketch-map. A few distance features could not be researched (Lemnazi and Sakoto Springs). For these features, approximate distances and azimuths were recorded from vantage points.

Field hikes with GPS units were used to also georeference the Contemporary Herder’s local grazing routes that the herders described and marked on the sketch map. Specific locations outside the village were collected, as these locations appeared to be important landmarks in many individuals’ narratives. In addition to the collection of GPS points, a GPS-enabled digital camera was used to obtain georeferenced photographs for each of the mapped features. Georeferenced photographs provided a secondary means of
collecting the proper coordinates for each features; they also were essential for
documenting and representing non-Cartesian space. Extensive field notes were taken to
describe the quality, any observed acts of resource use, and other notable characteristics
of the feature. Several features including the livestock reservoir and the Ruvu River
intake point, were visited multiple times to make more detailed observations of both the
physical and social characteristics of those water access points.

4.3.4. Semi-structured Interviews and Participant Observation

Semi-structured interviews and participant observations were conducted at the
livestock reservoir. Data collection at the reservoir took place over three separate days,
spanning across the course of fieldwork. Prior to the first days of observations and
interviews, field reconnaissance was done with fellow LKCCAP team members and the
Kirya subvillage chairman prior to the first day of observations and interviews to acquire
background information about the construction of the reservoir and the peak time of
herder’s usage. Convenience sampling was the sampling method employed to actively
find interviewees. Convenience sampling is the process of finding proper individuals by
utilizing what is available or ‘convenient’ (Bradshaw and Stratford 2005). The semi-
structured interviews followed a brief questionnaire that was prepared after field
reconnaissance but prior to the first day of participatory mapping. This allowed for more
spatially and temporally explicit questioning concerning water access at the reservoir.
The semi-structured interviews involved questions pertaining to herder’s daily herding
and watering routines, the impact of the reservoir on grazing and watering strategies, and
the personal conceptions and experiences at the reservoir. The interviews were administered in KiSwahili and were audio recorded with the participants’ consent. For only Maa speakers, an interpreter was present. Seven Contemporary Herders were interviewed across the span of three days. Many herders visiting the livestock reservoir were young herdboys. Due to IRB standards, these herders could not be interviewed.

Participant observations were conducted during the days at the reservoir. Participant observation is the method of being a part of the spontaneity of everyday interactions where systematic understandings of ‘place’ can emerge (Hay 2005, 194-195). This method of data collection involved observing the acts of water usage at the reservoir. While observing the habits of livestock watering, notes on the estimated size and composition of the livestock herd, the herder’s age, the direction from which the herder arrived at the reservoir, the time at the beginning of water usage, the ending time of water use, the duration of water use, the direction in which the herder left the reservoir, and several other factors (e.g. the use of donkeys for carry water, how many herders were in each group). Participant observations were carried out at convenient times on all three days of the semi-structured interviews discussed above.

4.3.5. Oral Histories Focused on Responses to Extreme Climatic Events

Participatory mapping exercises are naturally biased toward spatial representation and not as suitable for capturing the temporal dimensions of people’s lives. Moreover, despite assurances and best intentions of the researchers, mapping is known to make community members uncomfortable if they are reluctant to explicitly delineate their
livelihood space (Wood 1976). It would be understandable, for example, if participants did not want to reveal certain aspects of their activity space for fear of social or legal repercussions. Some others may just be more cautious and adopt a reluctant stance, regardless of the nature of the mapping exercise and the information sought.

Other qualitative data collection methods can help address some of the limitations associated with participatory mapping. Inspired by the information emerging from community narratives that materialized out of the LKCCAP workshops and the participatory mapping exercises conducted specifically for this research project, oral histories were used as a way to move beyond the limitations of the participatory mapping exercises. Oral histories are accounts of first-hand, lived experiences with an event or series of events, arranged in chronological order (Emerson et al. 1995). They not only provide the temporal perspective missing from mapping-based reconstruction of individuals’ livelihood space, but they also give an opportunity to the cartographically anxious participants to freely discuss their livelihood activities. Oral histories may or may not explicitly capture changes over time, but for this research, it was crucial to understand these changes, particularly in livestock herder, that had been experienced. Oral histories were used to record information about changes in the physical and social environment in Kirya, herders’ experiences leading up to extreme climatic events, and their responses to such events. The oral histories needed to be derived from the same focused groups of community members, the Past and Contemporary Herders. Using a convenience sampling technique, both engaged and rather soft-spoken participants identified from the mapping exercises, were asked individually if they would be willing to continue discussing their
personal experiences as herders. For the community members who did not attend either of the participatory mapping exercises, snowball sampling performed through the already established community relationships extended the opportunity to those who had never been interviewed during any previous research activity.

Oral histories were collected over a span of five days. Further meetings with participating members of the Contemporary Herder focus group were organized and planned during the participatory mapping exercise. Due to the recent drought of 2008-2009, which was discussed in the extreme climatic events workshop, oral histories with the individuals focused on the grazing and watering conditions in Kirya leading to this event and each individual’s personal response (Figure 5). To examine the spatial and temporal dimensions of their response to the event, a series of questions pertaining to the individual’s decision-making and long-distance mobility were asked. The questions pertaining to the role of information and communication technologies (ICT) and infrastructure development in their decision-making, as well as several questions concerning the individual’s opinions about future responses if similar climatic events occur. The oral histories of the members of the Contemporary Herder focus group from Staff were also included in this research. Nine Contemporary Herder oral histories were collected.
Once members of the Contemporary Herder focus group were interviewed, a visit with key elders in the community reestablished the intentions of this research and scheduled meetings to take place with members of the Past Herder focus group. Individually, members of the Past Herder focus group were asked about their experiences with water and grazing access when they used to be active herders. To first provide an idea of the relative age of the elder, they were asked what age set they belonged to. The individual was then asked to discuss any extreme event that occurred during their time as an active herder. If the individual could recall the approximate year, the event was recorded and the elder was asked a series of questions similar to the questions used for the collection of the Contemporary Herder oral histories. Towards the end of the oral history recordings, elders were asked to compare and contrast the events and responses of
today with the event they were discussing. Finally, elders were asked their opinions on the role of ICT and infrastructure development on pastoral decision-making. Six oral histories from members of the Past Herder focus group were collected.

Oral histories were elicited in KiSwahili and sometimes in Maa. The oral histories were collected only in the presence of the LKCCAP field coordinator, sometimes the Maa interpreter, and the author. Photography and audio recording was employed to record each oral history if the participant consented. Although the collection of the oral histories stuck to a relatively structured format, flexibility allowed for greater participant-led discussion and developed the power relations that existed between the researcher and the participants (Hay 2005).

4.3.6. Key Informant Interviews and the Collection of Secondary Data

Several local sources were explored to obtain village level data. The Mwanga District Agriculture and Livestock Extension Office was the source for population and livestock census data at the district level. Additionally, a formal land-use plan was recently drafted in Kirya prior to fieldwork with the assistance of the extension office. During a visit to the extension office, officials granted the researchers permission to photograph the land-use plan. After discovering the land-use plan, a meeting with several members of the Kirya Village Council provided more insight to the planning process that went into the establishment of the formal land-use plan. In Kirya, the NGO, Pastoralists Development and Education Trust (PADET), has played an active role in conflict resolution and land rights issues. An interview was conducted with two of the
organization’s coordinators because of their engagement with the community. The interview took place at the PADET office located in Mgagao. The primary purpose of the interview was to introduce the NGO with the LKCCAP team, inform them about the goals of LKCCAP, as well as this research project, and to understand the depth and scope of their involvement in Kirya.

4.4. Research Limitations

The methods used and the positionality of this researcher intrinsically presented numerous limitations throughout the entirety of this research. However, through the use of the mixed-methodology, the triangulation between methods provided a way to verify and build theories, instead of dwelling on these limitations and allowing them to constrict the findings of this research. First and foremost, a language barrier that was constant throughout the duration of fieldwork presented the most striking limitation to this research. The product of this dilemma is acknowledgeable throughout almost all of the limitations of this research. To overcome this language barrier, the LKCCAP field coordinator graciously acted as my interpreter during all interactions in and out of the field. Even as patient and enthusiastic as the field coordinator was, he still influenced all of the qualitative information collected. Although the field coordinator was frequently asked to limit his bias in many situations, it still came through in certain instances. Additionally, as translator, the field coordinator had the power to dictate what minor details or genuine emotional expressions were relayed. These limitations are inherent in all communication that deals with a language barrier; therefore, the field coordinator is
not at blame, as he provided countless personal and research-oriented support throughout the fieldwork stint. To overcome these concerns, all interactions were audio recorded and later revisited to validate what each participant discussed and what the research coordinator relayed. In cases where the research coordinator’s bias was more obvious, the bias was noted and only key points were documented to try to limit personal opinions.

The language barrier prevented formation of tight interpersonal relationships with the participants. This became another limitation of this research. Frequently, information that was somewhat controversial was discussed. This impacted the participants’ sense of security with the researcher, which imposed substantial limitations during the interview regarding the land-use plan with the Kirya Village Council. After becoming a familiar face to the residence of Emangulai A and Emanguali B, confidence grew in the researcher’s interests, allowing for more trust and willingness to communicate. Furthermore, gaining a close friendship with two members of the Contemporary Herder focus group helped gain inter-community trust. Entrusting these men with digital cameras rendered extremely beneficial, as it increased individuals comfort levels and provided a way of capturing unique experiences and photographs. To overcome these limitations, the two community members and friends of the researcher frequently met with individuals one on one previous to the researcher’s interaction to provide the individual with a thorough overview of what the researcher’s intentions and interests. If the individual remained uncomfortable, the individual would not be met with. In order to retain the sense of security with these individuals, one of the assistants remained present during the
entire interview to re-emphasize the research interests and to make sure the individual’s fully understood each question.

A second limitation of this research was in the composition of the household survey. The household survey was composed before the researcher’s involvement with LKCCAP; therefore the questions asked were out of the control of the researcher. Several important questions were omitted however, which limited the researchers full ability to understand some of the demographic characteristics of Kirya. For instance, donkeys played an important role in many of the household’s herd composition, as they are used primarily for transportation and labor purposes. Unfortunately, donkeys were overlooked during the survey design and omitted from the household survey all together. Other limitations in the household survey included the vagueness in terminology used in the survey, which made it difficult for the researcher to distinguish what was meant by some of the survey questions. Since the survey was not actually collected by the researcher, it is also unaware how this concern impacted the respondents’ acceptance of the research question. Since the survey was administered in KiSwahili and later translated to English, the wording of the questions to the respondents is unclear; therefore even more uncertainty was emitted through the survey process. If any survey questions had semantic confusion, they were omitted from analysis to avoid any interpretation errors. The household survey contributes only minutely to this research; therefore only straightforward questions were analyzed to cross-validate the qualitative data captured in the field.
During the participatory mapping exercises, several limitations also presented themselves. The first limitation was due to the scale of the 1:50,000 topographic maps that were initially brought to the field; however, this was overcome through what the researcher has deemed “MacGyver cartography” (discussed in Section 4.3.). Limitations in the mapping exercises were unique to the participatory mapping focus groups. During the Past Herder focus group, the use of the KiMaa translator further distanced the researcher from the participants, as it was common for communication to have to cross two language barriers (English to Kiswahili; Kiswahili to KiMaa). However, after several minutes of interpretation, the language barriers worked themselves out and a more even flow of communication was constructed. During the exercise, elders tended to be more comfortable sitting in front of the researcher. This proved to be a limitation as elders were not necessarily interested in interacting with the map but preferred the researcher to mark on the map for them. The researcher’s position as a middleman during the mapping exercise instates some ambiguity in the data that was collected; however after each sketch on the map, participants would be asked to judge its accuracy, which provided a way of correcting any mistakes or misrepresentations.

During the Contemporary Herder mapping exercise, opposite events transpired, which formed another limitation to this method. Participants were more than enthusiastic during the mapping exercise. Almost all 11 participants were actively engaging in the mapping exercise. Multiple dialogues during the exercise made the exercise a bit chaotic at times. To overcome this concern, three participants took the position as primary cartographers, which calmed the dialogues and interactions at the map. Lastly, the chaos
that entailed at the beginning of the mapping exercise resulted in the “misplacement” of dry-erase markers. This presented difficulties in the follow up mapping exercise at the community of Staff.

During the oral histories the main limiting factor was the language barrier. This time the language barrier did not necessarily limit communication between the researcher and the participants, but made it difficult to record the proper locations elicited during the oral histories. Many places distinguished by participants were Maa names, and since the researcher is unfamiliar with Maa, this made place names difficult to note accurately. Whenever the researcher came across a name that was uncertain, he would ask the individual to spell the place name. This provided the correct spellings of the location, which eased the difficult in acquiring the specific location of that place later on (Discussed in Chapter 4). During the collection of the Past Herder oral histories, it became difficult to fully understand the time period of the extreme event, which they were discussing. Several of the individuals could recall the specific year, but when they could not, they would discuss to the date of the event by distinguishing the age set of the children being born. This provided a means of validating the timeframe that the individual was discussing.

