DISSERTATION

PATHWAYS OF CONTINUITY AND CHANGE: DIVERSIFICATION, INTENSIFICATION AND MOBILITY IN MAASAILAND, KENYA

Submitted by

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY SHAUNA B. BURNSILVER ENTITLED PATHWAYS OF CONTINUITY AND CHANGE: DIVERSIFICATION, INTENSIFICATION AND MOBILITY IN MAASAILAND BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF THESIS

PATHWAYS OF CONTINUITY AND CHANGE: DIVERSIFICATION, INTENSIFICATION AND MOBILITY IN MAASAILAND, KENYA

In recent decades a combination of exogenous and endogenous drivers have led to changes in land use and livelihood strategies among Maasai pastoralists in the Greater Amboseli Ecosystem (GAE). The Kenyan government and international policymakers have engaged in an effort to modernize the Kenyan pastoral sector based on livestock intensification and land tenure change – linked to the assumption that private land ownership is a more effective foundation for economic growth than communal land tenure. Additional drivers, such as population growth, competition for territory with outside agricultural groups and conservation interests, greater engagement in the larger Kenyan economy, and frequent cycles of drought, are pushing and pulling pastoralists to adjust their livelihood strategies. Taken together, these drivers have created an atmosphere of unprecedented change in Maasailand, Kenya – a situation with potentially negative implications for pastoral well-being and resilience. How pastoral households are coping with these challenges is the central question of this PhD study. Three key responses are identified and analyzed: economic diversification, livestock intensification and livestock mobility.

I demonstrate that economic diversification and intensification of livestock production strategies are occurring in Maasailand, and address some of the underlying complexities that accompany both processes. All economic diversification is not unidirectional, but is instead based on economic need and characteristics of particular life stages. Households are also selling livestock at increased rates and actively experimenting with livestock crossbreeding strategies in order to increase returns from their livestock. Results show that in spite of economic diversification, livestock in Amboseli remain a critical component of pastoral livelihoods.

Previous efforts to document pastoral wealth have been based almost entirely on the number of animals held per household or per capita. I develop two new indices of pastoral wealth and compare pastoral wealth status across five wealth ranking methods in Amboseli. Results emphasize that while households are diversifying, livestock remains a critical component of wealth across poor, medium and rich groups of households. However, rich and poor households are diversifying along different trajectories. This finding has implications for greater wealth stratification in this pastoral society in the future.

I also analyze the role that mobility plays in pastoral production, as socio-political conditions push for land privatization, but households continue to face significant climate variability and low levels of investment in livestock infrastructure. A cultural-institutional system of grazing management in place in unsubdivided areas of the GAE

seems to allow herders to access sufficient forage *quantity* under normal precipitation conditions, as well as forage *quality* in particular periods of time.

Many of the changes occurring in pastoral Maasailand are also common to the experiences of pastoral groups globally. As such, results from this study will contribute to an ongoing discussion regarding the future viability of pastoralism under conditions of change.

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CHAPTER 1

INTRODUCTION

Livestock raising is the dominant land use in 25% of the world's landscapes and comprises the basic livelihood strategy of over 20 million households (Galaty and Johnson 1990; Steinfeld, Gerber et al. 2006). People who depend on livestock for their livelihoods go by a number of names; herders, ranchers, agropastoralists and pastoralists are a few of these. But those who depend on a combination of animal species for a majority of their subsistence are termed pastoralists. While the specific characteristics of how pastoralists raise their animals varies widely, traditional pastoralism has revolved around the twin requirements of accessing forage and water resources for herded animals across space and time – usually in extensive rangeland zones typified as arid or semi-arid (Reid, Galvin et al. 2007). These rangelands have most often been managed communally under systems where land was held and used based on locally-defined rights, norms and rules of access (Ensminger and Rutten 1991; Behnke 1994; Behnke 2007). Some form of mobility has been a primary feature of pastoral systems as well, as herders used movement to reduce risk and cope with substantial ecological and climatic variability (Ellis and Galvin 1994; Reid, Galvin et al. 2007). Pastoralism is an ancient form of land use, and one which has provided for successful subsistence production for human populations on a global scale for millennia (Spear 1993; Khazanov 1994; Blench 2001). However, the paradigm of progress that currently dominates discussions of economic development is one that prioritizes national-level economic growth and productive efficiency over localized subsistence.

Pastoralism functions in a global context under dramatically different political-economic systems (i.e., democratic and capitalist, post-socialist and newly capitalist, and communist with some engagement with market capitalism), different property rights regimes (communal vs. private vs. long term leasehold), and variable climatic contexts (temperate vs. sub-tropical). Yet, as different as these systems may be, there has been a gradual but systematic effort by national governments and policymakers from across the political-economic spectrum to modernize their pastoral sectors based on common prescriptions of economic intensification and land tenure change. A variety of other ultimate and proximate drivers, such as population growth, competition for territory with outside agricultural groups and conservation interests, and frequent cycles of drought, are acting on pastoral groups as well, and together have created an atmosphere of almost hyper-change and transition in pastoral systems extending from the steppes of Inner Mongolia to the savannas of Eastern Africa. However, adaptability, well-developed coping strategies and flexibility also remain strong historical characteristics of pastoralism. This dissertation is an effort to understand how these dual currents of change and continuity are playing out in one pastoral system; Maasailand, Kenya, East Africa. The combined effect of the drivers discussed above has been increasing economic and ecological unpredictability for Maasai pastoralists – a situation with potentially negative implications for pastoral vulnerability. What pastoral households are doing in response to these challenges is the central question of this study. Three key responses are identified: economic diversification, livestock intensification and livestock mobility. Another key question is also posed throughout each of three chapters: What are the implications of these responses for pastoral well-being?

Diversification and Intensification in the Kajiado Context

When change in pastoral systems is analyzed, two processes have received the most attention: Economic diversification and livestock intensification. Diversification includes the economic activities households choose to engage in *outside* of livestock production (e.g., agriculture, wage labor, business), and intensification is defined as the steps herding households take to increase outputs from their livestock (e.g., changing input levels or management strategies) (Galaty and Johnson 1990). Two previous studies of Maasai pastoralism by Bekure et al. (1991) and Rutten (1992) addressed these processes simultaneously, the implication being that although different, both processes were occurring congruently in time. There has recently been an especially active research agenda in East African pastoral areas to document patterns of economic diversification (Little, Smith et al. 2001; Thompson, Serneels et al. 2002; Desta, Coppock et al. 2004; Lesorogol 2005; Homewood, Trench et al. 2006; Thornton, Boone et al. 2007). However, this body of work does not address the process of intensification. The implication here may be to suggest that with diversification, there is a general trajectory for pastoralists to abandon their dependence on livestock and become something different – perhaps agropastoralists, or purely wage laborers? This dissertation takes a different approach. To look more broadly at changes occurring in Maasailand and their implications for pastoral well-being, I attempt to track simultaneously critical aspects of both economic diversification and intensification strategies. As well, because diversification and intensification trajectories in Maasailand are relatively recent, so too are efforts to document their occurrence. There are a variety of unexamined assumptions and complexities associated with both processes that should be addressed directly. These are described below.

Economic diversification

The body of research cited previously indicates that pastoral diversification across East Africa is widespread. This study attempts to pick up where Bekure et al. (1991) and Rutten (1992) left off and pinpoint specific patterns of diversification in southern Kenya, Maasailand, by asking what activities are being adopted, where, and what are the relative values associated with one strategy vs. another for different groups of households? An underlying assumption vis-a-vis diversification seems to be that the economic benefits accruing from it are uniformly positive and constitute straightforward value-added benefits for households. However, Sutter (1987) made the point even prior to widespread economic diversification in West Africa that pastoral populations are not homogeneous. Households have different social and livestock investment capabilities based on the livestock resources available to them. Other researchers working with agricultural populations have shown that the inherent capabilities of rich vs. poor households push them onto different economic pathways that have strongly divergent effects on livelihoods (Reardon, Delgado et al. 1992; Barrett and Reardon 2000; Barrett, Reardon et al. 2001). This question of differential capabilities and the resultant choices of diversification strategies will therefore be applied to diversification analyses of Maasai households.

Initial descriptions of diversification patterns also gave the impression that the process itself is unidirectional. In other words, once an individual makes the choice (or is pushed) to try something outside of livestock, they will remain diversified into the future. Researchers have described how Maasai populations were previously flexible in their adoption of agriculture and interactions with agriculturalists, particularly during times of stress (Spear and Nurse 1992; Spear 1993). The diversification patterns of Maasai may exhibit this flexibility in time, or current drivers acting on pastoral households may be so strong as to push them permanently into new activities. Specific activities may also have different characteristics. This assumption of unidirectional diversification through time will also be tested.

Livestock intensification

Livestock intensification is defined as an increase in the units of livestock produced (e.g., kg of meat, liters of milk or number of hides) based on a given level of inputs (e.g., feed, water, veterinary drugs, or labor) (Galaty and Johnson 1990). This process implies an increase not only in output levels, but also in the efficiency of output (i.e., output per unit of input). The logic of intensification has been part of the lexicon of pastoral development in East Africa since the 1950s, a time that coincides with the rise of modernization theory and its application to the conundrum of economic development in the Third World (Tipps 1973; Isbister 2006). The starting assumption of modernization theory is that traditional subsistence societies are economically stagnant. However, technological change (supported by a formal education) can lead to widespread economic growth as populations engage more efficiently over time with the market. Technological change is an umbrella concept here that represents the application of new productive inputs to production processes to increase efficiency and raise output levels.

Taking this logic and applying it to pastoralism in East Africa, economists and policy makers considered pastoral subsistence strategies to be economically inefficient and irrational, given that they were based on the maintenance of large, "unproductive" herds and mobility over extensive areas of land that were unused most of the time. Prescriptions to intensify pastoral production included increasing rates of livestock offtake, use of veterinary drugs, adoption of better livestock breeds, provision of credit, and water development. A final piece of the intensification and modernization paradigm was to move away from communal land use to a system of privatized property rights. Unnecessary animals were to be destocked (i.e., sold) so more grazing resources would be available in local areas. Mobility would then decline, economic returns to pastoralists would increase, national domestic markets would gain cheap sources of meat, and human well-being would rise. This vision of successful intensified livestock production was adopted partly from rangeland planners' experiences in the US livestock industry.

Many would now agree that policy efforts to modernize pastoralism through intensification have had a checkered history of achievement. In fact, results were so poor in East and West Africa in the 1980s and 90s that policy makers and funders pulled back their support for large-scale pastoral development programs (Ellis 1993; Oxby 1999). The sweeping transition from subsistence-oriented pastoralism to intensified livestock production for the marketplace has not occurred. The model of modern livestock production did not transfer directly to East Africa or Maasailand. Ongoing droughts mandated mobility and interfered with herders' willingness to destock animals that historically represented their ability to recover after drought had subsided. And more importantly, access to the productive inputs that were to be catalysts for intensification has been limited and in many cases non-existent for herding households. Yet, despite these significant challenges, ongoing debates regarding pastoral development and mobility still take place within a top-down development paradigm based on the goals of pastoral intensification and modernization.

Alternate visions of sustainable livestock development in semi-arid rangelands are emerging as well. Theoretical work in political science has underscored the inherent workability, effectiveness and rationality of communal land tenure (Ostrom 1990; Ostrom, Burger et al. 1999). Under non-equilibrium theory rangeland ecologists have outlined the unique climatic circumstances under which pastoral efforts to maintain large, mobile herds acts to offset risk, and may not lead to rangeland degradation (Ellis and Swift 1988; Vetter 2005). And the work of both ecologists and anthropologists continues to emphasize the strong role of mobility, social capital mechanisms and pastoral flexibility in supporting pastoral resilience in the face of change (Banks 2003; BurnSilver and Mwangi 2007; Galvin 2007).

The debate over the appropriateness of the intensification paradigm as the dominant model of pastoral development continues, but discussion of Maasai intensification efforts in this study does not focus on their support or non-support of the modernization paradigm. Instead, I take a household level approach that attempts to quantify intensification patterns, and identify under what circumstances Maasai are changing how they continue to do what they have always done – raise livestock.

The Maasai and the Study Region

The focal area of this PhD study was the Greater Amboseli Ecosystem (GAE - 8500 km^2), located in the southeastern corner of Kajiado District, Kenya. Kajiado is one of two pastoral districts in southern Kenya (Narok is the other), and both are the territory of the Maasai. Maasai territory continues south into Tanzania, however this study focuses only on the Kenya Maasai.

The Maasai are some of the most well-known (and well-studied) pastoralists in the world. They are historically milk-based pastoralists who depended for their livelihood on a combination of animal species, primarily cattle, sheep and goats. Prior to the mid-1960s, the Maasai land base was communal, and access to grazing and water resources was organized around membership in sub-tribes (or *ol-oshon*). These territories had fixed boundaries under normal conditions, which became fluid during periods of drought based on the mechanism of generalized reciprocity (Bekure, de Leeuw et al. 1991; Waller 1993). Since the 1970s the basis of land tenure has been in transition from communal to private land rights. Group ranches have been an intermediate stage between communal *ol-oshon* and private parcels, and mobility occurs within ranch boundaries in normal periods. Still, access to other ranches and *ol-oshon* may be negotiated during drought.

Livestock herds in Maasailand are owned individually, but herd owners and their families are organized into patriarchal and patrilineal extended households called *olmarei*. Marriage is polygamous, so one *olmarei* might consist of a herd owner, his wives, their children, married sons and their dependents, and possibly dependent parents. Multiple *olmarei* group together spatially into larger compounds (called *enkang*) for cooperative herding and social purposes. A system of male age-sets provides a leadership structure within Maasai society, and elders traditionally maintain most of the consensus decision-making powers. Layered social relationships based on kinship and clan relations, age-set membership and stock friendships form the foundation on which grazing access within and across boundaries is negotiated, and help in difficult times is asked for and received (Potkanski 1997).

The GAE includes portions of two Maasai *ol-oshon*, the Ilkisongo and the Matapaato. Geographically, the region encompasses the Amboseli Basin, swamps along the northern foot of Mt. Kilimanjaro, Amboseli National Park and neighboring rangelands (Western 1973; Katampoi, Genga et al. 1990). This area is unique culturally and ecologically, but it is also home to significant populations of wildlife that have traditionally co-existed with Maasai pastoralism, attributes which have combined to make Amboseli the second most visited national park in Kenya (Bulte, Boone et al. 2007). The juxtaposition of a substantial human pastoral population side by side with a critical conservation resource has placed the GAE directly in the center of debates over sustainable livestock development, human well-being, equitable sharing of conservation benefits with local communities, and efforts to conserve critical biodiversity.

Research for this study took place on one former (Osilalei) and three current Maasai group ranches (Imbirikani, Eselenkei and Olgulului/Lolarashi). Six study areas (Osilalei, Eselenkei, Lenkisim, Emeshenani, N. Imbirikani and S. Imbirikani) were selected across the group ranches to represent different levels of land tenure change (privatized vs. communal), agroecological potential (low to high), and infrastructure access (low to high). A sample of 184 Maasai households (*olmarei)* were interviewed for this study over a period extending from November of 1999 through March of 2001. Pastoral land use across the GAE spans from extensive transhumant pastoralism to sedentary agropastoralism, and as such represents a gradient across which changes in pastoral economic and productive strategies can be analyzed and understood.

Dissertation Chapters

This dissertation consists of three data chapters, an introduction and a conclusion. The questions pursued in each data chapter are outlined below.

The focus of Chapter One is to describe and quantify the responses of Maasai pastoralists to socio-economic and political drivers of change. It is clear that pastoralists across many East African systems are currently trying a variety of strategies to adapt to and cope with changes in their productive environment (Humphrey and Sneath 1999; Little, Smith et al. 2001; Coast 2002; Thompson 2002; Thompson, Serneels et al. 2002; Homewood, Trench et al. 2006). Maasai traditionally were dependent on subsistence pastoralism for their livelihoods. Currently, they also are diversifying their livelihood choices into activities that are well beyond the "traditional" raising of livestock for subsistence. However, what is the role of livestock given these moves to expand their livelihood base? The parallel process of livestock intensification is also ongoing, as Maasai try to "get more" from the livestock they do have (Galaty and Sperling 1990; Rutten 1992; Rege and Bester 1998). However, are observed trajectories of intensification on par with the expectations of policy makers? Additionally, given the close proximity of Amboseli National Park and the presence of significant wildlife populations outside of park boundaries, community-based conservation has emerged as a development focus for the region. A growing number of conservation-oriented enterprises are now in place across the Amboseli ecosystem – all based on the idea of improving pastoral well-being while simultaneously conserving wildlife populations over the long-term. The question remains however, in spite of substantial literature linking conservation and improved livelihoods, does conservation-based income contribute substantively to the well-being of Maasai households in Amboseli within the overall context of efforts by pastoralists to diversify and intensify their activities beyond subsistence pastoralism?

The chapter focuses on four themes; 1) describing patterns of diversification of pastoral livelihoods in the Amboseli system, both in terms of the combinations of activities households are pursuing and the relative value of those strategies to livelihoods, 2) identifying potential spatial and socio-economic determinants of why one strategy is chosen over another, 3) analyzing the relative importance of conservation-based income within household economic strategies of the Maasai, and 4) describing trajectories of change and future land use in Maasailand – linking analyses of diversification dynamics through time and the parallel process of intensification of livestock production strategies. Diversification patterns are described initially by study area and then quantified using cluster analyses, whereby study households are grouped according to the specific combinations of activities they pursue. In the context of these themes, the livelihood choices being made by the Maasai of Amboseli will contribute to the ongoing effort to describe the newly emergent faces of pastoralism in East Africa.

Chapter Two examines the spatial footprint of changing land tenure systems and economic strategies in Maasailand. Current trends towards privatization of land rights, economic diversification, and associated patterns of permanent sedentarization of pastoral households are putting pressure on Maasai patterns of mobility. Yet regardless of land tenure change, ecologically and climatically the system remains a semi-arid savanna ecosystem that is strongly characterized by the patchy nature of resources available to herders and their animals in space and time. Kajiado district is also an area characterized by low access overall to productive infrastructure and economic resources such as banking, credit and livestock markets that would theoretically pave the way for intensification of livestock production (Prugh, Costanza et al. 1999; UNDP 2001) and offset the need to be mobile (Boone, BurnSilver et al. 2007). Mobility has been a critical characteristic of traditional pastoralism that allowed herders to cope with uncertainty, but continues to be highly criticized by policy makers as irrational and unnecessary under the paradigm of intensification (Feder and Feeny 1991; Fratkin and Wu 1997; Fratkin and Mearns 2003). Within the context of this debate, does mobility continue to play a critical role in the productive decisions of pastoral households in Maasailand? Do people still depend on their livestock to a degree that mobility remains important? This chapter makes the case that an important link exists between the continued mobility of pastoralists and their animals, and maintaining resilient pastoral systems in the face of change.

With these general questions in mind, the chapter defines who continues to be mobile under a new set of economic and land tenure conditions. Current patterns of mobility are a juxtaposition of these new conditions onto grazing norms that are culturally and institutionally defined. Other studies have described the social and ecological importance of mobility (Turner 1989; Galaty 1992; Niamir-Fuller 1999), but this chapter seeks to quantify the benefits of mobility to households in terms of forage access. There is an expanding body of research in rangeland science and remote sensing using Normalized Difference Vegetation Index (NDVI) data to track patterns of forage greenness and biomass production (Reed, Brown et al. 1994; Pettorelli, Vik et al. 2005). SPOT NDVI data is the information used to quantify the forage resources available to pastoral herds in Amboseli under different scenarios of mobility. This research also took advantage of a natural experiment that occurred in the process of fieldwork. The year 1999 was a "normal" year of precipitation, while a serious drought involving the failure of two rainy seasons characterized the year 2000. This offered the opportunity to compare pastoral mobility under "normal" vs. highly stressed conditions.

The following questions are addressed in Chapter Two: 1) Given the background context of economic diversification, how important is livestock production to pastoral livelihoods in Amboseli, 2) How mobile are households in the Amboseli system under different climatic conditions, 3) What are the resources that mobile vs. immobile households are able to access through movement, and 4) What are the socio-economic and geographic characteristics that predict household mobility within this changing system? Results of these analyses should contribute to ongoing debates regarding the validity of movement as a coping strategy under conditions of change.

The starting point for Chapter Three is results from the two previous chapters highlighting that Maasai pastoralists are actively trying to adapt to new political, economic and ecological conditions, by changing what they do and how they do it. But how well are pastoral households doing based on these efforts? Researchers working in pastoral zones of East Africa have documented a trend of increasing pastoral poverty

(Rutten 1992; Broche-Due and Anderson 1999; Desta and Coppock 2004). This pattern seems to hold true in Maasailand as well. Substantial research has taken place to quantify the socio-economic status of households in agricultural and agropastoral societies with the goals of documenting change, or better targeting economic development activities (Dercon 1998; Morris, Calogero et al. 2000; Turner 2000). Metrics have been designed to capture wealth status and well-being in these systems, based variously on quantification of assets, income flows, and expenditure levels. Congruent efforts have been made to quantify wealth in pastoral societies, but the metrics used to measure economic status have heretofore been predicated almost entirely on the number of animals a household owns or sometimes the number of animals per capita a household can draw upon for subsistence. However, this chapter suggests that these measures are currently insufficient given the significant patterns of economic diversification and intensification documented in the GAE. Two new measures of wealth are therefore created: a diversified wealth index, which quantifies pastoral wealth as a combination of assets and income flows, and a breed-adjusted measure of herd size, which recalculates herd size based on the proportion of a household herd made up of larger, improved breed animals.

The broad goal of Chapter Three is then to go beyond baseline assertions that the pastoral economy of southern Kenya is changing, and make comparisons of pastoral wealth status across five wealth ranking methods. A wealth ranking of households based on a traditional measure, herd size, is compared to rankings of households based on four other wealth measures: 1) Tropical Livestock Units (TLUs) per capita; when household size is factored into wealth, 2) Wealth Ranking; when local informants define wealth criteria and group membership (Grandin 1988), 3) TLUs; when larger, graded animals are factored into the calculation of animal numbers per household, and 4) The new Diversification index of wealth; which is calculated as a combination of wealth stocks and income flows.

These analyses highlight how the status of pastoral households changes based on the criteria by which well-being is defined. Wealth levels according to animal herd size through time are also compared to look at changes in pastoral wealth status over the previous two decades. Additionally, comparison of wealth ranking methods should illuminate differences in how the parameters of wealth combine across the study area for poor, medium and rich households based on different levels of available services and infrastructure. Previous researchers have pointed out that societies in transition are far from homogeneous in the choices available to them and their subsequent trajectories of change (Thornton, Boone et al. 2007). The implications of these changes for human well-being are also equally variable (Reardon, Delgado et al. 1992) and this variability itself emerges as an important consideration in targeting development interventions in pastoral areas.

Data collection, manipulation and analysis methods are described in each chapter.

Critical Drivers of Change in the GAE

The following section provides an in-depth look at how historical precedents, formal policy alterations in land tenure laws and land use change conceptualized as a series of ultimate and proximate drivers have transformed the political, economic, demographic and cultural conditions facing Maasai pastoralists. This discussion is meant to provide a synthetic background to the three data chapters, as these processes of change are only summarized briefly in each chapter. Ultimate drivers represent fundamental system characteristics - originating both inside and outside the system, which set the stage for subsequent interactions between system components. Proximate drivers arise from the interactions between these fundamental features of the system and local conditions. The iterative effect in the Greater Amboseli Ecosystem has been to create an atmosphere of economic, social and ecological unpredictability and change for pastoral households. The combined timeline of changes is presented in Figure 1.

Ultimate system drivers

A variable and semi-arid climate, resource heterogeneity, human population growth, pastoral policy, and limited market access function as ultimate drivers within the GAE.

The climate in Amboseli is semi-arid, and rainfall patterns are highly variable temporally and spatially. Combined with large scale topographic, vegetation and soil gradients, the result is a resource base that is heterogeneous, or *patchy,* from the perspective of pastoralists and their animals. Mobility has been critically important in the face of this variability (Ellis and Galvin 1994; Galvin, Boone et al. 1999). Pastoral households timed their seasonal migrations to take advantage of diverse vegetation communities and key resources zones (e.g., swamps, riparian areas), and actively managed other areas as grazing reserves (e.g., highlands). These rangelands are already known for their variability, but climate change scenarios for East Africa also suggest that droughts and unprectability could intensify further in the future (Watson, Moss et al. 1998).

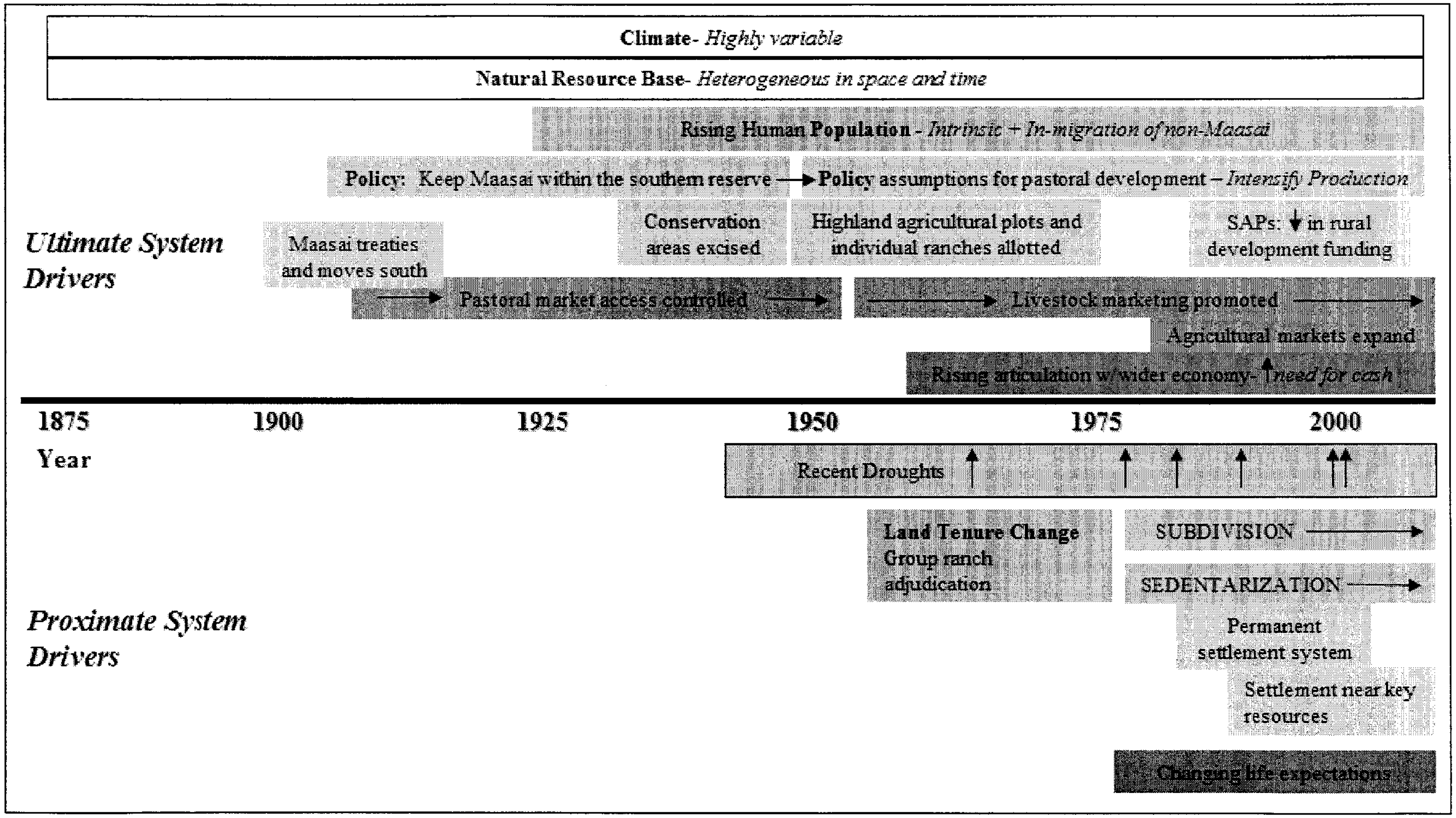

Figure 1. Timeline of ultimate and proximate drivers in Maasailand, Kenya. SAPs refer to Structural Adjustment Programs.

Human population in Kajiado climbed consistently throughout the 20th century, as a function of both intrinsic growth within the Maasai population and immigration of agriculturalist non-Maasai (Katampoi et al. 1990, Rutten 1992). Yet while human population has increased through time, livestock (cattle) populations have fluctuated but remained consistent over the long term (Bekure et. al., 1991). This has translated into a steady decline in livestock available per capita, and is an important factor in the rise of pastoral poverty documented in the region (Rutten 1992; Thornton, Kruska et al. 2003; Desta and Coppock 2004; BurnSilver 2005).

Historical land use policies and development priorities have also intensified competitive interactions between livestock, human and wildlife populations in Maasailand. At the advent of British rule Maasai territory extended over 60,000 km^2, but by 1911 the Maasai had signed treaties agreeing to remain within the boundaries of a 38,000 km^2 southern reserve (Kerven 1992). Losses of Maasai territory in the Amboseli region continued from 1930 to 1960, as successive influxes of non-Maasai cultivators to the Kilimanjaro highlands and swamps excised valuable grazing areas and habitat from use by herders and wildlife. Wildlife conservation priorities also led to the initial designation of the 3,260 km^2 Amboseli National Reserve in 1947, and finally the gazetting of a smaller Amboseli National Park in 1974 (390 km^2) (Western 1994), which nonetheless represented the permanent loss of access to key forage and water resources for local herders.

The economic policies of the British towards the Maasai in the early part of the century were equal parts "benign neglect" and "obstructionist" (Kerven 1992:40) as the Maasai were confined to the southern reserve and largely prevented from marketing their livestock. However, this policy stance changed in 1955 based on the Swynerton plan (authored by the assistant director for agriculture, RJM Swynerton) which emphasized the economic importance of pastoral areas to the Kenyan economy and charted the transformation of subsistence pastoralism to a system of intensive beef production, based on the assumptions of private property, enforced grazing controls and intensified use of production inputs (Oxby 1982; Rutten 1992; Fratkin and Wu 1997). In the 1990s, structural adjustment programs (SAPs) negatively impacted funding for rural development needs in pastoral districts, which translated into a decline in infrastructure and development services (e.g., veterinary programs, road development, schools and health care) (UNDP 2001; Boone, BurnSilver et al. 2007).

Market access for livestock producers, or the *lack thereof*, has been a key system driver that defines production options available to pastoral households. Historically, livestock markets were vital to Maasai livelihoods. Livestock marketing by Maasai was blocked during the colonial period to limit market competition with white settlers (Kerven 1992), but was later mandated by government intervention as the ideal mechanism to decrease stocking rates (Rutten 1992). The Maasai were criticized during this period as being market-averse (Herskovits 1926; Lamprey 1983). The parastatal Kenya Meat Commission (KMC) was created in the 1970s as a mechanism to guarantee markets and prices for pastoral livestock and promote market-oriented livestock selling. However the organization was plagued by funding and management issues and closed down in the 1990s. Much of the previous government marketing role was then filled by private slaughterhouses. The KMC reopened in 2005 and it remains to be seen how effective an institution it will be. Currently, selling of livestock is critically important for pastoral livelihoods, although the extent to which it is need-driven versus timed to take advantage of market prices is an ongoing question (Evangelou 1984; Zaal 1998; Zaal 1999). Marketing challenges in Kajiado are distance, lack of information and unstable prices (Kerven 1992; Holtzman and Kulibaba 1995; Zaal 1998).

Marketing and consumption of agricultural products has also emerged as a critical livelihood strategy in the swamps and the Kilimanjaro highlands since the droughts of the 1960s-80s (Southgate and Hulme 1996; Campbell 1999). Large swamp areas have been converted to agriculture, and significant conflicts are emerging over water management and reserve grazing areas for livestock and wildlife. Overall, the area of highland rainfed agriculture has increased 177% over the time period 1973-2000, while irrigation in the swamp areas increased by 45.2% (Campbell, Lusch et al. 2003). Market access is limited by poor transport infrastructure and high costs, and crop prices are highly variable. So while demand for agricultural products is expanding, agricultural returns to producers are often highly unstable (Norton-Griffiths and Butt 2003).

The trend is towards greater market articulation between Maasailand and the wider Kenyan economy. Livestock and agricultural products move from

Kajiado to the capital of Nairobi. In turn, there is now greater availability of and demand for services (e.g., education), foodstuffs and consumer goods in pastoral areas. Pastoral households thus have an increased need for cash to support these choices, but instability in livestock and agricultural markets limits efforts to satisfy them in practice.

Proximate system drivers

Proximate system drivers arise from interactions between fundamental system characteristics and local conditions. Proximate drivers in the GAE are recent drought history, land tenure change, changes in settlement patterns, and evolving livelihood expectations.

Droughts involving failure of either or both the long and short rains occur regularly in the GAE. The severe droughts of 1962-63, 1977 and 1984 signalled a period of sedentarization for many households as they settled in swamp areas to pursue agriculture as a survival mechanism and as a "short-term" strategy to build up their herds - with the goal of eventually returning to the system as pastoralists (Southgate and Hulme 1996; Campbell, Lusch et al. 2003). However, many of these households have not transitioned back into extensive pastoralism, and zones of sedentarized agropastoralism continue to grow.

Economic policies based on the premise that private lands would be managed more productively were the basis for formal changes in land tenure rules in Kajiado from the 1950s to the mid 1980s. Colonial administrators in the 1950s allowed Maasai county councils to grant *ad hoc* private title of communal trust lands to influential Maasai for individual ranches (Fratkin and Wu 1997; Galaty

1992). In the late 1960s, the newly independent Kenyan Government adjudicated over 38,000 ha of agricultural land on the Kilimanjaro slopes and individual ranches in Kaputei Maasai section (Rutten 1992). Then in 1968 based on funding from the World Bank and other donors, the government pushed to adjudicate Maasailand into community-leasehold Group Ranches. There is a rich history of research illustrating that the intensive production goals of the group ranch concept were not attained (Bekure, de Leeuw et al. 1991; Rutten 1992; Mwangi 2006). However, they did set the stage for a series of cascading changes to both formal land tenure rules and pastoral land use, the repercussions of which continue to play out in the system today.

One effect of the group ranch initiative was the installation of livestock infrastructure (e.g., stock dip tanks and water points), and other government - supported services (e.g., schools and health centers) in central locations. When group ranch boundaries disrupted traditional grazing arrangements in the Amboseli area, pastoral elders created a system of land use based on phased and enforced migrations between permanent (*emparnati*) and seasonal grazing (*enkaroni*) settlement areas (Worden 2007). *Emparnati* settlement zones evolved adjacent to newly installed local infrastructure, services and/or other key resources (e.g., roads and swamps) and these permanent settlement areas attracted additional services (e.g., local shops and grain mills). Thus infrastructure development and changes in settlement patterns were iterative to a process of land use change and additional sedentarization in these core areas.

Group ranches were a significant step in a formal effort to "rationalize" pastoral production. For policy makers, they were an intermediate step towards privatization of the rangelands, while many pastoralists saw group ranches foremost as a means of protecting their lands from further encroachment (Rutten 1992). But, almost from incorporation, there were calls to dissolve the ranches and subdivide further into private parcels. The dynamics for dissolution were both external and internal. There was widespread dissatisfaction with group ranch mismanagement and corruption, and a younger generation of pastoralists agitated to be registered in order to guarantee themselves future access to resources. Current members then voiced the need to subdivide sooner rather than later, since more registered members meant less land area ultimately for each household (Ntiati 2002). The Kenyan government was initially against group ranch subdivision, concerned that private parcels would neither be ecologically nor economically sustainable in such arid conditions, but this policy stance changed in 1983 to ideologically support individualized land tenure (e.g., private property) as a precursor to economic development (Fratkin and Mearns 2003).

Within the study area, only Osilalei is officially subdivided (since 1990). But, the membership of the three other ranches is currently debating how and when to subdivide their grazing lands. Division of these ranches into privately deeded parcels is now considered to be "inevitable" by many, although definitely not desirable by all (Ntiati 2002).

Life expectations among pastoralists are also changing. Greater market interaction between Maasailand and other areas of Kenya is one factor.

Economic opportunities are more available now than previously. But changing expectations also are an effect of economic and political drivers. Broader exposure to educational opportunities is another factor contributing to changes in how Maasai adults define "progress" and well-being for themselves and their children. There is a feeling among many Maasai parents that being a "pure" pastoralist is becoming more, not less difficult (pers. obs.).

Figure 1 illustrates that the new millennium in Maasailand is a time period when many ultimate and proximate drivers have combined to push for change. History, pastoral policy, land tenure change, population pressure and a mixture of economic opportunity and need are alternately pushing and pulling Maasai households to adjust what they are doing and how they are doing it. Alternately, the climate is dry, droughts are frequent, and the pastoral resource base remains highly variable in space and time.

In Sub-Saharan Africa, population growth, rising urban populations and greater income are projected to increase per capita demand for livestock meat and milk by 18% and 23% respectively through the year 2020 (Delgado, Rosegrant et al. 1999). This trend bodes well for pastoral households, but whether greater demand for livestock products translates into increased pastoral well-being in the future is, so far, an open question. Pastoralists are under unprecedented pressure to change, but important components of their landscape and productive environment also remain constant. What the emerging face of Maasai pastoralism will be is an unknown at this point. This dissertation is an effort to understand current trajectories of change and to peer forward into the future of pastoral Maasailand.

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CHAPTER 2

PATHWAYS OF CONTINUITY AND CHANGE: MAASAI LIVELIHOODS IN AMBOSELI, KAJIADO DISTRICT, KENYA

INTRODUCTION

The Greater Amboseli Ecosystem (GAE) extends approximately 8400 km^2 north, east and west from the base of Mount Kilimanjaro, and includes the Amboseli basin, swamp wetlands along the base of the mountain, and neighboring rangelands which act as seasonal dispersal areas for resident herbivore populations (Western, 1973). The ecological center of this system is Amboseli National Park (NP), however land use centers on the distinctive combination of transhumant pastoralism and wildlife habitat that has typically characterized a majority of East Africa's rangelands. Wildlife corridors, particularly for the area's substantial elephant populations, cross the Kenya-Tanzania border and link Amboseli ecologically with the Longido region to the south. This ecosystem is unique in many ways. It is a cultural and economic core area for Maasai pastoralism in southern Kenya, and the landscape has been characterized by both high wildlife diversity and abundance (Western, 2001). The combination of these human-ecological characteristics has made Amboseli NP one of Kenya's most visited tourist destinations. However, current literature on pastoral environments globally (Blench 2001) and in East Africa in particular (Fratkin and

Mearns 2003; Desta and Coppock 2004), emphasizes that the challenges facing pastoral ecosystems are daunting. The Amboseli system is typical in this respect, as research points out that local pastoralists there are becoming poorer overall (Rutten 1992; Campbell 1999), wildlife corridors are threatened (Noe 2003; Okello 2005), and some wildlife populations are in decline (Western 1973; Western and Nightingale 2003; Worden, Reid et al. 2003). Current challenges to Maasai pastoral livelihoods include an intensified recent cycle of drought in Eastern Africa (FEWS NET 2005), changes in land tenure from flexible use of communal rangelands to intensified use of small private parcels (Western and Nightingale 2003; Mwangi 2006; BurnSilver, Worden et al. 2007), sedentarization of land use (Fratkin 2001), and rising expenditures associated with greater involvement in the cash economy (Rutten 1992; Campbell 1999; Campbell, Lusch et al. 2003). Livelihood expectations among pastoralists are also changing, and the question of what a pastoralist should do to survive - let alone thrive - is increasingly relevant. Constraints on Maasai land use are alternately pushing and pulling pastoralists, constraining what they do - and how they do it.