Further limitations that emerged from fieldwork became more apparent in latter stages of this research. These limitations continued to revolve around the language barrier but also emerged as qualitative space and time dimensions that were collected through the oral histories and contained an abundant amount of uncertainty were analyzed. In the
next chapter, Data Analysis, several of these limitations are more thoroughly explored, as well as the methods the research used to overcome them.
5.0. DATA ANALYSIS

This chapter provides an overview of the analytical methods used to analyze the data that was collected through the methods discussed in Chapter 4. Section 5.1 discusses the technique of qualitative data coding, which was performed for of the qualitative data collected. In the next section, Section 5.2, the statistical procedures used to analyze the household survey data are discussed. The approaches the research took to render the participatory maps and integrate the information into the GIS are discussed in Section 5.3. The next section, Section 5.4, details how the qualitative oral histories were transferred from the word of mouth to geo-coded, visual narratives. In doing so, this section summarizes the literature that has employed similar techniques to highlight the purpose and theoretical understandings behind using a temporally enhanced GIS. The final section, Section 5.5, thoroughly documents the procedures taken to create the space-time paths used in this research to visualize these narratives.

5.1. Qualitative Data Analysis

After the data was collected from the suite of methods employed in this mixed-methods framework, data analysis took several different phases in order to clean, organize, and examine the data that was collected. The first stage of data analysis began with the transcription and translation of all qualitative data. In the field, field notes were constantly taken, while audio recordings, photographs, and videotaping were used at participants consent. These various forms of data collection provided a means of triangulating between data sources while transcribing the exercises, interviews, and oral
histories. After all of the data was transcribed into English, coding of the data was performed in order to generate analytical categories for each data source (Emerson et al. 1995). Coding is helpful for researchers to reduce the data to a manageable portion and distill any key themes that may emerge, while also helping to organize and more thoroughly explore the collected data (Cope 2005). To code the qualitative data, *NVivo*, a computer assisted qualitative data analysis software (CAQDAS), was employed. Initially, open coding was employed to allow for all possible themes emerge from the data. Once all of the data had been open-coded, focused coding was performed to cluster various themes and manage the data for later visitation. With the assistance of a KiSwahili speaking graduate student, the audio recordings that captured the LKCCAP community workshops was transcribed into KiSwahili. Later, another KiSwahili speaking graduate student translated the workshop transcriptions into English. After this process was completed, the English versions were brought into *NVivo* and coded similarly to the other qualitative data collected.

5.2. Household Survey Data

The household survey data was transcribed and placed in EPIDATA, a freeware data analysis software, by other LKCCAP personnel. Once obtained, the 22 household surveys from Kirya were extracted from the full dataset and imported into Excel. The data was sifted through and cleaned using scanned paper copies. Using the statistical software, Statistics Package for Social Sciences (SPSS) version 17, frequency tables for all questions were created and cross-tabulations were performed when necessary.
From the household survey, data on the household’s herd compositions was collected. To understand the herd compositions in a standardized fashion, tropical livestock units (TLUs) were calculated. TLUs provide a means of quantifying a variety of different livestock types and sizes in a standardized manner to present a single figure that expresses the total amount of livestock irrespective of the specific composition (FAO, 2011). To calculate the average TLU per household for surveyed sites, livestock coefficients were based on the weights from FAOSTAT, the global statistical database compiled by FAO (Table 2).
Table 2.

Livestock unit coefficients used for international comparisons (Source: FAO 2011)

<table>
<thead>
<tr>
<th>Region</th>
<th>Cattle</th>
<th>Buffalo</th>
<th>Sheep</th>
<th>Goats</th>
<th>Pigs</th>
<th>Asses</th>
<th>Horses</th>
<th>Mules</th>
<th>Camels</th>
<th>Chickens</th>
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<td>0.7</td>
<td>0.7</td>
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<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
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<td>0.6</td>
<td>0.75</td>
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<td>0.1</td>
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<td>0.6</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Africa South of Sahara</td>
<td>0.5</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Central America</td>
<td>0.7</td>
<td>0.1</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>0.5</td>
<td>0.6</td>
<td>0.6</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>South America</td>
<td>0.7</td>
<td>0.1</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>0.65</td>
<td>0.6</td>
<td>0.6</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>0.7</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.65</td>
<td>0.6</td>
<td>0.6</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>OECD</td>
<td>0.9</td>
<td>0.7</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>0.65</td>
<td>0.6</td>
<td>0.9</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>East and South East Asia</td>
<td>0.65</td>
<td>0.7</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>0.65</td>
<td>0.6</td>
<td>0.8</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>South Asia</td>
<td>0.5</td>
<td>0.5</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.65</td>
<td>0.6</td>
<td>0.6</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Transition Markets</td>
<td>0.6</td>
<td>0.7</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>0.65</td>
<td>0.6</td>
<td>0.6</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Carribbean</td>
<td>0.6</td>
<td>0.6</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.65</td>
<td>0.6</td>
<td>0.6</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Near East</td>
<td>0.55</td>
<td>0.6</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>0.56</td>
<td>0.6</td>
<td>0.7</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.6</td>
<td>0.6</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.65</td>
<td>0.6</td>
<td>0.6</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>
The household survey probed questions about several varieties of livestock including, indigenous cattle, exotic cattle, indigenous goats, exotic goats, indigenous sheep, pigs, and chickens. The FAOSTAT livestock coefficients (Table 2) for indigenous cattle (0.5), indigenous sheep (0.1), and indigenous goats (0.1) were compiled into one tropical livestock unit. The results of this are discussed in Chapter 6.

5.3. Rendering the Participatory Maps

Data analysis for the participatory mapping exercises took several different stages. All notes, audio recordings, and video recordings that were derived from the mapping exercises were transcribed and coded in NVivo with the other qualitative data. To digitize the participatory maps that were created in the exercise, the ground points collected in the field, detailed photographs of the completed participatory maps, and the administrative village boundaries provided by URT Surveys and Mapping Division were used in conjunction. First, ground points that were obtained at each of the features on the map were imported and overlaid with the administrative boundaries. These points were then used to relate features (points, lines, and polygons) from the photographed map to the georeferenced points and boundaries. The features that were added to the map by the participants, such as grazing areas, points of interest, watering locations, and grazing routes, were then digitized using the GIS tools available in ArcMap, which is part of the ArcGIS suite of mapping and spatial analysis software from ESRI®. This established a database to manage the data. If necessary, attributes that were included in a feature were placed in the attribute table in order to maintain as much detail as possible. While visiting the Mwanga Agriculture and Livestock Extension Office, a formalized land-use plan was
photographed. Using similar techniques, the land-use plan was digitized and stored in a database. In total three maps (Past Herder focus group, Contemporary Herder focus group, and the land-use plan) were digitized.

5.4. Visualizing Oral Histories and Understanding Space-Time Analysis

Clandinin and Connelly (2000, 50) suggest that narratives “have temporal dimensions and address temporal matters; they focus on the personal and the social in a balance appropriate to the inquiry; and they occur in specific places or sequences of places.” Kwan and Ding (2008) analyze the personal narratives based on the three main elements of this passage: action and interaction (personal and social), time (past, present, future), and space (physical places and storyteller’s places).

The questions in this research pertain to human activity in the form of seasonal resource access and mobility; therefore, Kwan and Ding’s (2008) three main elements (action and interaction; time; and space) were the key components that comprised each individual oral history. These elements are of equal importance and should be preserved when geovisualizing them in a GIS. In conventional GIS applications, however, the dimension of time has been rather equivocal. The incorporation of time into GIS has become an invigorating area of research within studies of transportation and human activity, as two-dimensional representations has been extremely limited to static spatial features based on a cartographic approach that only represents snapshots of time (Peuquet 2002; Ren and Kwan 2007; Kwan and Ding 2008; Wang and Cheng 2001). Torsten Hagerstrand’s time geography was a useful analytical and representational framework to
more holistically examine the complex individual experience across both space and time (Hagerstrand 1970). Hagerstrand’s time geography conceives of the events that create an individual’s narrative as a continuous life path in three-dimensional space (Hagerstrand 1970, Kwan and Ding 2008). In these life paths (from now on called space-time paths), the dimension of time (t) is considered equal to the dimension of space (x and y), establishing a three dimensional environment (x,y,t) (Yu and Shaw 2009). Space-time paths represent what Ren and Kwan (2007, 723) call a “3D aquarium” which provide detailed information including the starting and ending time and place of an activity, the chronological order of events, and the relative location of events that occurred within a specific timeframe (Yu and Shaw 2009). Theoretically, space-time paths contain all activities performed by a person, as all activities take place at explicit spatial and temporal dimensions. In the case of this research, this means that all of the herding strategies taken from whenever the individual began his oral history are captured and geovisualized within the space-time path. However, advancements and the constant evolution of ICT, such as cellular phones and sms (Short Message System; a.k.a. text messages), break these space-time path relationships as individuals can perform now perform various activities without a physical presence (Yu and Shaw 2009). To follow up on this concept in the field, questions of the role of ICT and transportation infrastructure were asked to explore the changes that may be occurring to the space-time paths of herders. The use of what Yu and Shaw (2009) calls “virtual space” removes the constraints of human activities to being dependent upon physical space, making individuals’ space-time path more spatially and temporally efficient.
5.5. Space-Time Path Construction

To compose individual oral histories, exploratory measures had to be taken which required multiple iterations and bats of trial and error. For the purpose of this research, the creation of the space-time paths was broken into several procedures. To begin, the oral histories had to be transcribed from the audio recordings that were collected in the field. Field notes were used to triangulate whenever something became unclear. For instance, during the collection of the oral histories, place names were elicited. Once the transcriptions were complete, each oral history could be more efficiently organized to pull out the spatial and temporal dimensions. Of the 15 oral histories, two past herder oral histories were too vague to use in the database. Therefore, a total of 13 oral histories were visualized in the GIS.

Space-time paths represent physical movements of individuals and are composed of a series of stays (vertical lines) and movements (horizontal lines) between locations (Wang and Cheng 2001; Yu and Shaw 2009). In the second procedure, travel diaries recording these stays and movements between locations had to be derived from the oral histories. Travel diaries consisted of the specific drought year mentioned, the travel time, place name, notes about that specific place, and the duration occupied at that place (Figure 6).
### Interview #1

**Drought Year: 2009**

<table>
<thead>
<tr>
<th><strong>Travel Time</strong></th>
<th><strong>Place Name</strong></th>
<th><strong>Place Name Notes</strong></th>
<th><strong>Conflict Zone?</strong></th>
<th><strong>Duration at Place</strong></th>
<th><strong>Notes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>2 days</td>
<td>Kirya</td>
<td></td>
<td></td>
<td>Starting Point</td>
<td>No fodder; cows died; no food for humans</td>
</tr>
<tr>
<td></td>
<td>TPC</td>
<td>Yes</td>
<td>2 weeks</td>
<td></td>
<td>Went because of fodder; irrigation system for sugarcane was source of water; conflict with sugarcane growers</td>
</tr>
<tr>
<td>1 day</td>
<td>Kahe</td>
<td>Moshi Rural</td>
<td>2 weeks</td>
<td></td>
<td>Searching for fodder; Ruvu was the source of water</td>
</tr>
<tr>
<td>1 day</td>
<td>Mikocheni</td>
<td>In Kifaru</td>
<td>1 month</td>
<td></td>
<td>Searching for fodder; Ruvu was source of water</td>
</tr>
<tr>
<td>* 1 day</td>
<td>Kncu</td>
<td>spillway (Lang'aata)</td>
<td>1 day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 day</td>
<td>Lembeni</td>
<td>Stayed at a place called Inonuet (Nururot) (Near Staff)</td>
<td>3 weeks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 day</td>
<td>Kirya</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*D = Turning point

---

Figure 6: Example of Contemporary Herder’s Travel Diary.
Once the 13 travel diaries were created, time dimensions had to be calculated and translated into Gregorian dates in order to be later imported into the GIS. During the field, specific dates were difficult to elicit. To overcome this issue, qualitative estimation based on knowledge of the bimodal rainfall patterns of the region had to be used in order to set a specific date of departure. The chosen data was November 1, 2008. Since one of the primary interests was visualization, the missing date is not necessarily an obstacle. While providing oral histories, several individuals stated the month in which a particular event took place. This provided a way to validate the estimated dates with what was expressed in the interview. With time translated from a generalized frame (hours, days, months, etc.) to Gregorian time (i.e. November 1, 2008), each individual oral history and event within that oral history was given an identification number. These were used to organize each oral history and chronologic event (Figure 7). A database of the 13 travel diaries and their individual events were then compiled into one spreadsheet.