It is clear that pastoralists across many East African systems are currently trying a variety of strategies to adapt and cope with changes in their productive environment (Thompson, Serneels et al.; Humphrey and Sneath 1999; Little, Smith et al. 2001; Coast 2002; Thompson 2002; Thompson, Serneels et al. 2002; Homewood, Trench et al. 2006). Maasai traditionally were dependent on a combination of livestock species, specifically cattle, sheep and goats, for their livelihoods. Currently, they are diversifying their livelihood choices into agriculture, businesses and wage labor, activities that are well beyond the "traditional" raising of livestock for subsistence. So are livestock still important in spite of these moves to widen their livelihood base? Research has pointed out that Maasai may also be intensifying their livestock production strategies - essentially an effort to "get more" from the livestock they do have (Rutten 1992; Rege and Bester 1998). Additionally, given the close proximity of Amboseli NP and the presence of significant wildlife populations outside of park boundaries, community-based conservation has emerged as a development focus for the region. A growing number of conservation-oriented enterprises are now in place across the Amboseli ecosystem – all married more or less closely to the idea of improving pastoral well-being while simultaneously conserving wildlife populations over the long-term. The question remains however, in spite of substantial literature and resources linking conservation and improved livelihoods, does conservation-based income contribute directly to the well-being of Maasai households in Amboseli – within the overall context of efforts by pastoralists to diversify and intensify their activities beyond subsistence pastoralism?

This chapter will focus on four themes; 1) describing patterns of diversification of pastoral livelihoods in the Amboseli system, both in terms of the combinations of activities households are pursuing and the relative value of those strategies to livelihoods, 2) identifying potential spatial and socio-economic determinants of why one strategy is chosen over another, 3) analyzing the relative importance of conservation-based income within household economic strategies of the Maasai, and 4) describing trajectories of change and future land use in Maasailand – linking analyses of diversification dynamics through time and the parallel process of intensification of livestock production strategies. In the context of these themes, the livelihood choices being made by the Maasai of Amboseli will contribute to the ongoing effort to describe the newly emergent faces of pastoralism in East Africa.

STUDY SITE DESCRIPTION

The focal area is the Greater Amboseli Ecosystem, which extends across the southern portion of Kajiado District, Kenya (Figure 1). Research took place in six study areas (Osilalei, Eselenkei, Lenkisim, Emeshenani, N. Imbirikani and S. Imbirikani), on four Maasai group ranches; Eselenkei, Olgulului/Lolarashi, Imbirikani and Osilalei. Mount Kilimanjaro and the Tanzania border lies to the south, and bracketing the study area are the Chyulu Hills to the east and the Pelewa Hills to the west. A line of swamps fed by the forests on Mt. Kilimanjaro extend east-west along the base of the mountain; the Enkong'o Narok and Longinye swamps are critical wildlife habitat inside Amboseli National Park, while Namelok and Kimana swamps lie outside the park, and are currently the center of intensive agricultural activities for the Maasai (and non-Maasai) settled there. Agriculture also takes place on the banks of the Kikaronkot River, which extends eastward out of the Kimana swamp. Namelok was fenced for agriculture in the early 1990s. The Kimana swamp remains unfenced to date, but because of intensive agriculture and its location adjacent to the Kimana Wildlife Sanctuary, it is currently a major hotspot for human-wildlife conflicts.

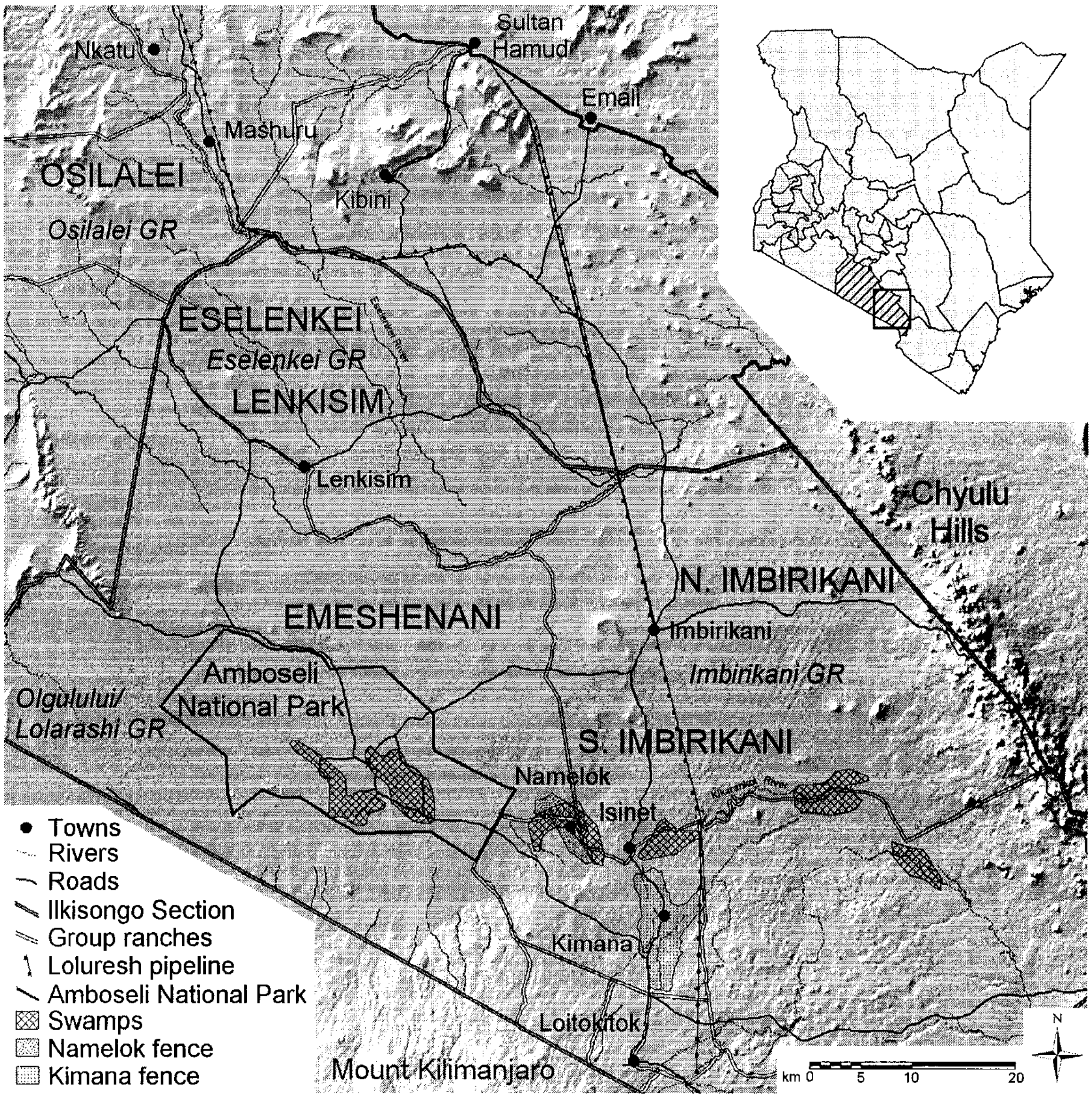

Figure 1. Map of Kajiado Study area.

The majority of southern Kajiado district is categorized as either arid or semi-arid lands (Katampoi, Genga et al. 1990), with only the Kilimanjaro foothills considered appropriate for rainfed agriculture. A rainfall gradient decreases north to south across the study area. Osilalei in the north receives 500-600 mm of annual rainfall, but Olgulului/Lolarashi -- in the rainfall shadow of Mt. Kilimanjaro -- receives only 350 mm/year on average. Rainfall patterns are patchy and irregular with substantial variability both within and between years. The rainfall coefficient of variation for the area is 27.8% (Boone and Wang 2007). Annual rainfall patterns are bimodal. Dominant vegetation communities in the study region include grasslands, wooded grasslands and bushland, with acacia trees and shrubs (e.g., *Acacia drepanolobium*) and red oat grass, *Themeda triandra* as the dominant plant species. Underlying soil and topographic gradients create a mosaic of vegetation communities on the landscape. When rainfall variability is overlaid on these gradients, the result is a highly heterogeneous landscape, where the availability of forage varies spatio-temporally and in terms of quantity and quality. The resultant patchy nature of grazing resources on the landscape was the major factor mandating mobility as a traditional coping strategy for pastoralists in this system.

Overall, access to productive infrastructure in the Amboseli ecosystem is low, but what resources do exist are also clumped in particular areas. A north-south all-season (dirt) road connects the large market towns of Emali and Oloitokitok, and links the Amboseli region to the main Nairobi-Mombasa highway (Figure 1). These towns offer major weekly markets, banking services and secondary schooling, and Emali is the region's largest livestock market. Smaller towns on or near this road (e.g., Kimana, Isinet, Namelok and Imbirikani) provide access to other basic services (e.g., primary schools, shops and health care). Kimana also hosts a smaller weekly livestock market. The Lolturesh water pipeline parallels the main N-S road, providing access (both paid and illicit) to clean water for livestock, household consumption and local wildlife. Namelok and Kimana swamps straddle the main N-S road and provide irrigation water for agriculture, and drinking water for wildlife, livestock and household use – although this water is highly contaminated with runoff from agricultural chemicals (Githaiga, Reid et al. 2003). Proximity to the main N-S road facilitates marketing of agricultural products from the swamps. N. and S. Imbirikani study areas lie along this service corridor. Another all-weather road connects Kajiado town and the N-S Emali/Oloitokitok road, and passes along the northern boundary of Osilalei and Eselenkei group ranches. A weekly livestock market, primary school and health center are located at Mashuru town in Osilalei study area. A secondary water pipeline off the Lolturesh pipeline parallels this road, and again provides paid (and illicit) access to water use for households and livestock.

Seasonally navigable roads connect the interior areas of Eselenkei and Olgulului/ Lolarashi group ranches. Lenkisim town is the center of Lenkisim study area, and is the location of a Catholic Mission whose development work has focused on offering health care, water provision, supporting local primary schools and building new nursery schools in the region. The interior study areas of Emeshenani, just to the north of Amboseli National Park, and Lenkisim are challenged by lower accessibility to markets and less access to dependable dry season water sources.

CRITICAL HISTORY IN THE GREATER AMBOSELI ECOSYSTEM

Land Tenure Change

Privatization of communal lands and sedentarization of pastoral households on particular areas of the landscape are two critical trends affecting Maasai land use and livelihoods, as well as the sustainability of wildlife populations in the Amboseli system. These changes have cultural and ecological implications, as the pastoral system transitions from one characterized by flexible and extensive movements keyed in response to forage conditions and water availability, to one based on intensive use of individual parcels (Reid et al. 2007; BurnSilver and Worden 2007). These changes also affect options for livelihoods, as most pastoralists recognize that privatization will imply declines in the numbers of livestock that can be maintained on small individual parcels (BurnSilver 2005), therefore pushing households to try other economic activities or substantially change the way they raise livestock. Subdivision implies fragmentation of the landscape into private parcels, while sedentarization describes a process of permanent settlement. However, these patterns are linked and self-reinforcing, as sedentarization may occur either prior to, or as a direct effect of subdivision (BurnSilver and Mwangi 2007). Conversely, households may settle permanently out of economic choice or need, without subdivision being a deciding factor. Both patterns however, imply a potential decline in the mobility of households (Fratkin, Roth et al. 1999).

The precursors of the subdivision process lie in the widespread assumption held by policy makers and rangeland specialists that private property is a more rational and productive basis for economic development than communal land tenure (Mwangi 2006). In Kenya, these assumptions translated into a policy goal with two foci, to 1) transform land tenure from communal to private, and 2) transition pastoralists away from a subsistence economy to one based on intensified production of livestock for the marketplace (Galaty 1992). There was some concern in the minds of policy makers that an abrupt change from communal land tenure to private parcels would not work (Oxby 1982), so the formation of group ranches was proposed as an intermediate step. In the 1960s, the Kenyan government – supported financially and programmatically by the World Bank – adjudicated communal rangelands in Kajiado and Narok districts into group ranches, whereby leasehold tenure was granted to groups of registered pastoral households (Hedlund 1980; Oxby 1982). Internal and external policy pressures have since the 1970s pushed the process to proceed further, and 40 of 52 group ranches in Kajiado District are now subdivided into private parcels (Kimani and Pickard 1998). In spite of initial concerns over the economic and ecological viability of small parcels in arid lands, the Kenyan government now supports private property on a national basis as a foundation of economic development (Mwangi 2003).

In the Amboseli study area, Osilalei group ranch is subdivided and most extended households are now split and sedentarized onto their individual parcels. Members of Olgulului/Lolarashi and Imbirirkani ranches have recently voted to proceed with subdivision in principle. Agricultural lands in Imbirikani (Kimana and

Namelok swamps) and Olgulului/Lolarashi (Namelok swamp and Emurutot on the slopes of Mt. Kilimanjaro) have been subdivided informally, but core rangeland areas are still intact and used communally. Pastoralists around Namelok and Kimana swamps who pursue agriculture are largely sedentary – linked to the permanency of their agricultural activities and the presence of other infrastructure services (e.g., schools, shops and markets). Land use patterns in other areas of the Amboseli system combine areas of permanent settlements located near infrastructure and services, with the flexibility for portions of households to migrate seasonally to dry season grazing areas (Worden 2007).

Wildlife Conservation in the GAE

An additional dynamic at play currently in the GAE are efforts to conserve biological diversity and link conservation to pastoral livelihoods. The Amboseli system is well-known as region that combines high biodiversity and unique cultural values, but the area is also known as the birthplace of "Community-based conservation", an approach that for the first time equally prioritized the dual goals of human development and natural resource conservation (Western 1994). In the case of Amboseli this approach crystallized in the mandate to make "wildlife pay its way", recognizing that while wildlife was the source of substantial tourism revenues, *living with wildlife* implied costs for Maasai pastoralists in the form of losses in territory and water resources, safety concerns, disease transmission and competition for grazing.

The creation of Amboseli National Park in 1974 was dramatic, politically-charged and controversial, and it challenged both local Maasai and conservation stakeholders to identify potential solutions to the conundrums of wildlife conservation over the long-term, and sharing of wildlife benefits with local communities. The agreements worked out in this early period called for a water distribution system to be set up to compensate Olgulului/Lolarashi group ranch herders for lost access to swamps inside the National Park, and revenue sharing of park gate receipts with the six group ranches closest to the park: Olgulului/Lolarashi, Imbirikani, Eselenkei, Kimana, Kuku and Rombo. The agreement reflected the ecological reality that some Amboseli wildlife disperse in and out of the park area on a seasonal basis (e.g., wildebeest, zebra and elephant), and other species of wildlife remain on Maasai rangelands year-round. Osilalei group ranch was never a part of this revenue-sharing arrangement as the group ranch was considered to be outside the park's wildlife dispersal zone.

Since this time, gate receipts have flowed to the original six group ranches and are earmarked at the community level primarily to subsidize secondary school fees for children of group ranch members. However, the water distribution system is widely seen as a failure (Boyd, Blench et al. 1999), and serious corruption and misuse of Kenya Wildlife Service (KWS) funds on the group ranches is an ongoing concern (pers. obs.). There are also additional sources of wildlife and tourism-based revenues coming into the Amboseli group ranches. On Imbirikani, bird shooting and game cropping are sources of benefits. Sales of gravel/sand to area lodges, fees from a public campsite and cultural boma visitation are sources of income on Olgulului/Lolarashi. The Amboseli-Tsavo Game Scout Association employs and trains group members from the same six Maasai ranches (Roque de Pinho 2004).

Additional community-based conservation initiatives, wherein group ranches have partnered with or leased group ranch lands to private tourism operators to share tourism benefits, include: Oldonyo Wuas, located in Chyulu Hills National Park (N. Imbirikani study area), Eselenkei Community Conservation Area (Lenkisim study area), Elerai and Kitirua (on Olgulului/Lolarashi GR) and Kimana Wildlife Sanctuary (Kimana GR). Elerai, Kitirua and Kimana are outside, but still close to, the study areas focused on in this chapter. These tourism operators lease group ranch lands, pay bed night conservation fees and employ group ranch members. Particularly in the cases of the Eselenkei and Chyulu enterprises, efforts were made by the operator to employ poorer community members.

All these sources of revenue: game cropping, park gate receipts, lease payments and bed night fees accrue at the community level and then are distributed outward (ideally), towards community development projects (e.g., school fees, construction of schools and water points). Opportunities for individual households to access tourism-based revenue include salary and wage employment, or involvement in other tourism-based businesses and craft sales. However, whether the initial promise of community-based conservation to "make wildlife pay" has been realized, and the degree to which wildlife contribute widely and meaningfully to individual livelihoods, is a still hotly contested issue. Many researchers have at this point questioned the initial assumptions and sustainability of community-based conservation – an approach alternately known in the literature as "integrated conservation development projects" (Barrett and Arcese 1995; Agrawal and Gibson

1999; Goldman 2003; Berkes 2004). Examining some of these assumptions in the context of Amboseli livelihoods is one goal of this chapter.

A Gradient of Land Use in the GAE

Current patterns of land use across the Amboseli system reflect previous policy narratives and current development foci. They are also a combined manifestation of access to infrastructure, economic opportunities, and settlement history. A gradient of pastoral land use is represented across the GAE, extending from agropastoral land use in the swamps, to pastoralism on subdivided parcels, to extensive pastoralism in interior, core rangeland areas. The livelihood decisions of pastoral households as they link to political-economic, infrastructure and ecological characteristics of the system will be a focus of the balance of this chapter.

METHODS

Results presented here are based on field research on Maasai livelihoods in the GAE which took place from November 1999 to March 2001. This research was part of a larger Ph.D. study (BurnSilver 2007) that focused on identifying Maasai strategies of economic diversification and intensification taking place within a larger political-economic context of land tenure change and landscape fragmentation. The year 1999 was considered "normal" by local Maasai, although 2000 was a year of serious drought.

Five of the six study areas are part of Ilkisongo Maasai section (Eselenkei, Lenkisim, Emeshenani, N. Imbirikani and S. Imbirikani), while Osilalei study area is part of Matapaato Maasai section. The six areas initially were chosen in an effort to represent a range of land tenure conditions (subdivided vs. communal), land uses (extensive pastoralism vs. sedentary agropastoralism) and degree of access to resources (e.g., irrigated swamps and services infrastructure) (Table 1). Agroecological potential across the study areas also differs, as the rainfall gradient declines from north to south. A sample of 184 households was chosen using a proportional stratified random sampling strategy based on wealth and location. Multiple community informants from each study area used Grandin's wealth ranking technique (1988) to categorize all the households from each study area based on locally relevant wealth indicators. The criteria cited most often that identified wealthy vs. poor households in this exercise were (in order of importance), 1) number of animals, 2) family size, and 3) access to "new" sources of wealth (e.g. salaries, a vehicle or agriculture).

A "household" was defined as an *olmarei,* consisting of a herd owner, his wives and dependents. Male heads of households were interviewed except in one case where the head of the household was female. Two survey strategies were used in working with households. A small subsample of households that were evenly spread across the six study areas (n=38) was interviewed twice; once in the dry season and once in the wet season. A larger sample of households (n=146) was interviewed once. The survey instruments consisted of specific household information and open-ended questions. Interview questions focused on household socio-demographics, livestock mobility, herd composition, livestock numbers, livestock inputs, livestock productivity, agriculture inputs/outputs, household economic timelines, and the timing and returns associated with all off-farm household economic activities.

Table 1. Distribution of study sample by study area characteristics.

	Study Areas						
Study Area Characteristics	Osilalei	Eselenkei	Lenkisim	N. Imbirikani	Emeshenani	S. Imbirikani	Total
Land Tenure	Divided	Communal	Communal	Communal	Communal	Communal	
Land Use	Sedentary	Extensive	Extensive	Extensive	Extensive	Sedentary	
Infrastructure access	High	Medium	Low	Medium	Low	High	
Agroecological potential	High	High	Medium	Medium	Low	Low	
Total hhlds surveyed	29	30	30	32	29	34	184

The diversification patterns of households were analyzed using two contrasting methods. Descriptive statistics were used to define the livestock-based, agricultural and off-land activities of each study area. Off-land activities were defined as either Petty Trade (e.g., micro-businesses), Business (larger-scale business activities), Wage and Salary jobs or Wildlife-based activities. Then households were re-categorized based on the ACEBIN binary clustering methodology in SAS, by which the 184 households were placed into groups according to the specific combinations of activities being pursued. All households were binary coded for presence/absence of particular activities, yielding groups of households with a narrower range of common activities. The economic returns to households based on combinations of strategies were also quantified across each method. A comparison of results between methods should illuminate different aspects of diversification patterns and their associated returns.

Multinomial Logistic Regression (SPSS Version 15) was then used to identify if spatial, demographic and productive variables explain livelihood cluster membership for groups of households. In other words, what factors predict livelihood choices? To address the question of "Who is doing well within the GAE?", a backwards stepwise regression technique (OLS in SPSS V.15) was run to identify factors that predict 1) household gross household income, and 2) livestock holdings (represented as Tropical livestock units (TLUs), where animal numbers are standardized according to their body mass in reference to a 250kg female Zebu cow (Bekure, de Leeuw et al. 1991). The measure of gross household income incorporates the contributions of non-livestock income to household livelihoods, while the TLU measure only considers the size of a household herd within the context of livestock production efforts. Gross household income was calculated here as gross returns in US dollars from livestock (sold, received as gifts, slaughtered, milk and hides/skins sold), off-land activities (Business, Petty Trade and Wages/salaries), and agriculture (sold and consumed products). An exchange rate of 73.5 Ksh to $1US was used throughout all analyses.

Both qualitative and quantitative data on livestock intensification strategies were analyzed and presented. Qualitative data on breed change, hiring of herding labor, livestock selling, and use of banking and credit resources reflects respondents' views on the degree of change occurring across the GAE (ranked from no change to high levels of change) . Quantitative data pulled from household surveys broke down these trends further. Discussion of future trajectories of change in the Amboseli system is based on household survey data. Household heads described the lifecycle of their productive activities, listing all the activities they had engaged in, the years those activities were started and stopped, and why. Analyses of activities based on age of household heads and year paint a picture of the ebb and flow of specific livelihood pathways in the GAE from the 1950s to the current day.

AMBOSELI LIVELIHOODS

The following sections describe current household combinations of activities in Maasailand in alternate ways. Descriptive statistics are presented, which quantify the breadth and distribution of activities engaged in by study area. Cluster analyses then group households according to the specific combinations of activities they are pursuing. Two questions underlie these analyses: What are people doing?" and "What are people getting from those activities?"

Study Area Analyses

Livestock production

All study households own at least some livestock. All households own at least two cattle, and all but three own some smallstock (either sheep or goats). Ninety-eight percent of households received at least some income from their livestock. Livestock income is defined as either cash or consumption value accruing from animals, milk or hides/skins sold, and animals slaughtered or received as gifts. On average households draw 64% of their gross income from livestock sources, but relative importance ranges from 45-84% depending on location. Livestock still generate greater than 50% of total gross income for 66.8% of households. However, the distribution of livestock across households is strongly skewed. In terms of TLUs per adult unit (AU), 75.5% of sampled households have less than eight TLU per AU – the number of livestock considered necessary to support a purely pastoral lifestyle (Bekure et al. 1991). The top 12.5% own 50.4% of all livestock TLUs within sampled households. These figures provide some initial insight as to why households are diversifying beyond core livestock activities.

Mean values for livestock holdings per household, holdings per adult equivalent and household gross livestock income are presented in Table 2. Livestock holdings per household and per AU are generally greater in core rangeland areas (e.g., Emeshenani and N. Imbirikani), and lower in areas where households are sedentary and/or settled on private holdings (Osilalei and S. Imbirikani). However, variability in livestock holdings within all study areas is high. Households located at the northern edge of the study zone (e.g., Osilalei and Eselenkei) have more smallstock than cattle, a trend possibly linked to greater demand for sheep and goat meat in the urban markets of Nairobi (Zaal 1999). Gross income from livestock is statistically different across the study areas (ANOVA $F=3.897$; df 5, 178; $p<0.000$); it is highest in Emeshenani and N. Imbirikani, and lowest in S. Imbirikani. As would be expected, gross livestock income and TLUs per household are highly correlated (Spearmans Rho, $r=0.762$, $p<0.001$).

Table 2. Livestock holdings across the study areas.

Study Area	Mean TLUs per household	St. Dev.	Mean TLUs per AU	St. Dev.	Ratio Cattle: Smallstock	Gross Livestock Income ($)	St. Dev. ($)
Osilalei	40.5	36.9	5.4	4.0	0.5	977	958
Eselenkei	63.2	67.5	7.0	6.1	0.7	1004	906
Lenkisim	60.8	82.4	6.1	6.8	0.9	915	1125
N. Imbirikani	76.2	98.1	6.8	4.8	1.1	1803	2111
Emeshenani	100.2	174.8	8.7	11.1	0.9	1415	1040
S. Imbirikani	30.7	43.3	4.3	5.4	1.1	551	769
Total	61.3	95.8	6.3	6.7	0.9	1111	1294

By far, most livestock income comes from sale of livestock across all study sites (65-91%) (see Appendix 1 for a detailed break down of livestock income sources). Livestock slaughter, livestock gifted into the household, and hides and skins make up only between 1 and 17% of income on average, depending on location. Milk-based income contributes little to the overall value of livestock returns, with the exception of S. Imbirikani, where milk sales represent 14% of total livestock income (e.g., based primarily on milk purchases by non-Maasai agricultural families).

Agriculture

Overall 87 households (53%) were gaining at least some returns from agricultural activities. Gross returns here are calculated as the market value of sold and consumed products. The mean number of households receiving returns from agriculture by study area ranged from a high of 94% in S. Imbirikani to a low of 17% in Lenkisim (Table 3). Agriculture represented greater than 25% of total gross income for 22.3% of households. However, only 8.2% of households received greater than 50% of their total gross income from agriculture. Results show that gross returns from agriculture are hugely variable across households, across study areas, and across agricultural types (Table 3).

Table 3. Agricultural activities by study site. The three types of agriculture are shaded to highlight differences in acreage and geographic distributions across sites.

Study Sites	Lowland Rainfed		Rainfed Highland		Irrigated		% Hhlds with AG Income	Gross Income AG ($)	Std. Dev. ($)
	Area (ha)	% Hhlds	Area (ha)	% Hhlds	Area (ha)	% Hhlds			
Osilalei (29)	1.1	97	0	0	0	0	79	175	140
Eselenkei (30)	0.6	27	0	0	0	0	23	155	100
Lenkisim (30)	0.1	3	3.5	10	2.8	3	17	759	1167
N.Imbirikani (32)	0	0	1.7	6	1.8	31	34	591	554
Emeshenani (29)	0.2	3	5.2	17	0.9	10	31	323	266
S.Imbirikani (34)	0	0	1.1	18	1.1	91	94	488	528
Total (184)	0.9	21	2.9	9	1.2	24	47	390	496

Three types of agriculture are practiced in the Amboseli system and these strategies are linked to available resources and agroecological potential (Table 3). *Irrigated agriculture* based on cultivation of horticultural crops (e.g., primarily tomatoes and onions) and consumption-oriented production (e.g., corn and beans) occurs in the swamp areas (S. Imbirikani). *Highland rainfed* cultivation of primarily corn and beans is carried out on upland Kilimanjaro slopes by households who have accessed land there through purchase, marriage or kinship relationships (e.g., primarily N. Imbirikani, S. Imbirikani and Emeshenani households). Potential for *lowland rainfed* cultivation of corn and beans is limited to the northern and wetter regions of the study area, e.g., Osilalei and northern Eselenkei, although crop failure is these areas is still common. Campbell et al. (2003) refer to lowland rainfed cultivation as "expeditionary agriculture", questioning its stability as a long-term source of benefits. But, despite this evaluation, most households in these study areas still cultivated. Households plant crops on old household compound sites where manure has accumulated and soil fertility is relatively high.Gross agricultural returns are highest per hectare in irrigated areas, followed by highland rainfed zones, but even these irrigated returns are highly variable: They are plagued by drought, unreliability of irrigation water and salinization issues. Results for irrigated returns per ha (Table 4) are also dramatically lower than those reported by Norton Griffiths and Butt (In preparation), again emphasizing the inherent variability in returns for irrigated crops. There is also strong spatial flexibility in agricultural activities, as households in rangeland areas with only low to medium agroecological potential (e.g., N. Imbirikani, Lenkisim and Emeshenani) still manage to engage in highland or irrigated agriculture. This is accomplished by splitting of households or forming agricultural partnerships. Thirty-one households (17%) spatially diversified their activities based on dividing households between settlements or traveling back and forth between livestock and agricultural activities. When households are split, one wife and school children may be located in one settlement, while another wife (or wives) stays at the livestock compound.

A high proportion of households in irrigated swamp areas also partner with others to carry out agricultural activities (Table 4). This arrangement became less frequent moving from irrigated and highland rainfed to rainfed lowland agriculture zones. Particularly in swamp and highland areas, partners are most often non-Maasai (e.g., usually of either Chagga or Kikuyu ethnicity). Under a partnership agreement, plot owners commonly front the costs of all agricultural inputs, while the partner provides the majority of day labor. At harvest time, input costs are subtracted from gross profits and the remaining returns (either crops or cash) are split 50/50 between owner and partner. Interestingly, there is almost no difference in net returns per hectare, per partner in partner vs. non-partner agriculture for either rainfed lowland and highland areas even after profits have been split, suggesting that the additional labor available under partnership arrangements may translate into greater productivity overall (Table 4). The gap between non-partner vs. partner returns in irrigated zones does increase, and average non-partner returns per crop are greater. However, the benefit of these partnerships may accrue at the household level for pastoral households with limited labor, or who do not choose to fully engage with agriculture themselves.

Table 4. Comparison of net agricultural returns per area and labor organization by agricultural types.

	Rainfed Lowland		Rainfed Highland		Irrigated	
Agriculture Labor	Mean Return/ha ($)	%	Mean Return/ha ($)	%	Mean Return/ha ($)	%
With Family	267	91	238	33	676	59
With Partner	256*	9	224*	67	467*	41

* These values reflect gross returns minus costs per cultivated crop, divided in half.

Off-land activities

Potential economic diversification options for Maasai households also include a variety of off-land activities, specifically; businesses, salary and wage income, petty trade and wildlife-based activities. Wildlife-based activities are a combination of business and salary/wage jobs. Remittances from represent a portion of each activity category. Over 58% of households were receiving some household income from off-land activities. However, the relative value of these activities is not evenly distributed across the study sample, as non-livestock and non-agricultural activities represent greater than 25% of income for only 37% of households, and greater than 50% of gross income for only 20.1% of households. Significant differences in both proportion of income coming from off-land sources (ANOVA F=5.878; df 5, 178; p<0.001) and mean off-land income (ANOVA F=3.086, df 5, 178; p=0.01) exist between study areas, although variability in returns across households is clearly high (Table 5). This variability is particularly noticeable in terms of wildlife-based income. Wildlife-based income is rare in S. Imbirikani, but highly lucrative, while it is more common, but less valuable in N. Imbirikani and Lenkisim. It is common in Emeshenani, but of almost no value and non-existent in Osilalei and Eselenkei.

In summary, there are clear differences in the activities that households engage in across the study sites. These differences generally appear to be linked to the specific agro-climatic conditions and potential existing around each site. One message is that Amboseli households are opportunistic – adapting their production systems according to the options available to them. However, results also show significant variation in household production strategies within study areas (preceding tables), but mean gross income levels across most study areas are within $350 of each other (although Emeshenani and N. Imbirikani seem significantly higher) (Table 6). This suggests that clustering households by similarity of strategies may allow a closer examination of the returns from specific livelihood choices, and the characteristics that define these groups of households.

Table 5. Distribution of off-land activities by study areas.

Study Sites	Hhlds with Off-Land Income (%)	Mean Income ($)	Std. Dev. ($)	Hhlds with Wildlife-Based Income (%)	Mean Income from Wildlife Activities ($)	Std. Dev. ($)
Osilalei	66	468	776	0	0	N.A.
Eselenkei	57	815	557	0	0	N.A.
Lenkisim	70	536	389	13	642	644
N. Imbirikani	66	829	857	22	786	793
Emeshenani	52	297	444	10	191	187
S. Imbirikani	32	494	516	3	1730	0
Total (184)	57%	589	644	8%	691	706

Table 6. Total gross income by study area.

Study Areas	Gross Income ($)	Std. Dev. ($)
Osilalei	1332	1162
Eselenkei	1443	1299
Lenkisim	1338	1723
N. Imbirikani	2556	2526
Emeshenani	1615	1260
S. Imbirikani	1194	1188
Total	1583	1655

Cluster Analyses

Application of the ACEBIN clustering method yielded eight clusters in the GAE. Basic characteristics of these clusters are presented in Table 7 based on the set of 12 original clustering variables. Names assigned to each cluster are meant to be descriptive only of the activity combinations of households within each group. Some immediate patterns are clear. Two clusters (*Livestock only intensive* and *Livestock only consumers*) base their livelihoods entirely on livestock. These clusters are differentiated only by the livestock purchasing actions of *Livestock only intensive* households. Two other clusters combine livestock primarily with either salary and wage activities (*Livestock wage earners*), or with business and petty trade activities (*Livestock business*). Households in four clusters carry out some form of agriculture. Use of the terms cultivator vs. agropastoralist differentiates the role and importance of agriculture in these four clusters. *Agropastoralists* not only carry out substantial agricultural activities, but these activities also contribute substantially to the households' livelihoods. In contrast, cultivator households are engaged in lowland agriculture only, returns are low and these activities do not contribute greatly to livelihood strategies. *Livestock lowland cultivator* households and *Diversified lowland cultivators* both engage in lowland rainfed agriculture, but are differentiated from each other by the addition of off-land activities to the livelihood strategy of the latter group. *Irrigated/upland agropastoralist* households combine either highland rainfed or irrigated agriculture with livestock production, while *Diversified agropastoralists* combine off-land activities with both agriculture and livestock activities.

Table 7. Proportion of households engaged in specific activities within clusters. Shaded columns are livestock only clusters. All values are percentages of households. All empty cells correspond to zero values.

Clustering Variables	Livestock intensive n=17	Livestock consumers n=22	Livestock-lowland cultivators n=12	Diversified lowland cultivators n=26	Livestock and business n=34	Livestock wage earners n=18	Irrigated/ upland agro-pastoralists n=23	Diversified agro-pastoralists n=32
TLUs	100%	100%	100%	100%	100%	100%	100%	100%
Livestock Income	100	100	100	100	94	100	100	97
Livestock Purchase	100		67	35	40	78	61	62
Livestock Slaughter	94	70	13	69	61	89	26	66
Crops Sold			8	11			91	87
Crops Consumed			83	85			83	81
Petty Trade				30	12	11		22
Business				54	97	18		59
Salary and Wage				35		100		41
Irrigated Agriculture							87	78
Highland Rainfed Agriculture							22	44
Lowland Rainfed Agriculture			100	100				

Proportional contribution of activities to gross household incomes

Focusing first on the question of what activities households are engaged in, clear patterns emerge across livelihood clusters. Figure 2 breaks down the activities of households according to their proportional contribution to household gross annual income. Milk sales are treated separately from livestock-based income in these analyses as this income stream emerges as important for specific household groups. As shown in the study area analyses, the relative importance of livestock activities across all clusters is high, but these differences become clearer across clusters. Additional activities are critically important for certain clusters, but the value of agriculture and off-land incomes combined is greater than 50% on average for only 4 of 8 clusters. So while a message of this chapter is that diversification is important to livelihoods, there are caveats to this assertion for certain types of households.

While households in four clusters do carry out agriculture, the proportion of income represented by agriculture is clearly different between lowland rainfed agriculture, and irrigated/upland rainfed agriculture, e.g. low vs. high. Poorer *Irrigated agropastoralists* depend proportionally to a much greater extent on agricultural returns relative to *Diversified agropastoral* households. *Irrigated agropastoralists* are livestock poor (Figure 3) and engage in no off-farm activities, thus in spite of successful diversification into agriculture, this group remains extremely poor. The importance of milk-based income also emerges in the two agropastoral clusters. Salary and wages make significant income contributions for *Livestock wage earners* and somewhat for *Diversified lowland cultivators* and *Diversified agropastoralists*. Highly diversified clusters (e.g., *Diversified lowland cultivators* and *Diversified agropastoralists*) display a pattern of more even dependence on a wider variety of household activities.

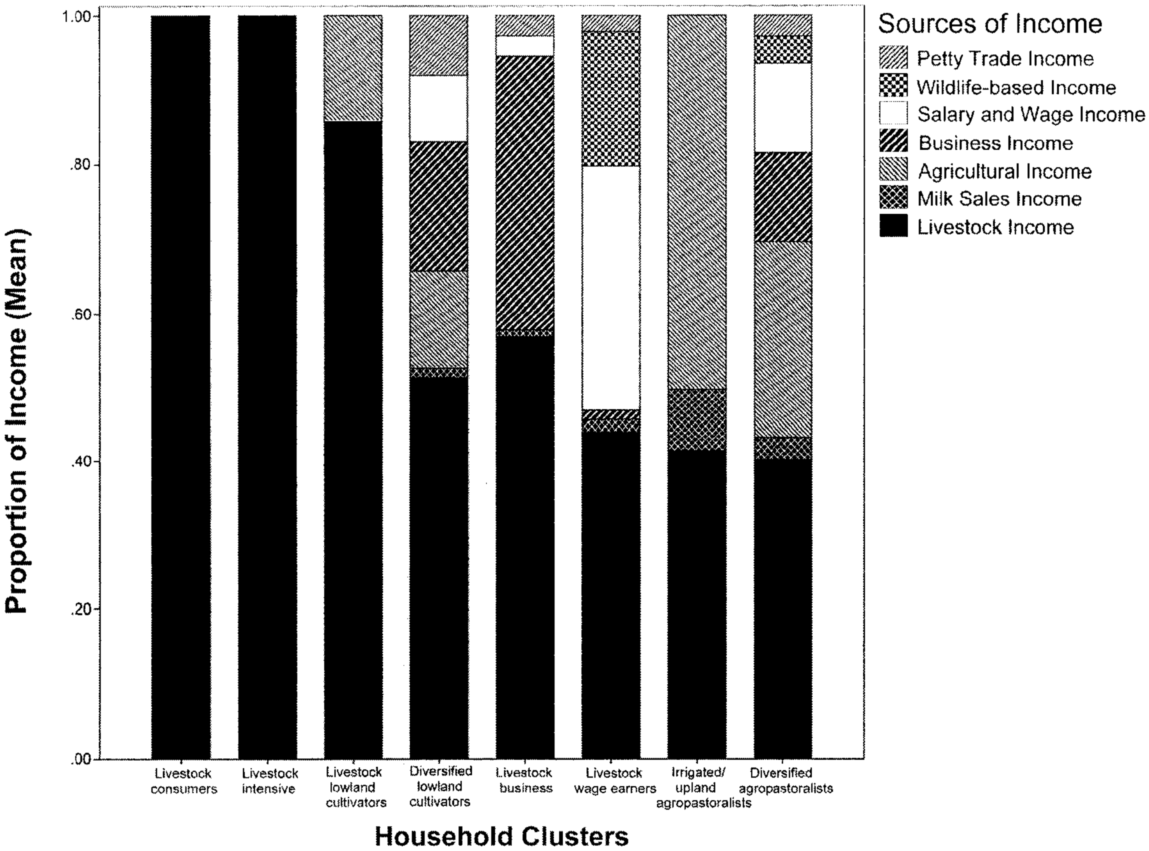

Figure 2. Proportion of income from all activities by cluster.

Gross returns from activities across clusters

Figure 3 begins to illustrate the connection between the degree of diversification (e.g., households involved in more than only livestock activities), the kinds of activities they combine and gross household income. When mean gross incomes are compared, the richest households are those that are either the most diversified (*Diversified agropastoralists*) or those that combine livestock with wage labor activities (*Wage* *earners*). A Levene's test identified that the assumption of homogeneity of variance in income does not hold across clusters ($F=4.625$; df 7, 176; $p<0.0001$), therefore a Tamhane's test was used to compare gross household incomes across groups. The gross income for "*Diversified agropastoralists*" is significantly greater than that of "*Livestock only intensive*", "*Livestock only consumers*" and "*Irrigated/upland agropastoralists*" ($F=4.509$; df 7, 176; $p<0.001$). While the mean income value for the *Salary/wage earners* group also looks high, the median value for this group is significantly lower, suggesting that while gross incomes are still higher on average, values from a few households are also inflating the mean for this cluster. Median gross income values for all clusters are less than mean values (Figure 3, cross lines). This is particularly true for clusters that are the most diversified (e.g.. *Wage earners*, *Diversified lowland cultivators* and *Diversified agropastoralists*). This result highlights that type of returns across activity types are highly variable, with the implication that diversification alone does not automatically imply greater well-being for every household.

The three poorest clusters in terms of absolute gross income are the two *livestock-only* clusters and *Irrigated/upland agropastoralists.* Comparison of mean livestock holdings (Figure 4, solid cross lines) across all clusters indicates that livestock-only households have comparable numbers of livestock to other clusters, and comparison of median values (Figure 4, dashed cross lines) highlights this even further. Median livestock numbers for *Livestock-only* households are actually higher than those of the more diversified clusters, but the effect of outlier values in diversified clusters for a few extremely livestock-rich households artificially elevates those cluster means for livestock holdings. Therefore, the stark differences in total gross incomes between clusters stem not from large differences in livestock holdings, but instead from the addition of other off-farm activities. The exception here is *Irrigated agropastoralists,* who have relatively small household herds. However, once other livelihood activities are considered, the low economic status of pastoral-only households indicates that *not* diversifying livelihoods may also be unsustainable over the long-term.

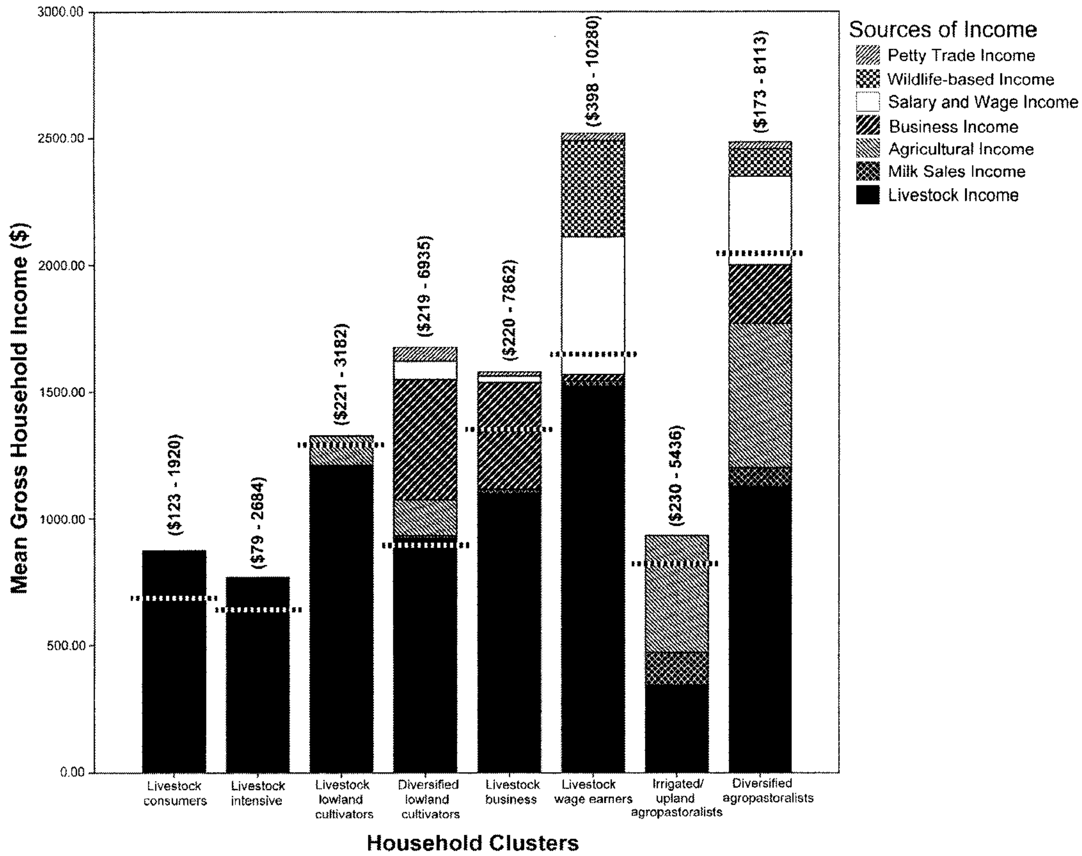

Figure 3. Mean gross income from all activities by cluster. Dashed cross lines are median values for each cluster.

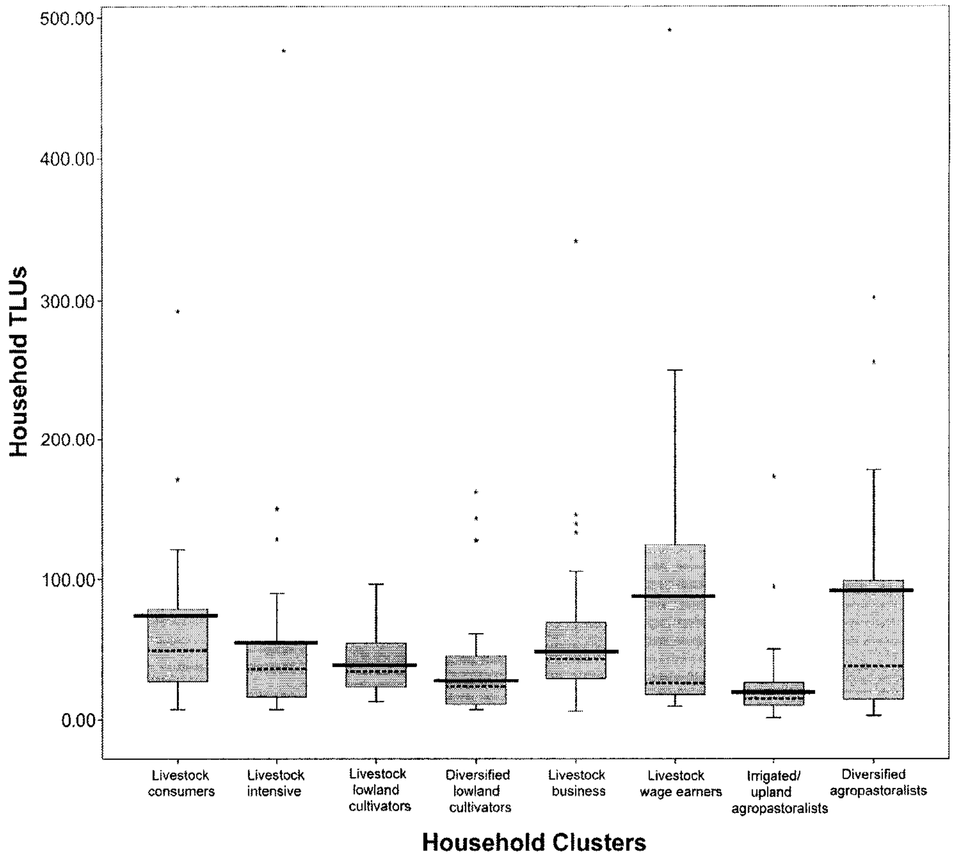

Figure 4. Mean and median TLUs per household by cluster. Mean values are solid lines. Median values are indicated as dotted black lines. Outlier values in each cluster are starred.

Despite comparable livestock holdings, total annual gross income derived from livestock is highest for the *Wage earners*, *Lowland cultivators*, *Livestock and business*, and *Diversified agropastoral* clusters. Greater livestock income stems from greater livestock selling for these groups ($1278, $986, $1092 and $1146, respectively) combined with greater slaughter and consumption values, particularly for *Lowland cultivators* ($209) and *Diversified agropastoralists* ($192) (see Appendix 2 for detailed results). *Irrigated agropastoralists* have lower mean returns from livestock sales ($274), and few households (26%) consuming livestock at very low levels on average ($37).

Whether households are reinvesting in livestock is an additional indicator of available resources. Those clusters with income from off-land sources are generally those re-investing most heavily in livestock. Seventy-seven percent of *Wage earners*, 60% of *Livestock business*, and 62% of *Diversified agropastoralists* purchased livestock annually ($368, $314, $351). As a frame of reference for these values, the average prices documented in the course of fieldwork was $102 for a mature female cow $17 for a female goat or sheep. Only 34% of *Diversified lowland cultivators* were purchasing livestock, but these households did it at a high level ($422). In spite of low overall gross income, 60% of *Irrigated agropastoralists* purchased livestock ($352); but given their low rates of livestock selling, this was probably based on invested returns from agriculture. The exception to this pattern is the *Livestock-only intensive* cluster, in which all households purchased livestock, albeit at a more moderate level ($282). More generally, most respondents spoke of the general practice of trying "to save some of your livestock" by reinvesting in a lower cost (e.g. smaller/younger) animal when an animal is sold (for example selling a cow, but simultaneously investing in a calf, a sheep or goat). However, number of livestock sold vs. purchased was positively correlated (Spearman's Rho=.398, $p<0.05$) only for *Diversified lowland cultivators*, indicating that although ideal, this practice may not be the norm.

Agricultural returns are a component of gross income for four clusters, but contribute substantially to only two groups that are practicing upland or irrigated agriculture; *Diversified agropastoralists* (the richest cluster), and *Irrigated agropastoralists* (the poorest cluster) (Figure 3). Households cultivating in lowland rainfed areas gained only marginal annual returns on average from their cultivation of corn and beans ($112 and $157, respectively). All households in the two lowland cultivator clusters planted, but the crops of 6 households failed entirely and only 4 of 32 households sold crops. In contrast, both agropastoralist clusters (those with households cultivating upland areas or irrigated swamp land) gained substantially from their agriculture ($512/yr and $615/yr, respectively). Seventy-one percent (35 of 49) households were consuming some of what they grew, but *Irrigated agropastoralists* sold 5.2 times the value they consumed and *Diversified agropastoralists* sold 2.3 times the value they consumed. These differences stem from the richer *Diversified agropastoralist* cluster having a higher proportion of households with upland rainfed agricultural parcels (5 vs. 10 households) and a focus on growing corn and beans for consumption compared to irrigated land used primarily to grow horticultural crops for sale. These results highlight that all off-farm activities do not contribute to livelihoods to the same degree. Agricultural activities make less of a contribution on average to gross income than do off-land activities. In other words, type of diversification *matters.*

Returns from off-land activities

A significant difference between richer and poorer clusters clearly stems from the presence of off-land income sources. Four clusters of eight have members engaged in either salary and wage, petty trade or business activities (wildlife-based activities are now folded into these three categories, but will be treated separately in the following section). Livestock trade was the most commonly cited business activity (30% of total). However, there are important qualitative differences between activities across the three basic categories. For example, owning a hotel or a shop is more lucrative and provides more certain and regular income than selling water or bead crafts, while working as a teacher or tourist lodge employee demands higher skills and gets greater rewards than working as a watchman or herder. Livestock trading requires substantial experience, but is associated with highly variable returns linked to drought conditions and cash flow. To explore the significance of these differences further, the off-land activities for each activity type were ranked simultaneously by the combined skill level (low to high) and predictability of returns associated with each activity (also low to high). Activities categorized as "high skill" were defined as requiring some education or explicit training over and above the skills acquired over time as a keeper of livestock. All activities engaged in by Amboseli households are listed and categorized in Table 8.

Interesting differences emerge when the returns from specific activity types are linked to associated skill levels and predictability (Figure 5). Petty trade activities generally require only low to medium skill. Returns were usually unpredictable and had the lowest mean and median values of any activity type. Salary and wage activities were generally more predictable with higher mean and median returns than other activity types (Table 8 and Figure 5). However, salary activities were also split into two groups; those that required greater skill levels in terms of strong literacy, a diploma, a license or a training course (e.g., teacher, government employer or game scout), and those that required only moderate to low levels of training (e.g., a watchman position or sweeping a church). Higher skill activities generally were better compensated (e.g., government or private sector employee), but this was not true in the case of teachers who made on average only $314 per year. A stronger skill base is therefore linked to better returns, but it does not guarantee them. Business activities covered a wide range of predictability, skill levels and associated returns. Many businesses were low skill (Table 8), but this did not equate necessarily with low returns – as low to medium skill activities may still be highly predictable or yield high returns (e.g., $2752/yr for renting commercial land) (Table 8 and Figure 5). Returns from livestock trading were widely variable across the sample, indicating simultaneous potential for both strong economic returns and great risk.

Table 8. Predictability and skill levels of off-land activities by category. Mean and median values by category are in parentheses in headings. Number of individuals engaged in activities are indicated in parentheses in the body of the table.

Skill/Predictability Combinations	Activity Types Petty Trade *(Mean=$173; Median=$113)*	Business *(Mean=$444; Median=$299)*	Salary and Wage *(Mean=$537; Median=$472)*
High Skill - High Predictability		In-home shop owner (6) Hotel owner (2)	Teacher (10) Tourist lodge employee (9) Government employee (7) Private sector employee (2) Assistant chief (1) Borehole operator (1) Shop attendant (1) Private sector driver (1) Game scout (1)
High Skill - Low Predictability		Private Tourist Guide (1)	
Low Skill – High Predictability	Buy/sell maize (1)	Rent commercial land (4) Renting agricultural land (3) Grain mill owner (2) Butchery owner (2) Rent houses (1) Livestock rest stop (1)	Watchman (7) Herding cows (5) Church cleaning (1) Bus conductor (1) Hotel worker (1) Goat slaughtering (1) Bead distributor (1)
Low Skill – Low Predictability	Livestock association (4) Casual work (4) Sell sugar (4) Buy/sell vegetables (2) Sell cloth (2) Make fences (2) Moran at Malindi (1) Wood/charcoal sales (1) Cut grass (1) Sell seed pods (1) Peddler (1) Carry water by bike (1) Bride price (1)	Selling water (6) Craft sales (5) Animal traction (3)	Research (4)
High Experience – Variable Predictability		Livestock Trade (46) *(mean=$457; Median=272)*	

Looking at the returns associated with skill and predictability attributes across clusters highlights that activity types have a lot to do with how much a household gains from their activities. *Wage earners* and *Diversified agropastoralists* receive much higher mean returns from their off-land activities than do *Livestock business* and *Lowland cultivator* households (Figure 5 – inset box), and these households also have the greatest involvement in wage labor activities that are higher skill and offer more predictable returns. These two clusters also have household members involved in petty trade activities, but the low value petty trade activities are not the primary source of their off-land income returns. In contrast, while *Livestock business* and *Lowland cultivators* have a few households receiving high value and wage and business (e.g., predominately low skill) returns, these households also depend to a much greater extent on more variable returns from livestock trading and low value petty trade activities. Many households in all four clusters are engaged in more than one off-land activity (Figure 5 - inset box). *Wage earner* households are engaged in fewer total off-land activities, but they still receive the highest mean and median returns per off-land activity than any cluster. In contrast, a higher proportion of *Diversified agropastoralists* (who are poorer) are engaged in multiple activities, but individual activities are of lower value overall, a fact borne out in the lower median return from off-land activities for this cluster. There is a difference here between quantity of activities engaged in, and the quality of that engagement.

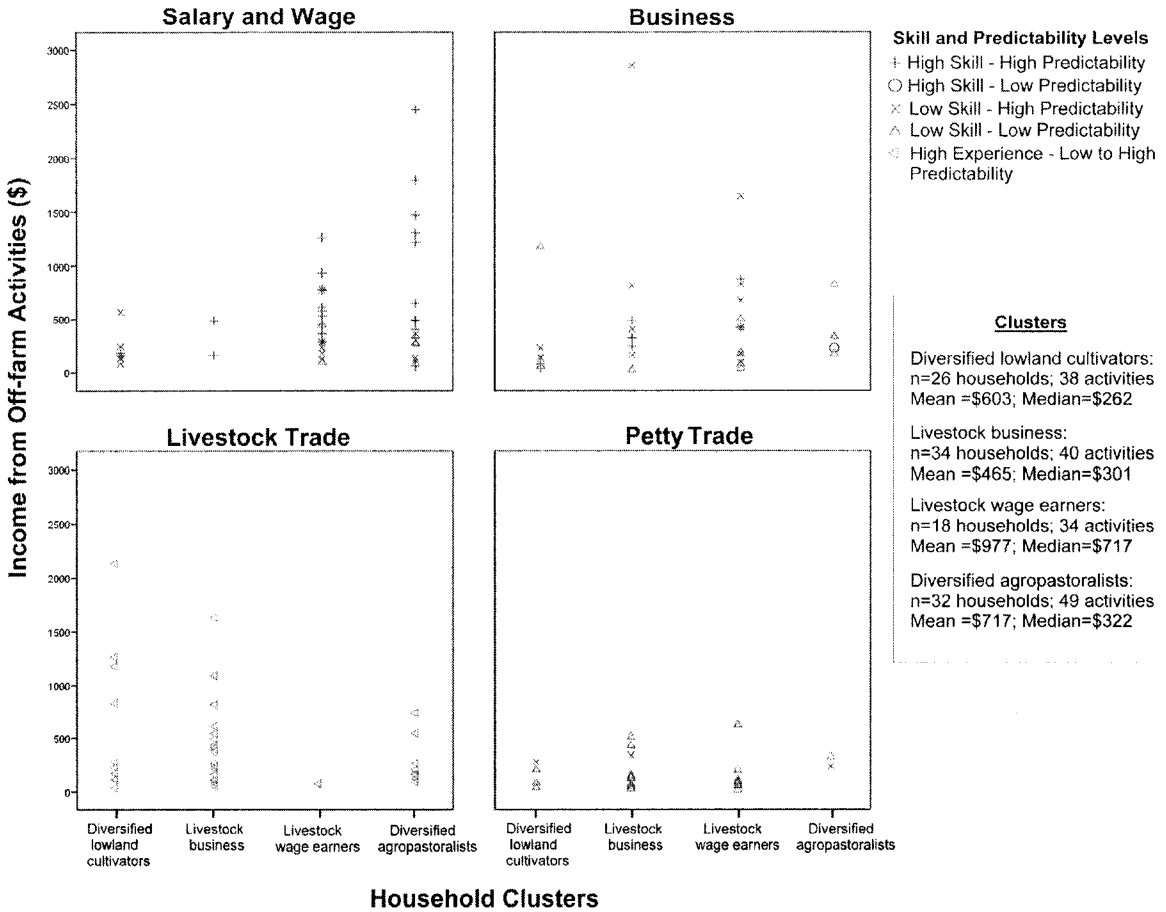

Figure 5. Income distribution of off-land activities by cluster, skill and predictability levels.

In conclusion, although off-land activities play an increasingly important role in economic well-being for households who are diversifying, not all off-land activities are the same in terms of value. The opportunities associated with petty trade activities vs. wage labor are vastly different. Similarly, variability in returns across off-land activities is high even within richer clusters (Figure 3), again highlighting the need to carefully examine the conditions under which all types of economic diversification is assumed to be a strong contributing factor to household well-being.

Returns from wildlife

The ways that wildlife-based returns in Amboseli add to economic well-being is important within this discussion of livelihood diversification. These results also contribute to ongoing debates over the potential of wildlife conservation to benefit local communities, maintain wildlife populations over the long term, and ideally, to "make local people into conservationists" (Roque de pinho 2004, Barrett and Arcese 1995).

Households in Amboseli receiving income from wildlife-based off-land activities are only found in the two wealthiest clusters; *Wage and Salary earners* (representing a mean of 16% of income) and *Diversified agropastoralists* (mean=4% of income). Wildlife-based results are disaggregated from other off-land activities in Table 9. Only 15 of 184 households (8.1%) are gaining direct economic returns based on a total of 22 individuals pursuing wildlife-based activities across these two clusters. Three extended households alone account for nine of these activities. The distribution of wildlife benefits across the household sample is clearly uneven. The range in annual returns from wildlife-based activities is also wide, particularly for tourist lodge employment, where the respondents' wages were regularly paid, but activities ranged from low skill slaughtering of goats for the kitchen (lowest returns) to high skill management positions (highest returns). Craft sales ranged in both level of remuneration and predictability. The most highly paid individual engaged in craft sales was also a distributor of beads, but this activity was not dependable given the ebb and flow of tourist traffic in Amboseli. There was a range of wage levels for research jobs, but predictability was high during the course of the employment. The game scout job was both predictable and highly paid, but it was also rare within the sample of households (n=1).

Table 9. Household-level returns from wildlife-based activities.

Wildlife-Based Activities	Number of Activities	Range of Returns/yr. ($)	Mean Returns/yr. ($)
Tourist lodge employment	12	136-1,306	553
Craft sales	6	24-816	412
NGO/research	2	136-490	313
Private tourist guide	1	218	218
Game scout	1	816	816

Whereas the number of households benefiting economically from wildlife-based activities was low, wildlife benefits also accrued at the level of the group ranches – and these revenues then ideally are put towards community-based development projects and support of group ranch students through secondary school. A partial distribution of these revenues for Imbirikani and Olgulului/Lolarashi group ranches are described and quantified in Table 10. Comparable data were not available for Eselenkei GR, and Osilalei GR has no tourism-based activities.

These benefits look substantial at the level of the group ranch, and they have been the basis for funding of needed development projects, such as; school classrooms, teachers' salaries, livestock crushes, boreholes and water reservoirs, support for community ceremonies and help for needy group ranch members (e.g., emergency food and medical care) (Roque de Pinho 2004). However, if total revenues are divided by the number of registered group ranch members in Imbirikani and Olgulului/Lolarashi (Ntiati 2001), the returns from wildlife only range between $14-15 per member per year. Furthermore, recognizing that households are larger than the number of registered members, these benefit figures would be substantially smaller on a per capita basis for both group ranches. The misuse of group ranch funds by members of the leadership is also a serious problem in the group ranches (pers. obs.). This issue is so problematic that frustration with the lack of transparency is contributing directly to the wish of some group ranch members to subdivide group ranch lands to better "control their own land" and potentially benefit more directly from wildlife than is possible under the current group ranch system (BurnSilver 2005).

Table 10. Group Ranch-level returns from wildlife-based activities.

Return Categories	*Imbirikani GR ($)*	*Olgulului/Lolarashi GR ($)*
KWS Revenue-Sharing	*11,564	16,326
Concession area lodge rent	9,524	20,408
Conservation Levy/Bed night fees (Lodges)	26,912	
Game Cropping	3,265	
Sand/gravel sales		408.00 (2002)
Bird Shooting	8,377	
Camping fees	2,612.00 (2001)	
Public Camp Site revenue		~13,605 (2002)
Amboseli Tsavo Game Scout Association	12 members employed @ 68.00-95.00 $/month	11 members employed
Total of all returns (employment excluded)	62,255	50,748
No. of group ranch members (2001) **	4,585	3,418
Calculated annual returns per GR member	13	15

* All data taken with permission from Roque de Pinho (2004). Unless noted otherwise figures are from 2001. Data from Eselenkei GR was unavailable. **Number of group ranch members taken from Ntiati 2001.

Demographic characteristics across clusters

Beyond differences in economic strategies, how do clusters differ in terms of household characteristics? No clear patterns emerge between clusters with respect to AUs per household, dependency ratio and number of workers in the household. A dependency ratio compares the number of unproductive members (<5 years old) per household to the number of productive (6-elderly) workers. All values vary minutely around mean values of 9 AU/household, a 0.4 dependency ratio, and 7 workers per household respectively. The average age of household heads was 41 yrs, with *Diversified lowland cultivators* being youngest (35 yrs) and *Livestock lowland cultivators* oldest (47 yrs). However, interesting differences did emerge between clusters in terms of educational attainment of household heads and children (Figure 6).

Heads of household from the two richest clusters have much greater educational experience both in terms of percentage of those who attended some school (50% of *Wage earners* and 37% of *Diversified agropastoralists*) and average number of school years attended (9 years for both groups). Similarly, a higher proportion of children from these richer clusters are attending school (38% of *Wage earners* and 44% of *Diversified agropastoralists,* respectively). Higher educational attainment by household heads within these richer clusters may be contributing to greater household engagement in higher skill, off-land activities that yield better returns with greater predictability – a result that emerged for these groups in the previous section. That households in these clusters also seem to be investing in schooling their children may be both a reflection of greater resources to invest, and first-hand experience with the benefits of education.

There is one caveat here however. The cluster with the highest proportion of children in school is *Irrigated agropastoralists* (45%) – one of the poorest clusters. This is a pattern previously documented by Bekure et al. (1991), where poor households in Imbirikani were investing their scarce resources in an effort to offer their children better options in the future, at rates higher even than richer households. Location may additionally contribute to this decision, as irrigated areas are also those located in infrastructure-rich zones (e.g., close to schools) within the study area.

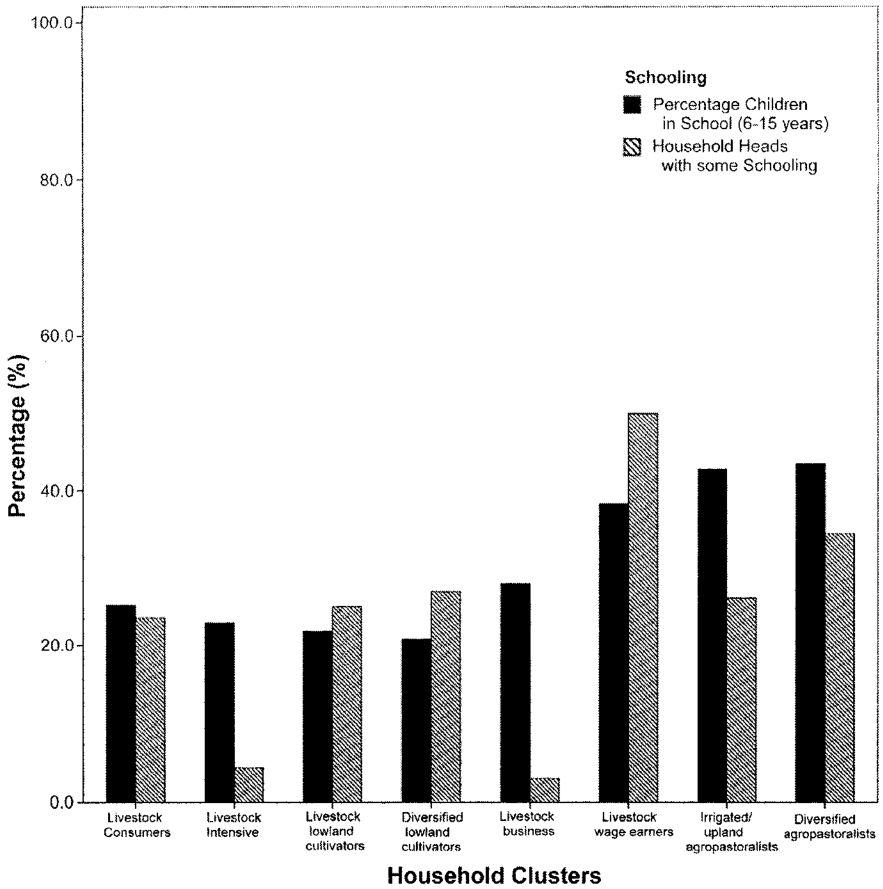

Figure 6. Percentage of household heads and children involved in schooling by cluster.

Cluster Membership and Study Areas

How does cluster membership link to household level activities occurring at the level of the six study areas we considered initially? If clusters and locations show perfect agreement, then cluster analyses provide no additional insight on diversification patterns, and trajectories of change must hinge predominantly on agro-ecological conditions. However, while there are some clear connections between study area and household clusters, cluster membership is not entirely straightforward (Figure 7). Many households from the two livestock-only clusters do come from drier, more isolated rangeland areas (e.g., Emeshenani, Lenkisim); the vast majority of Irrigated/upland agropastoralists come from S. Imbirikani, located around the swamps and close to the road leading to the upland agricultural areas, Seventy-five percent of *Livestock lowland cultivators* come from Osilalei (which has been subdivided) and over 68% of *Wage earner* households are drawn from N. Imbirikani and Lenkisim – also rangeland zones. However, the two clusters with wildlife-based income (*Livestock wage earners* and *Diversified agropastoralists*) include households from study areas both in close proximity and far from conservation areas across the region; e.g., Southern Imbirikani is adjacent to Kimana Wildlife Sanctuary, while N. Imbirikani, Lenkisim and Emeshenani are centrally located relative to from multiple conservation areas, but not adjacent to them (Figure 1).

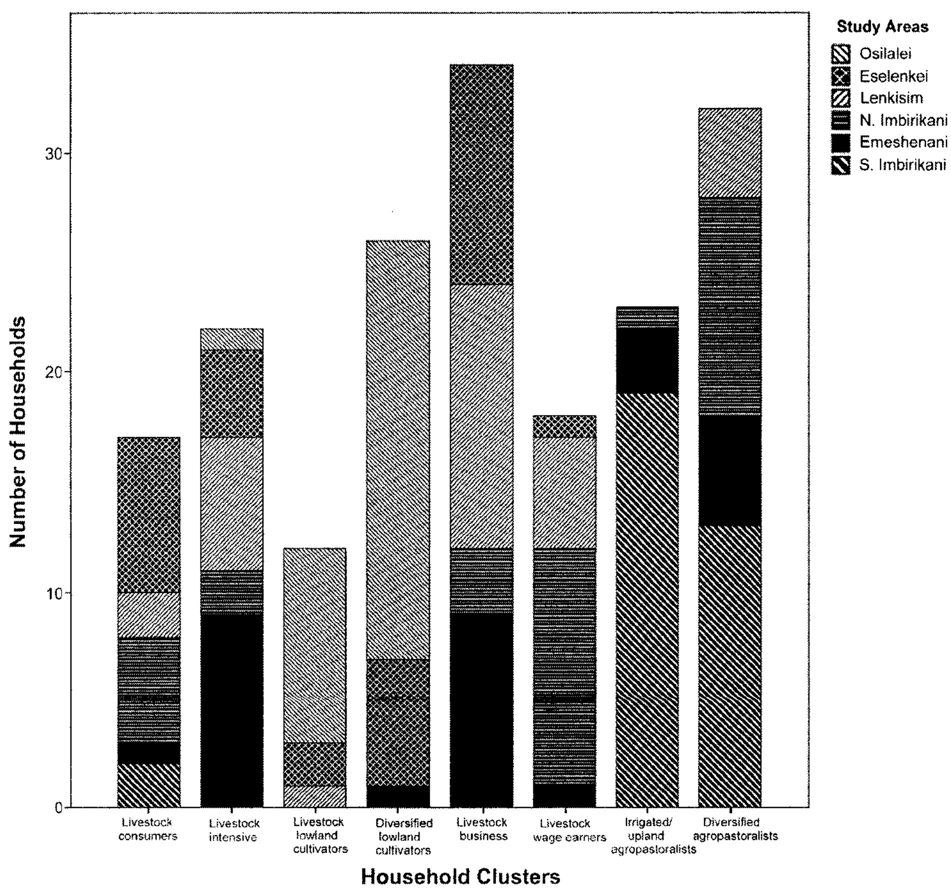

Figure 7. Distribution of study area households overlaid onto clusters.

Yet there are exceptions in all cases: livestock-only households actually occur in every study area; households in Eselenkei and Lenkisim are also cultivating lowland plots and some N. Imbirikani and Emeshenani households are also cultivating irrigated or upland areas, based on either mobility or splitting of households across pastoral and agricultural locations. Cluster analyses allowed a much more detailed analyses of specific patterns of diversification than was possible based on study areas alone. The non-agreement between clusters and areas also suggests that other factors beyond location must underlie household decisions to pursue different livelihood strategies, such as infrastructure access, and labor or wealth characteristics that are intrinsic to households.

PREDICTING LIVELIHOOD STRATEGIES AND HOUSEHOLD WELL-BEING

The focus of this section is to identify socio-economic, demographic and geographic factors that predict: 1) household cluster membership (e.g., what people are doing), and 2) general household well-being (e.g., how well people are doing based on those strategies).

Modeling Cluster Membership

To what degree can the extent and type of diversification pursued by households be predicted on the basis of geographical, demographic and socio-economic factors? Multinomial logistic regression analysis (MLR) was used to model cluster membership. The reference cluster used as the basis for these regression analyses was *Diversified* *agropastoralists* – the most diversified group of households, one of the richest clusters, and one of the largest. A series of crosstabs identified categorical variables that were related to cluster membership and therefore should be included in the model. Table 11 identifies the resultant list of continuous and categorical variables that were used in the regression. All were significant to at least the $p<0.05$ level. If two variables were related to cluster membership but collinear with each other, only one of the pair was included in the regression. The variable with the highest correlation value was included. McFadden's Pseudo R-Square statistic suggests that the MLR model selected explains only 56% of the variation in cluster membership, but that the model is better at predicting the data than chance (Chi square 416.512, df=84, $p<0.001$).

Table 11. Variables used in multinomial logistic regression analyses. All variables were significant predictors in the model to the level of $p<0.05$*. Schooling of household heads was categorized as 0=no schooling, 1=some schooling.

Category	Variables Included in MLR	Collinear with:
Demographic	Age of Household Head	
	Schooling of household head*	
Spatial	Services distance (km)	
	Road distance (km)	
	Livestock market distance (km)	
	Dry season water distance	
	Mean NDVI within $10km^2$	Coefficient of Variation in NDVI within $10km^2$
	Conservation area distance (km)	
	Proportion of pasture within 10km2	
Productive	Gross income	
	TLUs per household	TLU/AUs
	Mobility in drought year	

Significant parameter estimates for the multinomial logistic regression are presented in Table 12 (Complete statistical results are presented in Appendix 3.). Parameters with significant *negative* coefficients (B) decrease the likelihood of that response category with respect to the reference category (*Diversified agropastoralists*).

Likewise, parameters with significant *positive* coefficients increase the likelihood of the response category with respect to the reference category.

Table 12. Significant parameter estimates (B) from the multinomial logistic regression predicting cluster membership. All parameters significant at $p<0.05$ unless noted with an *. These parameters are significant at $p<0.1$. Shaded area denotes the reference cluster.

Clusters	Age of HH	Schooling	Services Distance	Road Distance	LS Market Distance	Water Distance	Conservation Distance	Mean NDVI	Pasture Proportion	Gross Income	Household TLUs	Drought Year Mobility
Livestock intensive			+	+			+	+		-	+	
Livestock consumers			+				+			-		
Livestock lowland cultivators	+ *		+ *			+	+	+	_			+
Diversified lowland cultivators			+		- *	+	+	+	-	+	-	+ *
Livestock business		+		+			+	+	-			
Livestock wage earners					+		+					
Irrigated agro-pastoralists						+ *	--			-		+
Diversified agro-pastoralists	Reference Cluster											

Geographic factors emerged as relatively strong predictors: Cluster membership in some cases seems to be predicated on whether households are located in core pastoral areas (far from services and roads) and are close to conservation areas. Areas within the study zones that have higher mean NDVI (e.g. Normalized Difference Vegetation Index – a measure of vegetation greenness), but a lower proportion of pasture within 10 km^2, are those near riparian areas or further to the north where tree cover is much greater. This includes the Osilalei study area that is predominately Acacia and Comiphora woodland and the Eselenkei study area where permanent settlement zones are inside or near the Eselenkei River corridor. The livestock assets (TLUs) and gross income of groups emerge as important factors for differentiating some clusters relative to rich *Diversified agropastoralists*, but definitely not all. Age and education are defining features of only two groups.

The only differences between *Diversified agropastoralists* and *Livestock wage earners* – by far the richest clusters – are that *Wage earners* are further from livestock markets and conservation areas on average. This reflects that a large proportion of *Diversified agropastoralists* are settled adjacent to Kimana Wildlife Sanctuary, while wage earner households are located in more core rangeland zones that are between conservation areas, but not bordering them. However, *Wage earners* are still one of the two clusters most heavily engaged in wildlife-based activities, so it does not seem that greater distance from conservation areas is constraining households from engaging in these income-earning strategies.