<table>
<thead>
<tr>
<th>Individual_ID</th>
<th>Trip_ID</th>
<th>ST_ID</th>
<th>PlaceName</th>
<th>Time (MM/DD/YYYY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001</td>
<td>1</td>
<td>100101</td>
<td>Kirya</td>
<td>11/1/2008</td>
</tr>
<tr>
<td>1001</td>
<td>2</td>
<td>100102</td>
<td>TPC</td>
<td>11/3/2008</td>
</tr>
<tr>
<td>1001</td>
<td>3</td>
<td>100103</td>
<td>Kahe</td>
<td>11/18/2008</td>
</tr>
<tr>
<td>1001</td>
<td>4</td>
<td>100104</td>
<td>Mikocheni</td>
<td>12/3/2008</td>
</tr>
<tr>
<td>1001</td>
<td>5</td>
<td>100105</td>
<td>KNCU</td>
<td>1/4/2009</td>
</tr>
<tr>
<td>1001</td>
<td>6</td>
<td>100106</td>
<td>Lembeni</td>
<td>1/6/2009</td>
</tr>
<tr>
<td>1001</td>
<td>7</td>
<td>100107</td>
<td>Kirya</td>
<td>1/28/2009</td>
</tr>
</tbody>
</table>

*Figure 7: Example of the Time Dimensions in Feature’s Attribute Table*

In the third procedure, the coordinates for each of the place names had to be collected in order to plot each individual location. Several methods were used to establish a georeferenced place name database. Using various sources (e.g. GoogleEarth, National
Geospatial Agency’s Geonames Search (GNS), literature searches, etc.), the coordinates for sites were obtained. In many cases, especially when names were derived from KiMaa, place names could not be found by such methods. For these place names, a spreadsheet with the missing data was sent to the field coordinator who had remained in Mwanga district. The field coordinator assisted by fixing misspelling and giving more detailed notes. If he did not know the name, he compiled a list and returned to Kirya to ask assistance from those who had provided oral histories. Finally, if a place name could not be found, it was approximately located using the previous and latter place names, as well as any additional notes that may indicate its location (e.g. near the Ruvu River, outside of Korogwe, etc). Once coordinates for all place names were found, the place names were plotted in ArcMap and the travel diaries were joined (Figure 8). A total of 58 different place names were plotted; however many place names were discussed more than once, both within individual oral histories and amongst the 13 total. In total, over 100 place names were discussed across the 13 oral histories.
Figure 8: Plotted Place Names Derived from the 13 Oral Histories.
Concepts of qualitative GIS were not only implemented in the production of the space-time paths, but also in the ability to query individual’s experiences. The next stage of processing involved linking the qualitative information derived from the oral history to each event. Qualitative information detailed the individual’s experience during each event and at each location. This included information about the herd’s health condition at certain times of their journey, times of resource concern or access issues, experiences with conflict, the use of transportation systems, and more. To be able to query and visually represent these experiences, by their topic, the notes had to be coded in order to standardize the experiences into specific categories. The coding of the notes was performed very similarly to the qualitative data analysis discussed earlier. However, because these codes would be used to query different experiences, a codebook had to be maintained in order to organize the codes across the entire database (Figure 9). The database could now be queried by personal experiences or place names in order to visually display or analyze specific events or experiences at a particular place across all 13 oral histories. Since the qualitative information was now georeferenced to a particular place, queries could also be performed by place name, allowing users to explore different experiences at a particular place of interest.
The next phase of database construction used the Extended Time-Geographic Framework Extension in ArcScene, the three-dimensional viewer of the ArcGIS software suite from ESRI®. The Extended Time-Geographic Framework Extension is an extension that was developed for the implementation of time geographic concepts in a space-time GIS, which consists of two-dimensional space and a one-dimensional time environment that occupies the z value. The z value normally represents elevation (Yu and Shaw 2009). Using the Extended Time-Geographic Framework user interface, the place name points and linked qualitative data were used as the input to the extension. Using the time markers for each travel diary, place names were connected in chronological order, forming a chain. This chain is then output as a single polyline, which rises along the z dimension (time) to form a space-time path for each individual oral history. This is a polylineZM feature (Figure 10).

**Figure 9**: Codebook used to organize qualitative information.
Figure 10: Contemporary Herders’ Coded Space-Time Paths (Red lines represent locations in space and time where oral histories detailed experiences of bad forage. Green lines illustrate experiences of good forage.)
This database is designed to be useful to query, analyze, visualize, and interact with the oral histories of both the past and contemporary herders. With the completion of the space-time paths in the GIS, the final step to complete the space-time database was to create a means of interacting with the oral histories. This involved linking the qualitative travel diaries back to each individual space-time path in a more aesthetically pleasing and user-friendly manner. Using Apple’s website development software, IWeb, travel diaries were turned into secure HTML webpages. Using the HTML Popup function in ArcMap and ArcScene, individual HTML travel diaries were embedded into each space-time path. Users can click on any individual space-time path and look at the herder’s travel diary in HTML format. Once complete, the qualitative spatiotemporal database included both two-dimensional (Figure 11A) and three-dimensional (Figure 11B) databases that visually represented each herder’s oral history and allowed the user to query, analyze, and interact with each individual’s experience with a past extreme climatic event. The database can be accessed from computer with the ArcGIS software suite and a stable Internet connection.
Figure 11A: Two-Dimensional Qualitative Spatiotemporal Database.
Figure 11B: Three-Dimensional Qualitative Spatiotemporal Database.
6.0. RESULTS

This chapter provides an overview of the results of this research. To begin, Section 6.1 provides an overview of the respondents’ characteristics from the household survey. This section provides a general descriptive window to go beyond the study area description to further introduce the individuals that reside within Kirya. Section 6.2 addresses the spatial and seasonal dimensions of water and grazing access in Kirya by first addressing these dimensions experienced by the Past Herders focus group. This section then explores the changes that have occurred over the past 50 years and their influence on resource access in Kirya. In doing so, Section 6.2 addresses contemporary resource access in Kirya. Through these results, Research Question 1, which addresses the spatial and seasonal distribution of resource access, is answered. In Section 6.3, the results from the household survey, community workshops, and oral histories are utilized to discuss the occurrence of past climatic events and how they have been conceived by the Maasai of Kirya. This section also reports the results of the oral histories on individual’s strategies taken during past extreme climatic events. Research question 4 is addressed in this section by illustrating the results of the spatiotemporal geovisualizations and the ability of exploring various patterns of macro-mobility.

6.1. Household Survey Respondents Characteristics

The total sample size for this research was 22 households (n = 22), however this number fluctuated depending on the amount of respondents that chose not to answer a question. The characteristics of the sample are displayed in Table 3. The composition of
each Maasai household varies and is also dependent upon how each individual respectably defines their own household. According to the household survey, the average Maasai household in Emangulai A and Emangulai B is composed of approximately 5.33 individuals (Table 3). Thirteen households identified to be headed by male household members, while nine households identified as being headed by female members.
Table 3.

*Household Demographics for Sample*

<table>
<thead>
<tr>
<th>Household Size (Individuals in Household)</th>
<th>Number of Samples n= 22</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td><strong>Min.</strong></td>
</tr>
<tr>
<td>5.33</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age Range of Household Head</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29</td>
<td>3</td>
</tr>
<tr>
<td>30-39</td>
<td>4</td>
</tr>
<tr>
<td>40-49</td>
<td>3</td>
</tr>
<tr>
<td>50-59</td>
<td>5</td>
</tr>
<tr>
<td>60+</td>
<td>4</td>
</tr>
<tr>
<td>No Response</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sex of HH Head</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>9</td>
</tr>
<tr>
<td>Male</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Head of Household Occupation</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle Herder</td>
<td>6</td>
</tr>
<tr>
<td>Farmer</td>
<td>3</td>
</tr>
<tr>
<td>Farmer and Cattle Herder</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spouse of Household Occupation</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle Herder</td>
<td>4</td>
</tr>
<tr>
<td>Farmer</td>
<td>3</td>
</tr>
<tr>
<td>Farmer and Cattle Herder</td>
<td>10</td>
</tr>
<tr>
<td>Petty Business</td>
<td>2</td>
</tr>
<tr>
<td>Student</td>
<td>1</td>
</tr>
<tr>
<td>No Response</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>*Additional Members of Household Occupation</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle Herder</td>
<td>2</td>
</tr>
<tr>
<td>Farmer</td>
<td>2</td>
</tr>
<tr>
<td>Farmer and Cattle Herder</td>
<td>19</td>
</tr>
<tr>
<td>Laborer Others</td>
<td>3</td>
</tr>
<tr>
<td>Student</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
<tr>
<td>*No Response</td>
<td>30</td>
</tr>
</tbody>
</table>

* Merged with questions accounting for 3 HH members
6.1.1. Herding and Livestock

Herding is the most commonly identified occupation for all of the households. In the results of the household survey, herding emerged in two different responses, “Cattle Herder” and “Farmer and Cattle Herder”. Eighteen of the household heads, 14 of spouses, and 22 of the additional members of the household are identified as cattle herders to some degree (Table 3). The majority of the households within the surveyed sites had various herd compositions with sheep, goats, and cattle. According to the responses from the household survey, Maasai households in Emangulai A and Emangulai B have average TLU of 8.548 (Table 4).
Table 4.

*TLU Calculations for Kirya Village, Mwanga District.*

<table>
<thead>
<tr>
<th>Livestock Type (TLU)</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indigenous Cattle (.5)</td>
<td>18</td>
<td>0.5</td>
<td>150</td>
<td>16.667</td>
<td>35.204</td>
</tr>
<tr>
<td>Indigenous Goats (.1)</td>
<td>19</td>
<td>0.4</td>
<td>40</td>
<td>5.932</td>
<td>9.992</td>
</tr>
<tr>
<td>Indigenous Sheep (.1)</td>
<td>17</td>
<td>0.3</td>
<td>10</td>
<td>2.876</td>
<td>3.022</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TLU</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>54</td>
<td>0.3</td>
<td>150</td>
<td>8.548</td>
<td>21.665</td>
</tr>
</tbody>
</table>
6.1.2. Cultivation

In Table 3, it is apparent that farming plays an important role in many Maasai households in Emangulai A and Emangulai B. Similarly to herding, farming as an occupation emerged in two responses, “Farmer” and “Farmer and Cattle Herder”. Fifteen of the household heads, 13 of spouses, and 21 of the additional members of the household are identified as one of these categories. According to the household survey, the majority of those that farm primarily cultivate maize (Table 5). During the community workshops, it was stated that those who cultivate maize use a modern seed, which they get from the Mwanga District’s Extension of the Ministry of Agriculture. It was also established that cultivation in Kirya is solely dependent on irrigation, with few if any individuals growing dryland crops such as sorghum, millet, etc. (Community Workshops 2010).

Table 5.

Cultivation Activities of the Maasai of Kirya

<table>
<thead>
<tr>
<th>Type of Crops</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>10</td>
</tr>
<tr>
<td>Maize and beans</td>
<td>2</td>
</tr>
<tr>
<td>Vegetables</td>
<td>1</td>
</tr>
<tr>
<td>No Response</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size of Plot</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between 1 and 3 acres</td>
<td>6</td>
</tr>
<tr>
<td>Between 3 and 5 acres</td>
<td>7</td>
</tr>
<tr>
<td>No Response</td>
<td>9</td>
</tr>
</tbody>
</table>

Cultivation plots in Kirya are located within the Kirya’s southern-most subvillage, Kirya. In this area, six of the respondents stated that these farm plots are between one and three acres, while seven responded that the size of their farm plots were between three and five
acres (Table 5). In several cases, individuals, including Maasai, have access to multiple plots. Six of the households in the sample had access to multiple plots. It was stated in one community workshop that several Maasai were not necessarily applying to access cultivation plots to farm, but were also using these places as areas to graze their livestock (Community Workshop 2010).

6.2. The Spatial and Seasonal Dimensions of Resource Access in Kirya

This section draws upon the results of the mixed-methodology to explore the first two research questions, which seek to understand the spatial and seasonal dimensions of watering and grazing resources for livestock in Kirya, as well as the changes that have occurred in accessing these resources over the past 50 years. First, the results of the participatory mapping and community workshops are discussed to illustrate these dimensions experienced by past herders. Next, this section highlights several major alterations that have occurred that have transformed watering and grazing access in Kirya. After reporting on these changes, this section addresses the contemporary dimensions of grazing and watering access in Kirya.

6.2.1. Past Herders Grazing and Water Access

In the time when participants of the Past Herders focus group were actively herding (between 1960-1980), the administrative boundaries of what is now Kirya, were nonexistent. Rather, several participants associated the area with the larger region of Maasailand. Participants of the Past Herder mapping exercise noted that there only
existed five non-Maasai homesteads in the area that is now Kirya subvillage. Similar to pastoral societies elsewhere, the Maasai in Kirya set aside areas as grazing reserves to be utilized depending on the shifting seasonality (Fernandez-Gimenez and Swift 2003). Wet season grazing primarily took place within a reasonable proximity to the homesteads, as indicated by Figure 12. This area spanned from the riverbanks of the Ruvu River to what was then acknowledged as an area with much higher tree density in the eastern region of now Emangulai A and Emangulai B. This area of high tree density provided the Maasai with various herbs and medicines, while also served as the boundary of the wet season grazing practices. It was inferred that the grazing area west of the forest was relatively small, but because there was such an abundance of forage available, there was no real need to graze anywhere else.