Irrigated/upland agropastoralists and the two livestock only clusters (*Intensive* and *Consumers*) are the poorest clusters overall. All three clusters are differentiated from the reference cluster of *Diversified agropastoralists* as likely to have significantly lower gross incomes. The regression model differentiated well between livestock only clusters, highlighting that the *Livestock intensive* households have more TLUs and come from more agroecologically productive areas on average as compared to *Livestock consumer* households (e.g., higher rainfall zones). And both clusters are more isolated from services and infrastructure than richer clusters. Another difference between the two groups is that *Livestock intensive* households are more mobile in critical drought periods. The *Irrigated agropastoral* group is closer to conservation areas (although no households in this group are benefiting from wildlife-based income), and although these households are more sedentary, they still move their animals in critical periods.

In conclusion, although the Multinomial logistic regression results identified characteristics of particular clusters relative to the reference cluster, they were not highly useful in identifying a cohesive set of factors that would predict why particular livelihood strategies are pursued by particular groups of households. Closer proximity to services (roads, markets, schools) has been identified by previous researchers (de Wolff, Staal et al. 2000; Njenga and Davis 2003) as a condition that contributes to economic opportunities and by association human well-being, but our analyses indicate that households at the crossroads of all these resources (e.g., agropastoralists) can be either rich or poor, perhaps dependent more on the baseline livestock resources they have available to them. Similarly, *Livestock wage earner* households are rich, but are located in core rangeland areas further from services. Therefore, these analyses provided some tantalizing clues linking household economic status, personal characteristics and resource access to activity choice, but no generalizable or predictive relationships emerged.In conclusion, although the Multinomial logistic regression results identified characteristics of particular clusters relative to the reference cluster, they were not highly useful in identifying a cohesive set of factors that would predict why particular livelihood strategies are pursued by particular groups of households. Closer proximity to services (roads, markets, schools) has been identified by previous researchers (de Wolff, Staal et al. 2000; Njenga and Davis 2003) as a condition that contributes to economic

opportunities and by association human well-being, but our analyses indicate that households at the crossroads of all these resources (e.g., agropastoralists) can be either rich or poor, perhaps dependent more on the baseline livestock resources they have available to them. Similarly, *Livestock wage earner* households are rich, but are located in core rangeland areas further from services. Therefore, these analyses provided some tantalizing clues linking household economic status, personal characteristics and resource access to activity choice, but no generalizable or predictive relationships emerged.

Predictors of economic well-being in Amboseli

Cluster analyses confirmed that Amboseli households are diversifying, but to what extent does this diversification predict household well-being? This question is posed for the general sample of households independent of cluster analyses. Traditional pastoral studies have focused almost exclusively on household herd size as an indicator of household wealth, and by association, economic status (Evangelou 1984; King, Sayers et al. 1984; Kituyi 1990; Bekure, de Leeuw et al. 1991). However, in the Amboseli system – where diversification is emerging as a defining characteristic of livelihoods – a wider definition of household well-being is needed. Consequently I also examined household gross income as a more general indicator of economic status, because it is based on income from combined off-land, agricultural and livestock activities. Are there particular demographic, production and spatial variables that contribute to the well-being of pastoral households, and which types of variables are most important? Table 13 presents the initial list of demographic, production and spatial variables that were regressed against gross income and household animal wealth (TLUs) in Amboseli. Gross income values for livestock, agriculture and off-land activities were used as independent predictors for the TLU regression, as in most cases they were more closely correlated than were proportion of income from livestock, agriculture and off-land activities. Most variables were transformed to achieve either normal or near-normal distributions. To minimize problems with collinearity, only variables with significant correlations (Spearman's rho $p<0.05$) with dependent variables were included in the regression analyses. In cases when two independent variables were correlated with each other, the variable correlated most highly with the predictor variable was included in the regression. Table 15 presents results from the most parsimonious OLS models using a backwards stepwise selection technique, with gross income and TLUs as dependent variables. The β values (standardized coefficients) indicate the magnitude and the size of the effect of each independent variable. Both models are significant at $p< 0.001$. The independent variables included in each model explained 54% of the variation in gross household income and 53% of the variability in TLUs across households.

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Table 13. Variables used in logistic regression to predict gross income and herd size. N=184 for all variables. *ln= log normal transformation of data values **Power= power transformation of data values.

Demographic Variables	Spatial Variables	Production Variables
Household AUs (ln)	Km from Livestock Market	Acres lowland rainfed agriculture (ln)
Age of Household Head (ln)*	Km from Large Town (ln)	Acres highland rainfed agriculture (ln)
Dependency Ratio: No unproductive (<5)/productive (6+) workers (ln)	Km from Road (power)	Acres irrigated agriculture (ln)
Proportion of Children Schooling 6-15 yrs old (ln)	Km from Services (primary school, health center, weekly market) (power)	Mobility of cattle herd in 2000 (drought year) (ln)
Household Head Years Schooling (ln)	Km from dry season water (ln)	Proportion of income from agriculture (ln)
	Km from conservation area (ln)	Gross income from agriculture +.01 (ln)
	Mean NDVI (10km^2)	Proportion of income from livestock (ln)
	NDVI coefficient of variation (10km^2)	Gross income from livestock + .01(ln)
	Proportion of pasture within 10km^2	Proportion of income from off-land (ln)
		Gross income from off-land + .01 (ln)
		Number of Off-land activities +.01 (ln)
		TLUs per household (ln)
		Gross income +.01 (ln)

Predicting Gross Income

The factor contributing most to household gross income was livestock holdings per household (Table 14). This confirms that although Amboseli households are diversifying their activities, they still derive a majority of their livelihoods from livestock. Number of off-land income sources was also a strong determinant of gross income for households as Figures 2 and 3 suggested previously. Proportion of household income from off-land sources and number of sources of income per household were highly correlated (Spearman's rho; r=0.855, p<0.001), suggesting that the more business, salary/wage or petty trade income streams a household has, the higher their off-land and gross income levels.

The proportion of income from agriculture was not a significant predictor of gross income, although the number of hectares of highland rainfed agriculture planted by households was. This confirms that the type of agriculture pursued by households matters more than just general engagement in agriculture. Age was additionally a positive predictor of gross income; the process of household development takes time, so older householders would generally be further along in terms of capital and livestock accumulation.

Household size, schooling level of the household head and mobility in a drought year were positively correlated with gross income, but dropped out of the regression once other variables were included. Interestingly, the proportion of income from livestock was negatively (but insignificantly) correlated with gross income, illustrating that while livestock still constitute the basis of household livelihoods for poorer households, they do not necessarily contribute to higher gross incomes. No spatial variables were correlated with gross income in spite of the variation in livelihood strategies observed across study areas, and consequently were not included in the regression model.

Table 14. Results of linear regression analyses predicting gross income and household TLUs.

Gross Income	Unstandardized Coefficients		Standardized Coefficients			**TLUs**	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	β	t	Sig.		B	Std. Error	β	t	Sig.
(Constant)	-3845.151	1100.227		-3.495	<0.001	(Constant)	1.139	0.300		3.791	<0.000
Age (ln)	685.921	297.313	0.117	2.307	<0.022	Hshld AU (ln)	0.688	0.107	0.350	6.446	<0.000
TLUs (ln)	792.002	77.364	0.528	10.237	<0.000	Mobility 2000 (ln)	0.246	0.048	0.275	5.169	<0.000
Highland Rainfed Agriculture (ln ha)	109.950	56.851	0.100	1.934	<0.055	Services Distance (power)	0.008	0.003	0.164	3.111	<0.002
No. off-land Income sources (ln)	642.266	79.611	0.409	8.068	<0.000	Gross livestock income (ln)	0.196	0.031	0.344	6.255	<0.000
						Gross off-land income (ln)	0.019	0.011	0.093	1.796	<0.074

Predictors dropped from Gross Income Model: Drought year mobility, Household AUs, and Schooling of household head. ANOVA, F=55.078; df 4, 179; $p<0.001$. Predictors dropped from TLU model: Mean NDVI, Km from large town, Km from Livestock market, Age of household head, Proportion agricultural income, and ha of irrigated/upland agriculture. ANOVA, F=41.527; df 5, 178; $p<0.001$.

Predicting TLUs

The strongest predictors of household TLU levels were livestock income and number of adult equivalents in the households (household size) (Table 14). TLUs also increased moderately with greater household mobility and greater distance from services (e.g., town centers with primary school and health facilities). In other words, households that are settled in more isolated core rangeland areas are larger and have greater livestock mobility – and have larger household herds. These characteristics are descriptive of more "traditional" pastoral households where large families provide herding labor and mobility is an integral component of pastoral production strategies. The off-land income variable was a predictor in the final model, but was not significant. Proportion of income from agriculture was negatively correlated with TLUs (Spearman's rho= -0.257, $p<0.001$), but was not significant in the final model.

SYSTEM TRENDS

It is apparent that Maasai households in Amboseli are part of a trend towards diversification occurring across pastoral systems both regionally and globally. But results also indicate that diversification does not mean that pastoral households automatically leave livestock production behind as they engage in new activities. In other words, all pastoralists are not becoming agropastoralists. The process seems to be more a question of combining new strategies with livestock production, not substituting these activities for livestock entirely. Similarly, the way that pastoral households raise their livestock is also changing. Pastoral *intensification* efforts are ongoing, as households try to gain more from the livestock they do have. But another question associated with diversification is also relevant here – once an individual has diversified in new economic directions, are these livelihood choices permanent, or are their diversification efforts dynamic through time? The following section focuses on these detailed questions regarding livestock intensification and livelihood trends in Amboseli.

Livestock Intensification

This discussion of livestock intensification is based on a definition taken from Galaty and Johnson (1990), where *intensification* refers to an increase in the units of livestock produced (e.g., meat, milk, hides) based on a given level of inputs (e.g., feed, water, veterinary drugs, or labor). The model of intensified livestock production advocated for pastoral areas in Kenya by development specialists revolved around increasing offtake rates, better veterinary care, water provision and lowered rates of transhumance (Hedlund 1971; Rutten 1992). Part of the intensification "package" was also to advocate for private property as a mechanism for investment, whereby title deeds could be used to guarantee loans for infrastructure improvement (Oxby 1982; Mwangi 2003; Mwangi 2006). In spite of concerted policy efforts and significant expenditures of resources, these intensification measures were never fully adopted by Amboseli Maasai (Bekure, de Leeuw et al. 1991), but there are current indications that pastoral households are making efforts to raise the productivity of their herds. An additional component of livestock intensification emerging currently in Amboseli is the actions of herders to improve the breeds of their animals by crossing their Small East African Zebu cattle and local smallstock breeds with improved breed animals. Results presented here focus on changes in cattle breeds, as producers mix local Zebu cows with Sahiwal and Borana animals, which have the genetic potential to produce more meat and milk (Rege and Tawah 1999).

Intensification results are based on households' responses to a series of questions regarding strategies associated with intensification of livestock production. Respondents ranked their perceptions on levels of change that had occurred vis-a-vis these strategies (from high levels of change to no change), and then enlarged upon their answers qualitatively. Results are presented in Table 15, categorized by study area and agroecological potential.

In response to the question: *"How has the breed of your cattle changed?"*, results show a strong differentiation across study areas in herders' efforts to hybridize local Zebu cows with Borana and Sahiwal cattle. A majority of households in areas with low to medium agroecological potential (Emeshenani and Lenkisim) and swamp areas (S. Imbirikani) indicated no or little change in the breeds of their cattle. Stated reasons for the slow change were the much greater needs of hybrid or purebred Borana and Sahiwal animals for forage and water resources, and their inability to migrate long distances during drought. Or, in the words of one Maasai elder, "....these animals are valuable, but they are like 'children', in need of much care". Response patterns shifted however in higher rainfall areas, with households in Osilalei, Eselenkei and even N. Imbirikani more evenly spread across a range of low to high perceptions of change. This suggests that individual households are weighing the tradeoffs associated with moving towards dependence on hybridized animals in what remains a highly variable environment.

Quantitative survey results on herd composition indicate that only 38% of households (n=70) had no improved animals in their herds in 2000-2001. Rutten (1992) initially identified a link between low productivity and lack of improved animals in dry area herds, and this pattern still holds true, as 79%, 40% and 50% of households in Emeshenani, Lenkisim and S. Imbirikani areas, respectively, were maintaining their cattle herds as pure Zebu. Alternately, the, Osilalei and Eselenkei and N. Imbirikani study areas show the lowest maintenance rate of pure Zebu herds by households (24%, 16.7% and 21%, respectively). N. Imbirikani is of moderate agroecological potential overall, however settlement areas there have better permanent water availability next to the pipeline than Lenkisim, and access to water is critical for these larger breeds. These areas also have the greatest proximity to Kaputei Maasai section to the north, where crossbreeding was established based on the importation of breeding bulls in the 1970s. Producers there have been more exposed to the experiences of other herders and have greater access to breeding stock. Figure 8 quantifies crossbreeding trends across the study areas. When the mean percentage of improvement by cattle age and sex category is weighted by the number of improved animals per herd, the same locational trends as above are upheld. For example, the hesitant pace of breed changeover in dry Emeshenani is clear. This figure also highlights the directionality of household-level cross-breeding strategies. Households begin by crossbreeding improved bulls with local cows so that initially calves, heifers and immature steers show higher levels of improvement than mature cows and mature steers. Areas with higher average improvement for cows and

Table 15. Indicators of intensification by study area and agroecological potential. Responses to questions are ranged from high to no levels of change. All figures represent percentages of households. Shading denotes agroecological potential.

Degree of change in production strategies	Study Areas: Osilalei (%)	Eselenkei (%)	Lenkisim (%)	N. Imbirikani (%)	Emeshenani (%)	S. Imbirikani (%)	Number of Responses	% of Total
Agroecological Potential	*High*		*Medium*		*Low*			
Breed Change								
High	24.1	76.7	17.2	25.0	0.0	21.2	50	27.3
Medium	31.0	13.3	34.5	21.9	10.0	9.1	36	19.7
Little	13.8	10.0	31.0	28.1	20.0	3.0	32	17.5
None	31.0	0.0	17.2	25.0	70.0	66.7	65	35.5
Total							183	100.0
Selling of Animals								
High	20.7	83.3	70.4	64.5	75.0	42.3	97	58.8
Medium	27.6	16.7	14.8	12.9	7.1	11.5	25	13.7
Little	10.3	0.0	7.4	0.0	10.7	7.7	10	6.1
None	41.4	0.0	7.4	22.6	7.1	38.5	33	20.0
Total							165	100.0
Use of Banking								
High	0.0	25.0	16.7	6.3	0.0	11.4	18	10.0
Medium	0.0	28.6	23.3	3.1	3.7	11.4	21	11.5
Little	3.6	32.1	43.3	6.3	0.0	5.7	27	15.0
None	96.4	14.3	16.7	84.4	96.3	71.4	114	63.3
Total							180	100.0
Use of Credit								
High	3.7	7.7	3.4	3.4	0.0	9.1	8	4.7
Medium	0.0	19.2	13.8	0.0	0.0	6.1	11	6.0
Little	0.0	46.2	6.9	6.9	4.0	3.0	18	10.7
None	96.3	26.9	75.9	89.7	96.0	81.8	132	78.1
Total							169	100.0

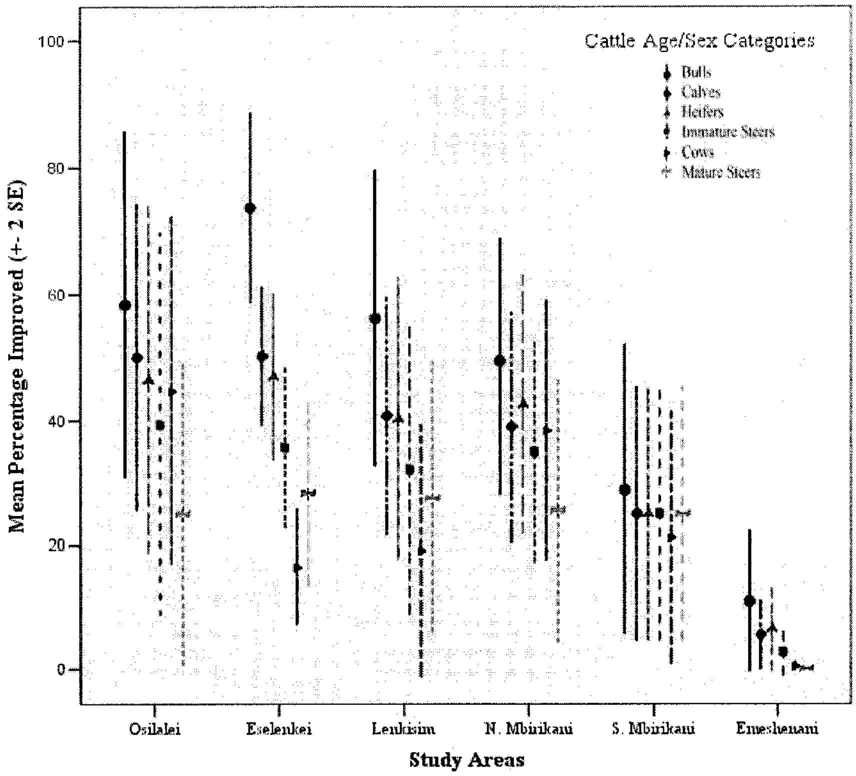

Figure 8: Mean level of breed improvement in cattle age and sex groups by study area. Bars are standard deviations around the mean.

steers are generally those where crossbreeding has been in progress for longer periods of time.

Households were asked "*To what extent has the amount of animals that you sell changed?*" Almost 60% of households replied that there was a strong increase in the number of animals that they were selling now versus in the past, but there was some differentiation in responses by area. Osilalei and S. Imbirikani were zones where the significant proportions of households indicated few or no changes in selling behavior. This makes some sense for S. Imbirikani, given that households there have more access to agricultural goods without selling animals, but the source of this difference in Osilalei is not clear. Are households selling fewer animals because they have larger hybrid livestock which yield more in the marketplace when sold? The reason given overwhelmingly for the general increase in selling behavior was that peoples' needs for cash were much greater now than previously, for example to purchase veterinary drugs, acaracides, school fees, food, clothing and consumer goods (bicycles, etc.).

It is useful here to compare the perception of greater selling to calculated offtake rates for Amboseli households, and then look at previous studies to gauge if livestock selling has risen through time. However, comparison with previous studies of livestock offtake in Amboseli is not straightforward, as no study used the same definitions of offtake in reporting results. Some studies reported net offtake only for cattle at the level of Kajiado District (Zaal 1998), or only commercial offtake for cattle and shoats (Zaal 1998), while Bekure et al (1982) reported net offtake (commercial and non-commercial) for all livestock (cattle and shoats combined). As well, the sources cited above only describe offtake for small areas of the total Amboseli study area, specifically Osilalei and Imbirikani group ranches. Calculated non-commercial offtake represents a substantially lower percentage of total net offtake than commercial offtake for all areas except for smallstock in N. and S. Imbirikani (Table 16). This suggests that slaughter and gifting of smallstock continue to occur at higher levels in these areas. However, calculated offtake rates for all study areas currently are greater than offtake rates reported by Zaal and Bekure for the 1980s and 1990s, except in Lenkisim and S. Imbirikani. This is particularly true for Osilalei, where a majority of households had the perception that there had been no

Table 16. Annual commercial and non-commercial offtake rates by transaction type, animal type and study area. Commercial offtake includes sold livestock. Non-commercial includes consumption and gifting out of animals.

Offtake Types		Study Areas Osilalei	Eselenkei	Lenkisim	Emeshenani	S. Imbirikani	N. Imbirikani	Total
Cattle	Commercial offtake	16.90	9.28	5.62	21.32	-3.52	5.68	8.86
	Non - commercial offtake rate	1.91	-1.11	.7562	.24	-3.91	.46	-.34
Shoats	Commerrcial offtake	15.91	7.68	-1.06	9.11	2.45	8.43	7.01
	Non-commercial offtake	.49	1.14	4.44	4.11	5.80	11.64	4.72
Total	Net offtake	**35.21**	**16.99**	**9.75**	**34.78**	**.82**	**26.21**	**20.24**
Historical Comparisons								
Bekure et. al 1991	1982: Net offtake					All livestock: 14.0%		
Zaal 1998	1994-95 period: Net commercial offtake	Cattle: 3% Shoats: 6%						
Zaal 1998	1994-1996 Net offtake Kajiado District:							Cattle: 15.5-17.5%

or few changes in selling behavior. Both qualitative and quantitative results for S. Imbirikani (Tables 15 and 16) indicate that selling of animals has not increased there. Offtake rates in all other study areas support qualitative perceptions of households that offtake has risen over the past decades.

Pastoral households were also asked to describe changes in their use of either banking or credit facilities. Given the often "boom and bust" cycles of animal populations because of recurrent drought (Desta and Coppock 2004), an increase in the use of banking could be a sign of pastoral movement away from using animals as "walking banks." But a majority of households indicated no or little change in their use of these resources. The study areas where some households perceived increased use of these options were Eselenkei and Lenkisim, in the center of the study region, and N. and S. Imbirikani. Eselenkei and Lenkisim are benefiting from help with banking offered to households through the Catholic Mission in Lenkisim. Those N. and S. Imbirikani households using these resources mentioned their relatively easy access to banking facilities in Oloitokitok and Sultan Hamud, at either end of the main Emali-Oloitokitok all-season road. Use of banking facilities was low, but use of credit was even more rare, and those few households (n=3) who had taken out formal loans had either well-paying, very predictable jobs, or were using informal livestock associations to access local credit.

Hiring of herding labor is another indication of intensification efforts. Thirty-four households (18.4%) had hired herding labor to watch after their animals. There was a relatively strong correlation between gross income and expenditures for hired herders in both 1999 and 2000 (Pearson coefficient, $r=0.552$, $p<0.0001$), indicating that wealthier households may currently be making decisions to free up household labor for other activities. Households stated that one of these activities is schooling for their children.

The results presented above highlight that in tandem with diversification, pastoral households are also changing aspects of how they raise, sell and manage their animals. Crossbreeding of animals is on the rise and there are indications that more animals are being sold. Infrastructure access and agroecological potential seem to be important criteria in terms of use of credit and banking services and efforts to crossbreed cattle herds. However, a perceived lack of available credit, or the high risk currently associated with gaining credit, may suggest that there is a limit to how far households can push efforts to intensify livestock production in the future (Boone, Thirgood et al. 2006).

Diversification Pathways through Time

The wealth of recent scholarship on diversification trends in pastoral societies has greatly contributed to a recognition that pastoral livelihood strategies are changing, and that benefits accrue from diversifying (Little et al. 2001; Thompson 2002; McPeak and Little 2005; Homewood et al. 2006). However, there has also been a tendency for researchers to think about diversification strategies as uni-directional, implying that once it occurs, a household will remain diversified indefinitely. However the Amboseli data indicates that the situation on the ground is much more fluid and specific to the situation and individual than this description implies.

Figure 9 presents diversification timelines for heads of households, as individuals moved in and out of eight categories of activities, from the time they began independent economic life (e.g., when they received their livestock), to the date of interviews (2001). The same data are presented in two ways; according to the ages and years when individuals began and stopped activities. Looking at the data by year highlights that some activities are situation-specific (for example linked to drought), while analyzing patterns by age illustrates that certain activities are more linked to the stage of an individual within their lifecycle. Table 17 then quantifies the reasons cited by individuals as to why they made the decision to start and stop activities within six of the eight categories. These reasons can be thought of a push (negative) and pull (positive) reasons for engaging or stopping an activity. Livestock herding and leadership activities are not addressed because very few individuals were herding for hire and all individuals who served as leaders eventually stopped. No one stopped keeping livestock, so livestock holding was also left out. The table does show results for investment activities that although rare, illustrate important characteristics of one type of diversification.

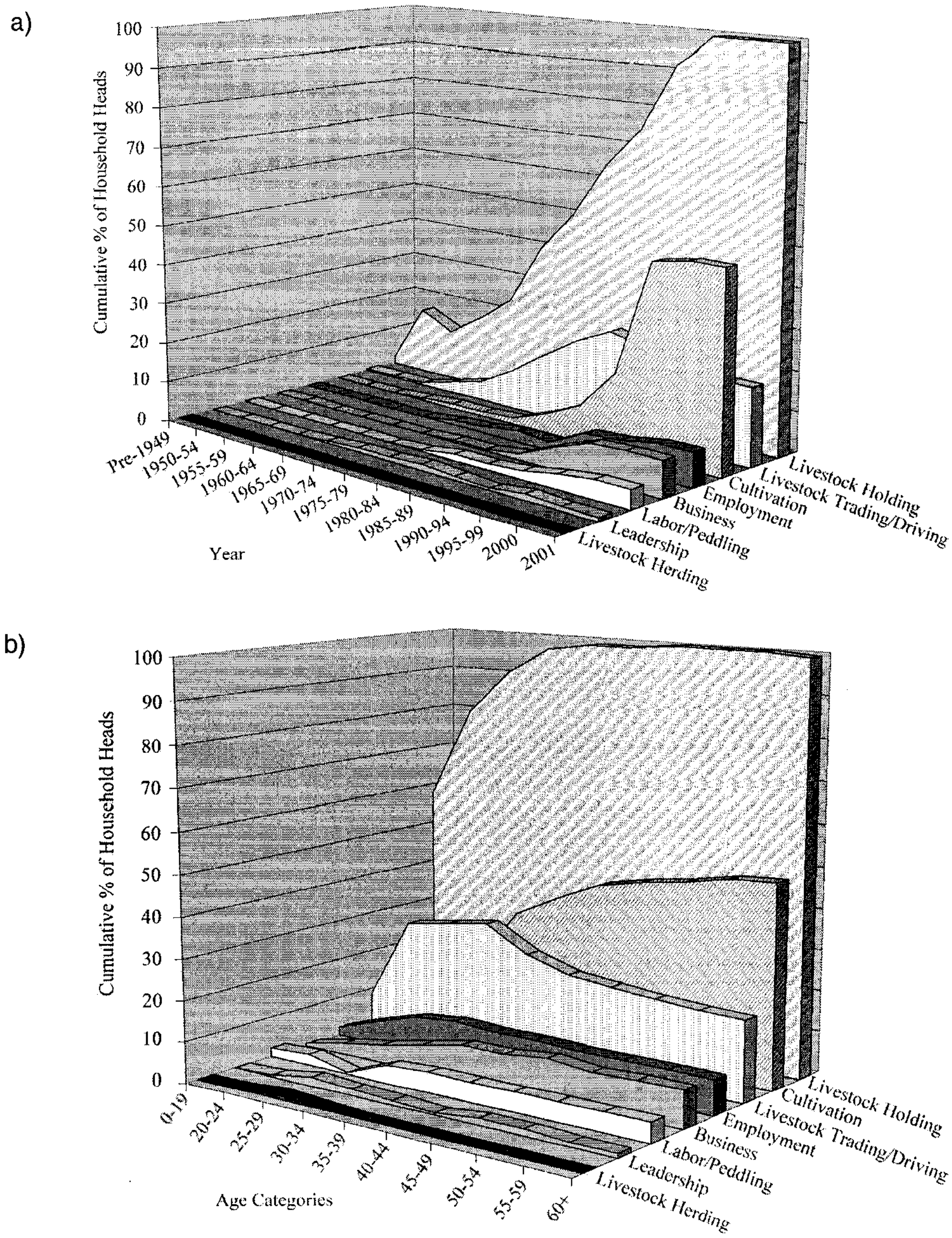

Figure 9. Diversification timelines by a) year and b) by age categories.

Livestock holding, livestock trading and employment as a livestock herder are activities clearly linked to the age of an individual (Figure 9b). However, while individuals kept their livestock once they had received them, the number of individuals engaged in livestock trading and herding activities declined significantly as they aged. The turnover rate for livestock trading was 69%, the highest of any activity (Table 18). The primary reason for beginning to trade livestock was the perception of potential economic gain (44%) although economic need was also a factor (19%). However, lack of capital, age and rising responsibilities were reasons cited for ending the activity. This is not to say that all trading was unsuccessful (although it was for some), but a successful trader with a growing household also has greater calls on his time, and this was one form of pressure cited by individuals that led to the cessation of trading and refocusing on their households and animals. This implies a form of diversification that is more short-term and is also more goal-specific. In contrast to these age-linked activities, adoption of cultivation is inelastic to age (e.g., individuals begin cultivation at all ages), and the strong pick up of cultivation seems to be more time and situation specific. Individuals rapidly diversified into cultivation during the period extending from the early to mid-1980s – a time of severe droughts – but cultivation has also continued to grow since then (Figure 9a). Cultivation also seems to be an activity that once begun, is rarely put aside, as only 12% of individuals who began agriculture then stopped. Also clear is that respondents primarily felt pushed into engaging in agriculture (Table 17). Individuals began cultivation out of economic need or in an effort to mitigate for livestock losses. A few people (16%) also indicated that they had a specific plan in mind to diversify their activities to minimize future losses from drought.

Business, wage and small-scale peddling (e.g., of goods and labor) activities seem to be sensitive to both time and age. There was a general period of strong growth in these activities from 1985-1995, but there is also a trend for individuals to begin these activities at younger to middle ages. There was by far less turnover in employment (30%) than in either business (48%) or small-scale peddling (44%) activities, but 30% turnover is still relatively high (Table 17). Again, negative reasons for beginning these activities were cited most often ("economic need"), but a few stated reasons were also positive (e.g. "profit potential" or "increasing/saving the herd"). Small-scale peddling was also perceived as "cheaper to start" than other activities. However, when asked why they ended activities, individuals cited overwhelmingly negative justifications, whether linked to family needs, drought, money issues or instability of the work itself. The exception was two individuals who stopped one activity to pursue something "better" (e.g., take a better job).

Two other activities, Leadership and Investment, demonstrate interesting diversification patterns. Leadership activities (e.g., group ranch committee membership) seem to be age-sensitive as there are two humps when individuals held offices (at around 30 and 55 years of age) (Figure 9a-b). These activities are therefore clearly of finite duration. This is an interesting illustration of the current pattern in Amboseli for leadership positions to be held on the one hand by respected elders, and on the other by younger, educated men. Table 17 summarizes the investment activities of the four individuals who purchased commercial and residential plots as rental properties. All these individuals were older, and had been

Table 17. Movement in and out of activities through time and reasons cited for changes. Values are percentages. Values in parentheses are numbers of household heads.

Activity Categories	Entry into activity (N=184)	Reasons for starting activity*	Mentioned by households % (No.)	Exit from Activity (%)	Reasons for stopping activity*	Mentioned by households % (No.)
Livestock Trade	116	Profit potential	44% (51)	69% (80)	Lack of capital	28% (32)
		Economic need	19% (22)		Animals needed attention	12% (14)
		Had family permission	2% (2)		Age - illness	10% (12)
Cultivation	102	Economic need	42% (43)	12% (12)	Climate - drought	4% (4)
		Tragedy - lost cows	16% (16)		Unsuccessful	3% (3)
		Effort to diversify	16% (16)		Taking a break	2% (2)
Employment	53	Need - had to make ends meet	21% (11)	30% (16)	The work ended	32% (17)
		"Requested" because of education background	9% (5)		Not paid well - money issues	11% (6)
		Profit potential - increase herd	9% (5)		Season ended - or fired	11% (6)
Business	33	Need- Avoid selling LS	27% (9)	48% (16)	Lack of capital	30% (10)
		Profit potential - increase herd	24% (8)		Climate - drought	9% (3)
		Investment - had capital	9% (3)		Had other option	3% (1)
Petty Trade	16	Profit potential	19% (3)	44% (7)	Animals needed attention	19% (3)
		Economic need	6% (1)		Used all the money	6% (1)
		Cheap to start	6% (1)		Became employed	6% (1)
Property Investment	4	Successful trader	50% (2)	(0)		(0)
		Helps livestock in drought	25% (1)			

* All respondents identified their economic activities, but not all cited reasons for why they started and stopped each activity.

successful at other activities (e.g., livestock trading) before investing their profits into property. One perception was that these properties would "help their livestock" as the income from investments decreased pressure to sell animals to satisfy family needs.

The goal of this section was to expand the discussion of diversification beyond identifying that, 1) people are doing it, and 2) diversification is economically important in the lives of pastoral households. Equally important is to "thicken" the understanding of under what circumstances individuals will diversify, and which activities may be time-specific and long-term (e.g., cultivation), versus more short-term, and age or goal-specific (e.g., livestock trading). People chose to diversify based on need or with high hopes of economic gain, but there was high turnover in business, wage employment and peddling activities, and not usually by choice, illustrating that while diversification activities are important to households, they are not necessarily *stable*. These analyses also suggest that households may link together some activities through time, for example reinvesting profits from one activity into investments or leaving one job for another, but more questions remain to be answered in this direction. However, it is clear that diversification in many cases is not unidirectional, rather the process is much more punctuated and fluid through time, linked to specific causes, circumstances and position within an individual's life stages.

MAASAI LIVELIHOODS: CURRENT AND FUTURE

The livelihood options embodied in an approach to conservation that is predicated on sharing of benefits with communities has been lauded in the literature since its inception in the 1980s – in Amboseli – as "Community-based conservation". The approach has been viewed equally hopefully by the Maasai of this region. However, the household-level results presented here show that proportionally very few households are benefiting directly from wildlife-related activities. Group ranch level benefits from the Kenyan Wildlife Service and local tourism operators are present in Amboseli, but there remain significant problems with transparency and fair distribution. If benefits were to be distributed directly to households, these revenues would be low ($14-15 per group ranch member), and wildlife-based employment was not widely distributed across the sample of GAE households. So the question remains, are the benefits that Maasai do receive from wildlife substantial enough to, 1) contribute positively to their livelihoods, and 2) sustain and generate positive conservation behaviors vis-a-vis their interactions with wildlife? Work by Barrett and Arcese (1995), Barrow et al. (2000), Goldman (2003), and Roque de Pinho (In preparation) suggests that the link between conservation benefits and local-level community development is still not strongly established in practice, and substantial institutional barriers exist that weaken the effectiveness of strategies on the ground. Despite community compensation programs now on the ground in Imbirikani group ranch, poaching and killing of problem wildlife is on the rise (McLennon, pers. comm.), and households perceive that there remain large costs associated with living with wildlife (Okello 2005). Similarly, in 2004, Kenyan President Mwai Kibaki's move to degazette Amboseli National Park in advance of the 2005 Kenya Constitutional Referendum, and give the park "back to the Maasai", illustrates that 30 years later, conservation in Amboseli still remains a highly-charged political issue and a focus of conservation controversy.

So it is important to take a step back and contextualize wildlife-based livelihood strategies within broader trends of economic diversification and livelihood change occurring in Maasailand. It seems clear that positive household level impacts of conservation are currently very small in comparison to returns accruing from general economic diversification. Economic diversification is well underway in southern Maasailand as it is in other pastoral areas of East Africa. But it is also critical to identify the circumstances under which diversification is linked to improved economic well-being for pastoralists. Results also showed that the vast majority of Amboseli households still gain more than 50% of their livelihoods from livestock and Maasai are intensifying aspects of their livestock production. Consequently, economic diversification and livestock intensification are *side-by-side* trajectories of change occurring in Amboseli, and they both link strongly to livelihoods and pastoral well-being.

Across all analyses, it emerged that livestock production alone is not the most remunerative current livelihood pathway being pursued in the Amboseli region. Study area analyses initially showed different levels of benefits accruing from categories of activities (e.g., agricultural versus off-land), and there were significant differences between benefits flowing from the three types of agriculture (e.g., higher value irrigated and highland rainfed in comparison to low value lowland rainfed agriculture). The application of a clustering methodology emphasized these differences further, highlighting that the three poorest groups of households were the two livestock-only clusters and *Irrigated upland agropastoralists*, who were pursuing cash crop agriculture in addition to livestock. Even the addition of high value agriculture to an impoverished livestock base did not improve the economic status of these households. Those pursuing livestock in combination with other activities were doing better on average in terms of gross income. However, a critical conclusion here is that the type of diversification pursued is important – just adding new activities to the base of livestock alone does not translate into straightforward improvements in economic well-being.

These qualifications regarding livelihood diversification are strengthened further based on results that broke down off-land activities by the economic returns associated with different predictability and skill levels. Predictable wage jobs requiring high levels of training offered the highest levels of remuneration to households, while petty trade jobs with low predictability and training requirements had the lowest returns. There were exceptions to this rule however, as some households with no outside education or training still engaged in highly remunerative activities (e.g., property investment, posho mills, and other businesses). The critical question remains, however – who has the means to make the large capital or schooling investments required to tap into the most successful activities? Petty trade activities may have low levels of remuneration, but they also require less capital outlay to begin and sustain them. The work of Barrett and Reardon (2001) in agricultural areas suggests that it is richer households who have the productive assets and education to engage in higher value diversification activities, and results of the current study support this claim for pastoral households in Amboseli.

Results of logistic regression analyses pointed out that both herd size (TLUs) and greater involvement in off-land activities predicted higher gross income levels for households. This points to a potential divergence between investment and activity trajectories for those households with previous successful involvement in wage labor or business, or larger herd sizes, versus those without these foundations on which to diversify and invest. In other words, richer households have the tools to capitalize on their success in the direction of more skilled or highly predictable activities, while poorer households may be much more limited in their efforts to diversify into either predictable or high skill endeavors. One caveat here is that households in the poorest cluster – *Irrigated agropastoralists* – were still schooling their children at rates higher than all the other clusters. Schooling in this sense is a future investment in diversification, one which may pay off over the longer term for these households.

Quantifying the connection between specific livelihood choices and well-being was also a focus of this chapter. Results indicated that greater age, engagement in highland agriculture, larger herd size (TLUs), and more off-land income sources, were predictors of higher gross incomes for households. Mobility during critical drought periods, larger households (AUs), *greater* distance from services, and greater income from livestock and off-land income sources were significant predictors of herd size. Greater mobility in critical drought periods was also a variable that differentiated membership between some household clusters. Results emphasize the livelihood contributions of agriculture, businesses and wage jobs. However, being older, having larger households, maintaining large herds, and greater mobility are components of a more "traditional-pastoral lifestyle", suggesting that in spite of ongoing economic diversification into other activities, the characteristics that have always contributed to being a successful pastoralist are still critical today. It is interesting to note that the presence of off-land activities was the only common predictor of both livestock wealth and higher gross income, although variables such as age and household size are cross-correlated. This could suggest that the trajectories between greater herd size and higher gross incomes may not be necessarily mutually reinforcing over the long term.

The importance of mobility in predicting herd size is also of interest given the currently strong pressures on pastoralists and group ranch committees to subdivide rangeland areas in Imbirikani, Eselenkei and Olgulului/Lolarashi group ranches – particularly for the proportion of households in Amboseli (21% in my sample) who were dependent only on their herds. Other researchers have linked mobility with wealth (Fernandez-Gimenez 2001) and risk alleviation in drought prone environments (Niamir-Fuller 1999; Adriensen and Nielsen 2002). Even in already subdivided Osilalei group ranch, households were highly mobile in drought periods in spite of sedentary grazing patterns during normal years (BurnSilver and Mwangi 2007). That mobility emerged as a significant predictor of herd size in spite of ongoing diversification efforts, strongly suggests that further sedentarization and subdivision of group ranch lands could have significant and negative effects on human well-being given the continued importance of livestock to the Maasai economy (Fratkin and Mearns 2003).