The Maasai communities in Kirya are located less than two kilometers away from the banks of the Ruvu River. It is reasonable to believe that the close proximity to the river is one of the key variables that resulted in the initial settlement in this location, as the river has been a source for human water consumption, bathing/cleaning, and livestock watering year round, especially during the wet season. Several individuals said that prior to the construction of Nyumba Ya Mungu reservoir in 1965, the river’s overall volume was much larger, however the installation of the reservoir resulted in more perennial flow. When accessing the river for livestock watering, Past Herders stated that there was not one specific location of access but that access was principally determined by the physical presence of corridors that enabled the herd to reach the river’s water. It was explained that corridors consisted of areas near the water with relatively low slopes that
were manageable by the incoming livestock, as well as areas with rather low densities of surrounding thicket and unpalatable vegetation that inhibited movement to the water. Past Herders’ wet season grazing and watering is illustrated in Figure 12.
Figure 12: Past Herder Wet Season Map.
During the dry season, herders moved away from their wet season foraging area into two different reserved locations for grazing (Figure 13). The household’s smallstock, were typically left at the homestead to graze along the banks of the Ruvu River, which was also used during this time to provide adequate water. Mature cattle herds were taken to the area known as Mlima Lemnazi. Mlima Lemnazi is an area of slightly higher elevation, which is located in the south-eastern region of what is now Emangulai A It was said that pasture around Mlima Lemnazi was not only extremely abundant but was also of high quality and favored by the cattle. Because the Maasai homesteads are located within close proximity to the Ruvu River, the river was still frequently accessed for mature cattle in the morning or late evening before or after the trips to Mlima Lemnazi. However, individuals illustrated during the participatory mapping exercise that it was possible to access water from a small gully near Mlima Lemnazi by digging down into the ground. With water access in close proximity to Mlima Lemnazi, several said they had set up temporary bomas in the area. Past Herders’ dry season grazing and watering is illustrated in Figure 13.
Figure 13: Past Herder Dry Season Map.
While discussing dry season grazing at Mlima Lemnazi, Past Herders frequently acknowledged the presence of visiting herders, most commonly arriving from neighboring areas such as Pangaro, Lembeni, Mgagao, and Kiverenge to access forage at Mlima Lemnazi (Figure 13). Individuals clarified that customary institutions arranged between these herders and the herders of Kirya provided visiting herders with access to the pasture around Mlima Lemnazi. It was said that the resources within the areas that these visiting herders were traveling from provided them with sufficient watering that allowed them to come into Kirya to graze without having to access the Ruvu River. With the assistance of the qualitative spatiotemporal database, it was later discovered that these locations (Pangaro, Lembeni, Mgagao, and Kiverenge) were frequently utilized as important hubs during several of the Past Herders’ larger-scale movements during extreme disturbances.

6.2.2. Transitions in Resource Access

Over the past five decades, access to the necessary grazing and watering resources in Kirya has changed. In this sub-section, results detailing the source of these transitions are highlighted. Subsection 6.2.2.1 discusses some of these initial changes that have come about with the in-migration of other populations seeking other livelihood practices. This resulted in the emergence of irrigated cultivation and the later conflicts of interest in resource access (Sub-section 6.2.2.2.). Change is continuing to occur in Kirya as other resources have been mobilized (Subsection 6.2.2.3.) and the formalization of land and these resources is taking place (Subsection 6.2.2.4.).
6.2.2.1. In-Migrations and Multiple Resource Users

Past Herders stated that the initial migrants mostly moved into the lowland region to fish in the Ruvu River, but began cultivating the ground shortly after (Community Workshops, 2010). With in-migrations, additional production systems placed further pressures on the resources that have been of primary importance to Maasai pastoral production, particularly the Ruvu River. Past Herders noted the first two farms, Sanapa and Selani, emerging in the sub-village of Kirya and depicted the progression of cultivation in the area, spreading north into the sub-village of Emangulai A. Today, cultivation has become a widespread livelihood practice among the non-Maasai residents and just recently, among the Maasai of Kirya. Over a period of four years (1970-1974) those who were interested in cultivating at the time constructed a traditional irrigation system to make farming more physically and economically feasible in Kirya and also to expand the area suitable for cultivation within the riverbanks of the Ruvu (Community Workshop, 2010). For three decades, those who utilized the irrigation canal relied on traditional infrastructure and design to provide water to cultivation plots. However, in 2002, a project backed by the Tanzania-Japan Food Aid Counterpart Fund (TJFACF) improved the tradition irrigation system by pouring concrete in the irrigation canals and stabilizing the intake with necessary wire fencing. Although the improvements were meant to modernize the irrigation system, making it more efficient and improving its integrity, the changes have not necessarily reduced the vulnerability of the irrigation intake to substantial physical disasters, such as floods. During one community workshop,
participants noted the results of two rainfall events that occurred in February of 2010, which damaged the intake beyond its workable threshold. At the time of fieldwork, the villagers were still in the process of restoring the intake from the damage by using stones provided by Mwanga District. Participants said that although stones had been provided, the government needs to provide tractors to arrange the stones and other tools and infrastructure because “…without tools, we can’t do anything…” (Community Workshop, 2010). The degree of vulnerability associated with the irrigation intake and its central role within the livelihood production systems of many residents has led to the perception of the area around the intake as being highly valuable by both farmers and herders in all of the communities that reside or manage some sort of livelihood production system within Kirya. During the elder’s workshop in Emangulai A, an individual suggested the importance of the intake, stating: “I think next year is likely to have hunger here because the intake is not working anymore…how are we going to fight against hunger while there is no intake for irrigation?” (Community Workshop, 2010). Through this narrative, the emphasis on the importance of the intake system is obvious. To the individuals in Emangulai A, most of who are farmers, the intake is acknowledged as the backbone of their livelihood production systems.

6.2.2.2. Conflicting Resource Interests

As it was previously highlighted, the Ruvu River has been a primary resource for livestock watering year round. However, the expansion of cultivation in Kirya has resulted in a significant reduction in the ability of the herders of Kirya to access the water
of the Ruvu. Only two corridors enable livestock access to the perennial river. One access corridor is located in the mid-western edge of Emangulai B. This access point (“Ruvu River Access Point” in Figure 16) is frequently visited by herders who reside in the community of Staff, which is located in the northern extent of Emangulai B. A thorough understanding of the reasons why herders from community of Emangulai B did not access water from this watering location remains unclear. Access at this location was omitted from almost all narratives during fieldwork, but it is assumed that a reasonable explanation exists. Therefore, this watering location cannot be followed up on completely.

The second corridor that provides access to the river has become quite a controversial location as it has not only been a corridor utilized for livestock access to the river but is also the location of the intake for the irrigation canal that feeds the cultivation zone in Kirya. When discussing the plurality of water use at the intake area, various instigators emerged depending on the occupation and identity of the individual or group who was involved in the discussion. Farmers of Emangulai A interred that when herders take cattle to water in the area around the intake, damage to the irrigation canals and the trampling of cultivation plots are a frequent result. When asked about the conflicts that are occurring in the area around the intake, one key informant, a resident and farmer of the subvillage of Kirya, said “…when the herders are going down there with their cows, you know what happens? They break the irrigation canals and get into other peoples farms” (Key Informant Interview 2010). When discussing these issues with herders, a different story is received, which places more emphasis on the expansion on cultivation
in areas of prime livestock importance. During the Past Herder participatory mapping exercise, one participant stated:

“It is not easy for cows to go down there [the river] and get water. This has resulted in a lot of conflict between farmers and herders and then in those days it was very easy because when they go for watering the cows. It was possible to find green pastures at the riverbank but nowadays, they cannot do that. They are now fined heavily if their cow eats someone’s crops. Then they go to the village office or court and they have to pay for their cows”. (Past Herder Participatory Mapping Exercise, 2010)

As this narrative positions land-use practices at the center of the emerging conflict, individuals acknowledged that the tensions emerging around the intake were not necessarily between herders and farmers, as many farmers saw themselves as cattle herders and many herders now considered themselves farmers. Many individuals actually stated that the conflicts that were emerging were due to the agents of each production systems, the farm plot and the livestock. In the field, this relationship became apparent when an injured donkey was stumbled upon while walking within the intake area. When asked what occurred that put the donkey in this state, it was asserted that the donkey had wandered into a farmer’s cultivated plot. As a means to teach the herder who managed the donkey a lesson, the farmer occupying the plot cut the hoof off of the donkey,
debilitating the donkey and leaving it extremely susceptible to nearby crocodiles (Figure 14).

Figure 14: The Results of Conflicting Interests in Resource Access.

6.2.2.3. Mitigating Conflict and Securing Irrigation

In response to the escalating pressures around the area that has served as both a livestock corridor and the irrigation intake, such as just illustrated in the previous example, the Kirya Village Council sought means of mitigating the growing conflict. The sedentary nature of cultivation and the mobile characteristics of livestock resulted in an alternative solution that would reduce herder’s need to access the Ruvu River. With the assistance of the Ministry of Agriculture and Food Security and the Ministry of Water and Livestock Development, a livestock reservoir was dug in 2007. The reservoir, or what was frequently referred to as the Lambo or Bwawa la Kokoto (Gravel Dam), is a
human-dug pool that is 28,139.77 m.$^2$ and has a capacity of approximately 79 million liters of water. While observing in the field, it was quickly recognized that the structure is rain-fed with no flow of water entering or exiting. The installment of the reservoir served a primary purpose of livestock watering during the dry season, however during fieldwork additional uses, such as personal bathing and using jerry cans and donkeys to carry water with them as they departed from the reservoir were observed.

With the installation of the reservoir, the village council enacted one major stipulation that has greatly impacted water access among the herders of Kirya. The herders were no longer allowed to access the Ruvu for livestock, as the village council deemed livestock watering at the river prohibited. If conflicts continued to occur, herd owners were now subject to consequences in the form of monetary fines paid to the village council or livestock confiscation until payments can be made.

6.2.2.4 Formalization of Land-Use

During a discussion with several key informants, it was revealed that a formal land-use plan had been drafted with collaboration between the Mwanga District Council and the Kirya Village Council. When followed up with several members of the Kirya Village Council, it was noted that the plan was drafted in 2007 in response to the conflicts that were occurring around the River. In Figure 15, it is illustrated that the land-use plan categorizes the land of Kirya into several zones including: Forest, Homes/Residential, Pasture, Cultivation and Reserved Land. In addition to the zoning, the land-use plan illustrates the expansion of the cultivation zone along the entire span of
the Ruvu riverbanks that lie within the Kirya village boundary. The interview with the
council members revealed that the implementation of another irrigation system was part
of the plan, which would provide water from the Ruvu to the northern extension of the
cultivation zone (Land-Use Plan Interview, 2010). During a tour of the farm plots located
within the current cultivation zone of Kirya subvillage, a member of the village council
explained the expansion of the cultivation zone beyond its current eastern boundary to
eventually be bounded by the Ruvu and the road. The formal plan also indicates the
addition of several infrastructure developments that specifically target herding
livelihoods. Of these developments, two rain-fed livestock reservoirs located in areas
called “Laboo” and “Ngoto”, as well as one cattle dip, or *josho*, are in the plan (Land-Use
Plan Interview, 2010). As of the time of fieldwork, none of the additional infrastructures
had been constructed.
Figure 15: Kirya’s Proposed Land-Use Plan.
At the time of fieldwork, zoning was being executed, but the plan’s full implementation was waiting on bylaw endorsement by Mwanga district headquarters. Of these bylaws, one shifted livestock access at the Ruvu River from being “prohibited” to being deemed “illegal”. When asked about the future village concerns with the land-use plan, one council member said “We are not afraid of the affects in the future, because we will have bylaws. If you have bylaws and you break the bylaws, then the law will act on your side.” (Land-Use Plan Interview, 2010). When asked how the land-use plan and bylaws will be followed in times of drought, the village council members stated that because of the additional infrastructure being implemented, the bylaw deeming livestock access at the river illegal will be maintained. Additionally, it was discussed that educational plans will be enacted that will seek to educate the Maasai to reduce their livestock herds (Land-Use Plan Interview, 2010). This educational system was only briefly mentioned during the single interview and not further expressed.

6.2.3. Contemporary Herder’s Watering and Grazing

The changes documented above, as well as numerous other factors originating across multiple scales have transitioned resource access in Kirya to what it is today. In the wet season, the pasture of Emangulai B is generally utilized, reserving the forage surrounding the livestock reservoir in Emangulai A for dry season grazing. When comparing the Contemporary Herders’ wet season participatory map (Figure 16) with the past herder’s wet season participatory map (Figure 12), it is apparent that a large portion of the wet season reserve for past herders has remained intact in today’s grazing schemes.
Figure 16: Contemporary Herder Wet Season Map.
During the Past Herder mapping exercise, participants illustrated that the area that contained the high tree density and acted as an important boundary for the wet season grazing reserve has demised due to increased use of the forest resources for charcoal production. Several participants said that because the tree density has immensely reduced, herders are now going much farther into and beyond the eastern region of Emanguali B in search of forage. During the wet season, a gully containing two small pools, which were referred to as Malambo Madogo (Little Lambos) becomes a seasonal location of water access. These pools provide herders with a location near the wet season forage to water livestock before and after accessing wet season pasture. Several herders also stated that the livestock reservoir is a very favorable wet season watering location because it is within relative proximity to the households. However, it was said that grazing around its parameter is generally reserved for dry season grazing.

The pasture in Emanguali B, which predominantly goes ungrazed during the wet season, is eventually opened back up for dry season grazing. With access to the river for livestock watering prohibited and the seasonal drying up of the seasonal pools, livestock water access in Kirya is solely dependent on the livestock reservoir during the dry season (Figure 17).
Figure 17: Contemporary Herder Dry Season Map.
Of the seven semi-structured interviews conducted at the livestock reservoir, all noted frequent use of the livestock reservoir on a weekly basis (Table 6). The use of the reservoir fluctuates on a daily basis. During fieldwork, which occurred during the dry season prior to the short rains (vuli), observations at the reservoir indicated that its use is variable on a daily basis. In the morning, use of the reservoir is sporadic with several herds wandering in from time to time. Around noon, water access quickly picked up with herders arriving at the reservoir from all directions. Analysis of the reservoir users is complicated by the fact that herders may alternate the days in which they are watering their herds, and even these grazing strategies may fluctuate depending on seasonality and changing forage considerations (Table 6).