Based on these findings, results that begin to document the intensification of livestock production in Amboseli are also highly significant to a discussion of pathways of change and continuity in Maasailand. Four emergent components of intensification trends in the region were described, and although results did not quantify the economic benefits of these strategies, there are clearly economic implications for households as these strategies mandate changes in how households raise, sell and manage their livestock. For example, there are potential benefits to households from bigger, more valuable livestock for sale in the marketplace (King, Sayers et al. 1984; Bekure, de Leeuw et al. 1991; Zaal 1998; Scarpa, Kristjanson et al. 2003). However the risks associated with raising hybrid animals in a highly drought-prone environment are also significant – a fact of which pastoralists themselves seem well aware (Boone, BurnSilver et al. 2007). Combined qualitative and calculated results indicate that households are selling more livestock now than previously. Selling livestock to satisfy basic needs alone implies greater economic needs overall, but selling of livestock when timed to take advantage of good market prices is a potential positive for pastoral households. However, this a step that researchers have pointed out must be predicated on more numerous and more stable livestock marketing outlets for pastoralists (Zaal 1998; Zaal 1999; Barrett, Chabari et al. 2003; Osterloh, McPeak et al. 2003). Similarly, access to credit and banking infrastructure is low in the Amboseli region, and yet credit availability is considered a foundation of economic growth for underdeveloped rural areas (Dercon and Krishnan 1996; Barrett, Chabari et al. 2003; Desta, Coppock et al. 2004). The impetus to intensify production strategies comes from both external (e.g., national government) and internal sources (pastoralists themselves), but there is currently a lack of developed infrastructure and support to push this process forward in Amboseli.

The discussion of diversification pathways in Amboseli ended with another qualification – one which pointed out that the process of diversification is neither unidirectional nor static. Results show that movement of individual household heads in and out of activities throughout their economic lifetime is common. Some activities, such as agriculture, show less elasticity over time. Others, for example livestock trading, are activities undertaken for shorter, defined time periods to satisfy particular goals. Results show overall that decisions to begin and especially to end economic activities were more likely to be made for negative reasons (e.g., economic need) than positive ones (e.g., responding to growth and success), pointing out that diversification is undertaken in many cases under conditions of economic duress.

The goals of this chapter were to describe trajectories of livelihood change and diversification in pastoral strategies in the Amboseli system, in terms of "what people are doing," then quantify how well households are doing based on various combinations of economic activities, and finally, to begin identifying the determinants of why one pattern is chosen over another. Research over the past decades has documented that pastoralists are currently poorer according to traditional metrics of pastoralism (Sutter 1987; Bekure, de Leeuw et al. 1991; Rutten 1992), and research results for the study area certainly indicate that pastoral herders *feel* poorer overall (BurnSilver 2005). Similarly, recent poverty mapping efforts in pastoral areas globally shows that 25-35% of the population in Kajiado District, Kenya is below the international poverty line, defined as subsisting on less than 1$/day (Thornton, Kruska et al. 2003). Questions remain unanswered in terms of the potential of economic diversification and livestock intensification efforts to raise pastoral households above this poverty threshold. Similarly, whether community-based conservation can be molded and managed in ways that contribute more directly to pastoral livelihoods in Amboseli is also unknown. However, the Greater Amboseli Ecosystems remains a region that epitomizes for many the hope of successfully integrating Maasai culture, a vibrant pastoral economy, and protected wildlife and ecology.

This research focused on households, both rich and poor, who remained engaged with pastoralism in Amboseli, but the approach probably missed those households who have lost their livestock and already dropped out of the system entirely – and these households certainly represent another face of economic change and pastoral poverty in the region. While livelihood diversification is a new economic reality in Maasailand, hopefully these results also begin to highlight some of the complexities and nuances implied by this process. There are both potential benefits and costs associated with these trends for households who have different means available to them. For many reasons, the future of traditional, extensive pastoralism in Amboseli is unclear, but certainly the faces of Masaai pastoralism to emerge over the next few years will be increasingly complex and multi-faceted.

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APPENDICES

APPENDIX 1. Breakdown of livestock-based income by proportion and study area. Values are percentages of households.

Study Areas	Livestock Sold	Livestock Slaughtered	Livestock Gifts Rec'd	Hides/Skins Sold	Milk Sold	Total
Osilalei	81.5	8.3	6.3	2.0	1.9	100%
Eselenkei	82.0	6.4	8.0	3.5	0.2	100%
Lenkisim	68.9	13.5	5.4	11.2	0.9	100%
N. Imbirikani	64.4	17.6	9.2	4.6	4.3	100%
Emeshenani	90.7	5.0	2.7	0.9	0.7	100%
S. Imbirikani	65.3	3.2	10.5	7.1	14.0	100%
Total	75.1	9.0	7.1	4.9	3.9	

APPENDIX 2. Livestock production characteristics by household cluster. All values are in $US. Values of livestock given out, received and slaughtered are calculated based on average selling prices documented during the study period. Bolded values are means.

Household Clusters		TLUs per Household	*Livestock Sales	Livestock Slaughter	Livestock Purchase	Livestock Gifts OUT	Livestock Gifts IN
Livestock intensive	Mean	**73.4**	**732.8**	**89.0**	**281.7**	**29.6**	**38.0**
	Std. Deviation	70.8	462.8	112.7	398.6	52.9	67.9
Livestock consumers	Mean	**62.5**	**712.2**	**52.4**	**0.0**	**16.5**	**0.6**
	Std. Deviation	97.6	644.0	64.5	0.0	38.1	3.1
Livestock lowland cultivators	Mean	**41.7**	**985.8**	**139.4**	**22.9**	**116.8**	**61.9**
	Std. Deviation	25.6	642.1	276.5	53.6	187.3	115.2
Diversified lowland cultivators	Mean	**39.4**	**764.8**	**70.1**	**145.9**	**37.5**	**72.3**
	Std. Deviation	42.6	1118.2	100.5	397.9	70.3	137.3
Livestock business	Mean	**59.8**	**959.2**	**77.7**	**190.8**	**71.0**	**45.0**
	Std. Deviation	62.9	1231.3	137.4	349.9	149.2	109.8
Livestock wage earners	Mean	**83.3**	**1206.9**	**144.9**	**286.5**	**51.9**	**159.5**
	Std. Deviation	122.1	2050.6	159.3	418.1	88.3	381.2
Irrigated / upland agropastoralists	Mean	**27.1**	**261.9**	**9.7**	**214.5**	**77.9**	**69.0**
	Std. Deviation	37.5	222.32	20.3	386.6	209.7	221.2
Diversified agropastoralists	Mean	**93.2**	**931.4**	**125.8**	**219.1**	**83.4**	**50.6**
	Std. Deviation	164.3	912.4	209.7	287.6	136.9	78.8
Total	Mean	**61.3**	**813.9**	**85.0**	**175.3**	**59.8**	**58.9**
	Std. Deviation	95.7	1063.4	149.9	337.1	130.6	166.9

APPENDIX 3. Significant parameter estimates: Multinomial Logistic Regression

Clusters		B	Std. Error	Wald	df	Sig.	Exp(B)
Livestock intensive	Intercept	-33.844	14.194	5.685	1	.017	
	TLUs per household	.009	.004	4.205	1	.040	1.009
	Gross income	-.002	.001	10.646	1	.001	.998
	Mean NDVI	.241	.096	6.316	1	.012	1.272
	Services distance	.226	.099	5.222	1	.022	1.253
	Conservation area distance	.231	.117	3.904	1	.048	1.260
	Road distance	.283	.140	4.111	1	.043	1.327
Livestock consumers	Intercept	-9.509	10.163	.875	1	.349	
	Gross income	-.002	.001	9.694	1	.002	.998
	Services distance	.255	.098	6.773	1	.009	1.290
	Conservation area distance	.303	.119	6.493	1	.011	1.354
Livestock wage earners	Intercept	-15.343	12.516	1.503	1	.220	
	Conservation area distance	.242	.128	3.584	1	.058	1.274
	Livestock market distance	.179	.083	4.646	1	.031	1.196
Livestock business	Intercept	-18.295	9.169	3.981	1	.046	
	HH* (no) schooling	3.182	1.278	6.199	1	.013	24.086
	HH (some) schooling	0(b)	.	.	0	.	.
	Pastprop_10km2	-14.891	6.464	5.308	1	.021	3.41E-007
	Mean NDVI	.213	.077	7.672	1	.006	1.238
	Services distance	.381	.104	13.317	1	.000	1.463
	Conservation area distance	.371	.117	10.060	1	.002	1.449
	Road distance	.304	.106	8.218	1	.004	1.356

Livestock lowland cultivators	Intercept	-14.087	14.032	1.008	1	.315	
	Pasture proportion 10km^2	-67.325	22.631	8.850	1	.003	5.77E-030
	Mean NDVI	.545	.162	11.285	1	.001	1.724
	Services distance	.405	.230	3.087	1	.079	1.499
	Dry season water	1.384	.542	6.528	1	.011	3.990
Irrigated/upland agropastoralists	Intercept	2.793	9.512	.086	1	.769	
	Gross income	-.001	.000	4.957	1	.026	.999
	Dry season water	.561	.300	3.502	1	.061	1.753
	Conservation area distance	-.501	.264	3.602	1	.058	.606
	Mobility in drought year	8.787	3.482	6.368	1	.012	6545.871
Diversified lowland cultivators	Intercept	-35.968	15.961	5.078	1	.024	
	TLUs per household	-.071	.020	12.317	1	.000	.931
	Gross income	.002	.001	8.137	1	.004	1.002
	Pasture proportion 10km^2	-39.391	18.585	4.492	1	.034	7.81E-018
	Mean NDVI	.667	.179	13.898	1	.000	1.949
	Services distance	.290	.126	5.303	1	.021	1.336
	Dry season water	.782	.404	3.748	1	.053	2.186
	Conservation area distance	.576	.163	12.480	1	.000	1.779
	Livestock market distance	-.161	.088	3.347	1	.067	.851
	Mobility in drought year	8.563	5.039	2.888	1	.089	5235.359
	Age of household head	-.099	.064	2.384	1	.123	.906

CHAPTER 3

PASTORAL MOBILITY IN THE CONTEXT OF CHANGE: A CASE STUDY OF FOUR GROUP RANCHES IN MAASAILAND, KENYA

INTRODUCTION

Common characteristics of pastoral systems in arid and semi-arid zones globally have been some degree of mobility, in combination with cooperative labor sharing, herd splitting and livestock diversification. This suite of strategies has been acknowledged as very effective in minimizing risk and maximizing flexibility in environments that are characterized by a high degree of variability (Galaty and Johnson 1990; Swallow 1994; Galvin, Boone et al. 1999; Niamir-Fuller 1999). However, the ability of pastoral populations to maintain mobility as a critical coping strategy is declining worldwide for a variety of political and economic reasons (Blench 2001).

Variability and risk in pastoral systems arise most often from a combination of climatic (e.g., precipitation and temperature) and ecological conditions (e.g. topography, slope, soil) expressed on the pastoral landscape as forage and water resources that are heterogeneous both temporally and spatially (Behnke and Scoones 1993; Ellis and Galvin 1994; Galvin, Boone et al. 1999). In terms of mobility, the pattern and degree of movement adopted by pastoral groups globally spans a gradient from nomadism, to transhumance, to more agropastoral and settled animal keeping, and depends on a variety of circumstances, for example; climatic regime (temperate vs. tropical), rainfall patterns (unimodal vs. bimodal), labor availability (Sikana and Kerven 1991), specific combinations of animal species, and whether a production system is based on milk or meat consumption (Khazanov 1984; Sieff 1997). Broadly speaking, the practice of mobility engages pastoral households in systems of movement that are highly seasonal and involve migration across extensive areas of a grazing territory that may be culturally, economically or politically defined (Behnke 1994). Movements translate into intensive and punctuated use of forage in one area, followed by migration to other areas with desirable forage and water resources. The strategy of pastoral mobility then becomes a common way to compensate for the patchy nature of resources on landscapes that are as dramatically different as the plains of East Africa and the steppes of East Asia.

The dominant land use in the greater Amboseli ecosystem (GAE) of Kajiado District, Kenya is Maasai pastoralism. Along the gradient of pastoralism, Maasai historically would have been categorized as transhumant – whereby all or portions of households migrated seasonally away from more permanent settlements. Prior to 1950, this was a grazing system characterized by wet season dispersal movements to access green, high quality forage, followed by a return in the dry seasons to permanent water sources and grazing in nearby areas (Western 1973; Worden 2007). However, water infrastructure provision in 1950s, followed by land tenure change, economic diversification and outside efforts to intensify livestock production in subsequent decades have initiated a gradual, but dramatic switch in the basic social and ecological organization of the grazing system. These trends now represent a basic shift in the ecology of this pastoral system (Worden 2007) one that is putting stress on traditional patterns of Maasai transhumance – and consequently poses important challenges for livelihoods in present day Maasailand (Thompson and Homewood 2002).

Current land use within the Amboseli ecosystem reflects all these processes of change to varying degrees. Some pastoral areas are still managed based on principles of communal land ownership, but now herders collapse in on zones of permanent settlement, infrastructure, and permanent water sources in wet periods, and disperse outward in dry periods (Worden 2007). A cultural and institutional system of grazing "stages" has been in place since the 1980s to control and manage movements of households gradually outward from permanent settlement zones towards areas where forage resources have been monitored and "saved" from grazing since the previous season. Pastoral movement is now based on a system of dry-season dispersal, in contrast to the pattern of wet-season migration previously in place. Alternately, some communal areas have now been privatized down to the level of individual parcels, with the implication that households become sedentarized with their herds on particular areas of the landscape over the long term. Year-round grazing in privatized parcels is just the opposite of the punctuated, but intermittent grazing over extensive areas that characterized the system historically. The privatization of communal land is a significant trend in Kajiado District, as 40 of 52 group ranches in the district were subdivided by 1990 (Kimani and Pickard 1998; Kabubo-Mariara 2003). Finally, there are also zones of market-based agriculture organized around key resource zones containing permanent swamps. Maasai households in these areas do have animals, but they are increasingly agropastoral (BurnSilver Ch. 1).

Clearly, a dominant feature of this system is change. The trends towards continued privatization of the communal land base, sedentarization, and economic diversification are a function of political and socio-economic drivers emanating from a combination of local national, and international sources (Behnke 2007). However, ecologically and climatically the system remains a semi-arid savanna ecosystem that is strongly characterized by the patchy nature of resources available to herders and their animals in space and time. And it is the driest areas of the district that still remain unsubdivided. Kajiado district is also an area characterized by low access overall to productive infrastructure and economic resources such as banking, credit and livestock markets that would theoretically pave the way for intensification of livestock production (UNDP 2001; Boone, BurnSilver et al. 2007). Mobility has been one of the critical benchmarks of traditional pastoralism that allowed herders to cope with uncertainty. But in this changing system, does mobility continue to play a critical role in the productive decisions of pastoral households? Do people still depend on their livestock to a degree that mobility remains important? And if mobility remains a widespread coping strategy, what proportion of Amboseli households would then be the most affected by a transition to an increasingly non-mobile, sedentarized and privatized system? This chapter makes the case that an important link exists between the continued mobility of pastoralists and their animals, and maintaining resilient pastoral systems in the face of change.

With these general questions in mind, the approach taken in this chapter is to ask who continues to be mobile under a new set of economic and land tenure conditions, and then to begin quantifying the resources accessed by mobile vs. immobile pastoral households in the Amboseli ecosystem. Interviews and movement data gathered from Maasai households across a gradient of pastoral land use from traditional to agropastoral, and living under variable land tenure arrangements and levels of sedentarization, are the basis for linking livelihoods to the socio-economic characteristics of mobility. There is an expanding history of research in rangeland science and remote sensing using Normalized Difference Vegetation Index (NDVI) data to track patterns of forage greenness and biomass production (Reed, Brown et al. 1994; Pettorelli, Vik et al. 2005). SPOT NDVI data is the methodological platform used in this chapter to quantify the forage resources available to pastoral herds in Amboseli under different scenarios of mobility. This research also took advantage of a natural experiment that occurred in the process of fieldwork. The year 1999 was a "normal" year of precipitation, while a serious drought involving the failure of two rainy seasons characterized the year 2000. This offered the opportunity to compare pastoral mobility under "normal" vs. highly stressed conditions.

In this chapter I ask the following questions:

- Given the background context of economic diversification - how important is livestock production to pastoral livelihoods in Amboseli?
- How mobile are households in the Amboseli system under different climatic conditions?
- What are the resources that mobile vs. immobile households access through movement?
- What are the characteristics of households who are still mobile within this changing system? What are important predictors of this mobility? Are they effective in; 1) predicting whether a household is mobile or

immobile, and 2) identifying the degree of mobility for households that do move?

The Context of Mobility in Pastoral Systems

The baseline goal of subsistence pastoral production systems is to procure sufficient forage and water resources to sustain the population of domestic animals on which a human population is dependent. Climatic, ecological and social conditions define the circumstances under which domestic herbivores graze – e.g. are they free-roaming or are they herded, and what are the drivers of their movements across a landscape in time and across space? Different herbivore groups each have specific dietary preferences, for example; goats and camels are browsers while cattle and sheep are primarily grazers. Consequently, pastoral groups usually manage specific animal types under different grazing and herding regimes (Dyson-Hudson and Dyson-Hudson 1980; Oba and Lusigi 1987). Recognition of these differences is the basis for the high diversification in both herd species and labor strategies observed across many pastoral societies. The wide diversity in herded species and their grazing niches is interesting in and of itself, but this chapter will focus specifically on the herding of cattle – as the majority of animal biomass – and therefore human livelihoods in Maasailand, rest in its cattle herds (Coppolillo 2000). Cattle are also the core of many cultural beliefs and social structures in Maasailand (Spear and Waller 1993).

A basic difference across grazing systems that helps to define grazing distribution and resource access by herbivores is whether animals are herded, fenced or free-roaming (Turner, Hiernaux et al. 2005). Senft et al. (1985) and Coughenour

(2007) showed that unherded but fenced domestic cattle selected for both relative forage quantity and quality within a pasture, and Pickup and Chewings (1988) illustrated that in addition to preferences for specific vegetation types, water availability exerted primary control on the spatial extent and pattern of daily grazing movements. Vegetation *quality* here is defined as crude protein content, which is highest in green vegetation (Kawamura, Akiyama et al. 2005). Vegetation *quantity* is reflected in forage biomass, which represents the combination of both live and dead plant matter, the relative proportion of which is dependant on local grazing pressure and timing within the growing and dormant seasons (Reed, Brown et al. 1994).

In the case of most traditional East African pastoral systems, Maasailand included, cattle are not left to roam – they are herded, leaving family compounds in the morning and returning typically at the end of each day. Grazing therefore begins and ends at a "central place", and animals are led to water and through areas of forage by herders (Coppolillo 2001). Cattle may still select for both forage quality and quantity as they move along a grazing path, but the choice of the path (e.g. direction and distance traveled) is made by the herder (Turner, Hiernaux et al. 2005). This process occurs at the daily scale, but access to resources for animals in these highly variable systems ultimately depends on mobility strategies employed also at seasonal and annual scales. Seasonality is defined by the switch between wet and dry periods and is reflected in the timing of periods of forage green up and senescence. Most water sources for animals also follow this seasonal trajectory. While some sources are permanent (e.g. pipelines, bore holes or wells), others; streams, rivers, ponds and dams, for example are ephemeral, filling during the wet season rains, but gradually being used and/or drying out. New forage zones are commonly accessed through some form of seasonal transhumance, by which all or a portion of a household and their herds moves to new grazing areas. The territories of pastoral groups customarily are divided into locally-defined zones of wet or dry season grazing, with certain areas commonly recognized as high value drought refuges (e.g. high altitude areas) or key resources (e.g. swamps or seasonal streambeds), that are exploited during the driest periods (Scoones 1991; Illius and O'Connor 1999). The forage quantity and quality available to cattle herds based on successive movements depends again on the timing of mobility within and across seasons, e.g., where cattle are herded relative to the seasonal patterns of vegetation green up and dry down. So for example, researchers have identified that transhumance patterns can be oriented towards exploiting current or expected future green flushes in vegetation (Adriensen and Nielsen 2002), towards accessing areas of standing biomass that are already senescing (Marsett, Qi et al. 2006), or a combination of the two strategies across time. Moving up in scale, annual patterns of precipitation – both timing and quantity of rainfall – set the pace for seasonal patterns of transhumance, e.g. defining within one year when dry and wet seasons begin and end, and consequently when movements occur. Since a defining characteristic of these semi-arid systems is their large variability (Ellis and Galvin 1994), this affects mobility patterns of pastoral herds, in terms of such metrics as total annual distance traveled, the number of times herds move and the duration of these moves.

Social, ecological and policy views on mobility

Questions regarding the validity of nomadic and transhumant pastoralism as a productive strategy, and the "rationality" of pastoral mobility as a primary component of these systems have been debated vociferously in the social and ecological literature over the preceding decades. On the one hand East African pastoralists have long been accused of acting under the cultural sway of a "cattle complex", by which large, unproductive herds are maintained primarily for status purposes, leading to overstocking of rangelands, low per animal productivity and inevitably, rangeland degradation (Herskovits 1926). Mobility, large households and a need-based rather than market-based orientation to selling animals are characteristics of "traditional" pastoralism that have been heavily criticized by rangeland managers and policy makers under this paradigm (Kerven 1992). Mobility in pastoral systems has historically occurred within the context of communal land tenure and land use (Behnke and Scoones 1993; Lane and Moorehead 1994), whereby access to grazing territories is negotiated based on a bundled set of norms and use rights. These rights are structured as multi-layered relationships of clan, blood ties, marriage and stock-friendships (Kituyi 1990). However, transitioning pastoral systems from communal property towards private property as a basis for land use has been advocated as a primary solution to the problem of low pastoral productivity, the assumption being that individuals will invest more systematically in their own property and resources, and this will translate into greater economic offtake and development in pastoral regions over the long term (Pinckney and Kimuyu 1994). The logic here comes from the tragedy of the commons argument initially articulated by Hardin (1968), but subsequently used as the conceptual basis for policies oriented towards privatizing communal resources globally (Ostrom, Burger et al. 1999).

However more recently, a variety of theoretical work in Political Science, Anthropology and Ecology has begun to underscore the logic of both common property resources (CPRs) and mobility as important aspects of pastoralism that do not inexorably lead to landscape degradation – and on the contrary, may contribute to system resilience.

A substantial body of literature now contradicts Hardin's initial assumption which equated common pool resources with "open access" use of rangelands. First, this work differentiates between the characteristics of CPRs and property regimes. Ostrom et al. (1999) identified four types of property regimes; open access, state-owned, common property and private property. Each regime differs in terms of the specific rights which govern access to and control over resources, and with whom the locus of control resides (Hanna and Munasinhge 1995). In the case of "open access", no group or entity governs use of a resource, whereas under a common property regime, a specified group either "owns" or is granted control over specific resources. In the case of pastoralists, the resources in question (usually grazing land and water) often lie within a specified territory that is defined by kinship, clan or section membership. Critical characteristics of CPRs themselves are, 1) the difficulty involved in protecting them or excluding others from unauthorized use, and 2) the principle of subtractability, which specifies that exploitation of the resource by one individual subtracts from the quantity of resources remaining for others to use. The specification of differences between property regimes and CPRs underscores the contradiction in assuming that common pool resources function as an "open access" resource, when by definition, CPRs imply control over resources exerted by a group of users.

An important outcome of the work by Ostrom and others has been the identification of a set of design principles, which predict the circumstances under which use of common pool resources can be sustainable (Ostrom 1990; Ostrom, Burger et al. 1999; McCay 2002). The emergence and continuity of communal land use mechanisms are hypothesized in systems where resources are characterized by high spatial uncertainty, where economic value per resource unit is low, where perceptions of resource limitations are held in common, and where a history of reciprocal action between households (or communities) is present (Agrawal 2002; Dietz, Dolsak et al. 2002). This description closely describes the characteristics of semi-arid rangelands and cooperative social mechanisms governing pastoral mobility found in Maasailand specifically, and many other pastoral systems as well.

Theoretical work in rangeland ecology has also questioned the automatic linkages between pastoral herd densities and rangeland degradation. The ecological model of grazing management which dominated rangeland science through the 1980s, was based on Clementsian ideals of vegetation succession and the classical model of plant –herbivore vegetation dynamics (Clements 1936). This is an equilibrium ecological model, under which animal density and vegetation responses are assumed to be tightly coupled. On the basis of initial work by Weins (1984), Ellis and Swift (1988), and ongoing research by others in a variety of rangeland contexts (e.g., (Fernandez-Gimenez and Allen-Diaz 1999), non-equilibrium, or disequilibrium (Illius and O'Connor 2000) understandings of ecosystem dynamics have gradually emerged. These models posit that abiotic and stochastic conditions common in rangeland systems (e.g. low rainfall, recurrent drought and high coefficients of variation) can act to decouple the relationship between vegetation and herbivores, so that forage conditions (e.g. total biomass, species richness and abundance) can be independent of herbivore density under specific conditions. This is particularly the case in areas where variability is extremely high (e.g. CVs over 33%) (Ellis 1994). The debate over equilibrium vs. non-equilibrium understandings of rangelands continues, but one effect has been that rangeland scientists have become less apt to immediately label pastoral land use as the cause of ecological degradation through overgrazing (Vetter 2005).

A second trajectory in ecological research relevant to pastoralism focuses on the impacts of landscape fragmentation on ecosystem processes, structure and function (Debinski and Holt 2000). Landscape heterogeneity is a function of large scale gradients of climate, topography and soils which result in vegetation communities patchily arranged on landscapes (Illius and O'Connor 2000). However, unless a landscape is strongly homogeneous, heterogeneity declines as landscapes are fragmented because features drop out as scale decreases (Ellis et al. 2001; Hobbs et al. 2007). In the context of traditional pastoralism, movement across landscapes allowed pastoralists to exploit the spatially and temporally heterogeneous resources present in a system. However, in landscapes fragmented by privatization of communal lands or the process of sedentarization, the scale of movement is curtailed and access to a full range of resources declines across space and time (Curtin, Sayre et al. 2002).

In terms of pastoral development policies, the vision of pastoralists as non-productive, apt to overstock and unnecessarily mobile was the basis for widespread sedentarization, privatization and modernization campaigns applied during the period from 1950 to 1990 in East and West Africa (de Bruijn and van Dijk 1999; Niamir-Fuller 1999; Turner 1999; Kerven, Alimaev et al. 2003) and Asia (Banks 2003; Kerven, Alimaev et al. 2003; Yeh 2004). The policy vision for the transformation of pastoral systems in this period was sedentary animal producers who could be more easily provided with services, who maintained smaller, more productive herds, used livestock markets efficiently (e.g. became production maximizers instead of subsistence producers), and made use of credit resources to finance productive inputs such as water resources and veterinary supplies (Blench 2001). However, there is widespread acknowledgement in pastoral development circles that this suite of strategies was largely ineffective in raising production levels in pastoral zones (Behnke and Scoones 1993). And in many cases these policies were accused of increasing pastoral poverty (Fratkin, Roth et al. 1999), while simultaneously weakening social mechanisms that had allowed pastoralists to mediate risk in these highly variable environments (Kituyi 1990; Galaty 1992; Galvin 2007). Additionally, the package of economic developments envisioned for pastoral areas is input-intensive, for example, depending on the existence of well-developed livestock markets, transport and veterinary infrastructure and access to credit for producers. However, the current global economic environment stresses fiscal conservatism and structural adjustment as stimulants for national economic growth (ADF 2003; Njenga and Davis 2003). The resultant fiscal belt-tightening has translated into a resource-poor development environment for rural producers generally and pastoralists specifically (UNDP 2001; Akcura 2002; Boone, BurnSilver et al. 2007). Yet, the research described above has begun to underscore the logic of both common pool resource management and mobility. Pastoral mobility is now being re-emphasized as critical and rational in the face of ecological variability and economic and institutional frailty. Questions asked in this chapter regarding the current extent and importance of mobility in the Amboseli pastoral system take place within this ongoing policy and research debate.

STUDY AREA DESCRIPTION

Maasai Pastoralism

Maasai pastoralists traditionally depend on animal herds that are a combination of cattle, sheep and goats. Individual herds are privately owned, and large, patriarchal and multi-generational households manage livestock cooperatively. Maasai pastoralism is milk-based and a majority of Maasai nutritional energy historically came previously from milk (primarily cows'). Meat and blood from opportunistic slaughter also contributes to household nutrition (Nestle 1985), but cereals (primarily corn) and some vegetables are now increasingly integrated into the pastoral diet (Homewood 1995; Smith 1999)

Six sub-tribe designations of Maasai, called sections or *ol-oshon*, are located within Kajiado District. The greater Amboseli ecosystem overlaps portions of three

Maasai sections; Ilkisonko, which lies in the southeast corner of the district, Kaputei in the north, and Matapaato, which extends north and west of Ilkisonko (Figure 1). Maasai sections have exclusive claims to rangeland territories, follow their own cultural calendars and have unique variations in dress and language (Spear 1993). The historical basis of Maasai land use was communal management of rangelands first within *ol-oshon* territories, and then locally based on elders' consensus on when seasonal movements should occur. However, economic and cultural interactions take place across sectional boundaries, and in times of severe drought, access to grazing in other sections can be negotiated on a reciprocal basis (Galaty 1993).

Biophysical Description

The focal study area for this paper is the Greater Amboseli Ecosystem (The GAE - approximately 8,500 km^2), located in the southeastern corner of Kajiado district. The area is defined as a core area encompassing the Amboseli Basin and swamps along the northern foot of Mt. Kilimanjaro, and include the dry season dispersal movements of herbivores between the swamps of Amboseli National Park and neighboring rangelands (Western 1973). Topographically, the system is bounded by the Chyulu hills to the east, the Kilimanjaro foothills to the south and the Pelewa hills to the northwest (Figure 1). Dominant vegetation communities are broad leaf dry tropical forests and woodlands on the Kilimanjaro and Chyulu slopes, open grasslands and seasonally flooded plains, riverine forests, halophytic grass and scrubland in the Amboseli Basin, and scattered Comiphora and Acacia woodlands in rangeland areas to the north and east of the park (BurnSilver, Worden et al. 2007). A gradient of decreasing rainfall extends north to south across the study area. Northern areas receive 500-600 mm of annual rainfall, but in shadow of Mt. Kilimanjaro, the Amboseli basin receives only 250-300 mm/yr. The majority of southern Kajiado district is categorized as either arid or semi-arid lands (Katampoi, Genga et al. 1990), but higher altitude zones along the Chyulu hills and Kilimanjaro foothills receive more precipitation. Peak biomass production at the low end of the rainfall gradient (300mm/yr) was calculated by de Leeuw and Nyambaka (1988) as 760 kg/dm/ha^{-1}, while at the high end of the gradient (500 mm/yr), it rose to 1510 kg/dm/ha^{-1}. Rainfall patterns are patchy and irregular with substantial variability both within and between years, and it is not uncommon for seasonal rains to fail altogether. The rainfall coefficient of variation (CV) for the study region is 28.89% (Boone and Wang, 2007). Annual rainfall patterns are bimodal, with rainfall occurring Nov – Dec (short rains) and Mar – May (long rains), interspersed with two dry seasons, Jan – Feb (short dry) and June – Oct (long dry).

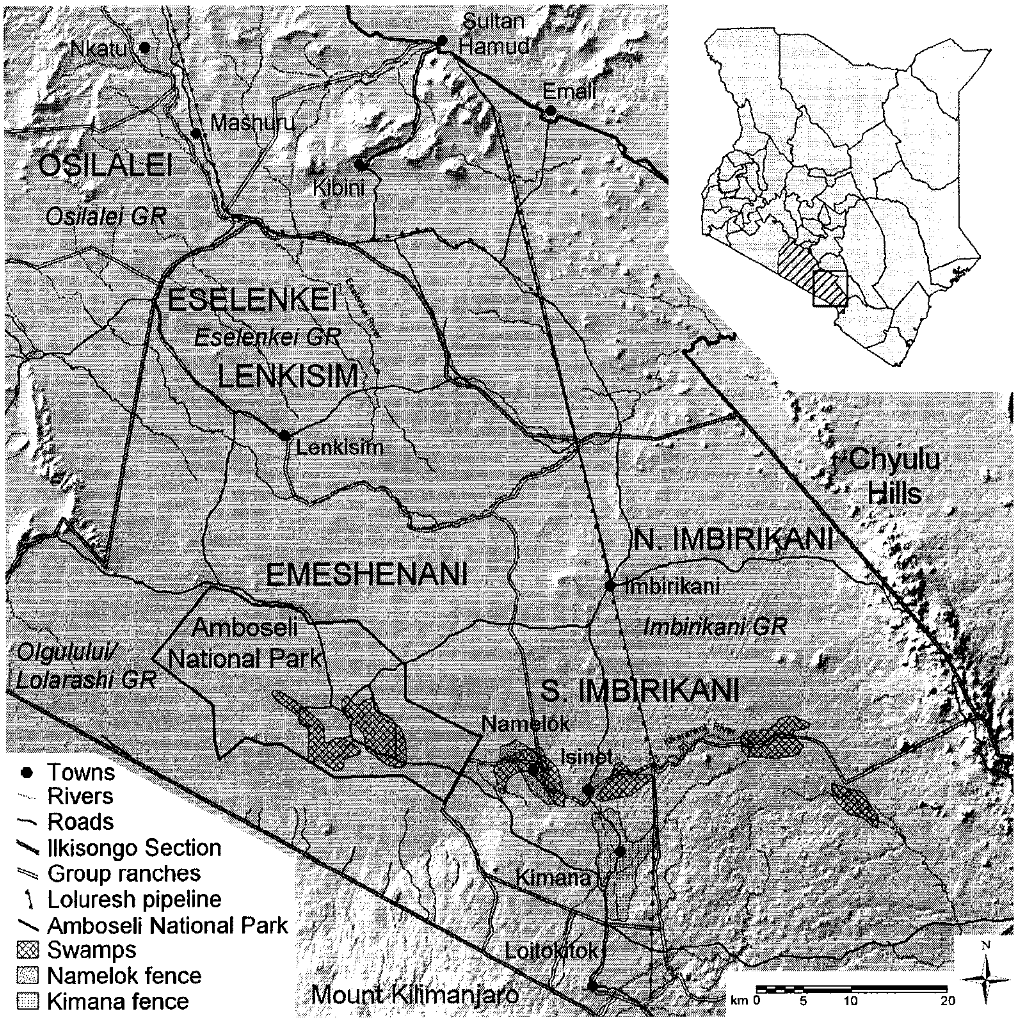

Figure 1. Study area map indicating the four Maasai group ranches where research took place (Capital letters), and six study sites (Lower case italicized).

Land Tenure and Land Use Trends

A process of land tenure change has been ongoing in Maasailand since the mid-1960s. The starting point to this process was communal use of rangelands, but the long term trajectory is towards privatized use of individual parcels. Group ranches were an initial step in this process, whereby in 1968, groups of Maasai were given corporate title to tracts of land based on the Group (Land Representatives) Act. The policy premise for this program was to create development incentives for Maasai pastoralists to destock and intensify their production strategies, thereby decreasing grazing pressure and preventing perceived rangeland degradation. The stated objectives of the group ranch program required elected group ranch committees to enforce stock quotas over their members, prevent livestock mobility across group ranch boundaries, and use group title as collateral to finance loans for livestock infrastructure development. While the program to create the group ranches was administered by the Kenyan government, funding and expertise for its implementation came from the World Bank, other bilateral donors and outside rangeland experts (Oxby 1982; Evangelou 1984). The failure of the group ranch concept to achieve its stated goals has been widely reported in the literature (e.g., (White and Meadows 1981). These included; rampant mismanagement of development funds, continued pastoral mobility, and low rates of destocking and livestock marketing. However, group ranches did contribute to solidifying and strengthening the borders of Maasai territory. This was important, as non-Maasai (e.g. agricultural) groups had been moving to settle in higher potential areas of Maasai rangelands over the preceeding decades (e.g. the Kilimanjaro highlands), and loss of territory was a salient issue for many pastoralists at the time (Rutten 1992).

In response to these problems with the group ranches, and even before the group ranch adjudication process in Kajiado district had been concluded, some ranches began to subdivide and distribute individual parcels to their members. This period of privatization has extended from the late 1970s to the present day. The motivations for pursuing subdivision over continued membership in the group ranches have also been widely commented on (Kituyi 1990; Kimani and Pickard

1998; Galaty and ole Munei 1999; Mwangi 2003; Mwangi 2006), however it is important to point out that they stem from both internal and external sources. Externally, the policy context in Kenya supports private property as a precursor to economic development (Mwangi 2003). Internally, populations on the group ranches are rising, there is conflict over the registration of new and younger members, and dissatisfaction with mismanagement of funds and lack of accountability continues to push the process forward. However, pastoralists themselves, as well as researchers, are concerned with the viability of raising livestock on small, private parcels in this highly variable environment (Grandin 1986; Galaty 1992; BurnSilver 2005).

Congruent in time with changes in formalized land tenure has been a process of land use change in Maasailand. Even prior to the application of the group ranch development scheme, assumptions regarding the necessity of raising livestock productivity placed a priority on the development of infrastructure. Beginning in the 1950s, stock dip tanks and new water points (bore holes and holding tanks) were installed in isolated rangeland areas with the idea of allowing pastoralists to access additional grazing territory that had been out of reach previously due to dry season water constraints (Worden 2007). This emphasis on productive infrastructure then continued during the group ranch period. The Amboseli area was adjudicated in the late 1970s, and additional water points and livestock marketing infrastructure were installed based on the provision of loans. This infrastructure acted as a spatial magnet for a corresponding build-up in social services (e.g. schools and medical clinics) and economic activities (e.g. local shops and markets) occurring at the same time around the group ranches. The late 1970s and early 80s were also a period of successive droughts, during which time many herders lost large proportions of their herds (Campbell 1984; Rutten 1992), and thus began to turn to agriculture in the Amboseli swamps as a livelihood option. This period represents a juxtaposition of constraints and opportunities for herders: economic hardship, but new economic choices available, coupled with rising human populations and changes in the grazing areas now accessible to herders because of water provision. Households moved closer to infrastructure services and new settlement patterns emerged. Households also began to diversify economically, a process that can be attributed both to the push of rising poverty – as livestock units per capita declined during this period (Bekure, de Leeuw et al. 1991) – and the pull of new economic options (BurnSilver Ch. 1).