Table 6

Frequency of Reservoir Use by Respondents

<table>
<thead>
<tr>
<th>Herder</th>
<th>Resident</th>
<th>Use of Reservoir Per Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>* Kirya</td>
<td>7 Days</td>
</tr>
<tr>
<td>2</td>
<td>Emangulai B</td>
<td>7 Days</td>
</tr>
<tr>
<td>3</td>
<td>Emangulai A</td>
<td>4 Days</td>
</tr>
<tr>
<td>4</td>
<td>* Kirya</td>
<td>6 Days</td>
</tr>
<tr>
<td>5</td>
<td>* Kirya</td>
<td>2 Days</td>
</tr>
<tr>
<td>6</td>
<td>Emangulai A</td>
<td>2 – 3 Days</td>
</tr>
<tr>
<td>7</td>
<td>Pangaro</td>
<td>3 Days</td>
</tr>
</tbody>
</table>

* Unclear of the administration level in reference

As illustrated in Table 6, the reservoir is an important livestock watering location for the herders in Kirya and is visited very frequently. When asked how much time is spent watering at the reservoir per day, the typical answer ranged between 20-30 minutes. The
time and frequency of the reservoir is also dependent upon the composition of the herd. Many herders identified that they still took some smallstock to the Ruvu because it is the closest source to their homesteads, but all mature cattle herds are taken to the reservoir. However, it was declared that even the smallstock that are taken to the Ruvu must be managed with extreme caution and that adults must accompany young herders if attempting to access water from the river. While observing at the reservoir, large herds of sheep and goats were frequently brought to the source of water by young herders.

When asked why each individual uses the livestock reservoir for watering purposes, four of the seven respondents thought that it is a decent source of water and relatively close to grazing land during the dry season. One herder said:

“Other places are very far and this gives the cows a lot of suffering because they are walking very far places…it is easier to graze cattle [at the reservoir] because the lambo [reservoir] is located in the grazing land. So cattle are not walking great distances.” (Reservoir Interview, 2010)

Another respondent said that his main reason for going to the reservoir is that it is the sole place they can access water because of the cultivation that has emerged around the river.

Being the sole watering location during the dry season, herders also acknowledged a number of critical concerns. Several individuals said that because the reservoir has become the only socially and politically acceptable location of livestock
watering during the dry season, almost every herder is accessing the reservoir. One herder stated, “The lambo [livestock reservoir] is a very bad place because the lambo [livestock reservoir] water is very dirty. The water does not move and it is contaminated by cow excretion and urine” (Reservoir Interview, 2010), while another said “…the lambo [livestock reservoir] is very contaminated because of different groups of cows and even some cows are sick from other places” (Reservoir Interview, 2010). In the dry season, this results in very stagnant water conditions, which are only mixed by the livestock that enter during watering. Figure 18 illustrates the quality of the water of the reservoir during the time of fieldwork. On its far ends, dense aquatic vegetation blocks livestock from access. Because there is no interaction with the water of these areas, various forms of algae congregate. Cases as such are common in places with prolonged periods of little to no rainfall frequent contamination with animal feces, such as the case of the reservoir of Kirya. In addition to the concern for the presence of livestock diseases, these types of conditions are also a breeding ground for mosquitoes that transmit diseases such as malaria.
6.2.3.1. Regulation of the Reservoir

In addition to the physical concerns that are arising with the quality changes of the livestock reservoir, sociopolitical adjustments are furthering the difficulty of balancing the benefits of the reservoir with its adverse characteristics. Up until the time of fieldwork, accessing the reservoir was free of charge and purely dependent on the herder’s preferences, the local grazing quantities and qualities, and the physical presence of potable water. During the time of fieldwork, however, a barbed wire fence spanning the entire parameter of the reservoir was erected and managed by the Kirya Village Council. The fence stands approximately 10 meters from the water’s edge (Figure 18). During the time of the first observations at the reservoir (July 15, 2010), fence posts had been piled on the ground around and several postholes had been dug. At the time of the
second visit (August 02, 2010), many of the fence posts had been placed upright in the ground, yet still lacking their support structures. By the last day of observations (August 22, 2010) these ±7 foot tall fence posts were completely erected and joined by five strands of barbed wire gapped approximately a foot and a half apart (Figure 19). At a later follow-up interview with a village council informant, the individual brought to the attention that visiting herders are traveling from distant locations, such as Pangaro, to access the reservoir. While discussing the fence with another village council key informant, it was suggested that all users should pay for access because it is “hard to tell the difference between Maasai from here [Kirya] from others” (Key Informant, 2010). With the construction of the fence, a regulation system will be put in place to collect payment for accessing the reservoir. It was recommended by one key informant that regulation will either be in the form of payment per herder, regardless of the herd size, or payment per head of livestock. The same key informant suggested that the latter is more likely, as group herding would be an easy way around the first alternative form of regulation.

Figure 19: Progression of the Fence around Livestock Reservoir
6.2.3.2. Perennial Flows: Now a Safety Net?

While the seasonally fluctuating reservoir provides numerous benefits such as its primary purpose serving the livestock keepers; its proximity to grazing land; and its accessibility, the drawbacks experienced during the dry season shroud the reservoir with skepticism. This feeling of doubt was matched in 2009 as the failure of the rains resulted in the structure completely drying out. Even with the recently formulated bylaws that criminalize access to the River, many individuals stated that with the drying of the reservoir, they returned to the irrigation intake area of the Ruvu River. The bylaws drafted with the land-use plan were still delayed in the Mwanga District headquarters; therefore, they were not completely enforced. To manage the impact of the dried livestock reservoir, the Kirya Village Council admitted access to the Ruvu River for herders.

When asked how they would react to future extreme events that may result in the drying up of the livestock reservoir, many herders had no contentions about returning to the intake area, even with the ever-evolving restrictions on the area. One herder said that he “would suffer to get water because it is not easy to go to the Ruvu River due to farming activities” (Reservoir Interview, 2010). While discussing individual drought experiences, almost all 15 individuals (both Past and Contemporary Herders) said that it was the reduction of forage that drove them to leave the boundaries of Kirya, not a lack of water. Even during extremely dry periods, the Ruvu River is reliable. While discussing future drying events, one contemporary herder said: “I have to go to the Ruvu, because life entails a lot of uncertainties, so the only certainty is that the Ruvu is flowing at all
time” (Reservoir Interview, 2010). Therefore, during the drought of 2008-2009, the dependence on the Ruvu had not subsided, even though restrictions were beyond the formulating stage but yet entirely enforced. The opening up of access Ruvu became a buffer for the herders to continue grazing in the dryland reserves until it was necessary to seek resources elsewhere.

6.3. Extreme Climatic Events and Patterns of Macro-Mobility

The previous section highlighted the spatial and seasonal dimensions of water and grazing access among herders in Kirya, as well as major changes that have occurred over the past 50 years. This section mostly focused on the local scale and was situated within a relatively circulative temporal scale, revolving between dry season and wet season. However, the occurrences of large-scale disturbances such as droughts and livestock disease were frequently discussed in the field. In fact, of the households that responded to the household survey, 95.2% perceived drought and livestock diseases as occurring very often. Additionally, 86.4% perceived the invasion of pests and 54.5% perceived strong wind events occur very often. Interestingly enough however, 72.7% perceived the occurrence of floods is very rare, or in fact, never occur (Table 7).
Table 7.

*Household Perceptions of the Frequencies of Large-Scale Disturbances*

<table>
<thead>
<tr>
<th>Occurrence</th>
<th>Frequency</th>
<th>Percent</th>
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</tr>
<tr>
<td></td>
<td>very often</td>
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<th>Occurrence of</th>
<th>Frequency</th>
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<tr>
<td>drought</td>
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</tr>
<tr>
<td></td>
<td>never happened</td>
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<td></td>
<td>very often</td>
<td>5</td>
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<table>
<thead>
<tr>
<th>Occurrence of floods</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>few occasions</td>
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<td>4.5</td>
</tr>
<tr>
<td>moderate occasions</td>
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<td>72.7</td>
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<tr>
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<thead>
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<th>Occurrence of pest invasion</th>
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<th>Percent</th>
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<table>
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<tr>
<th>Occurrence of crop and animal disease</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>few occasions</td>
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<td>4.5</td>
</tr>
<tr>
<td>very often</td>
<td>21</td>
<td>95.5</td>
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<table>
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<th>Occurrence of strong winds</th>
<th>Frequency</th>
<th>Percent</th>
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<tbody>
<tr>
<td>few occasions</td>
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<td>40.9</td>
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<tr>
<td>moderate occasions</td>
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<tr>
<td>very often</td>
<td>12</td>
<td>54.5</td>
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This section reports on conceptions and experiences with these events collected through several of the methods of the mixed-methodology including the community workshops, household survey, and oral histories. As a means of visualizing individual responses to these events, this section also illustrates the results of the final research question, which seeks to understand what benefits might accrue from the representation of narratives in a temporally enhanced GIS.

6.3.1. Extreme Climatic Event Timeline

During the elder’s community workshop with the Maasai of Emangulai B, several major climatic events were discussed in-depth including the droughts of 1974, 2000, 2005, and 2008-2009, as well as major rainfall events, including a flood in 1988 and the 1998 El Niño (Figure 20).
In Figure 20, the severity markers indicate that participants conceive of the drought of 1974 and 2009 to be the most severe. Participants stated that in 1974, the government supplied residents of Kirya with maize and beans. During a similar workshop with elders of Emangulai A, participants said that bananas were also provided to residents of Kirya, which led to the labeling of the drought as “Njaa ya Ndizi” (Banana Hunger) (Community Workshops, 2010). Even with the assistance of the government, it was stated that many cattle died.

An oral history provided by one participant of the Past Herder focus group captured the responses taken during “Njaa ya Ndizi” (Past Herder 2). The individual
stated that in 1974, both the short rains (*vuli*) and long rains (*masika*) had failed, resulting in the drought. Because of the condition of their cattle, the Maasai were given powdered milk in addition to the maize and beans provided by the government. He said that the forage within Kirya had eventually exhausted, which led to the decision to seek sufficient pasture elsewhere. The individual left Kirya traveling over a Euclidean distance of approximately 104 kilometers over a course of nearly five months. After searching for resources, he returned to Kirya, even though the rains had yet to return. This entire oral history is captured within the qualitative spatiotemporal database and is illustrated in Appendix A.

6.3.2. Comparisons of Drought Severity Over the Past 10 Years

Table 8 highlights household comparisons between the droughts of 2000, 2005, and 2008-2009. The table indicates that both the drought of 2000 and 2005 are perceived as moderately severe, while 86.4% of the households perceived the drought of 2008-2009 most severe.
When comparing Table 8 to Figure 20, the narratives line up. During the community workshop, participants noted that from the 1974 event onwards, the impacts of the droughts have become less severe, except for the most recent drought of 2008-2009. The data collected the household survey, also indicates that the drought of 2009 is considered most severe (Table 8). During the community workshop, participants highlighted several transitions that have occurred between each extreme event that mitigated some of the impacts of the drought event. For instance, participants stated that in 2005, many households turned towards casual labor to continue to provide sufficient financial capital. It was said that many men and women were collecting firewood from the local forests to

Table 8.


<table>
<thead>
<tr>
<th></th>
<th>2000 Drought</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 drought compared to 2005 and 2008</td>
<td>Least Severe</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Moderately Severe</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Most Severe</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No Response</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2005 Drought</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005 drought compared to 2000 and 2008</td>
<td>Least Severe</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Moderately Severe</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Most Severe</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No Response</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2008-2009 Drought</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-2009 drought compared to 2000 and 2005</td>
<td>Least Severe</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Moderately Severe</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Most Severe</td>
<td>19</td>
</tr>
</tbody>
</table>
sell alongside of the roadway. Additionally, households were using local markets to sell healthier cattle to maintain subsistence. Participants acknowledged diversification into cultivation as the primary coping mechanism utilized by households to meet subsistence and reduce concerns of food security during the drought of 2008-2009. While discussing past climatic events, participants seemed to gauge the severity of each drought event by the amount of human suffering and the overall losses of livestock. Therefore, as the quantitative data reveals an overall agreement that the drought of 2008-2009 was the most prolonged and resulted in high rates of cattle losses, when conceptualizing the human suffering component of the equation, it was acknowledged that having multiple coping strategies reduced the overall human suffering.

6.3.3. Changes in Transportation Infrastructure and Communication

When discussing the drought of 1974, individuals frequently placed the event within the context of the more recent drought events. In doing so, it was frequently mentioned that the drought of 1974 was most severe because of the lack of infrastructure that existed. It was stated that beginning with the drought of 1997, lorries or trucks, were used to transport cattle to more distant locations to accommodate changes in watering and grazing (Research Question 3). Sixteen responding households perceived changes in transportation over the past ten years. Of the households that responded, six noted that transportation is now abundant, while only three actually consider these changes to be actually increasing the quality of transport. Another three considered transportation still scarce. The frequency of responses is shown in Table 9.
Participants also frequently noted the role of cell phones in these strategies as well. According to the household survey, sixteen households reported an increase in communication technologies (Table 10). Of these households, six households noted communication technologies have become more abundant, while an additional six noted that the quality has increased.
6.4. Oral Histories: A Window to the Past or to the Future?

A total of 15 oral histories were collected that explore individual experiences with extreme disturbances that drove the herders to seek resources elsewhere. These oral histories provided a snapshot of past decision-making and the coping strategies taken during extreme events. In all 15 oral histories, herders had expanded their local grazing and watering orbits to seek resources elsewhere. When asked what variables drove the decision to move, all 15 oral histories said that it was the demise of forage that drove them outward, and that water was never a major concern because the Ruvu River was continually flowing. Figure(s) 22A and 22B illustrate the geovisualized patterns of macro-mobility.