Elders in Amboseli also describe this period as chaotic in terms of where people and their animals were grazing, with resulting negative impacts on their ability to manage their grazing resource (pers. obs.; Worden 2007). In response, one famous elder in Eselenkei group ranch in the early 1980s articulated to group ranch members a combined settlement and grazing plan. It was adopted first by Eselenkei and ultimately spread to the other Amboseli group ranches (Olgulului/Lolarashi, Imbirikani, Kimana, Kuku and Rombo). This was the period in which the switch from a wet season to a dry season dispersal system began. The new system was based on a new idea of the "*emparnat*", or a "permanent settlement" in combination with a series of grazing stages which allowed herders to access "*enkaron*", or "dry season grazing settlements" at orchestrated times. The *emparnat* idea gave households the option to settle in one area close to infrastructure or services (e.g. schools, roads, shops or water points), and then all or a portion of a household could still move with animal herds out to dry season grazing zones. The timing of moves between *emparnati* and *enkaroni* was based on seasonal conditions, but it was predicated on households returning to their *emparnati* at the beginning of each wet season. Meetings of elders occurred regularly, and when it was reported that nearby grazing resources were exhausted, the next grazing stage was opened. This meant that herders were the furthest from their *emparnat* at the height of the each dry season (and particularly in the long dry season). Permanent dry season water points were usually located near permanent settlement areas, which required that animals trek gradually further and further between *enkaroni* and water. The length of the grazing:watering rotation depended on forage conditions and the distance between grazing sites and settlement areas, but generally increased from daily watering and grazing in the rainy seasons, to a 1:1, 1:2 or 1:3 grazing:watering schedule in the dry seasons. When the rains came, herders could take advantage of seasonal dams which filled at *enkaroni*, but eventually were required to come back to their emparnat locations to allow grazing stages to rest and recover. Herders who did not obey these grazing norms were "chased" by groups of warriors sent to enforce the rules, and could be sanctioned. The evolution of this *emparnat/enkaron* system is unique, but it is also interesting because in combination with infrastructure development, its adoption ultimately cemented the change in Amboseli from a wet-season dispersal, to dry-season dispersal system (Worden 2007).

Sedentarization of pastoral households is another land use dynamic that has emerged based on the processes just described. Sedentarization here is defined as permanent settlement of a household in one place. The process usually implies building more permanent dwellings and may or may not imply a cessation of seasonal movement. Households can be sedentarized based on their economic activities (e.g. agriculture or wage labor), which may imply less of an economic dependence on livestock, or alternately fewer livestock to be concerned with (BurnSilver Ch. 1). Sedentarization can also occur as a choice, when households stop moving in order to link with services, markets and education for their children (Salzman 1980; Fratkin, Roth et al. 1999). Alternately, subdivision of group ranch lands can mandate (in principle) that a herder remain on one parcel on a full time basis. There is therefore an interaction in time between subdivision and sedentarization, as these processes can occur independently, or can feed into the occurrence of the other. The adoption of the *emparnat/enkaron* system across Amboseli does imply some degree of more permanent settlement; however, herders are still free to move with their herds under its mandate, while the rest of a household remains at the *emparnat*.

The juxtaposition of these institutional/cultural norms for movement, with processes of land tenure change, sedentarization and economic change makes identifying the importance of mobility in Amboseli a complex proposition. Whether a herder is mobile with his animals depends not only on economic need, and the grazing management system, but also potentially on intra-household level characteristics, such as; parcel size, education, children's involvement in schooling, labor availability, herd size (Kabubo-Mariara 2003; BurnSilver and Mwangi 2007), and ecological considerations (e.g. how much grass is there at home vs. in rangelands further away).

Maasai pastoralism in Amboseli currently represents a mosaic of the land tenure and land use dynamics described above. This study therefore focuses on one former and three current group ranches in the system; Osilalei, Eselenkei, Olgulului/Lolarashi and Imbirikani (Figure 1). These areas represent a gradient of land tenure types (communal and subdivided), land use types (agropastoral and pastoral), access to infrastructure (low to high) and agroclimatic potential (low to high). As such, questions regarding the current relevance of mobility to pastoralists in Amboseli can be asked under a range of socio-economic, ecological and political conditions.

METHODS

Data Collection

Socio-economic and grazing data were collected from November 1999 to March of 2001 in six study areas (Osilalei, South Imbirikani, North Imbirikani, Lenkism, Eselenkei and Emeshenani) across the four Maasai group ranches (Figure 1). A sample of 184 households was chosen, initially stratified by wealth and study area (Table 1). The unit of analysis used throughout the study was the "*olmarei*", a Maasai term which corresponds approximately to an independent male head of household and his dependents (e.g. wives, children, married sons and their dependents). One hundred forty-six households were interviewed once to gather data on herd size, livestock production strategies, additional economic activities pursued within the household, their associated returns, and household demographics.

Table 1. Land tenure, land use and infrastructure gradient across the six study areas.

Study Areas	No. Hhlds.	Land Tenure	Land Use	Infrastructure access	Agro-ecological potential
Osilalei	24	***Former* Group Ranch** Subdivided	Pastoralism + rainfed agriculture	Medium	High
S. Imbirikani	27	**Imbirikani Group Ranch** *Informal* subdivision of agricultural areas Communal rangelands	Agropastoralism (Irrigated market crops)	High	Low
Eselenkei	24	**Eselenkei Group Ranch** Communal rangelands	Pastoralism + rainfed agriculture	Medium	High
Lenkisim	24	**Eselenkei Group Ranch** Communal rangelands	Pastoralism	Low	Med
Emeshenani	24	**Olgulului/Lolarashi Group Ranch** Communal rangelands *Official* Subdivision of agricultural areas	Pastoralism + irrigated or highland rainfed agriculture	Low	Low
N. Imbirikani	24	**Imbirikani Group Ranch** *Informal* subdivision of agricultural areas Communal rangelands	Pastoralism Access to irrigated agricultural areas	High	Med
	Total N=146 Missing n=5				

Data on herd mobility was gathered in three ways. During household interviews the monthly grazing and settlement locations, and labor arrangements for the 146 households main cattle herd over a 24-month period (Jan 1999- Dec 2000) were documented verbally. The "main" cattle herd is defined here as encompassing non-milking cows, heifers, steers and some bulls. Lactating female cows and calves are usually herded separately from the main herd and are not as mobile. The movements of calf and milking cow herds are not included in the current analyses. Additionally, the daily (sunrise to sunset) movements of the primary cattle herds of 38 additional households were documented using a handheld GPS (Garmin 12) unit at

30 minute increments. These households' main herds were followed once in the dry season and once in the wet season. Some herds were combined based on existing cooperative grazing arrangements, and five dry season orbits are missing for the Osilalei study area, yielding 69 total herd follows. Wet season grazing orbits included watering of the animals, while dry season orbits were carried out on non-watering days.

Normalized Difference Vegetation Index (NDVI) data at 1-km^2 resolution from the Satellite Pour L'Observation de le Terre, Vegetation satellite (SPOT4 VGT) is used as a basis for quantifying the grazing resources available to Amboseli herders in 1999 and 2000 (http://free.vgt.vito.be/). Remote sensing has become an important tool for detecting and predicting changes in the distribution and dynamics of vegetation at large spatial and temporal scales (Kerr and Ostrovsky 2003; Pettorelli, Vik et al. 2005). Across many ecosystem types remote sensing techniques have been used successfully to estimate net primary production (Todd, Hoffer et al. 1998), degree of ecological change, and patterns of biodiversity (Turner, Spector et al. 2003). In rangelands specifically, vegetation indices have alternatively been used to quantify and predict patterns of green up, duration of the growing season (Reed, Brown et al. 1994), relative production of live and dead biomass (Jianlong, Tiangang et al. 1998; Kawamura, Akiyama et al. 2005; Kawamura, Akiyama et al. 2005), and rangeland condition (Reeves, Winslow et al. 2001). NDVI indices have also been related directly to the calving behavior and movement of caribou (Griffith, Douglas et al. 2002) and wildebeest (Boone, Thirgood et al. 2006; Musiega, Kazidi et al. 2006) through landscapes. Calculation of the NDVI is based on the differences in reflectance patterns between soil and vegetation at different pheonological stages across the electromagnetic spectrum. NDVI is the ratio of the differences between red (visible) and near-infrared reflectances, where:

$$NDVI = (NIR - RED)/(NIR + RED)$$

Equation 1

NDVI index values range between -1 and +1, with highly positive values corresponding to more green vegetation biomass and negative values indicating no vegetation or bare ground. Senescing vegetation takes on values between these end points, although previous efforts to validate NDVI results based on fieldwork measurements show lower correlations between standing dead biomass and NDVI (Todd, Hoffer et al. 1998; Kawamura, Akiyama et al. 2005; Marsett, Qi et al. 2006). NDVI values are scaled between 0 and 255 for processing purposes, and these scaled values are used throughout this paper. Analyses of forage access in this study are based on 72 SPOT NDVI images representing 10-day periods (i.e. dekades) extending from Jan 1999 to Dec 2000.

Data Processing

Amboseli livelihoods

Based on household socio-economic surveys (N=146), I calculated total gross annual household income as the summed value of all agricultural, off-land and livestock-based economic activities. All livestock and agricultural activities were valued at market prices reported during the study period. Agricultural income combines the total value of consumed and sold agriculture. Livestock production includes the total of livestock slaughtered, livestock sold and received as gifts and milk sold, while off-land activities combine reported income from all wage labor, petty trade, and business activities. The relative proportion of household gross income represented by these different economic activities was also quantified to identify the economic importance of livestock to household livelihoods across the GAE.

Mobility

In order to compare mobility across households and study areas I developed a series of grazing metrics based on the verbal descriptions of mobility from the household surveys. This was the basis for calculating: the number of mobile vs. immobile households. Then for mobile households only, I quantified the number of annual moves of the main cattle herd, timing of first move, duration (no. months) spent away from each household's *emparnat* per year, and the number of households that left their home group ranches per year. I developed a general mobility index (MI) for each household where calculated MI values for each household were standardized for the study region. This index incorporates the dual nature of total mobility of a household as a combination of both frequency and duration of movement.

$$MI = \left[\begin{array}{l}\text{No. months away} \\ \text{from emparnat/year}\end{array}\right] * \left[\begin{array}{l}\text{No. moves of main} \\ \text{cattle herd/year}\end{array}\right] \Big/ \begin{array}{l}\text{Maximum MI value of all} \\ \text{households}\end{array}$$

Equation 2

With the help of local informants, each grazing settlement location from 1999 and 2000 from the household surveys was georeferenced to UTM coordinates on 1:50,000 topographic maps, yielding a spatial and temporal database of mobility at a monthly time scale over 24 months. Complete sets of grazing locations could not be identified for five households, and they were dropped from the analyses (total N=141). All the monthly moves of household herds were entered into a GIS (Arcview 3.3) and represented spatially. Total distance traveled by households as well as average distances between grazing settlement locations were quantified. The GPSd daily grazing movements (N=69) were also entered into a GIS and average daily grazing distances in the wet and dry seasons were calculated by study area.

The daily grazing radii for wet and dry were averaged for each study area, and this value was then multiplied by two, in order to identify the grazing diameter of a hypothetical circle within which grazing herds would have daily access to forage resources from the starting point of their grazing settlement locations. This grazing area was overlaid onto SPOT-NDVI images, and yielded the annual cumulative, average monthly and 10-day dekadal values of NDVI (as an estimation of forage biomass) available to each household's main cattle herd as they moved between grazing settlements over the 24 month study period. When household herds migrated from one study area to another, the size of their grazing diameter changed to reflect the average daily distance traveled by households in the new area.

The size of the total grazing area available to households in the NDVI analyses was essentially all of south eastern Kajiado (Figure 1). However, particular features of the landscape were made inaccessible to herds in the NDVI analyses given known policy considerations. Amboseli National Park was categorized as inaccessible, and 7 km^2 of Kimana Swamp was masked as off-limits to cattle grazing because of ongoing agricultural activities and the location of the Kimana Wildlife Sanctuary.

Binary logistic regression and Classification and regression tree (CART) analyses were used to identify important predictors of household mobility. A combination of ecological, household demographic and production variables were used as independent variables in these regression analyses (Table 2). An initial round of correlations were run to identify variables correlated with mobility (including age of household head, and education levels of both household head and children) and variables collinear with each other. Only those which were significantly correlated with mobility according to Spearman's Rho test ($p<0.01$) for non-parametric data were included in the regressions. In cases where variables were collinear, the variable most closely correlated with mobility was chosen.

"Herding arrangement" reflected if households were moving their animals based on cooperative labor agreements (0=No, 1=Yes). Household herding labor was calculated as the number of adults and children (ages 5-85) minus the number of children enrolled in school within a household. The size of a household's mobile cattle herd in 2000 was quantified as the total number of reported adult cattle (heifers, cows, steers, bulls), minus the number of calves (a proxy for the number of lactating female cows). These cattle numbers were transformed to cattle TLUs whereby different age and gender classes are counted based on their weight equivalency to a 250 kg adult female cow (Bekure, de Leeuw et al. 1991). The number of mobile animals owned within a household in 1999 was then calculated by subtracting cattle mortality, animals gifted out and animals sold by age and gender class as reported by households in 2000 for the previous year. As an independent variable for the binary regression, an average NDVI value (within the relevant grazing radii) for the three dekades prior to the month in which a herd moved was calculated, using the logic that local forage conditions would be a push to make the decision to be mobile vs. remain at a household's *emparnat.* In contrast, the cumulative annual NDVI available to herds based on all their movements was used as a predictor of how mobile a household was in total (e.g. their mobility index) in the regression tree analyses. Size of a grazing area was calculated as square kilometers available within the traditional grazing stages for each of the six study areas. These variables can be loosely grouped into more traditional parameters, which have been a part of the Maasai production landscape, compared to those which are a function of recent changes in Maasailand (Table 2).

Table 2. Regression variables used in binary logistic regression and CART analyses. Shaded parameters are newer, non-traditional variables thought to be important in mobility decisions.

Statistical Analyses	Binary Logistic Regression	Classification and Regression Tree
Dependent Variable	Mobile vs. immobile (categorical)	Mobility Index (MI for study areas)
Independent Variables	Herding arrangement (categorical yes/no)	Herding arrangement (categorical yes/no)
	Household herding labor (No.)	Household herding labor (No.)
	Mobile livestock TLUs	Mobile livestock TLUs
	NDVI from 3 dekades prior to move	Cumulative annual NDVI
	Gross annual income	Proportion of income from livestock activities
	Number of hired herders	Gross annual income
		Number of hired herders
		Size of grazing area

Monthly rainfall data from the Kajiado Maasai Rural Training Center rainfall gauge for the period 1962 to 2003 was used to calculate mean annual precipitation figures for the study area. Figure 2 depicts annual rainfall standardized by the standard error for all years. Respondents identified 1999 as a "normal year" (467.50 mm of rainfall: 138.65 mm below the 1962-2003 long term mean), while 2000 was labeled "a bad year" (222.30 mm of rainfall: - 383.85 mm below the long term mean) (Kenya Met station data 2003). Combined with local observations of rainfall start and end dates, this information provides climatic context for the mobility patterns of households in 1999 and 2000.

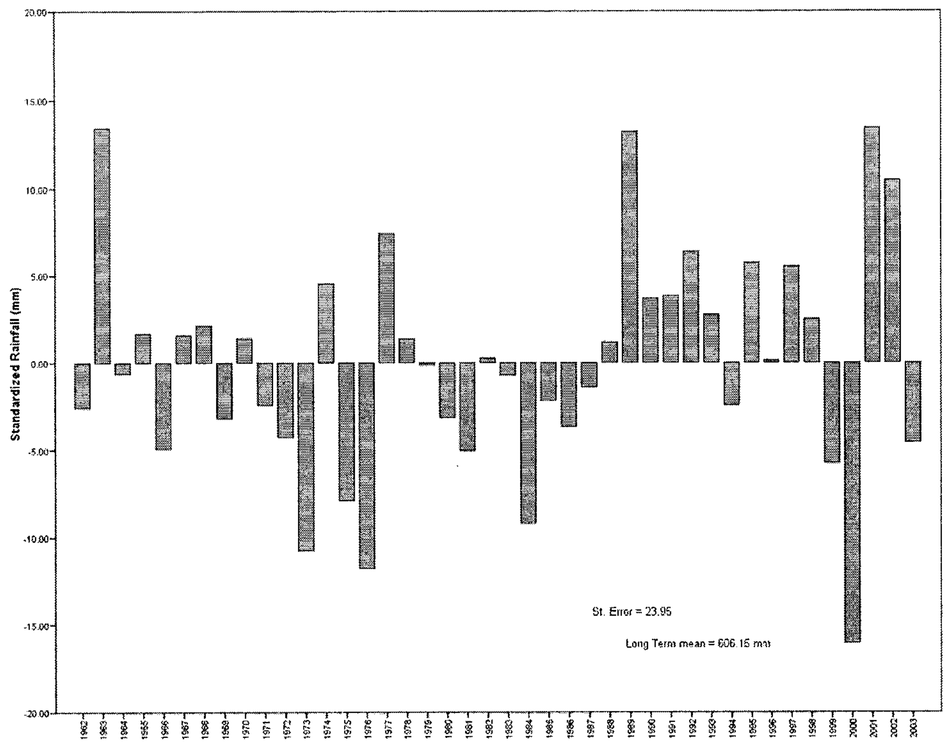

Figure 2. Annual Rainfall in Kajiado District from 1962-2003. Bars represent annual precipitation standardized as deviations above and below the long term mean. The study period was 1999 and 2000.

Data Analyses

The Dunnett's T3 test for samples with unequal variances identified if there were significant differences between movement metrics across study areas, and Wilcoxon Rank Sum tests for non-parametric data measured differences between levels of mobility in 1999 (the "normal" year) and 2000 (the drought year).

Household mobility patterns and their relative effectiveness in accessing greater NDVI for cattle herds through time were analysed in two ways. Worden (2007) showed that cumulative annual standardized NDVI across the study areas for mobile vs. sedentary households did not differ significantly. Consequently, the focus of these analyses is on the effectiveness of monthly movements to access forage biomass at monthly time steps. I compared average differences in monthly NDVI accessed across the two 12 month time periods for households that migrated away from their *emparnat* at least once, to those who were sedentary at their permanent settlements throughout the year. Additionally, I plotted all the monthly NDVI profiles (averaging 3 dekades per month) of households for each study area, where households were categorized as immobile, moving 1-2 times, or moving 3 times or more per year. Households that move 1-2 times are usually moving out to one *enkaron*, and then returning to their *emparnat*. Households that move 3 or more times are either moving between dry season grazing areas and their *emparnat* multiple times, or are linking together successive moves between *enkaron*. There is a quantitative difference between these groups in terms of

mobility. All analyses were done separately for 1999 and 2000. The month by which 50 and 80% of all households had migrated are used in these analyses as an indicator of timing when mobility was most important.

To examine the relative effects of individual movements on gaining access to forage, I quantified the gains and losses in access to NDVI between moves for the N. Imbirikani and Lenkisim study sites. At each time point that a herd moved, the NDVI from the last dekade at the old settlement site was subtracted from the NDVI value in the first dekade at the new settlement site. Positive values correspond to a gain in forage greenness, while negative values correspond to a loss. These difference values were charted by month, and coded in terms of their directionality of movement, i.e., 1) to a household's *emparnat from enkaron*, 2) to a household's *enkaron from their* *emparnat*, and 3) *between 2 enkaron*. I then correlated these data to when households in these two areas were moving, and the start and stop dates of rainfall periods.

Binary logistic regression analysis (SPSS Version 15.0) was used in order to identify the probability of a household's membership in one of two dichotomous groups (i.e. mobile or non-mobile) in 1999 and 2000 based on a set of independent predictor variables (Table 2). Model selection was based on the forward stepwise likelihood ratio technique. Results reported include significant parameter estimates, wald statistics, standard error and significance values as well as log likelihood ratio test statistics for each year. This dual approach eliminates a problem identified for the Wald statistic whereby very large effects may result in large standard errors and small Wald chi-square values, and subsequently lead to Type II errors (Meynard 2002).

Classification and regression tree (CART) analyses were carried out (SYSTAT 10.0) in order to examine a more specific question: Once a household has moved once (i.e. becomes mobile), what are the predictors of how mobile that household will be? CART regressions were run on households with mobile herds in 1999 (N=88) and 2000 (N=120). The dependent variable in this case was a Mobility Index (MI) – calculated and standardized by study area. The different study areas were chosen based on their representative differences in land tenure and land use. Consequently, predicted mobility represented by mobility index scores standardized by study area, should reflect these differences. CART analyses explain variation on a continuous response variable by splitting households into homogeneous groups multiple times, based on combinations of explanatory variables. Splits minimize the sum of squares between groups, and the tree eventually explains a certain percentage of the total sum of squares for the response variable (analogous to the r^2 value in regression analyses) (De'ath and Fabricius 2000). A second set of TREE regressions were run on the entire study area (lumping together the 6 study sites) with the dependent variable set as Mobility Index (standardized for the entire study region) in 1999 and 2000. An additional variable called "size area" was added to these regressions to reflect the size of each study area's cumulative grazing zone. In contrast to the regressions above which focused on identifying study site level predictors of degree of movement, these last regressions were an effort to see if the combined set of predictors could explain general movement across the entire study region.

RESULTS

Amboseli Livelihoods

Analyses of household livelihood sources indicate that 22.3% of households (31 of 141) are entirely dependent on livestock production alone. Thirty nine percent of households gain greater than 80% of their gross income from livestock, while over 66% are dependent on livestock for at least 50% of their livelihoods. Looking at livelihood patterns by study area highlights more specific economic patterns (Figure 3). Households in centrally-located and agropastoral S. Imbirikani depend on livestock to a much lesser degree on average than all other study areas (44%), while Emeshenani households on average gain over 86% of their gross income based on selling and consumption of livestock. The four other study areas range from 58% (Lenkisim), to 69% (Eselenkei) dependence on livestock. That said, households across all study areas are clearly diversifying their activities. Irrigated agriculture accounts for greater than 43% of gross income in S. Imbirikani, but much less across the other study areas (between 2-13%). Off-land activities (either businesses, petty trade or wage labor), represent a greater proportion of gross incomes on average than agriculture, ranging from a low of 8% in dry Emeshenani to highs of 31% in N. Imbirikani and 38% in Lenkisim.

Figure 4 compares average gross income values for households across the six study areas. S. Imbirikani households have the lowest average annual income ($1193), while N. Imbirikani households have the highest ($2556). N. Imbirikani households have on average high returns from both livestock and off-farm activities. Results of an ANOVA suggest that mean gross income across study areas were significantly different (F=3.058, df: 5, 179, p=.01), however multiple comparison tests between study areas showed no significant differences. Standard error bars and cross bars representing median gross income values for each study area (Figure 4) illustrate that income variability within study areas is high. Median values are lower than mean gross income values across all the study areas – particularly in N. Imbirikani. This effect comes from a few very rich households in each study area. The actual value of livestock-based income is greater than off-land or agricultural

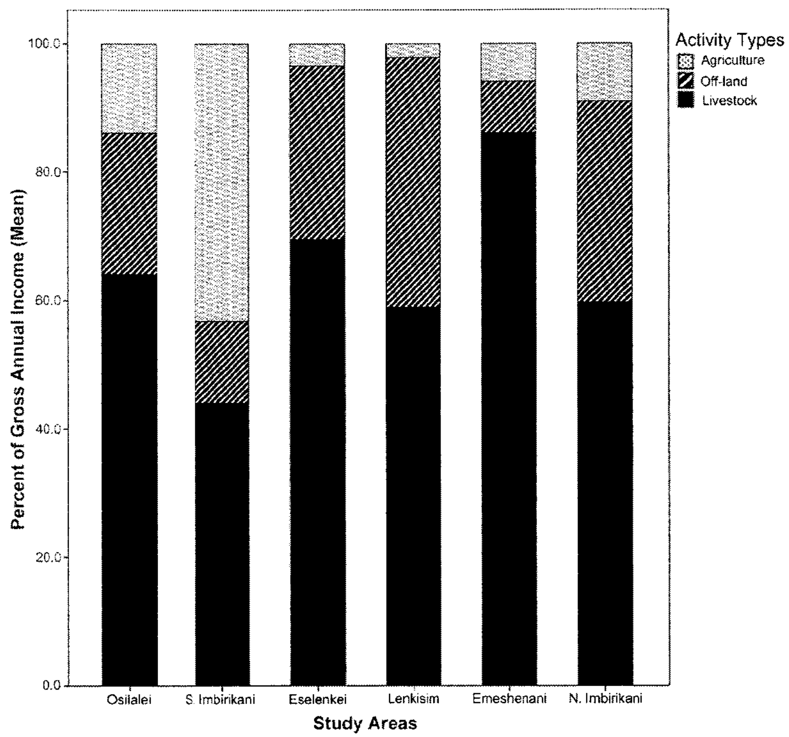

Figure 3. Proportion of gross annual income from different activity types by study area. Bars represent mean percentage of annual gross income accruing from three main livelihood activities across the six study areas: Agriculture (sold and consumed), off-land (wages and salaries, business and petty trade), and livestock (animals and milk sold, animals consumed and received as gifts).

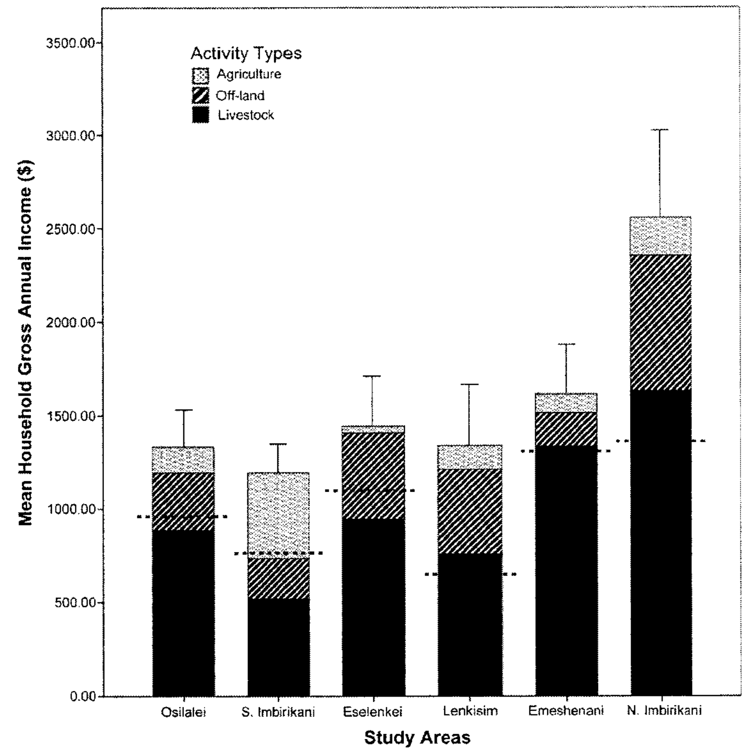

Figure 4. Mean gross annual income based on activity types by study area. Bars represent mean values of annual gross income accruing from three main livelihood activities across the six study areas: Agriculture (sold and consumed), off-land (wages and salaries, business and petty trade), and livestock (animals and milk sold, animals consumed and received as gifts). Error bars are +1 SE above the mean. Dotted cross lines are median gross income values.

income across all study areas except S. Imbirikani. Similar to livelihood patterns identified in Figure 3, the absolute value of off-land activities to gross incomes remains greater than agricultural activities (again excluding S. Imbirikani). S. Imbirikani households are dependent on agriculture and off-land activities for 54% of their livelihoods (Figure 3), but the computed value of these non-livestock activities are low compared to other study areas (Figure 4). Similarly, off land activities were proportionally important to livelihoods in Lenkisim, but the actual contribution of these off-land strategies to average gross income is much lower. Lenkisim households have the second lowest gross and lowest median income levels of all the study areas.

Household Mobility Patterns

The shape and extent of daily grazing pathways are presented in Figure 5. Shifts between wet season grazing outward from permanent settlements and dry season *enkaron* locations are evident from left to right. Wet and dry season orbits rarely overlap, reflecting spatial progression through the grazing stages. Distance analyses of the 69 daily grazing orbits show a pattern where wet season daily grazing maximum distances are shorter on average than one-way distances traveled in the dry season across most study areas (Figure 6). This pattern is pronounced in Eselenkei and S. Imbirikani and less pronounced in Lenkisim, Emeshenani and N. Imbirikani. Dry season distances are missing for Osilalei, but herders related that in a normal year they normally remain within private parcels, suggesting that dry season and wet season radii would be similar. The exception to this pattern is Emeshenani, where the dry season daily maximum distance is marginally shorter than in the wet season. The sample sizes per study area are small and there is not equal representation of wet vs. dry season daily orbits (Table 3), but these data do provide the foundation for more detailed analyses of mobility patterns.

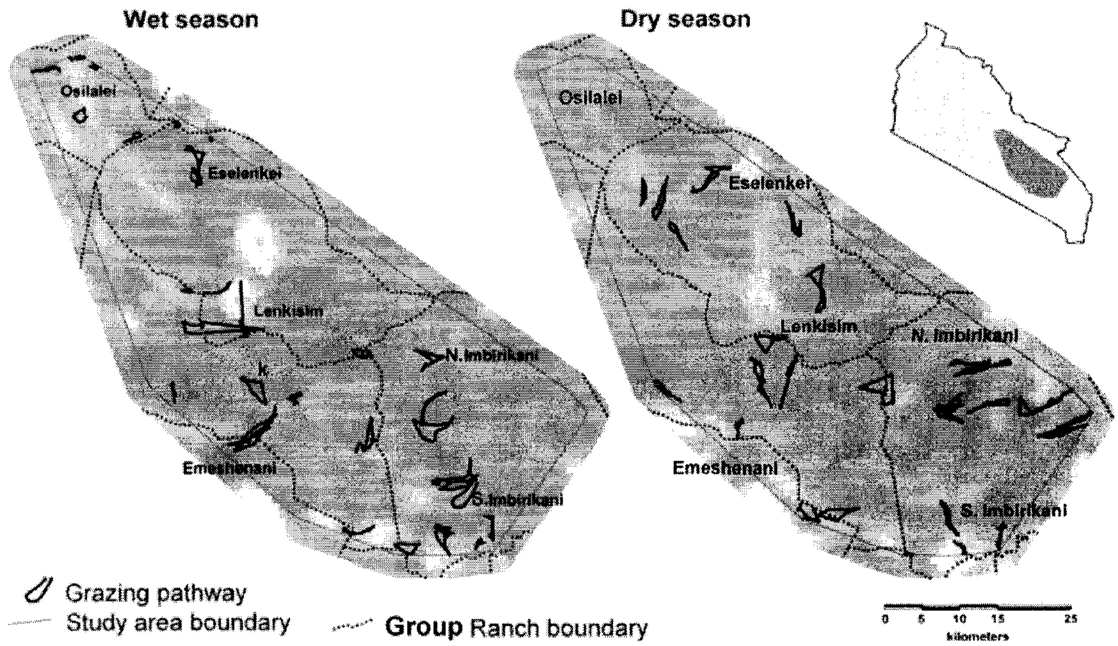

Figure 5. Shape and extent of wet and dry season daily grazing orbits. The figure is based on N=69 GPSd grazing pathways across the six study areas, carried out in the a) wet season and b) dry seasons of 1999 and 2000.

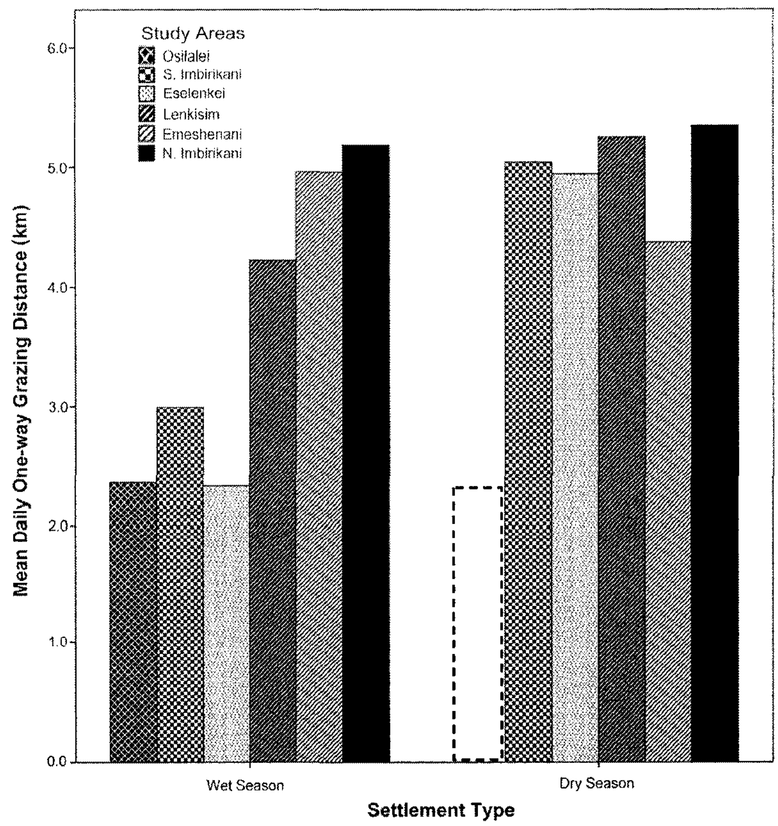

Figure 6. Wet and Dry season daily maximum grazing distances by study area. The dotted box represents verbal description of missing grazing dry season orbits for Osilalei.

Table 3. Daily one-way grazing distances across the study areas. The size of grazing areas for NDVI analyses were calculated as the average of these wet and dry maximum distances for each study area multiplied by two.

Study Areas	Daily Wet season (km)	Daily Dry season (km)	Computed length of grazing radii (m)
Osilalei	2.3	Missing	2326
S. Imbirikani	2.3	5.0	3286
Eselenkei	2.3	4.9	3518
Lenkisim	4.2	5.2	4680
Emeshenani	4.9	4.3	5252
N. Imbirikani	5.2	5.3	4778
N	47	22	69

A series of grazing metrics were developed based on the database of household monthly movements to compare mobility patterns across the study areas. In the "normal" year of 1999, many more herders migrated with their cattle herds at least once away from permanent settlements in Eselenkei (87.5%), Lenkisim (62.5%), Emeshenani (100%) and N. Imbirikani (91.7%), than did herds in subdivided Osilalei (8.3%) and agropastoral S. Imbirikani (40.7%) (Table 4). However, the number of mobile herds increased dramatically across *all* study areas in 2000, the year of severe drought. Almost 71% of cattle herds were mobile even in subdivided Osilalei, while 83% of herds were mobile in S. Imbirikani. Between 91 and 100% of all cattle herds in the other study sites also migrated at least one time in 2000.

However, mobility is defined by more than just migrating once with household herds. The number of total moves per year, the timing of initial moves, the duration of time spent away from permanent settlements, and the distance traveled between grazing settlements - all are measures which define how mobile a household is in space and time once they have made the decision to become mobile. Results show that in 1999, N. Imbirikani cattle herds were significantly more mobile than herds from all other study areas. They moved significantly more often, spent more months away from their emparnat, moved earlier in the year and had a higher mobility index score than all other study areas (Table 4). However, there seems to be relatively little variation between the mobility metrics of the other study areas. This is true even for Osilalei and S. Imbirikani households where a lower proportion of herds were mobile in 1999, but those herds that were mobile moved on par with other study areas. Mobile S. Imbirikani herds actually spent significantly more months away from their emparnat than all areas except for N. Imbirikani, and herds from these two areas traveled significantly greater distances to successive grazing settlements than other areas' herds in the normal year (Figure 6 and Table 4).

Mobility patterns intensified dramatically in 2000. While N. Imbirikani households again had significantly higher mean scores on most indicators of mobility, mobile households in other study areas – even those from sedentary and subdivided areas – spent longer away from permanent settlements and moved more often in 2000 (Table 3). Movements also occurred earlier in the year on average. Results of Wilcoxon rank sum tests show that households in all study areas but Emeshenani traveled greater mean distances in 2000 than in 1999 (Figure 7a-b and Table 5). Figure 7a illustrates that in 1999, most movements to grazing settlements (*enkaron*) were within group ranch boundaries and proceeded according to the culturally prescribed grazing stages. However, the density and length of lines (e.g. distances between grazing settlements) increase dramatically in 2000 (Figure 7b) in all study areas. Except for Emeshenani, more herds also migrated outside their group ranches in 2000 than in 1999 (Table 4). The direction of this off-ranch travel, particularly for herds in the western parts of the study area, was generally from west to east (Figure 7). Osilalei herds moved from their subdivided area to Imbirkani group ranch where rains had been better, and where forage at the Chyulu hills had been preserved based on the grazing stages system. Herds from subdivided Osilalei traveled on average five times further in 2000 than in 1999, making them more similar to S. and N. Imbirikani households than to other study areas in terms of distances moved between

Table 4. Mobility metrics by year and by study area. Numbers in parentheses for all households are percentages. Numbers in parentheses for mobile households only are standard deviations. Mean mobility values for study areas that do not share a superscript letter are significantly different (Dunnett's T3 test, $p<0.05$). Shaded boxes highlight subdivided and agropastoral study areas. Total distance refers to the cumulative mean distance between households' grazing locations for the year period.

	Mobility Categories	1999						2000					
		Osilalei	S. Imbirikani	Eselenkei	Lenkisim	Emeshenani	N. Imbirikani	Osilalei	S. Imbirikani	Eselenkei	Lenkisim	Emeshenani	N. Imbirikani
All Households	N	24	27	24	24	23	24	24	27	24	24	23	24
	Mobile Households	2 (8.3%)	11 (40.7)	21 (87.5)	15 (62.5)	23 (100.0)	22 (91.7)	17 (70.8%)	17 (83.0)	22 (91.7)	24 (100)	22 (95.7)	24 (100)
	Mobile in 1999 **and** 2000	-	-	-	-	-	-	2 (8.3%)	9 (33.3)	21 (87.5)	15 (62.5)	22 (95.6)	22 (91.7)
Mobile Households Only	No. moves	2.0^{a,b} (0.0)	1.9^{a} (0.8)	2.2^{a} (0.9)	2.0^{a,b} (0.0)	1.7^{a,b} (0.5)	3.2^{c} (1.7)	2.1^{a} (0.6)	1.7^{a} (0.9)	3.0^{b,c,d} (0.8)	2.9^{c} (0.9)	2.1^{a,c} (1.2)	4.5^{b,d} (2.1)
	No. total months off Emparnat	3.0^{a} (0.0)	5.6^{b} (1.4)	2.8^{a} (1.6)	2.9^{a} (1.1)	3.6^{a} (1.6)	7.7^{b} (3.6)	4.9^{a} (1.7)	5.5^{a} (1.9)	4.9^{a} (1.2)	5.3^{a} (1.5)	5.1^{a} (1.8)	9.0^{b} (2.5)
	Month of 1st move	8.0^{a} (0.0)	7.3^{a} (1.3)	8.6^{a} (1.5)	8.3^{a} (1.6)	7.3^{a} (2.6)	3.8^{b} (3.7)	6.4^{a} (1.7)	7.0^{a} (1.9)	7.1^{a} (1.1)	6.5^{a} (1.3)	6.8^{a} (1.6)	2.9^{b} (2.8)
	No. herds off ranch	1	5	1	2	1	4	9	7	6	4	2	7
	Month of off-ranch move	8.0 (0.0)	6.4 (3.8)	11.0 (0.0)	11.0 (1.4)	1.0 (0.0)	8.0 (4.2)	7.0 (1.0)	6.4 (1.9)	9.2 (1.3)	9.0 (1.4)	6.0 (2.8)	8.1 (4.9)
	Mobility Index	0.11^{a} (.00)	0.19^{a} (.11)	0.10^{a} (.19)	0.10^{a} (.04)	0.11^{a} (.06)	0.46^{b} (.33)	0.12^{a} (.07)	0.12^{a} (.12)	0.17^{a} (.10)	0.18^{a} (.10)	0.11^{a} (.01)	0.45^{b} (.30)
	Total Distance (km)	15.49^{a}	35.18^{b,c}	10.48^{a}	16.53^{a,c}	12.73^{a}	53.71^{b}	75.98^{a}	41.42^{a,b}	41.42^{a,b}	38.10^{a,b}	19.90^{b}	70.81^{a}

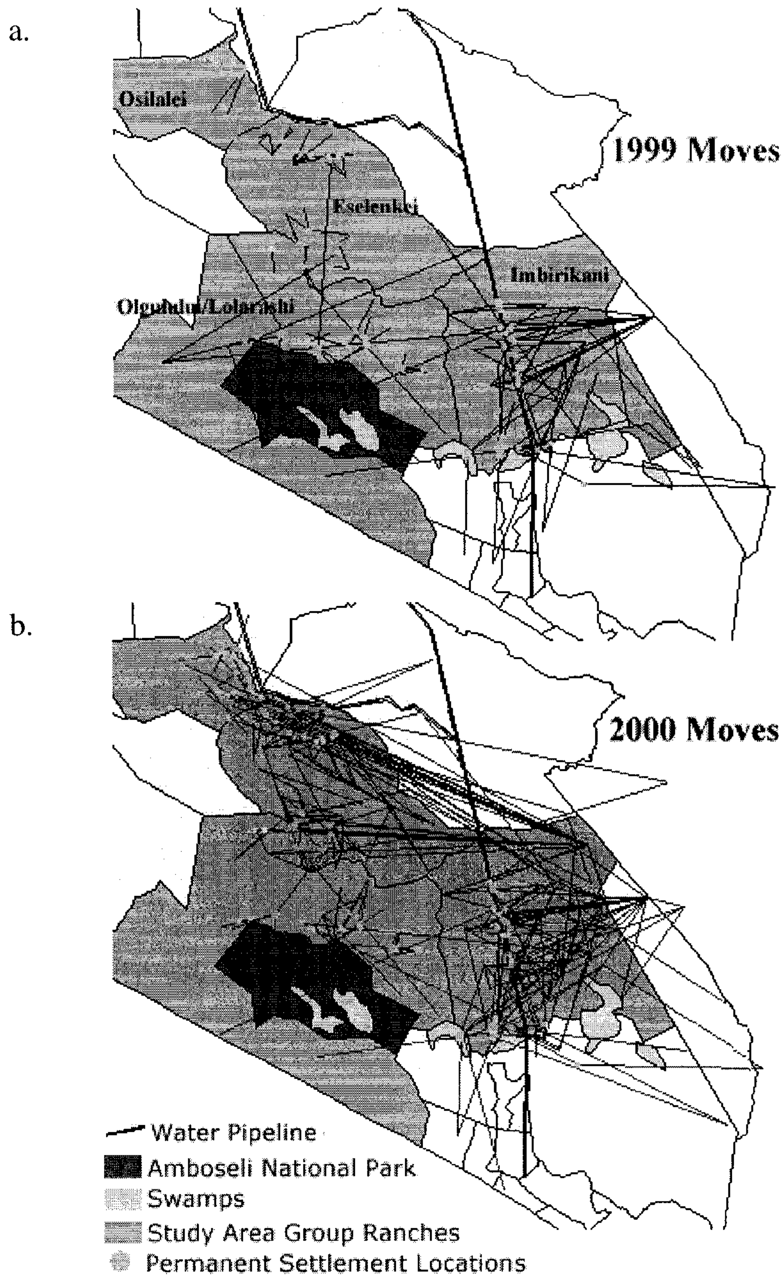

Figure 7. Successive monthly grazing movements for herds in a) the "normal" year of 1999 and b) the drought year of 2000. Circles are permanent settlements. Lines in 7a represent distances traveled for movements between permanent settlements and grazing settlements in 1999. Lines in 7b represent the same successive movements per household herd for the drought year of 2000. All lines begin and end at household permanent settlements. Households moving out to only one grazing settlement and then returning to their permanent settlement show as a straight out and back line, while households with movements between multiple dry season grazing settlements show as polygons.

successive grazing settlements (Table 4). Osilalei and Eselenkei show greater significant differences across mobility metrics when comparing 1999 and 2000 (Table 5). However herds from all study areas except for S. Imbirikani spent significantly longer periods away from their emparnat, and all areas but Emeshenani and S. Imbirikani moved significantly more often between the two years.

Table 5. Significant differences in mobility metrics between 1999 and 2000. Table values are p-values from Wilcoxon signed rank tests for non-parametric data. P values <0.001 are denoted with an **. P values <0.05 are denoted with *.

Mobility Metrics	Osilalei	Eselenkei	Lenkisim	Emeshenani	S. Imbirikani	N. Imbirikani
Number moves/yr	0.000**	0.002**	0.025*	0.376	0.219	0.006**
Months off emparnat	0.001**	0.001**	0.041*	0.045*	0.061	0.043*
Timing of 1st move	0.000**	0.013*	0.257	0.072	0.127	0.572
Mobility Index (MI)	0.000**	0.002**	0.114	0.808	0.904	0.648

Mobile and Immobile Herders' Access to NDVI

One approach to quantifying the value of mobility is to compare the forage biomass accessed by mobile versus immobile cattle herds by study areas through time. Figure 8 makes this comparison, where NDVI values for all mobile herds are averaged for 10-day periods (72 total dekades) and compared to mean values for immobile herds across 1999 and 2000. Bar values above the zero line would reflect mobile households accessing greater NDVI in those dekades than immobile households, and values below the zero line indicate the opposite. I defined mobile herds as those that migrated away from permanent settlements at least once. Sedentary herds in these analyses (and future analyses) are those herds which remained at household *emparnati* throughout a 12 month period. These analyses were carried out in 1999 for 5 of 6 study areas, and in 2000 for 4 of 6 study areas, where there were both mobile and immobile households.

Results from the previous section indicate that a majority of herd movements begin in the dry seasons – particularly in the long dry season extending from June to October (Table 4). Consequently, the months by which 50% and 80% of herds were mobile in each study area are marked with dotted and solid arrows, respectively. The number of mobile vs. immobile households is also indicated for each study area. Beginning in April of 1999, figure 8 shows a general pattern of greater access to forage biomass for mobile herds in S. Imbirikani, Lenkisim and earlier for N. Imbirikani herds (i.e., January). This pattern is clear even earlier in 2000 in S. Imbirkani and Emeshenani and again for N. Imbirikani. The magnitude of differences between mobile and immobile households is highest from April to June in these study sites, and declines gradually into the height of the long dry season, although values remain positive in most dekades. Mobile herds in these sites are accessing between 5 and 10 NDVI units above that accessed by immobile herds. Based on a comparison of average minimum and maximum NDVI across all study areas (Table 6), this is equivalent to a 4.6% increase in forage biomass at 5 units and 9.1% increase at 10 units in 1999, and 4.8% and 9.5% increases at 5 and 10 units of NDVI respectively, in 2000. It should also be noted that mobility of herds in each study site implies a decline in competition for forage for those households who do not move.

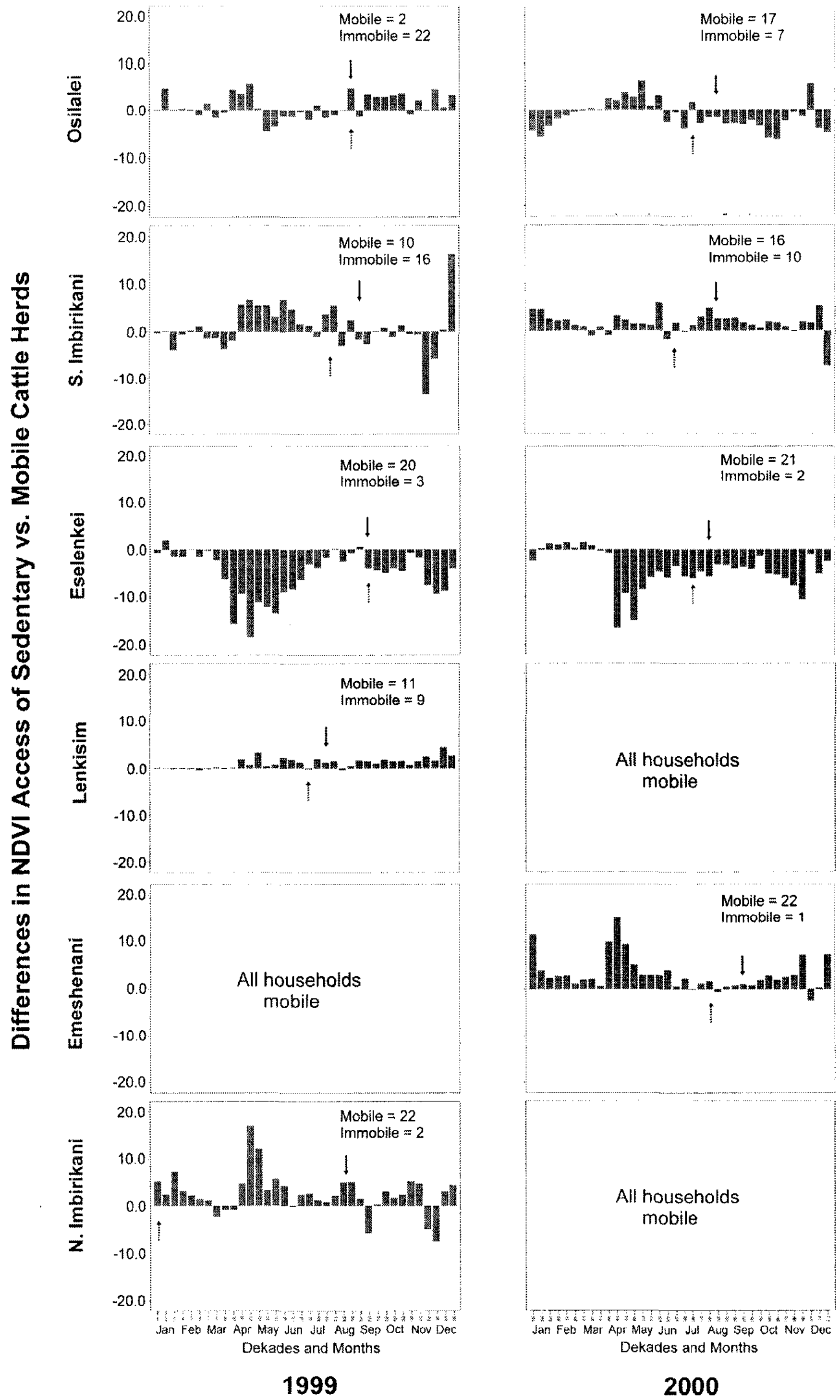

Figure 8: Differences in NDVI access of sedentary vs. mobile herds by study area and year. Bar values above the zero line denote greater average NDVI values per dekade for mobile herds. Values below the zero line are greater access to NDVI for immobile herds. Dotted arrows indicate the dekade by which 50% of study area herds were mobile. Solid arrows indicate the *dekade by which 80% of herds were mobile.*

Table 6. Average minimum and maximum NDVI values for the study region. NDVI unit percentage increases were calculated based on the range between minimum and maximum NDVI values for 1999 and 2000 (i.e., Percentage change in NDVI for 1 dekade = (No. unit increase /annual range)*100).

Year	Average Minimum	Average Maximum	Range
1999	57.1	166.1	109.0*
2000	56.5	162.5	106.0

The Osilalei and Eselenkei study sites are exceptions to this pattern of mobile herds accessing greater NDVI than immobile herds. Particularly in the dry season of 2000 when a majority of Osilalei households moved their herds, immobile herds had consistently greater access to NDVI than mobile herds. This could reflect less competition for remaining local forage when mobile herds left the area. Alternately, the NDVI signature of Comiphora forest in Osilalei could be greater overall than the destination grazing area of open grassland in N. Imbirikani. However, comparable NDVI greenness signatures for mixed woodland vs. grassland in this case would not reflect equal forage value, as commiphora are not a useful forage species for cattle. The same pattern is true in Eselenkei throughout all seasons and across both years, although this pattern is linked in large part to a majority of Eselenkei permanent settlements being located within or near to the riverine forest corridor adjacent to the Eselenkei River. Therefore, any movement southward into the grazing stages for Eselenkei is effectively away from this evergreen tree canopy, and would show as a decline in access to green forage biomass.

The above results suggest that movement confers a benefit for herds in terms of greater access to forage biomass at certain times and in particular study areas. In order to further examine these patterns, Figure 9 presents overlaid NDVI profiles of individual cattle herds by study area and through time. These analyses define mobility more specifically in order to identify if NDVI access differs by mobility strategy.

If increasing movement conferred greater benefits on household herds, we would expect to see red lines (most mobile) rise to the top of the profile bands across all dekades, followed by blue lines (limited mobility) and then black lines (sedentary) at the bottom. However, the picture is more complex than this (Figure 9). In Eselenkei and Osilalei study areas, black lines are within the same NDVI range of more mobile herds – echoing the patterns seen previously in Figure 8. In other study areas there are times in 1999 when individual profiles of some sedentary herds are on par with the NDVI values of mobile herds (e.g. S. Imbirikani). This is the case even in the dry season when there is ostensibly little forage left to exploit in permanent settlement areas, and the dry season grazing stages have been opened. And, some herds with limited mobility still have higher NDVI access than highly mobile herds, illustrating that one or two well-timed moves can provide the same or better access to forage in some cases as more frequent moves. However, there are times during both years when more mobile households have greater overall access to forage biomass. Clear differences between blue and red profiles emerge in the long dry season (June to October) in N. Imbirikani, Emeshenani, S. Imbirkani and Lenkisim, in both 1999 and 2000. The magnitude of these differences seems greater in the drought year.

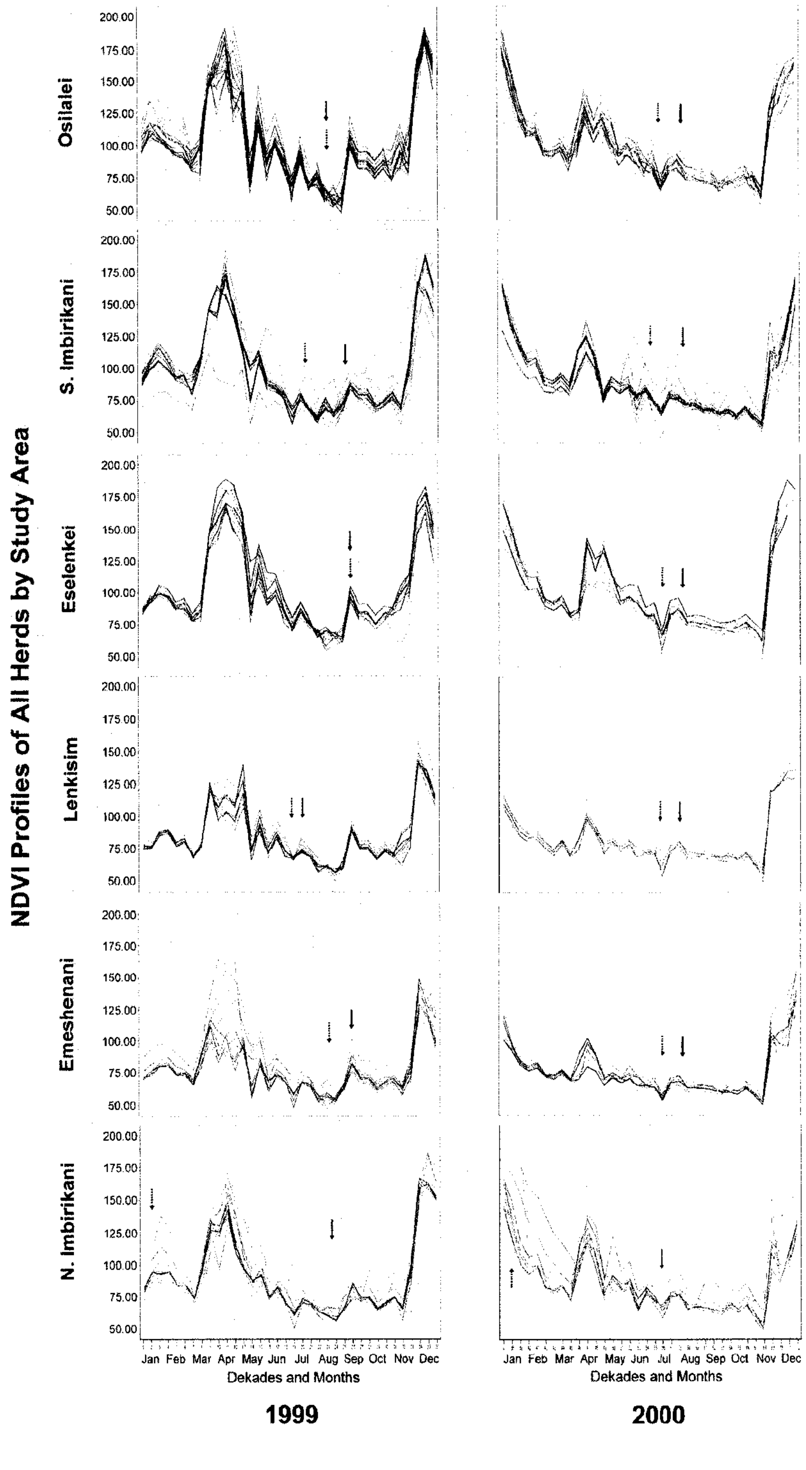

Figure 9. Annual NDVI profiles for individual cattle herds by study area and year. Black lines represent herds that did not migrate away from household emparnati. Blue lines represent herds that moved 1-2 times per year. Red lines represent herds that moved 3 times or more annually. Dotted arrows indicate the dekade by which 50% of study area herds were mobile. Solid arrows reflect the dekade by which 80% of herds were mobile.

The switch from a wet season to a dry season dispersal system, and the associated creation of the grazing stages management scheme has mandated that the access of Amboseli households to forage is linked to both cultural/institutional and biophysical conditions. But how these factors intermingle to affect the ability of herders to access green (higher quality) forage vs. standing biomass (low quality, but assured quantity) in good and bad years is still open to question. The former strategy implies that herders are opportunistically maximizing their access to green forage, while the latter implies a maintenance strategy through time. Using the logic that herders make decisions regarding when to move based on a comparison of grazing conditions of their current location, to other possible destinations with "better" grazing, I calculated the difference between the NDVI of a household's current settlement (in the final dekade of that location) and the NDVI of the destination settlement (in the first dekade of a move), and plotted these differences through time. Analyses were carried out for the N. Imbirikani and Lenkisim study areas (Figures 10 and 11), as examples of locations where mobility occurs at very high levels (N. Imbirikani) compared to more intermediate levels (Lenkisim). Positive values indicate moves from a location of lower NDVI to one with higher NDVI. Negative values indicate the opposite.

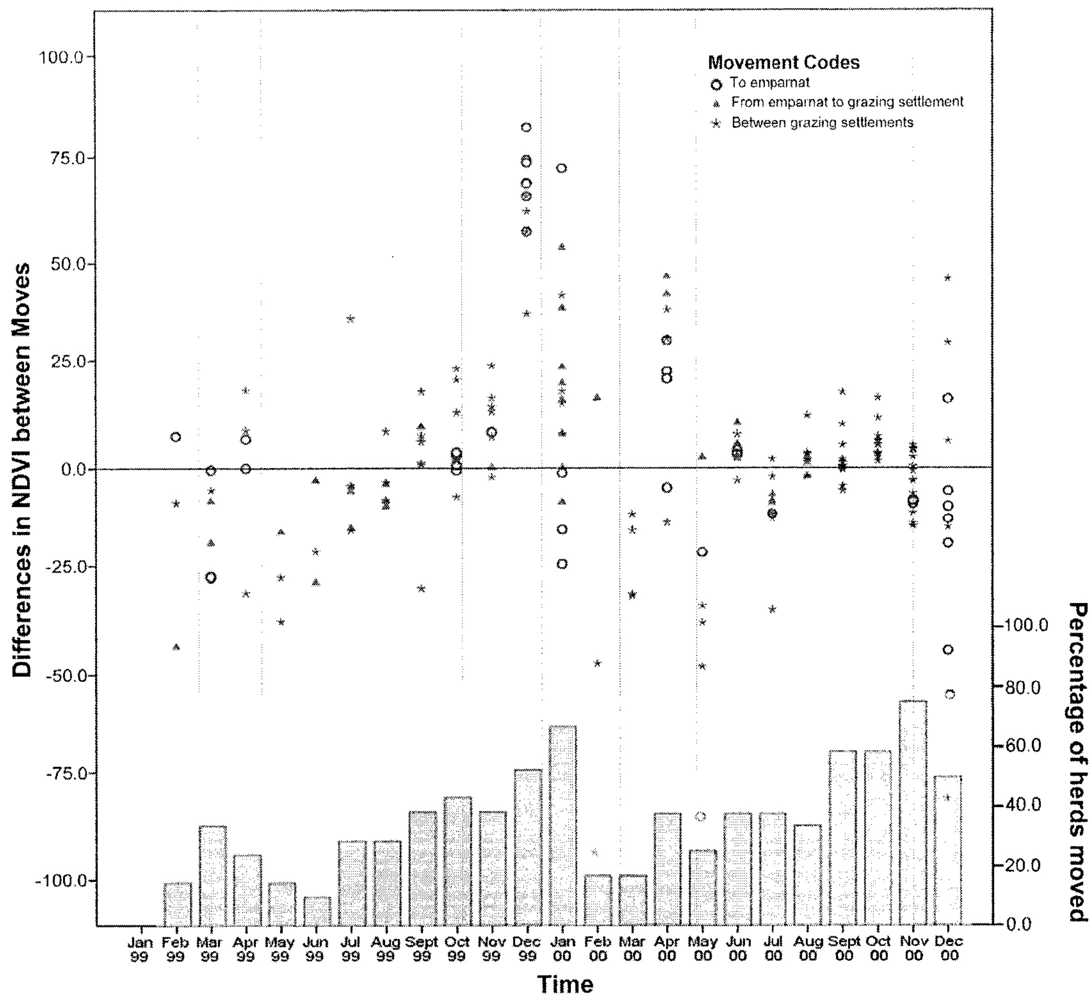

Figure 10. Differences in NDVI accessed based on movement in N. Imbirikani. Differences were calculated for all households that moved at least one time in either 1999 or 2000, as the NDVI of the source settlement (in the final dekade of that location) subtracted from the NDVI of the destination settlement (in the first dekade after a move). Positive values indicate households that moved from a location of lower NDVI to one with higher NDVI. Negative values indicate the opposite. All moves are coded by grazing settlement type. The secondary y-axis represents the proportion of households moving in any given month (Jan 1999 to Dec 2000). Vertical lines indicate the actual timing of the four rainy seasons which occurred during the study period.

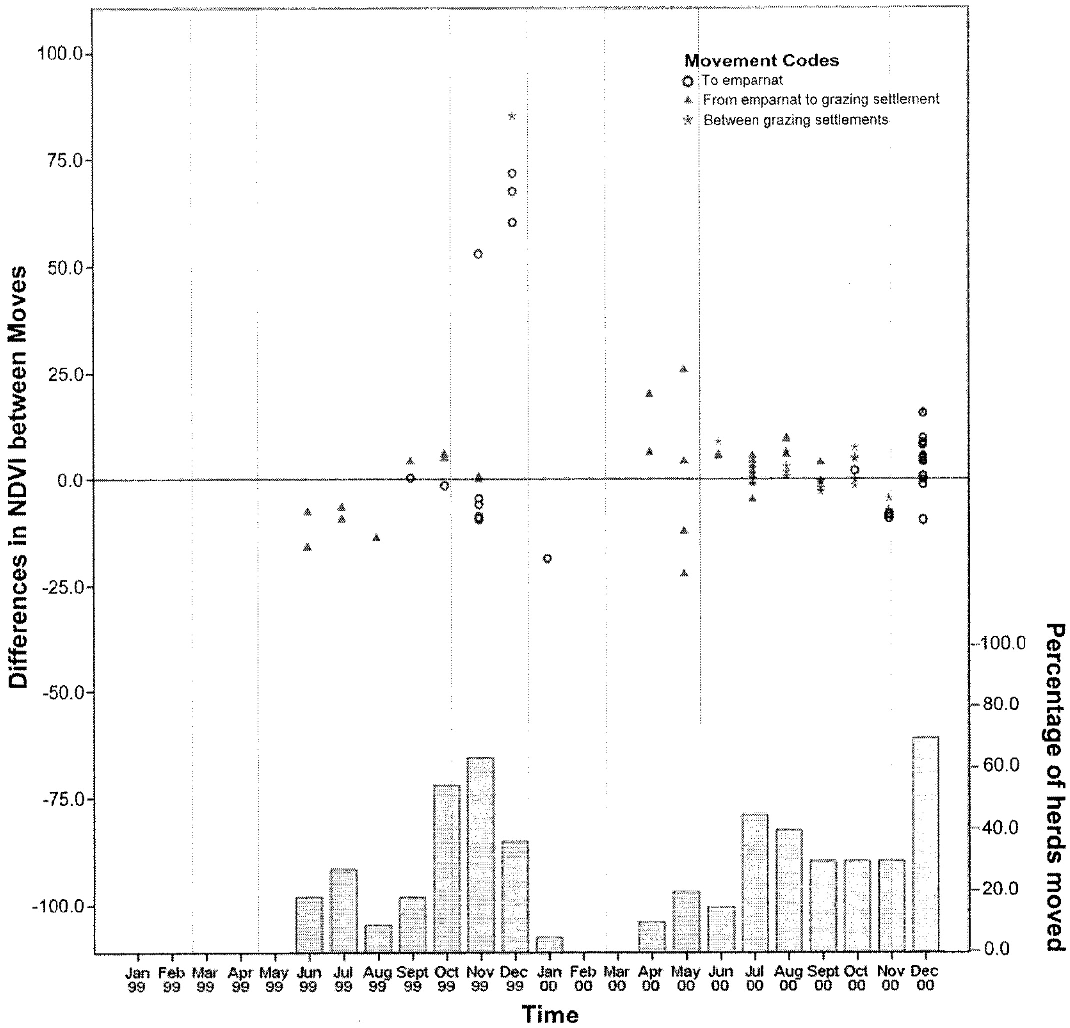

Figure 11. Differences in NDVI accessed based on movement in Lenkisim. Differences were calculated for all households that moved at least one time in either 1999 or 2000, as the NDVI of the source settlement (in the final dekade of that location) subtracted from the NDVI of the destination settlement (in the first dekade after a move). Positive values indicate households which moved from a location of lower NDVI to one with higher NDVI. Negative values indicate the opposite. All moves are coded by grazing settlement type. The secondary y-axis represents the proportion of households moving in any given month (Jan 1999 to Dec 2000). Vertical lines indicate the actual timing of the four rainy seasons which occurred during the study period.

Immediately clear from a comparison of Figures 10 (N. Imbirikani) and 11 (Lenkisim) are differences in the timing of movement between areas. N. Imbirikani households are moving during two periods annually – February to April, and June to December – with the greatest proportion of movement occurring in the long dry season (June to November). In contrast, many Lenkisim households move only once – during the long dry season, with movements generally increasing throughout that time period. This pattern highlights that in N. Imbirikani, all households do not necessarily return to their *emparnat* at the beginning of each wet season. Interviews with herders confirm that some remain out at *enkaron* settlements until ephemeral water sources (dams and ponds) dry up and then return to their *emparnat.* This is the period during either wet season when herders may be "chased out" of distant grazing stages and told to pull back to grazing zones around permanent settlements by groups of warriors (acting on the behalf of decision-making elders).

Looking at the type of moves that occur throughout the 24 month study period, this general pattern of returning to *emparnat* at or within the wet seasons (circles) is clear across both sites. Then, with the onset of the dry season, moves from *emparnat* out to grazing settlements (triangles) occur, followed by moves from one grazing settlement (*enkaron*) outward to another grazing settlement (stars). However, moves between *enkaron* are entirely absent in Lenkisim during the normal year 1999, while they are common in N. Imbirikani during the same period. *Enkaron* to *enkaron* moves do occur however in Lenkisim in the long dry season of 2000, and intensify as well in N. Imbirikani. Again, this cycling of movement between the three movement types occurs twice annually in N. Imbirikani if a household opts to be extremely mobile, while it occurs only once in Lenkisim. However, there are exceptions to these patterns evident in both study areas, suggesting that, 1) there is flexibility in the system of grazing rules, and/or 2) there are herders who flout these rules despite community norms.

These two figures also allow consideration of how the cultural/institutional grazing rules link to the needs of individual herders to access the best possible forage for their animals within the range of options institutionally available to them. There is an S-shaped curve evident in the N. Imbirikani figure, where positive differences in NDVI access between moves are generally small or negative early in the year (February-June), but become increasingly positive through the long dry season (July-October) based on initial or successive moves to or between grazing settlements. These increases are incremental, but they increase during the driest period of the year when forage resources are the most limited. Given that it is not raining during these dry periods, it seems probable that positive NDVI differences for these herders comes from leaving an area where forage has been grazed down, and moving into a grazing stage where standing forage biomass is still present. This vegetation will be senescing and ultimately entirely dry, but the NDVI differences between moves are still positive. Then, just after the October or November rains, NDVI values jump high, and movements in this period are either further out to new *enkaron*, or back to household permanent settlements. This S-shaped pattern is repeated within both annual cycles in N. Imbirikani – even in 2000, a year of severe drought. The same S-shaped curves are present also in Lenkisim, however the pattern is more truncated in time and of less magnitude. This would be expected however, given the lower scores of Lenkisim households on most indicators of mobility in comparison to N. Imbirikani. Thus, the effects of the 2000 drought seem to be mitigated by the grazing stages somewhat, in that there are still positive incremental increases in NDVI gained by herders as they moved through the long dry season. However, in both study areas in 2000, the NDVI accessed by moves occurring in November (when the rains were at this point a month late), dropped in magnitude and began to decline. This time period may reflect the threshold at which additional moves have no value for livestock.

Another pattern also illustrates that flexibility remains in the strategies employed by herders to still exploit green vegetation at certain times – even within the institutional strictures of the grazing stages. In December of 1999, some households in N. Imbirikani chose to move back to their emparnat, while others moved further out to new *enkaron*, but both strategies yielded strongly positive NDVI differences between moves. In January, some N. Imbirikani herders moved out to *enkaron* quickly, and again NDVI differences were positive. Their animals were accessing biomass that was probably very green at this point, given the highly positve NDVI differences plotted between moves. But the strategy that works one year may not the next, as in contrast in 2000, those herders in both study areas who moved back to *emparnati* in December, accessed much lower NDVI for their animals than those who made the choice (or were able) to remain out at their grazing settlements into January.

Predictors of Household Mobility

Results of two questions are presented in the following section. First, what factors predict whether or not a household makes the decision to become mobile? And secondly, once herds are mobile (i.e., have moved at least once), what socio-economic and ecological factors predict how mobile that herd will be overall? Binary logistic regression addressed the former and CART analyses addressed the latter question. Both types of analyses were carried out separately for the years 1999 and 2000.

Binary logistic regression

Binary logistic regression analyses predict the probability of one of two dichotomous outcomes based on a set of predictor variables. In this case the final model is meant to identify the probability of households becoming mobile (i.e., moving at least once) as opposed to remaining sedentary. The predictor variables used in the regression, their means and standard deviations are presented in Table 7.

Table 7. Summary statistics for binary logistic regression variables. Table values reflect means and standard deviations (N=141).

Independent Variables	Mean	St. Dev.
Herding Arrangement (Categorical Yes/No)	0.7	0.4
Household Labor (No.)	6.8	4.5
Gross Annual Income ($)	1406.1	1627.6
Mobile Cattle TLUs 1999	58.5	109.5
Mobile Cattle TLUs 2000	50.4	102.4
Hired Herders 1999 (No.)	0.3	0.7
Hired Herders 2000 (No.)	0.4	0.7
NDVI value in month prior to move 1999	91.5	27.1
NDVI value in month prior to move 2000	85.9	19.1

In 1999, three variables; the number of hired herders, the size of a household's mobile cattle herd, and NDVI values in the dekade prior to a herd's initial move explained 63% (Nagelkerke's pseudo-R^2) of the variability in whether a household moved at least once (Table 8). The decision to become mobile was strongly related to the number of hired herders brought into a household in addition to their own labor pool. Larger herd sizes and lower NDVI values (i.e., lower NDVI values at a household's *emparnat* in the month prior to a move) were also significant parameters although not as strong. All parameters were significant at $p<.01$ level. The Hosmer and Lemeshow goodness of fit test indicated that the model was a good fit for the data (Chi-square 7.287, df 8, p=.506). These model results are confirmed by the Likelihood Ratio test (Table 9), which showed significant positive increases in the -2 likelihood ratio as each parameter was added to the final model.

Table 8. Results of Binary Logistic Regression 1999 and 2000. A forward stepwise Likelihood ratio method was used for model selection. Variables removed from the model in 1999 were: Household Labor, Gross income and Herding Arrangement. Variables removed from the model in 2000 were: Household Labor, Herding Arrangement, NDVI, and Mobile cattle TLUs.

Model Parameters		Coefficients	Standard error	Wald statistic	Significance
1999	Hired Herders 1999	2.57	.95	7.26	<0.007
	Mobile cattle TLUs 1999	.03	.01	8.61	<0.003
	NDVI at dekade prior to move 1999	-.08	.01	26.35	<0.000
	Constant	6.96	1.58	19.33	<0.000
2000	Hired Herders 2000	18.46	4293.61	.00	<0.997
	Gross Annual Income	.01	.00	6.38	<0.011
	Constant	.231	.48	.22	<0.632

Table 9. Likelihood Ratio results for 1999 and 2000. Positive increases in the -2 Log Likelihood values indicate that the full models in 1999 and 2000 are the best fit for the data.

Parameters		Model Log Likelihood	Change in -2 Log Likelihood	df	Significance of the change
1999					
Step 1	Cumulative NDVI 1999	-91.36	45.99	1	<0.000
Step 2	Hired Herders 1999	-68.36	26.19	1	<0.000
	Cumulative NDVI 1999	-83.25	55.97	1	<0.000
Step 3	Hired Herders 1999	-54.05	12.60	1	<0.000
	Mobile cattle TLUs 1999	-55.26	15.03	1	<0.000
	Cumulative NDVI 1999	-69.04	42.58	1	<0.000
2000					
Step 1	Hired Herders 2000	-55.44	13.233	1	<0.000
Step 2	Hired Herders 2000	-49.37	10.517	1	<0.001
	Gross Annual Income	-48.83	9.428	1	<0.002

In 2000, only the number of hired herders and household gross income were significant parameters in the final model, and these parameters explained only 27% of the variability in initial herd movements (Nagelkerke's pseudo-R^2). The Hosmer and Lemeshow goodness of fit test indicated that the model was a good fit for the data (Chi-square 5.215, df 8, p=.734). However, the standard error value for hired herders was highly inflated in the final model (Table 8), and no wald statistic was produced. Results of the Likelihood ratio test (Table 9) are therefore more reliable under these circumstances, and a positive increase in the -2 likelihood ratio value under the model with annual gross income included indicate that the combined model is the best fit for the data.

Classification and regression tree analyses (CART)

Results presented below address the question; once a household becomes mobile with their animals, what predicts how mobile they will be throughout the year? Many more households were mobile in 2000 than in 1999, so the sample increased from 88 to 120 households with mobile cattle herds between the two years. The means and standard deviations of all variables used in the CART analyses are presented in Table 10.

CART analyses quantified the variation on a continuous response variable (e.g. the Mobility Index value (MI)), and split mobile households into homogeneous groups based on combinations of explanatory variables (Table 11). The shapes of the individual regression trees identify important variables in each study area that act as cut points for the data (Figures 12a, 12b and 13), and the "proportional reduction in error" statistic reflects the proportion of variability in the MI which is explained by the final model (Table 11). Variables are grouped according to a subjective classification of how "traditional" vs. "modern" they are within the current productive framework of Maasai pastoralism. Whether a household shares labor or combines their herds, the size of the household labor pool, the size of their mobile cattle herd, their dependence on livestock as a proportion of their total income, and the relative productivity of forage resources are variables which traditionally have been a component of livestock productivity and mobility decisions in Maasailand. However, the size of a household's gross income (which includes other sources of non-livestock income), and the degree to which households hire additional herding labor are more recent, and more "modern" aspects of pastoralism in Maasailand.

Table 10. Summary statistics for CART analyses variables. Values are means by study area and standard deviations (in parentheses). CART analyses were run for 1999 (N=88 mobile households) and 2000 (N=120 mobile households). Subdivided Osilalei and Sedentary S. Imbirikani study areas are highlighted.