<table>
<thead>
<tr>
<th>Change in telephone communication in past 10 years</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>16</td>
</tr>
<tr>
<td>No Response</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What Changes?</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abundant</td>
<td>6</td>
</tr>
<tr>
<td>High Costs</td>
<td>2</td>
</tr>
<tr>
<td>Quality has Increased</td>
<td>6</td>
</tr>
<tr>
<td>Scarce</td>
<td>1</td>
</tr>
<tr>
<td>No Response</td>
<td>7</td>
</tr>
</tbody>
</table>
Figure 21A: Geovisualization of the Macro-Mobility Patterns of Contemporary Herders.
Although it is problematic to quantify data that is derived from knowledge about past experiences, especially with such a low sample size, the quantification provides a
means of describing the experiences of macro-mobility over a temporal scale in addition to the geovisualization products. Across the 13 oral histories that could be visualized, a total Euclidean distance of approximately 6,110 km. was referenced. Table 11 illustrates the descriptive statistics for both the spatial and temporal dimensions of each of the individual scales of macro-mobility collected through the 13 oral histories.

Table 11.

Characteristics of Past and Contemporary Herder Oral Histories

<table>
<thead>
<tr>
<th>Past Herders</th>
<th>Distance (km)</th>
<th>Time (day)</th>
<th>Velocity (km/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>178</td>
<td>376</td>
<td>0.47</td>
</tr>
<tr>
<td>2</td>
<td>104</td>
<td>135</td>
<td>0.77</td>
</tr>
<tr>
<td>3</td>
<td>78</td>
<td>5485</td>
<td>0.01</td>
</tr>
<tr>
<td>4</td>
<td>136</td>
<td>109</td>
<td>1.25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>496</strong></td>
<td><strong>6105</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>124</strong></td>
<td><strong>1526.25</strong></td>
<td><strong>0.63</strong></td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td><strong>43.11</strong></td>
<td><strong>2641.9</strong></td>
<td><strong>0.52</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contemporary Herder</th>
<th>Distance (km)</th>
<th>Time (day)</th>
<th>Velocity (km/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>386</td>
<td>87</td>
<td>4.44</td>
</tr>
<tr>
<td>2</td>
<td>85</td>
<td>310</td>
<td>0.27</td>
</tr>
<tr>
<td>3</td>
<td>400</td>
<td>169</td>
<td>2.37</td>
</tr>
<tr>
<td>4</td>
<td>552</td>
<td>285</td>
<td>1.94</td>
</tr>
<tr>
<td>5</td>
<td>1373</td>
<td>494</td>
<td>2.78</td>
</tr>
<tr>
<td>6</td>
<td>341</td>
<td>396</td>
<td>0.86</td>
</tr>
<tr>
<td>7</td>
<td>1369</td>
<td>542</td>
<td>2.53</td>
</tr>
<tr>
<td>8</td>
<td>866</td>
<td>554</td>
<td>1.56</td>
</tr>
<tr>
<td>9</td>
<td>242</td>
<td>251</td>
<td>0.96</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5614</strong></td>
<td><strong>3088</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>623.78</strong></td>
<td><strong>343.11</strong></td>
<td><strong>1.97</strong></td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td><strong>474.75</strong></td>
<td><strong>165.25</strong></td>
<td><strong>1.25</strong></td>
</tr>
</tbody>
</table>

* Days are representative of months standardized to 30 days
The collected Past Herders’ experiences range from traveling a Euclidian distance of 78-178 km. over a duration ranging from 109-5485 days. Past Herder 4’s duration of travel (5,485 days) represents the experience he discussed in the oral history, which was a long-term migration with his livestock out of Kirya for 15 years due to a windstorm that occurred in the 1960s. Although this oral history exceeds what may conform to the definition of macro-mobility, to the individual it was equated as a similar experience as the others, and therefore must remain included. Overall, the spatial dimensions of the various Past Herders’ experiences have a mean Euclidean distance of 124 km. with a standard deviation of 37.11 km. The temporal dimensions of these experiences have a mean of approximately 1,526.25 days with a standard deviation of 2,641.90 days. The experience of Herder 4 was an exceptional experience that significantly influences the measure. When Herder 4 is removed from the calculation, the mean Euclidean distance drops to 139.33 km. with a standard deviation of 37.11 km., while the mean duration drops to 206.67 days with a standard deviation of 147.22 (Table 11).

Across the nine Contemporary Herders’ oral histories, the Euclidean distance traveled during the 2008-2009 drought ranged from 85-1,373 km. over a duration ranging from 87-554 days. Overall, the spatial dimensions of these experiences have a mean Euclidean distance of 623.78 km. with a standard deviation of 474.74 km. The temporal dimensions of these experiences have a mean of 343.11 days with a standard deviation of 165.25 days (Table 11).

In addition to the descriptive statistics calculated for the oral histories, velocity was calculated to assess the difference in the rate of change between the Past and
Contemporary Herder focus groups. This measure was calculated using the simple formula:

$$V = \frac{\Delta d}{\Delta t}$$

The average velocity of Past Herders was .63 km./day. When removing Herder 4 from the measure, the velocity of the three remaining Past Herders is .83 km./day. The Contemporary Herders’ mean velocity is 1.97 km./day (Table 11).

Again, the purpose of quantifying the oral histories and presenting them in statistical form is similar to the purpose of the geovisualization and map productions, which is to provide alternative means of visualizing and exploring oral histories. With the construction of the qualitative spatiotemporal database, all qualitative oral histories have been maintained and are interactive with the user, providing the most effective means of maintaining the individuality of each experience.
7.0. THE SHIFTING DIMENSIONS OF RESOURCE ACCESS AND PASTORAL MOBILITY

Many of the changes that have occurred to resource access within Kirya have resulted in some form of manipulation of the biophysical (more sporadic rainfall events), while they have also been a product and driver of dynamic sociopolitical transformations (land tenure change). The coupling of these two subsystems is what constructs the complex human-environment system; therefore, to understand the interaction between PLE in Kirya, these subsystems must be approached in parallel (Turner and Robbins 2008). This chapter presents these subsystems in parallel to discuss the findings of this research and associate them with recent literature detailing changes in resource access and pastoral mobility. Section 7.1 discusses what is occurring to resource access within the confines of Kirya and how this is constricting the mobility patterns of the herders and livestock herds. To do so, two forms of landscape fragmentation that are occurring on the ground in Kirya are discussed. In Section 7.2, changes in adaptation responses to extreme climatic events are highlighted to discuss how the patterns of macro-mobility are expanding. These adaptation responses are not even; therefore Section 7.3 elicits the idea that socioeconomic stratification that needs to be considered when thinking about these adaptation strategies.

7.1. The Constriction of Micro-Mobility Patterns

In Kirya, landscape fragmentation and an overall reduction in the ability to access resources have resulted in the constriction of mobility patterns of the Maasai.
Constricting mobility patterns have major consequences for those who maintain pastoral livelihoods. These concerns are placing those who continue to rely on mobility, such as the Maasai of Kirya, in a less secure state to cope with the spatial and temporal variability, especially under increased climate variability (Campbell 1999).

In parts of Kirya, especially around primary watering locations, both decoupling and dissection concepts of fragmentation (Section 2.2.2.1, p. 51) presented themselves through the data that was collected, which have and continue to inhibit resource access. The concept of decoupling is apparent with regards to herd access to the Ruvu River. This has occurred as a creeping process that started with the irrigation zone and the expansion of the cultivation zone and has continued to propagate as increased security measures are taken. Dissection of the landscape has more recently presented itself around the livestock reservoir in Kirya. This is the result of misguided measures taken to counteract quality concerns that are assumed to be stemming from over-exploitation of the resource rather than the defining of the need for implementation from the beginning. The emblem of this form of fragmentation is the barbed-wire fence that was erected in 2010.

7.1.1. A (De)Coupled System

Burnsilver et al. (2008) found that in Kajiado district, Kenya, the subdivision of group ranches was a leading source of fragmentation as herders were confined to progressively smaller land areas with limited ecological heterogeneity. In their study areas, they found that the limited mobility caused from transitions in land tenure and the
subdivision process drove many households to diversify their livelihood activities and intensify livestock production strategies; thus, become more sedentary. In their study, the two factors, subdivision and sedentarization, are both provocateurs and products of one another, which have worked in parallel to greatly inhibit pastoral mobility and resource access. In the case of Kirya, the expansion of crop cultivation and protection of the Ruvu River are the primary hinderers of resource access. An understanding in the ways in which the Maasai of Kirya have diversified their livelihood practices was not fully captured, but over half of the households associated their household livelihood practice with some form of farming. Judging by the recent history of resource access in Kirya, it is assumed that the pressures on resource access are one of many factors that have driven the Maasai of Kirya to seek alternative sources of production through cultivation practices. Similarly to Burnsilver et al. (2008), this has progressed resource access concerns in the sense that these transitions are placing additional emphasis on the security of the cultivation zone.

In Kirya, the expansion of cultivation into critical pastoral dry and wet season watering and grazing zones eventually reduced the spatially and temporally viable livestock corridors to the river, which resulted in increased adverse interactions between livestock and cultivation plots. The social, economic, and political tension that emerged around the Ruvu River, particularly around the irrigation intake drove the Kirya Village Council to seek solutions to mitigate the concerns and protect cultivation from the now-perceived adversary, the “encroaching herder”. This perception coincides strongly with historical connotations of the Maasai that have persisted over time and continue to
socially and politically marginalize the Maasai (Hodgson 1999; Hodgson 2001). The continuation of these colonial-constructs facilitated the need to deal with the “encroaching herder” and to secure the area of around the Ruvu by installing the livestock reservoir. This process reduced the connectivity that was important for herds.

7.1.1.1. The Preservation of Social Connectivity

Creeping sociopolitical processes first led to a loss in connectivity to the Ruvu, but these processes did not erode the connectivity entirely. The sustained connectivity is identifiable as regulations at the river were lifted with the failure of the rains of 2008. The re-connectivity that emerged in the 2008-2009 drought eased pressures on herding households, as water resources were accessible at the Ruvu River again. The accessibility of the Ruvu River became a buffer for the Maasai of Kirya, providing households with the ability to continue grazing livestock within their dry season reserves until the necessary decisions were made to seek resources elsewhere.

The full implementation of the formal land-use plan is likely to have serious implications on sustaining social connectivity to pastoral resource areas in Kirya. The bylaws in place that criminalize livestock access to the Ruvu River during the entire year are likely to be enforced in times of drought; therefore, the social buffer that provided herders with necessary access to minimize the impact of the drought of 2008-2009 is likely to erode entirely. Flexible social systems have become more rigid in Kirya, which can be acknowledged as both physical and social connectivity to the Ruvu River continues to become more fragmented with time and persisting government policies that
7.1.2. Dissection of the Landscape

The installation of the reservoir was the initial means in which the Kirya Village Council found it appropriate to mitigate conflicting interests, and, as discussed above, to protect the sensitive area around the Ruvu for irrigated cultivation. The recent regulation of the resource in the form of the barbed-wire fence has resulted in the second form of fragmentation mentioned by Hobbs et al. (2008), which is the dissection of the landscape. As noted in Chapter 2, the dissection of the landscape is frequently in reference to the use of barriers in order to control access to more spatially extensive resources; however, in the case of Kirya, the fence has been erected as a means of protecting a much less spatially extensive resource, but one of equal or greater importance to the Maasai of Kirya, the only dry season watering location. Regardless of whether a barrier is set in place with the intention of prohibiting grazing land or prohibiting water access, the purpose and outcome is the same, which is to regulate access to a specific resource, and thus, hinder resource access for those may rely on that resource (Hobbs and Boone 2004).

7.1.2.1. Erecting a Fence and “Blaming the Victim”

The decisions that led to a regulation system around the reservoir were in fact intended to reduce the quality issues that had been emerging during the dry season. To combat these quality issues, the village council and extension offices had to first
determine the factors that were reducing the quality of the reservoir in the first place. Using the same logic as USAID during MLRMP (Chapter 3)(Hodgson 1999; Homewood and Rogers 1991) and numerous other pastoral development projects, the village council and extension officers determined that the most obvious driver of water degradation was the users of the livestock reservoir, which are dominantly the Maasai of Kirya and the secondary users of outside locations. In this view, it was the lack of proper ecological knowledge and the poor livestock management practices on the behalf of the reservoir users that has led to the consistent destruction of the reservoir during the dry season. These quality issues did not go unrecognized by the herders. In fact, individuals frequently voiced concern that it was the location and flow (or lack there of) of the livestock reservoir mixed with its dependence from all herders in the dry season that had resulted in the poor conditions of the reservoir. These opposing dialogs of degradation had poor if not complete absence of communication in the proper mitigation efforts, which in turn has ensued improper management. To the reservoir users, it is assumed that the upkeep of the reservoir is in the hands of the formal institutions (Kirya Village Council and extension offices) that had initially implemented the reservoir. Since there has been little involvement with these institutions, the problems seem to stem from the absence of institutional support in management. This has been the case of many livestock-oriented water development projects in Africa (Homewood and Rogers 1991; Sandford 1983). To these institutions, however, quality concerns are a result of over-exploitation from the reservoir users. Therefore, it is assumed that the most straightforward and least capital-intensive way to mitigate these concerns is to control
access through the use of formal regulation. In many pastoral development schemes, similar to this, these outcomes of misaligned accusations have increased skepticism on the behave of the pastoralists, as intervention after interventions fail due to the lack of upkeep of the infrastructure and the departure of the extension aid (Homewood and Rogers 1991).

7.1.2.2. The Predetermined Outcomes of the Livestock Reservoir

In the case of Kirya, it is not necessarily just a lack of communication or misguided management of the livestock reservoir that has resulted in the concerns, but similarly to Hodgson’s (1999) theory of the issues that impeded in MLRMP’s ability to reach any of their goals, the concerns that are now faced at the reservoir stem from the formation of the plan and the implementation of the livestock reservoir in the first place. With this in mind, it is reasonable to state that in contemporary “pastoral development” projects, even as small-scale as the livestock reservoir in Kirya, the subtleties of Leach and Mearns’ (1996) “received wisdom” still resonate and continue to obscure the plurality of other possible understandings of environmental change (Bassett and Zueli 2003; Blaikie and Brookfield 1987; Fairhead and Leach 1996).

Several different factors emerged in and around the livestock reservoir that point to this argument. To begin with, the implementation of livestock reservoir did not spawn out of interests to build the capacity of pastoral livelihoods in the region. As previously stated, the livestock reservoir came about as a form of collateral that was applied to allow for the more productive lands to be taken out from under the pastoralists. Like many past
pastoral development schemes (Niamir-Fuller 1999; Hodgson 2001; Homewood and Rogers 1991; Anderson and Broch-Due 1999), the plan grew out of the intention to meet government policies and secure the productive land for cultivation. In doing so, it was deemed necessary for the village council to eliminate any concerns that had the possibility of hindering this goal, which became the “encroaching herder”. The plan was intended to ‘deal’ with the pastoral system rather than aid the pastoral livelihood (Water-Bayer and Bayer 1994). Like MLRMP, this has yet to make any progressive moves towards benefiting the stakeholders or even in meeting the primary goal of the plan, which was to vanquish pastoral dependence of the Ruvu River. This can be seen, as quality issues and the complete disappearance of the reservoir in 2008-2009 have not established much confidence in the reservoir, and if anything, reasserted the benefit of the perennial flows of the Ruvu River.

A second factor that backs this argument has to do with the physical characteristics of the reservoir itself. The quality reduction of the livestock reservoir does not stem from the over-exploitation of the livestock reservoir, as it was thought by the village council and extension officers, but is a result of a system that was designed for an equilibrium environmental system rather than an environmental system that is characterized by fluctuating and sporadic rainfall regimes (Behnke et al.1993; Scoones and Graham 1994). Being a rain-fed system, the livestock reservoir does not have any consistent water flow entering or exiting, meaning that all the water that is contained during the dry season and into drought has been collected from the previous rains, hence the drying up of the livestock reservoir with the failure of the rains in 2008. With
criminalization occurring to water access at the Ruvu, the reservoir has become the only source of watering during the dry season, which has amplified the debilitating outcomes of these problems. Water projects in pastoral areas have had a history of being rather piecemeal and to a large part, unsuccessful (Homewood and Rogers 1991; Sandford 1983). These projects have been short-term fixes that have been implemented to supply the most direct, immediate action without any regards to the knowledge of herders and even carefree about their longevity over extended amounts of time (Hodgson 1999; Homewood and Rogers 1991). The livestock reservoir in Kirya is no different. The plan that led to the implementation of this reservoir failed to even consider the implications of placing a rain-fed system in an environment that experiences annual dry seasons, let alone the situation that would transpire during a future drought event. This concern alone points to the continued re-emphasis on the coupled human-environment system.

A third concern that sheds light on the foundation of the reservoir concerns is due to the fact that herders traveling from neighboring villages were placed at the central focus of the need for intervening resource management. These secondary users have not been seen as exclusive rights holders, but rather as nomadic freeloaders, traveling into Kirya to exploit another area’s resources. Seemingly unaware or simply unsympathetic of the flexible systems of management that are used by pastoralists in ASAL regions, this misguided view has not just placed the secondary users as central instigators of degradation, but in doing so, have placed the Maasai of Kirya along side them, or “beyond the fence”. As stated in Chapter 6, the residing areas of the secondary users frequently served as hubs during the large-scale mobility patterns taken to cope with
large-scale disturbances. This was true in 2008-2009 as many of the herders traveling from Kirya have spent both short and extended stays in Pangaro and other areas mentioned. Additionally, several of the Past Herder oral histories included accounts of spending extended amounts of time at each of these locations during their experience with large-scale mobility. These connections with secondary users have been historically imbedded in the community of Kirya and have provided the necessary social flexibility.

The reciprocal relationship between the Maasai of Kirya and the secondary reservoir users are important forms of social capital that need to be sustained to maintain flexibility in dealing with the spatial and temporal variability of the semi-arid landscape. This is especially true in the face of increased frequency of extreme climatic perturbations. The regulation of the only source of dry season water access may have serious implications on the maintenance of the critical social networks that are used during such times of need; therefore by blaming the secondary users as the culprits for environmental change, the village council is actually placing the larger pastoral system at blame. These implications ultimately stem back to the first point addressed, which is that the livestock reservoir was not meant for the livestock herder, but an attempt to deal with an essential aspect of the pastoral production system that has provided pastoralists with the ability to cope with change for thousands of years (Fratkin 2001; Niamir-Fuller 1999).

Now that these concerns have been fully experienced in Kirya, the additional livestock reservoirs that are displayed in the land-use plan come into question (Figure 15, p. 155). It was stated that similar systems will be implemented, but does this mean that
they will carry the same burden as the livestock reservoir already implemented? Without taking the current concerns into mind, the Kirya Village Council is likely to suffer from Hodgson’s (2001), “historical amnesia”, resulting in the improper implementation and management system to coincide. This is very possible, as the repetition of the same mistakes has become a common theme in pastoral development projects (Sandford 1983, 63-64). Without including the knowledge of the stakeholders throughout the entire process from planning to management, the additional livestock reservoirs are likely to face the same concerns and induce similar skepticism amongst the herding communities towards the infrastructure (Galvin 2009; Nori et al. 2008). Judging by the chosen location of the future livestock reservoirs, it seems that the process has already taken a recursive path, but it is never too late to seek stakeholder participation (Figure 15, p. 155).

7.2. The Expansion of Macro-Mobility Patterns

The previous sections of this chapter have primarily highlighted the changes in resource access within the confines of Kirya village (Research Question 2). Resource access, particularly access to water, has become a critical concern as continuous measures, all connected to the larger top-down goal of expanding agriculture, place pastoral practices on the backburner. In regards to the mobility patterns (Research Question 3), this has resulted in a constriction in patterns of micro-mobility, induced mostly from two forms of landscape fragmentation. This constriction is faced as flexibility has diminished and the liberty to access critically important resources has been extinguished. The collection of oral histories in this research provided an insightful way
of accessing patterns of macro-mobility that are not frequently explored due to their coarse spatial and temporal scales (Chapter 2). When compared with the constriction of patterns of micro-mobility, the patterns of macro-mobility of the Maasai of Kirya elicit a different story in terms of the spatial and temporal dimensional shifts. The oral histories that were collected point to the assumption that across space, macro-mobility patterns are experiencing an expansion (Figure 22). This means that herders traveled much farther during the drought of 2008-2009 as compared to previous drought responses. Even though herders traveled much farther in 2008-2009, they did so over shorter durations; therefore, the overall temporal durations have reduced. Overall, the Past Herder oral histories had an average velocity of .83 km./day (excluding Herder 3) and the Contemporary Herder oral histories had an average velocity of 1.97 km./day (Table 11177). Therefore coupling these dimensions and measuring them in unison indicates that the rate of the patterns of macro-mobility has become more rapid. Quantifying these oral histories and geovisualizing them in a temporally enhanced GIS captured this phenomenon, which would not have been identified through traditional qualitative data analysis (Figure 22).
Figure 22: Expansion of Spatial Dimensions of the Patterns of Macro-Mobility.
7.2.1. Factors Inducing the Dimensional Shifts of Macro-Mobility

Work in political ecology has documented the multi-scalar network of contributing agents that are associated with changes in the human-environment system (Peet and Watts 2004; Robbins 2004). It is therefore extremely difficult (if not impossible) and, likewise, extremely problematic to distill any specific roots behind this phenomenon that is occurring to these patterns of macro-mobility, as no proximal and identifiable forces have remained constant, and a priori definitions of boundaries and “unwarranted assumptions about the stability of units or systems” should be avoided (Vayda 1983, 266). The small sample size of this study creates additional difficulties in identifying these forces. However this may be, several factors materialized in this research that appear to be associated with these dimensional shifts.

7.2.1.1. Unique Drought Experiences

The most identifiable factor that is contributing to these shifting dimensions is the fact that the events documented between the two focus groups are accounts of entirely different extreme climatic events. Chapter 6 briefly discussed the identification of several of these differences perceived between the different drought events. Severity measures collected through both community workshops and the household survey pointed to the observation that the 2008-2009 drought was perceived as being the most severe of the recent decades. It is possible to assume that because of the increased severity of the event that more intensive coping strategies were taken (i.e., more exaggerated mobility patterns). However, as Burnsilver et al. (2008) point out, decisions that are made prior to
the drought strongly affect the strategies taken to cope with the event. In their case, it has been the diversification of land-use practices making pastoralists more sedentary that has led to more extreme movements taken in times of drought. In Kirya, the Maasai acknowledged the fact that they had began cultivating and sought market access prior to the drought of 2008-2009, which reduced the amount of human-related concerns during the drought; however, it was claimed that livestock-related concerns were more profuse during this event. These strategies may have induced dimensional shifts, as herders were able to obtain alternative sources of subsistence for themselves and their stock, rely on alternative labor to meet the household demands, and ultimately build more bountiful financial storages deposits (Turner 1999). All of these strategies point to the ability of the household to have taken more demanding coping strategies to deal with the high degree of severity associated with the drought of 2008-2009.

7.2.1.2. Not Alone in this Fragmented World

In addition to the decisions that led up to the event, prior resource concerns set the pace for the adaptation strategies employed by the household, and thus result in the overall expansion of the patterns of macro-mobility (Burnsilver et al. 2008; Campbell 1999). The socio-political measures that are inhibiting resource access in Kirya are occurring elsewhere in Tanzania. Thinking about Kirya not just as the initial location of the Maasai of Kirya but also as a hub for visiting herders, it is acknowledged that visiting herders are no longer received in other areas with open arms. The fragmentation and increased plurality on resources that is reducing the flexibility and constricting patterns of
micro-mobility in Kirya is leading to a need for continued movement in search of suitable resources during times of drought. Simply put, herders more hastily overstay their welcome.

Furthermore, emerging regulation and privatization measures are impacting herder’s ability to seek refuge for extended amounts of time at locations that they may have been able to stay in the past. For example, in Kirya, it was documented that herders from Pangaro were obtaining resources in the past from areas like Mlima Lemnazi. Today, herders from Pangaro are still accessing resources in Kirya, however measures are being taken to control their use and progressively push the herders out of the village. Fees and payments of access made prior to and during macro-scale movements may pull from financial storage deposits prematurely, resulting in the inability to stay at a particular location for a prolonged duration not only due to the exhaustion of these deposits but also out of the need to maintain sufficient resource for future situations. As a result, herders may have sought resources elsewhere, and thus, leading to the expansion of the patterns of macro-mobility.

7.2.1.3. Broadening Connectivity: The Role of Transportation and ICT in Mobility

“As human societies reach historically unprecedented levels of ‘connectivity’ (through globalized communication technologies—cell phones, email, international travel), the ‘natural’ world becomes more and more disconnected and fragmented” (Goldman 2009, 352). As this statement may be taken with numerous connotations, to this research, it has two. The first derivation is more theoretical in that it holistically
grasps many of the contemporary concerns that are facing pastoralists across the globe. This is the fact that “connectivity”, or what in the case of the quote could also be seen as “modernity”, has progressively oppressed those who have not necessarily conformed to the push and pulls of the global political economy. The second connotation serves more as a practical derivation and is more representative of the theme of this section. This is, in the midst of coping with drought in the 21st century, it is the role of “modernity” in the form of various technology (i.e., cell phones, SMS) and infrastructure developments (i.e., lorries, road networks) that has culminated in more infused “connectivity”. This is an identifiable factor contributing to the expansion of patterns of macro-mobility.

It was mentioned in Chapter 6, that participants of the community workshops associated the severity of the drought of 2008-2009 with the severity of the 1974 (Njaa ya Ndizi), however one major distinction was mentioned. Individuals stated that between these two events, it was the improvement of infrastructure that provided households with opportunities to take alternative and additional coping strategies. As pastoral areas are typically rural ASALs with sparse populations and have been viewed as being unproductive landmasses, not contributing to the national economy, these areas have been largely underdeveloped. On the ground this is recognizable as national planning and development has frequently ignored drylands in terms of transportation infrastructure development (Homewood and Rogers 1991; Niamir-Fuller 1999). Of all the districts in the Kilimanjaro region, Mwanga has the lowest road density (Chapter 3); however this may be, it was obtained through the household survey that the majority of the households had perceived an increase in transportation over the past ten years. Even with rather scant
infrastructure, the Maasai of Kirya have utilized the developed transportation system’s capacity to its full potential, which has linked households with areas beyond the confines of Kirya, supplying greater connectivity with alternative markets access, the ability for individuals of the household to seek peri-urban and urban migrations, send remittances from outside areas back to the household, and migrate as a household out of the village all together (Baker and Aina 1995). Ultimately, this has expanded the household spatial interdependence on more distant locations.

Coupled with the development of transportation infrastructure, the use of ICT, has provided further connectivity with outside areas, and thus fortified this interdependence. Opportunistic measures taken to adapt to change means that clear, reliable, and, if possible, real-time communication is essential to respond to disturbances as they emerge. Therefore, this emphasis places communication as a staple of pastoral economic, physical and social decision-making. Research has documented the potential of ICT in poverty alleviation (Ashley et al. 2009; Domatob et al 1996; Marker et al. 2002). In this literature, ICT has frequently been referred to as having the ability to provide rural farmers with information of the latest crop prices, education and health resources, government services, and so forth in order to share knowledge and seek solutions to problems (Marker et al. 2002). In the case of the Maasai of Kirya, ICT in the form of cell phones and SMS has recently provided a more efficient way of relaying information and ecological knowledge ranging from topics as diverse as rainfall patterns, pasture conditions, areas of conflict, herd health, and more. In regards to the patterns of macro-mobility experienced by the Maasai of Kirya, the development of transportation and ICT
has facilitated the expansion of these patterns in two identifiable ways. First is the use of these technologies in the process of ecological tracking (socioecological coping strategy; Chapter 2) and the second is through the process of using lorries to transportation livestock in times of drought (socioeconomic coping strategy; Chapter 2).

Prior to moving herds from place to place during extreme disturbances, ecological knowledge about proximal location is critical, especially due to the heightened vulnerability associated with the disturbance event. This is where the role of ecological tracking (Chapter 2) comes into play. Past Herders stated that in their experiences with extreme disturbances that drove them outward, individuals would be sent towards familiar locations to search for places with the necessary social and ecological characteristics that would be suitable to move their livestock. Individuals stated that these processes have changed significantly over the recent decades due to the increased ability to travel by other forms of transportation rather than walking. One elder even highlighted the influence of bicycles and motorcycles in this in enabling mobility. Contemporary Herders frequently suggested that under current conditions, it is easy because instead of walking to a location and back, they can just pay for a ride on one of the daily doladola (minibuses) that pass through Kirya, arrive at the destination, examine the social and physical characteristics of the location, board another shuttle, and arrive back in Kirya by nightfall with first hand knowledge about the locations of suitable resources. Coupled with this process, cell phones and SMS have supported further opportunistic decision-making. Some herders claimed that once they arrived at a sufficient location to move the livestock, instead of boarding other transport, they could now call back to Kirya, inform
the household where suitable resources could be found, and meet up with the herds at those particular locations. In addition to the use of transportation and ICT during tracking, herders utilized these technologies to maintain connectivity with the household members who remained in Kirya. Herders would stay connected with the elders of the household to keep them updated on the condition of the herd, receive information about the conditions of the resources in Kirya, and relay critical decision-making back to the elders, as elders would request the herders to continue searching for resources or move back to Kirya.

The second way that transportation and ICT have resulted in the expansion of patterns of macro-mobility amongst the Maasai of Kirya is through the use of lorries in transporting the herders across long distances. During the community workshops, it was mentioned that the use of transporting herds by lorries had began in 1997 and was additionally carried out during the 2008-2009 drought. Individuals stated that although it was expensive, it was a last resort taken to seek sufficient resources for the diminishing herds. Similarly to their use in resource tracking, cell phones could then be implemented to keep connected to the elders and provide them with up-to-date information on the conditions of the herd. One oral history collected highlighted the role of such coping strategies, as one household’s livestock and two herders (brothers) boarded lorries and headed south to areas near Korogwe. At one point the herders split the herd, where one herder continued grazing and the other returned back to Kirya to bring dairy cattle back to the household. Due to the health of the herd that remained on migration, the returning herder eventually boarded a shuttle to Moshi to obtain livestock medicines and then
rejoined with the other herder. Using ICT and transportation engaged the household in a socio-economic coping strategy, which was captured in the geovisualizations created for this research (Figure 23).
Figure 23: Herders Who Transported Their Livestock Using Lorries During 2008-2009 Drought.

Herders split the herd to return some cattle back to the household in Kirya.
7.3. Socioeconomic Stratification Among the Maasai of Kirya

Opportunities are not necessarily available for everyone, as groups that may be in a less vulnerable state may be more inclined to take incentives if they have the ability. The two coping strategies discussed above fall under this principle, as they are dependent on the ability of the household to afford such socio-economic measures, clarifying the financial and political characteristics of adaptation (Adger et al. 2004; Eriksen and Lind 2009; Smit and Wandel 2006). Furthermore, the shifting patterns of both micro and macro-mobility discussed in this research are not homogenously experienced by all of the Maasai of Kirya, or pastoralist elsewhere. Poorer pastoral households may not be able to take some of the recognized socio-economic coping strategies that others may be able to. Likewise, some households may have to reduce their herd size to meet the payment for access to the reservoir, while others may benefit from its regulation through patronage networks to the village council; therefore, socio-economic differentiation becomes evident as something that needs to be taken into consideration. It is not only important to acknowledge the already induced social stratification that has resulted in different experiences of daily resource access and during extreme climatic events, but also the potential for greater stratification as landscapes are further fragmented, local resources are becoming more regulated and socially explicit, and alternative coping strategies taken in times of extreme disturbances are becoming more readily available but with extremely expensive price tags (Lesorogol 2003; Brockington 2001; Wangui 2008). Ultimately, this means that some households are likely to access local resources and cope with the onset of future disturbances better than others. In terms of pastoral mobility, this means that
some households may be experiencing an expansion in patterns of macro-mobility, while others may be constrained by their access to labor pools or financial storage, and ultimately experience more difficulty in mobilizing their herd, thus reducing their patterns of mobility. In the face of further the uncertainty and greater variability associated with climate change, these differentiations are likely to become more distinct, instigate future inter and intra-community concerns, and continue to shift the dimensions of pastoral mobility across the rangeland.
8.0. CONCLUSION

This thesis sought to understand what is occurring to resource access and pastoral mobility in the Kilimanjaro region of northern Tanzania over the past 50 years. In doing so, it has identified the spatial and seasonal dimensions of resource access in Kirya (Research Question 1), the changes that have occurred to resource access over the past 50 years (Research Question 2), and how herders are adjusting their mobility patterns to accommodate for these changes (Research Question 3). This research has contributed to the knowledge of pastoral resource access and mobility by presenting a new way of addressing changing mobility patterns. Rather than acknowledging mobility as a coping strategy that is only facing the constraints at the local scale that result in the constriction of micro-mobility patterns, mobility should be seen as a coping mechanism that is expanding outwards and becoming even more dependent on distant locations in times of extreme climatic events. This points to the fact that these events are becoming more severe, eliciting greater energy expenditures and more elaborate coping strategies, but it also points to the idea that pastoralists continue to seek opportunities, such as transportation and cell phones, to maintain herd health and mobility. A more holistic approach to understanding the changing dimensions of resource access and pastoral mobility, such as this, can contribute to pastoral development by providing a platform to accommodate for the multiple scales of mobility, especially in the face of further climate variability and the increased frequency of extreme climatic events. In doing so, pastoral development practices can reemphasize the importance of pastoral mobility in dryland regions to embrace the looming consequences of further climate uncertainty.
8.1. Benefits of the Methodological Framework

Transforming oral histories that accounted for responses to extreme climatic events into geo-coded narratives revealed the latent patterns that were imbedded in each of the oral histories, turning the very complex patterns of macro-mobility into a tangible entity that could be visualized and analyzed (Research Question 4). This innovative framework made several additional contributions to this research project. First and foremost, this framework provided an excellent route to bring two different knowledge systems together in collaboration to communicate interesting patterns that would be very difficult to explore through other approaches. A core principle of the critical GIS paradigm is concerned with democratizing the knowledge that is integrated and disseminated through a GIS to make these systems more epistemologically inclusive from the collection of geographic knowledge to its (re)production (Cope and Elwood 2009; Schuurman 2009). The methodological approach used in this research was formulated out of retaining this core principle throughout the entire research process. In doing so, it can honestly be said that it was the knowledge and experiences of the Maasai of Kirya that directed this research and (re)produced the geographic knowledge that is embedded in this work. As a researcher, it was my duty to act as a middleman to present the individual stories of each participant using a geovisual medium.

It was important to maintain a mixed-methodological approach throughout the entirety of this research. By maintaining the qualitative information within a quantitative geographic information system, a second benefit of this framework was found by providing the researcher with more conducive methods of data management. Rather than
relying on multiple qualitative and quantitative data management software packages, the researcher was able to employ several standard ArcGIS functions to formulate a single database that included all of the various forms of data. By storing the space-time paths for each individual oral history in one database, visualization and cross-comparisons between multiple oral histories became more manageable as visual patterns were more easily distinguishable than they would have been if performed using traditional qualitative data analysis techniques. Additionally, by compiling the necessary data into one database, the database can be disseminated more conveniently by relying only on a person-to-person transfer or over a stable Internet connection.

8.2. Concluding Remarks

This research has answered each of the proposed research questions, mapped individuals’ livelihood space, presented a means of utilizing other forms of knowledge to explore the shifting relations within the human-environment system, and elicited an innovative framework to visualize the strategies taken by pastoralists to deal with a shifting social, political, and biophysical landscape that is always and will always be dynamic. But what does this mean for the Maasai of Kirya? As resource access continues to be a major concern for the Maasai of Kirya, mitigation techniques thus far have been implemented in such forms as pastoral infrastructure development and land-use planning in Kirya, which are clearly not focused on providing pastoralists with necessary resources. If anything, this research points to the fact that these concerns will continue to amplify as boundaries become more and more rigid, landscapes continue to become more fragmented, planning is performed for the pastoralist and not with, and improper
management persists (Nori et al. 2008; Water-Bayer and Bayer 1994). The findings in this research assume that of these changes that are occurring, it is the changes in water access that have the potential to greatly impact herders into the future. Without access to perennial water resources that actively flow, hardships are likely to continue to ensue and future water implementation projects, such as the additional livestock reservoirs noted in the land-use plan, are likely to come in the form of “old wine in new bottles”, displaying the same concerns as the current livestock reservoir. It seems more likely that this will result in increased skepticism, rather than the mitigation of any resource concerns. This has the potential to further increase pastoralists’ dependence on the Ruvu, as its use is currently the only suitable option for livestock rearing households to maintain herd health during the late dry season and in times of drought. Furthermore, these emerging pressures over water access may result in a transformation in resource pressures in the face of future climatic extremes. As past decisions to seek resources elsewhere have been primarily driven by a reduction in forage, increasing concerns over water access may prompt future decision-making to be influenced by water scarcity, resulting in more immediate and extreme movements, greater social conflict, and an overall increase in more detrimental consequences.

From this research, it becomes rather difficult to answer the question that was posed above, as resource access and pastoral mobility is just one piece of the puzzle. As constrictions in mobility are occurring in the local scale and the already variable climate becomes more variable, these factors tend to make the future of pastoralism appear bleak, doomed to failure, or as Nori and Davies (2007, 2) put it, make pastoralists look like they
are the “canaries in the coalmine”. However, this view continues to underestimate the fact that pastoralists have been and will continue to be dynamic. They have adapted to different situations that may be seen as debilitating and have taken opportunities to combat the consequences of a shifting human-environment system. Since this research project only focused on the aspects of mobility and resource access, it has presented a partial view of the future of pastoralism; however, by exploring resource access and pastoral mobility in the daily context and visualizing mobility in times of extreme climatic events, this research project has documented that pastoralists continue to maintain their mobility into the 21st century, and in fact, are embracing the new opportunities to expand mobility and connectivity that this generation has to offer.
REFERENCES


APPENDIX A: HOW TO INTERPRET THE SPACE-TIME PATHS

This appendix walks through the space-time path created for Past Herder 2’s response to the drought of 1974 (“Njaa ya Ndizi”) (Discussed in Section 6.3.1, p. 168-170).
3) The herder stayed for one month (November) in Kiverenge and access water in Ngulou.

4) The herder left Kiverenge and traveled ±20 km (8 hours) to Taloha (part of Same District at the time because there was no Mwanga District).
5) The herder and his cattle stayed in Taloha for 2 weeks. Initially it had rained but soon after, things began to dry up and the livestock were only relying on standing water.

6) The herder left Taloha and traveled ± 19 km (7 hours) to Ndea (near Mkomazi G.R.).
7) The herder stayed at Ndea for 2 weeks. During this time, lions were a problem and the Maasai could not sleep. A ranch on one side and the two game reserves (Mkomazi and Tsavo) caused access issues.

8) Herder left Ndea and traveled ± 18 km (6 hours) to Pangaro.
9) The Herder stayed in Pangaro for 3 weeks. He was grazing illegally at night in a reserve.

10) The herder left Pangaro and traveled ±13 km (5 hours) to Mgagao. During this time, his cattle were very weak and very slow.
12) The herder left Mgagao and traveled ± 15 km (8 hours) to Laboo.

11) The herder stayed in Mgagao for 3 days.

14) The herder returned home from Laboo and traveled 5 km (4 hours) back to Kirya.

13) The herder stayed in Laboo for 2 days. The rains had yet to come.
Herder’s complete space-time path.