Variables	Osilalei	S. Imbirikani	Eselenkei	Lenkisim	Emeshenani	N. Imbirikani	Total
Herding Arrangement (Categorical Yes/No)	0.7 (0.5)	0.8 (0.4)	0.6 (0.5)	0.80 (0.41)	0.6 (0.5)	0.9 (0.3)	0.7 (0.4)
Household Labor (No. of individuals)	5.9 (1.8)	5.81 (4.2)	6.6 (3.5)	7.5 (3.6)	8.9 (5.9)	6.6 (5.9)	6.8 (4.5)
Gross Annual Income ($)	1197.8 (1178.9)	1004.0 (1140.2)	1145.2 (1126.6)	1229.6 (1845.6)	1365.2 (775.3)	2486.0(2657.5)	1406.1 (1627.6)
Proportion of income from Livestock	59.6 (27.0)	38.3 (32.3)	69.2 (32.4)	48.4 (39.4)	88.5 (13.9)	62.7 (34.8)	60.9 (34.3)
Mobile Cattle TLUs 1999	24.9 (32.0)	25.7 (38.7)	54.2 (79.1)	38.8 (59.5)	92.7 (192.3)	68.0 (113.4)	50.4 (102.4)
Mobile Cattle TLUs 2000	31.5 (38.0)	28.5 (45.4)	63.9 (93.3)	48.6 (73.5)	104.9 (199.0)	76.4 (117.5)	58.5 (109.6)
Hired Herders 1999 (No. of individuals)	.00 (.00)	0.3 (0.5)	0.3 (0.5)	0.3 (0.5)	0.0 (0.0)	0.9 (1.1)	0.3 (0.7)
Hired Herders 2000 (No. of individuals)	0.3 (0.5)	0.3 (0.5)	0.4 (0.7)	0.3 (0.5)	0.0 (0.0)	1.0 (1.1)	0.4 (0.7)
Cumulative annual NDVI 1999	3756.8 (136.9)	3596.0 (107.9)	3677.7 (108.1)	3076.8 (59.3)	2879.5 (100.4)	3354.1 (201.2)	3403.6 (343.4)
Cumulative annual NDVI 2000	3592.2 (102.8)	3339.2 (135.1)	3563.1 (117.0)	2997.4 (77.7)	2744.2 (68.3)	3395.8 (271.0)	3282.45 (336.1)
Size Area (km^2)	17.1	18.5	32.2	46.1	80.2	89.6	29.0

Table 11. Summary of results for CART analyses. Significant cut points and directionality of variables predicting greater mobility for household herds are shown by study area for 1999 and 2000.. Shaded areas are more "traditional" predictors of mobility. Unshaded areas to the right are newer, more "modern" household characteristics. The variable "size area" was used only in CART analyses for the entire study area. Numbers represent order of cut points in Regression Tree graphs. Subscript letters denote left or right hand split. > and < symbols in parentheses indicate the direction of the variable value which predicts **greater** mobility for that area. The "Proportional Reduction in Error" statistic in regression tree analyses are analogous to the R^2 explained in other regression techniques. NDVI conditions in 1999 correspond to the NDVI value in the dekade before a household moved from its permanent settlement for the first time that year. NDVI conditions in 2000 reflect the cumulative value of NDVI per household accessed over the course of that year based on all moves.

		CART Variables							
Study Areas and Year	Proportional Reduction in Error*	Herd sharing arrangement (Yes/No)	Total Labor	Mobile Animal TLUs	Proportion of income from livestock	NDVI** conditions	Hired Herders	Gross Income	Size Area
1999									
Osilalei	NA								
S. Imbirikani	0.56					1(>)		2a(>)	
Eselenkei	0.37					1(<) , 2b(>)			
Lenkisim	0.45			2b(>)				1(<)	
Emeshenani	0.57			2a(<)		1(>)		2b(<)	
N. Imbirikani	0.77				1(<)	2b(>) ,3b(>)			
Study Area	0.51				2b(<)				1(>)
2000									
Osilalei	0.53							1(>) , 2a(<)	
S. Imbirikani	0.75			1(>)					
Eselenkei	0.68					1(<)		2b(<)	
Lenkisim	0.76		1(<)	2b(>)				2a(<), 3(>),4(<)	
Emeshenani	0.47				1(<)				
N. Imbirikani	0.34		2a(>)		2b(<)		1(>)	3a(<)	
Study area	0.44								1(>)

Results across the study areas for 1999 explained between 37% (Eselenkei) and 77% (N. Imbirikani) of the variability in the calculated MI (Table 11). The range of variability across the study sites explained in the drought year of 2000 was similar, between 34% and 76%, but the variability explained in N. Imbirikani declined precipitously (77% down to 34%), while Lenkisim rose (from 45% to 76%).

Table 11 also summarizes the results of the individual regression tree analyses by study site. Results indicate clearly that there are differences across sites in the variables which predict how mobile households are and there are differences in which variables were important predictors of mobility across years.

Whether a household was sharing labor or combining herds was not an important factor in household mobility in either 1999 or 2000. The size of a household's labor pool was only relevant in Lenkisim and N. Imbirikani in 2000, but the variable was a cut point for greater mobility in opposite directions – with more household labor (>7 people) contributing to greater mobility in N. Imbirikani, but households with smaller labor pools (<9 people) exhibiting lower mobility in Lenkisim. Hiring herders – the modern method for increasing the size of a household's labor pool – was not a relevant variable for any study site except N. Imbirikani in 2000. Hired herders was the first cut point in this regression tree (Figure 12b), and households with more than 2 hired herders were more mobile. Household labor seems to be an important factor in this study area, as those N. Imbirikani households with fewer than 2 hired herders, smaller labor pools (<7 people), but gross incomes greater than $1128 were the least mobile of all households in 2000. From these results household labor does not seem to be a limiting factor to mobility in any site except for N. Imbirikani during the drought year.

The size of a household's mobile cattle herd was the first (and only) cut point for one study site (S. Imbirikani in 2000), and the second cut point for three other study sites, Lenkisim and Emeshenani in 1999 and Lenkisim in 2000. In all cases but Emeshenani, a larger mobile cattle herd contributed to greater mobility. This result intuitively makes sense as households with larger herds logically need to move more often to satisfy their animals' needs for greater forage biomass. In the case of Emeshenani, the households for which herd size was a cut point, were accessing areas of lower NDVI on a cumulative basis (<2891 units annually). Within this group (N=16), those with smaller herds (<66 TLUs) were moving more.

Proportion of gross income from livestock was an initial cut point for two sites (N. Imbirikani in 1999 and Emeshenani in 2000), and a secondary cut point in N. Imbirikani in 2000. In all cases households with less dependence on livestock as a proportion of gross income were more mobile relative to other households in those sites. Thus households who are engaged to a greater degree with other economic activities (e.g. agriculture or off-land business or wage labor), are more mobile than those households who are dependent on livestock alone.

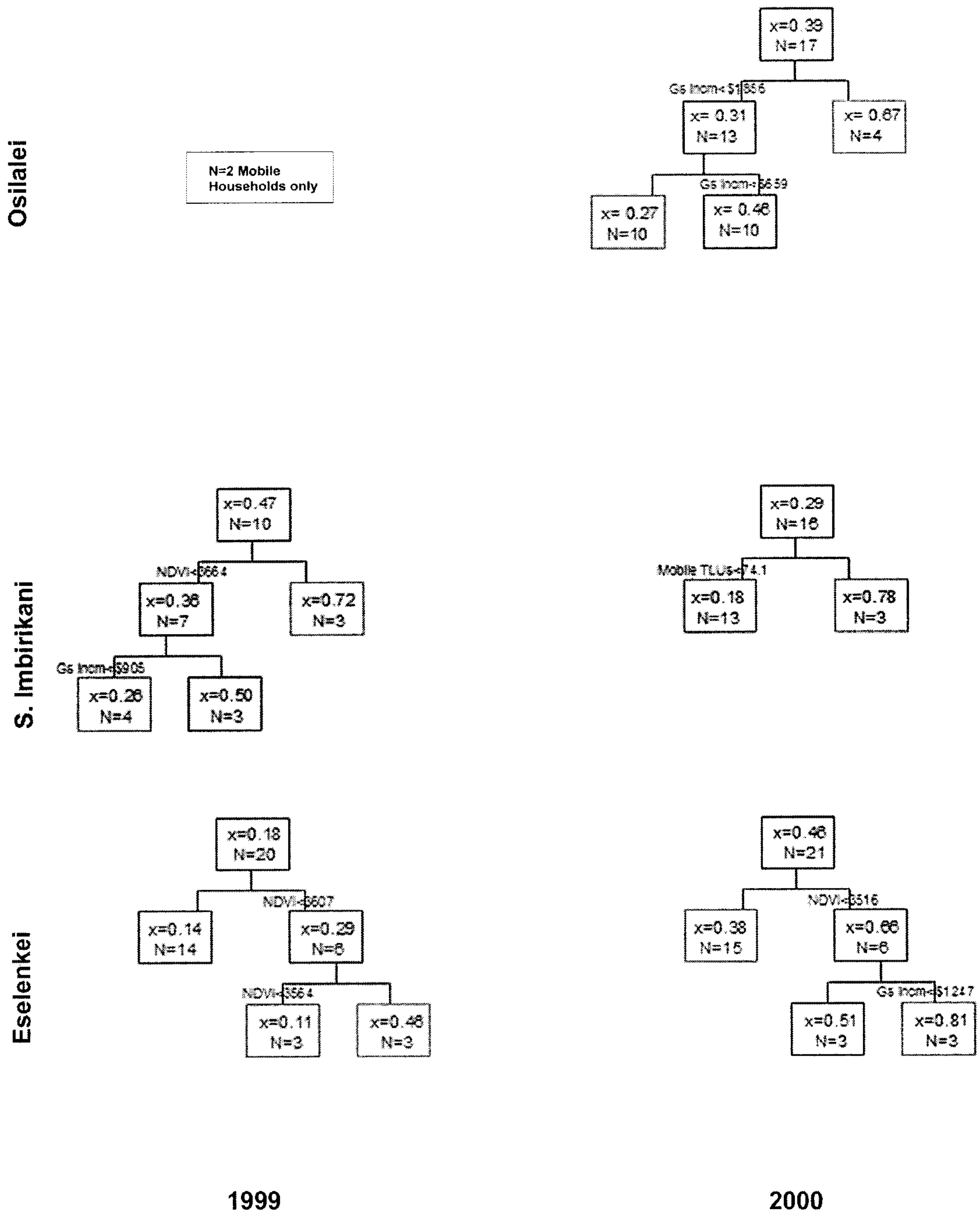

Figure 12a. Results of CART Analyses by study area and year. The dependent variable was the mobility index (MI) for 1999 and 2000, standardized by individual study area. Values inside nodes are mean MI values for households and the number of similar households at each cut point. The variables which differentiate mobility at each cut point are indicated. Terminal nodes for households with the highest and lowest mean MI values are indicated in blue (lowest) and red (highest).

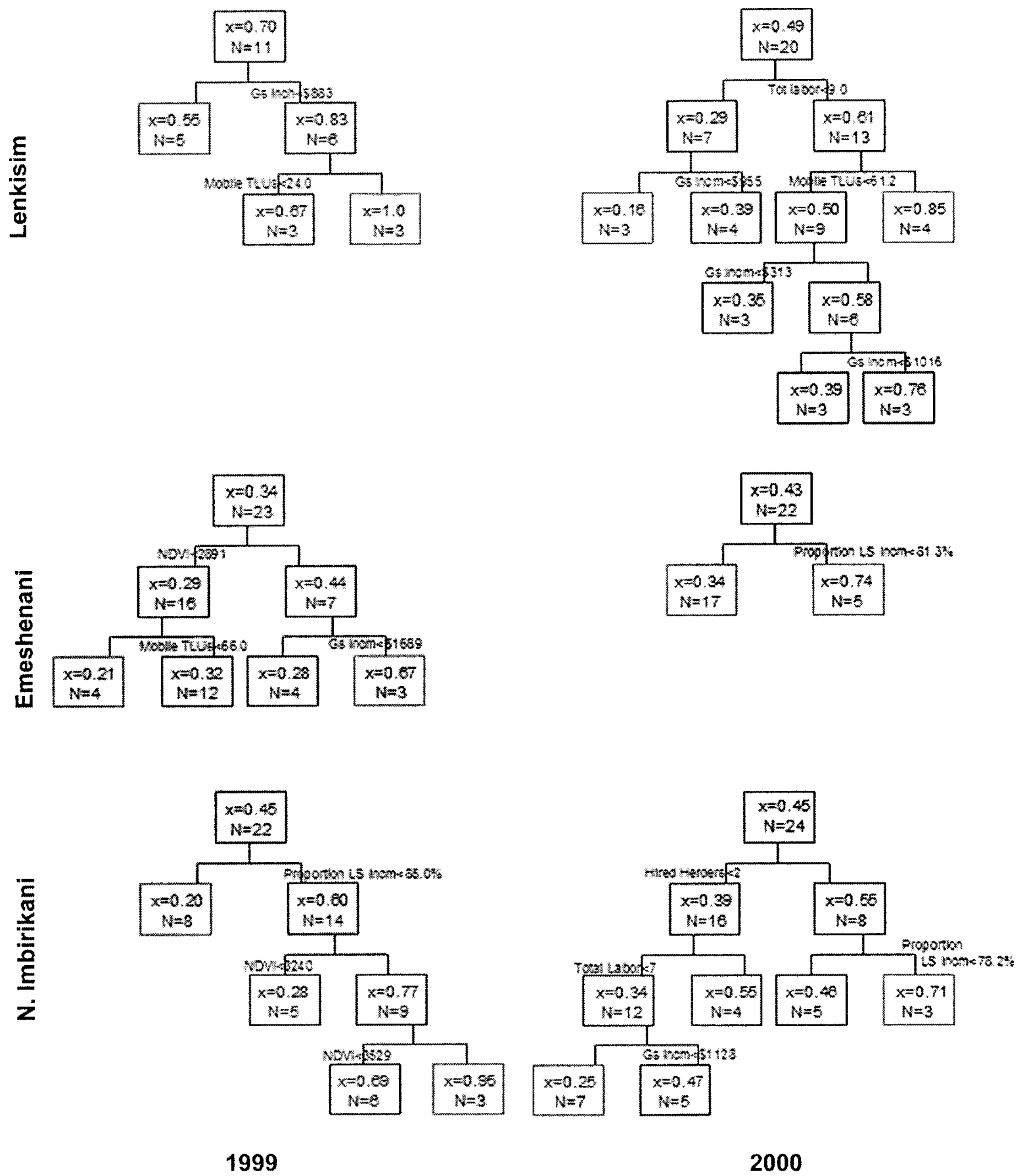

Figure 12b. Results of CART analyses by study area and year. The dependent variable was the mobility index (MI) for 1999 and 2000, standardized by individual study area. Values inside nodes are mean MI values for households and the number of similar households at each cut point. The variables which differentiate mobility at each cut point are indicated. Terminal nodes for households with the highest and lowest mean MI values are indicated in blue (lowest) and red (highest).

Cumulative NDVI was strongly linked to mobility in 1999, but less so in 2000. Greater NDVI accumulation through time explained the greatest variability in mobility in S. Imbirikani and Emeshenani, and was a second and third cut point for household mobility in N. Imbirikani. An exception here is Eselenkei study area where in both 1999 and 2000, households with lower cumulative NDVI were more mobile. This is explained however, by the fact that Eselenkei households are settled close to or within the riverine forest of the Eselenkei River corridor, so as described previously, any mobility will be quantified as a loss in access to green biomass. However, once this move away from the riverine corridor occurred, households who accumulated the greatest NDVI over the year were also the most mobile (Figure 12a).

Gross income was an important predictor of mobility in 1999 and 2000, but particularly in the drought year. However, the variable was a cut point for mobility in both directions, as gross income was linked to a range of mean mobility scores. Of the nine times gross income was a cut point for mobility, higher income levels implied greater mobility in three cases, and lower relative incomes were linked to greater mobility seven times (Table 11). Gross income was also a multiple cut point within particular study areas, for example in Lenkisim in 2000, the gross income variable separated households along a continuum of mobility. Bigger households (>9 people) with an annual income greater than $955/yr were the least mobile of all Lenkisim households (Figure 12b). Smaller households (<9 people) with fewer than 61 TLUs in their herds, but less than $313 in income were the least mobile, while households with intermediate incomes ($313-$1016/yr) were the most mobile, and the richest households (>$1016/yr) were moderately mobile. A similar pattern holds true in Osilalei, but richer households were the most mobile (>$1856/yr), households with moderate income were the least mobile (>$659/yr) and poor households were moderately mobile (<$659/yr). Gross income encompasses a more modern conceptualization of economic change in Maasailand. However, there is a strong positive correlation between gross income and mobile animal TLUs across all the study areas except S. Imbirikani (Spearman's Rho 1999 r=.586; 2000 r=.602, p<.000). This suggests that poorer households (e.g. with low gross incomes) have fewer livestock, and may be on the lower to middle end of a mobility gradient. In contrast, households with higher gross incomes are engaged in additional economic activities, but still have larger herds. They are on the middle to higher end of the mobility gradient – with moderate income households being both more and less mobile in different locations. In S. Imbirikani, where gross income and herd size are uncorrelated, and both are low relative to other study areas (Table 10), herd size alone was the critical cut point for mobility in 2000.

Two additional regression tree analyses were run for all the study areas combined (Figure 13). Results for 1999 explained 51% of the variability in mobility across households, and 44% of the variability in 2000 (Table 11). Both regression trees are small with few significant cut points. The relative size of the traditional grazing area (i.e., the combined area of each study sites traditional grazing stages), was the only significant predictor in 2000 and the first cut point for households in 1999. The larger a grazing area, the greater the herd mobility. The second cut point in 1999 was proportion of income from livestock, and households that were more dependent on livestock were again less mobile. The size area variable however, lumped together 75% and 80% of households in 1999 and 2000 respectively, as being from smaller sized grazing areas. The cut point for lower mobility was <89.5 km^2 in both years. This figure corresponds to the upper range of all study areas except N. Imbirikani's traditional grazing zone, again highlighting that mobility in this study site is distinctive from that occurring in other areas across the study region.

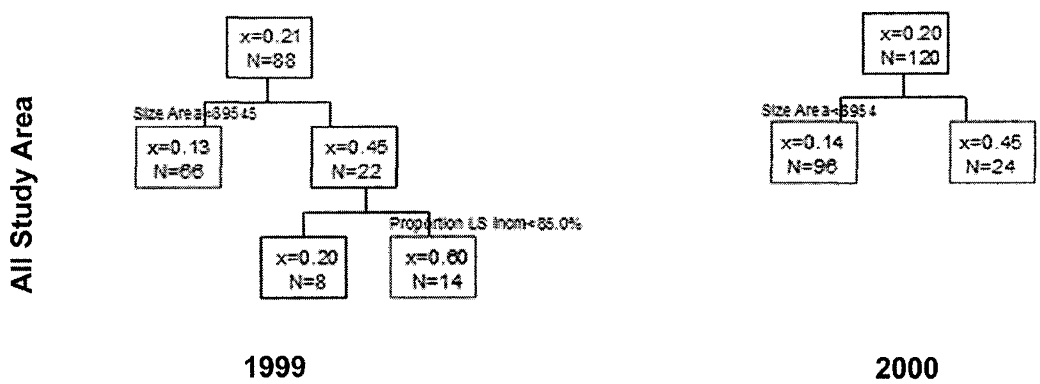

Figure 13. Results of CART analyses for all study areas combined by year. The dependent variable was the mobility index (MI) for 1999 and 2000, standardized for the study region as a whole. "Size area" was added as an independent variable for these analyses. Values inside nodes are mean MI values for households and the number of similar households at each cut point. Terminal nodes with the highest and lowest mean MI values are indicated in blue (lowest) and red (highest).

DISCUSSION AND IMPLICATIONS

The goals of this chapter were to first quantify the economic importance of livestock within the diversifying economy of the Greater Amboseli Ecosystem, and then to identify the current characteristics and extent of pastoral mobility in a "normal" year and a year of severe drought across areas distinguished by different land tenure (private vs. communal rangelands) regimes and degrees of sedentarization. I then quantified and compared the access of cattle herds to forage biomass based on their degree of mobility, and identified characteristics of pastoral households which predicted both initial mobility and the overall degree of movement pursued by households in good and bad years. The results of these analyses are important within the context of ongoing pressures for pastoralists to privatize communal grazing lands and sedentarize livestock production existing in the GAE. They address questions regarding the proportion of pastoral households who are currently dependent on mobility as a critical coping strategy in this semi-arid landscape, and therefore who would be affected by a decline in their ability to be mobile in the future?

Results of the economic analyses clearly indicate that Maasai households across the Amboseli system are diversifying beyond livestock production into agriculture and off-land activities (e.g. businesses and wage labour). However, livestock still represent a high proportion of gross income in Amboseli, ranging between 44% – 86% (Figure 3). Areas still heavily dependent on livestock in general are those in core rangeland zones, while households in sedentary areas – e.g. S. Imbirikani – derive a higher proportion of their livelihoods from non-livestock sources. Even households in the subdivided area of Osilalei were still heavily dependent on livestock for their livelihoods. The same pattern of dependence on livestock holds true when mean annual gross income was compared across study areas (Figure 4). Off-land and agricultural income is important, however livestock-based income (e.g. animal sales, hides/skins, milk and slaughter) consistently represented between 50-75% of household gross income on average. Average household herd sizes in S. Imbirikani and Osilalei were smaller than other study sites (BurnSilver Ch. 1), but results indicate that livestock were still critical to economic well-being in these areas. In spite of economic diversification, I found a strong correlation between gross income and size of mobile cattle herds across all the study areas, indicating a potential positive feedback between richer households who are engaged in an array of economic activities, but who are still investing in their livestock. Livestock still continue to function as a store of value, or wealth, in Maasailand. Congruent with significant levels of diversification, livestock remain very important to pastoral livelihoods in the GAE.

Results also show that in spite of ongoing economic diversification, sedentarization and pressures to subdivide, mobility is still widespread as a component of the current livestock production system in the region. Mobility was carefully defined in these analyses to differentiate among multiple characteristics of movement, as there are vast differences between households who move their herds consistently and often, compared to those who only move once for a short duration of time. Analyses of movement patterns show that herds in core rangeland zones (where livestock also remain most critical to livelihoods) move more often and spend more time away from their permanent settlements (Table 4). N. Imbirikani households were significantly more mobile than all the study areas according to almost every calculated grazing metric. This study site is also the largest and contains within its traditional borders the higher altitude Chyulu hills, an area long used as a grazing refuge in drought periods. Results also confirmed that more households remained sedentary in Osilalei (subdivided) and S. Imbirikani (agropastoral) in the "normal" year of 1999, and that daily wet season grazing distances in these areas were shorter (Figure 6). However, in the year of 2000, an additional 62.5% of Osilalei households and 22% of S. Imbirikani herds became mobile under drought-stress conditions, an increase that brought their number of mobile herds up to levels comparable to the other study sites. Analyses also showed that when households made the decision to be mobile, there were few significant differences in their degree of mobility as compared to other households for whom mobility was more common. In other words, when an otherwise sedentary S. Imbirikani household moved their herd, they moved on par with even herds from extremely mobile N. Imbirikani. There were also significant differences in mobility between years for herds in sites according to the metrics measured (Figure 7); herds moved longer distances, most herds moved more often, and herders spent longer time periods away from their permanent settlements (Table 5).

These results point to differences between customary and practiced mobility on the one hand, and drought-induced mobility on the other. Many households in sedentary and subdivided areas, and some households from other sites (e.g. Lenkisim) were not mobile in what was locally considered a "normal" rainfall year, but became mobile in the drought of 2000. So it seems that sedentarization does decrease mobility for some households, but they do currently retain the ability to become mobile in this system when necessary. Fifty-two percent of mobile Osilalei households in 2000 moved across the entire study area during the drought to graze in N. Imbirikani (Figure 7), and consequently traveled greater mean distances in accessing this area than all other mobile herds in 2000 (Table 4). This movement was from a subdivided area to an unsubdivided area, suggesting that in spite of subdivision, some flexibility to negotiate access within the restrictions posed by private property still remains in this system currently. This access was negotiated between a group of private Osilalei parcel holders and leading elders from N. Imbirikani, who then opened all of Imbirikani group ranch to the drought refugees based on traditional understandings of reciprocity (Kituyi 1990; Waller 1993). However, it is an open question whether movement in the opposite direction (e.g. communal to subdivided) could occur as easily if the situation was reversed, as this would require households from communal areas to negotiate with multiple owners for access to individual (and small!) parcels.

NDVI analyses indicate that the cultural/institutional system of grazing management as currently applied in communal areas of the GAE, acts to maintain herder access to forage *quantity* through time. However, herder movements are no longer predicated on maximizing animals' overall access to high *quality* green forage. This may have been true in Amboseli prior to the switch from a wet to a dry season dispersal system, and it may continue to be true in other transhumant or more nomadic pastoral systems, such as Turkana in northern Kenya (McCabe 1990; McCabe, Dyson-Hudson et al. 1999). But it is not the case in Amboseli now. Worden (2007) showed that herds in Emeshenani, Lenkisim, Eselenkei and Osilalei were accessing forage that was below the average NDVI available in each study area for the majority of 1999 and 2000. However, more detailed analyses of individual herd movements at dekadal time steps indicated that the grazing stages system seems to allow mobile herds to access greater standing biomass throughout the long dry season (Figures 8-11). The standing crude protein content of this vegetation is declining through time, but if the rains arrive when expected, the standing biomass saved at each grazing stage is enough to allow animals to continue to function metabolically (Fryxell, Greever et al. 1988; Rege and Tawah 1999). There is a point however, at which animals become so weak that they die of hypothermia at the onset of the rains, even as the grass finally flushes green. This phenomenon occurred in November of 2000 when the rains were late, and animals were pushed to their absolute limits by the drought. However, the system worked well in 1999 – the year of "normal" rainfall. The grazing stages system also encompasses time periods when herders do access high quality green forage, particularly after the rains arrive and depending on the chosen timing of herd movements between grazing areas and their permanent settlements (Figures 10 and 11). A herder can choose for his animals to remain out at a distant grazing settlement and let animals recover on high quality forage and abundant standing water, but this strategy also may be constrained by intra-household characteristics such as labor availability, the agricultural calendar, or the need to get children back home for the beginning of school (e.g. in January). Inter-household relationships such as labor sharing and animal lending strategies could minimize these constraints, however household level needs may rise in importance as households continue to diversify. The results of these NDVI analyses are therefore suggestive of the interplay in Amboseli between the cultural/institutional grazing management system, the system's underlying ecology, and household level needs and capabilities.

NDVI was an effective methodology to use in these initial analyses in quantifying animals' access to biomass based on mobility patterns. However, results presented here also identified limitations to its use. NDVI indices have been criticized as not sensitive enough to quantify senescent vegetation effectively (Todd, Hoffer et al. 1998; Kawamura, Akiyama et al. 2005; Marsett, Qi et al. 2006). NDVI analyses have been shown to work well when the goal is to correlate NDVI with NPP, or to quantify characteristics of vegetation phenology during the growing season (Reed, Brown et al. 1994). However, in pastoral and ranching systems where animals use rangelands on a year-round basis and are mimimally dependent on outside inputs (e.g. hay) during the winter or dormant periods, NDVI measurements have not been as effective in predicting the quantities of remaining senescent vegetation available for consumption in dry periods. In response, Marsett et al. (2006) tested the SATVI index in US rangelands as a method to better quantify available forage across multiple seasons, using an approach based on the differences between short wave infrared and red hyperspectral bands and including a soil adjustment factor. Current results also showed that SPOT NDVI data was not effective in separating the vegetation biomass signatures of grass vs. trees. So, for example in Eselenkei study area, herders consistently looked as if they were moving away from "greenness", when they actually might have been choosing between alternate grazing habitats in different time periods; i.e., the grass understory in the riparian area as compared to forage available in the mixed Comiphora rangelands. As well, Amboseli herders utilized additional strategies to access forage resources for their cattle herds that would not show up in NDVI analyses of relative biomass availability. Cultural and economic-based coping strategies were used by households in both years, including; purchase of corn stalks, utilization of pods from *Acacia tortillis* trees, moving into lands that were as yet unoccupied in subdivided areas, or sharing parcels between friends. These strategies are not quantified here, but they were documented during the course of the study and they were important (see BurnSilver and Mwangi 2007 for discussion of these results). It will be critical to address the caveats outlined above in future efforts to understand mobility, and its role in accessing to forage resources in year-round and low input grazing systems like the GAE.

The GAE is a pastoral system characterized strongly by economic and land tenure change, but given that results show a strong continued dependence on livestock, and there are indications that mobility does confer some benefits in terms of forage access – what household-level and ecological characteristics predicted who will be mobile in good and bad years? Sixty-three percent of the variability in first movement (Tables 8 and 9) was explained by three variables: NDVI conditions at a household's *emparnat*, the size of the mobile cattle herd, and the number of hired herders brought into a household. However, in 2000, the explanatory power of the model declined to 27%, based only on number of hired herders and gross income. These results again illustrate the difference between mobility in a good year, and drought-induced or "stress mobility" – when conditions deteriorate to such an extent that normally important household-level characteristics decline in significance for predicting mobility, and many households become mobile regardless of habit, readiness or inclination. The size of a household's mobile herd, or overall wealth matters less in a drought year, as large or small, rich or poor, there is a greater need for households and animals to move and find adequate forage.

Results from classification and regression tree analyses went further in beginning to quantify the ecological and household-level characteristics that predicted how mobile a household would be once they made the decision to move (Table 11, Figures 12 and 13). Again, predictors of mobility differed across years. For example in 1999, NDVI accumulation was a significant predictor of mobility for a majority of study areas, but it was not an important cut point for the data in 2000 when forage was already limited across most of the study region locations. The strength of different predictors also differed across study areas. Labor did not seem to be a limiting factor in mobility in any area except for N. Imbirikani, where households were the most mobile overall and the study area is the largest. In her study of factors affecting migration in Kajiado district, Kabubo-Maria (2003) identified that larger herds predicted greater migration, and higher gross income levels led to less migration overall. Current results agree that in most cases households with larger herds are more mobile. However, results for gross income were more complex, as a gradient of gross income levels existed, which led to greater mobility in some study areas (N. Imbirikani) and in others, less (Lenkisim). In general though, households poor in livestock TLUs were never the most mobile, and households rich in livestock were never the least mobile. One clear result was that gross income and mobile animal TLUs are correlated, as is gross income and household involvement in additional economic activities (BurnSilver Ch. 1). Therefore, even with greater economic diversification, moving household herds remains an integral component of household livelihoods, and as such mobility will also arguably remain important in the GAE into the future. Kabubo-Maria (2003) also reported that owning a private parcel in a subdivided area was a strong predictor of declines in mobility. Results in this study support this conclusion in a normal year, but are strongly contradictory in a drought year. Drought is a condition which occurs often enough to be considered the norm in this system, and under scenarios of climate change, drought is expected to increase in the future (Watson, Moss et al. 1998). This emphasizes the importance of taking ecological variability into account when making generalizations regarding the criticality of movement in this system. Patterns of mobility in wet and dry years differ, but results presented here support that maintaining flexibility within the system is one key to strengthening households' overall resilience in the face variability in this pastoral system.

The debate over mobility in the Amboseli system specifically, and across many pastoral systems globally continues to take place within a context of changing land tenure systems and policy drivers that act to push pastoralists to sedentarize and privatize their communal rangelands (Banks 2003; Behnke 2007; Reid, Galvin et al. 2007). Researchers advocating for the institution of private property rights have suggested that; 1) private property regimes lead to greater efficiency and investment (Li, Rozelle et al. 1998; Kabubo-Mariara 2005; Deininger and Jin 2006), and 2) the addition of production inputs to livestock systems would negate the need for households to migrate with their herds (Evangelou 1984; Kabubo-Mariara 2003; Kabubo-Mariara 2005). It is interesting to note that much of the literature cited in support of the connection between secure land tenure (i.e. private property rights) and greater productivity in pastoral systems comes out of work with agricultural groups engaged in a process of intensification. However, even results from within this research tradition have begun to question the straightforward causation between privatized property rights, and greater productive efficiency and investment (Feder and Feeny 1991; Besley 1995; Brasselle, Gaspart et al. 2002). I question as well the direct applicability of results from studies of sedentary farmers to the specific challenges of mobile pastoralism in dryland environments. Infrastructure and development inputs in Maasailand – as well as most other pastoral regions – remain very low (Banks 2003; Boone, BurnSilver et al. 2007), and show little sign of increasing in the near future (IRIN 2007). So if infrastructure (e.g. road access, well-developed markets, access to credit) is an important precursor for pastoral intensification, then much remains to accomplish before these inputs can act as an effective substitute for mobility.

The recent work of Banks (2003) and others (Boone and Hobbs 2004; McAllister, Gordon et al. 2006; BurnSilver and Mwangi 2007; Wen, Ali et al. 2007) also goes beyond the classic private/communal argument over appropriate forms of land tenure to look at the characteristics of production and mobility that pastoral groups themselves are using to cope with land tenure change and variability. This work emphasizes that some form of collective management – even within the framework of privatized rangeland parcels – represents a critical way for pastoralists to maintain *or regain* the flexibility to move their animals in response to ecological imperatives, as well as to preserve the social assurance networks that are an integral component of human well-being in these systems. Examples here include cooperative management of multiple private parcels, and pasture sharing, trading or agistment (i.e., a commercial swapping arrangement between pastoralists who have more forage than they need with those who have less). The fact that these coping mechanisms are emerging in post-subdivision (privatized) situations should also stand as cautionary notes to those still advocating for straightforward privatization of rangelands in dry environments.

Regardless of ongoing debates in the literature over causal linkages between communal vs. private property rights, human well-being, and economic productivity, pastoralists currently remain stuck in a position between climatic variability, historically unfavorable policy assumptions, and a lack of development infrastruture and inputs that would facilitate livestock intensification. This study has highlighted that transhumance of household herds in the Greater Amboseli Ecosystem allows animals to access more, and in some cases better, forage. Mobility thus remains a critical strategy to preserve flexibility and resilience in the face of the twin challenges of economic change and ecological variability. Pastoralists in the GAE are currently deciding how and to what extent subdivision of their rangelands should occur. There is little doubt that the mechanisms of mobility will change as herders make these decisions and engage increasingly in a diversifying pastoral economy. But the results presented here should be taken into account as the debate over the role of pastoral mobility in development continues.

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CHAPTER 4

USE OF MULTIPLE INDICES TO COMPARE WEALTH IN A CHANGING PASTORAL ECONOMY

INTRODUCTION

Livestock raising is the dominant land use in 25% of the world's landscapes and comprises the basic livelihood strategy of over 20 million households (Galaty and Johnson 1990) and reviewed in FAO 2001). People who depend on a combination of animal species for the majority of their livelihoods are termed pastoralists. While the specific characteristics of how African pastoralists raise their animals varies widely, traditional pastoralism has revolved around the twin requirements of accessing forage and water resources for herded animals across space and time – most often in rangeland zones typified as arid or semi-arid. In Sub-Saharan Africa, population growth, rising urban populations and greater income are projected to increase per capita demand for livestock meat and milk by 18% and 23% respectively through the year 2020 (Delgado, Rosegrant et al. 1999). Yet despite growth on the demand-side for livestock products, the ecological, economic, and social sustainability of livestock-based livelihood systems across much of dryland Africa is currently being challenged for a variety of reasons. Pastoralists are now under increasing pressure to "rationalize" livestock raising away from subsistence consumption and towards a more market-based production system (Ellis 1993; Zaal 1998). National governments across Africa also support land tenure change, so heretofore communal rangeland systems are now being pushed towards a process of privatization (Behnke and Scoones 1993; Ndagala 1994; Mwangi 2006). Pastoral groups have lost access to high value resources within their traditional territories based on in-migration by agricultural groups (Rutten 1992; Fratkin and McCabe 1999; Fratkin 2001), and the creation of national parks and protected areas in the name of wildlife conservation (Western 1994). The combined effect of land privatization on the one hand, and loss of high value territory on the other has been an ongoing fragmentation of the pastoral land base, which translates into greater competition for resources overall (Reid, Thornton et al. 2003; Hobbs, Reid et al. 2007). Development services (e.g. schools and health care) and access to market infrastructure in rangeland zones are notoriously low (UNDP 2001; Akcura 2002; Boone, BurnSilver et al. 2007; IRIN 2007). Many researchers have pointed out recently that poverty levels across pastoral populations are generally high (Thornton, Kruska et al. 2003), but also that pastoralists have been growing gradually poorer through time (Rutten 1992; Campbell 1993; AMREF 1998). Human populations also continue to rise, and this already challenging productive environment is exacerbated by highly variable rainfall and recurrent drought (Ellis and Galvin 1994; Galvin, Boone et al. 1999). Scenarios of climate change also suggest that Sub-Saharan rangelands will experience even greater risk of drought in the future (Watson, Moss et al. 1998). The combined effect of these conditions lends itself to an atmosphere of unpredictability and change for pastoral groups in Africa – a situation with negative implications for pastoral vulnerability and well-being.

However, pastoral populations are actively trying to adapt to these new political, economic and ecological conditions, and in the process are changing what they do and how they do it (BurnSilver Ch. 1). Both economic diversification and intensification of livestock production strategies are now ongoing in these systems. BurnSilver et al. (2007) documented that only 21.7% of households in the Amboseli region of southern Kenya fully depended on livestock alone for their livelihoods. There is a wealth of recent literature describing the changing faces of pastoral livelihoods, as pastoralists diversify into agriculture, wage labor and business activities (Levine 1998; Little, Smith et al. 2001; Coast 2002; Thompson, Serneels et al. 2002; Lesorogol 2005; Homewood, Trench et al. 2006). Others have documented changes in breeding strategies (Trail and Gregory 1981; King, Sayers et al. 1984; Bekure, de Leeuw et al. 1991; Rege and Bester 1998; Zaal 1998), increased use of veterinary drugs (Bekure, de Leeuw et al. 1991; Rutten 1992) and greater use of markets (Zaal 1999) – all example of livestock "intensification" strategies (Galaty and Johnson 1990). The adoption of new economic activities is based on both constraints and opportunities, as households are pushed and pulled into expanding beyond subsistence pastoralism (Barrett, Reardon et al. 2001). However, an important question remains largely unanswered. What is the relative value of these new economic activities to households? In other words, under current conditions of widespread change, how well are pastoral households doing under various combinations of old and new activities?

Substantial research efforts have been expended to quantify the socio-economic status of households in agricultural and agropastoral societies with the goals of documenting change (Fratkin and Smith 1995), or better targeting economic development (Dercon 1998; Morris, Calogero et al. 2000; Turner 2000) and health interventions (Morris, Calogero et al. 2000). Much of this work has been based on researcher-defined economic criteria, for example, defining well-being based on household consumption levels, expenditures, owned assets or income flows (Barrett and Reardon 2000). Combinations of these variables are then manipulated depending on research goals in order to stand as a proxy for wealth, well-being or degree of diversification. Efforts have also been made to quantify wealth in pastoral societies. However, since historically pastoral economies were primarily subsistence-based and based on either meat or milk for consumption, most of these efforts proceeded simply by quantifying the size of household herds available for consumption and use (Evangelou 1984; King, Sayers et al. 1984; Homewood and Rodgers 1991). In this vein, Tropical Livestock Units (TLUs) are calculated based on the number of animals a household owns relative to a 250kg female cow, or some other standard based on the key livestock species within a system (e.g. Small Stock Units (SSUs) for sheep and goats). Animal units per households are used to represent wealth, or available TLUs per capita are the basis for grouping pastoral households into wealth categories (Bekure, de Leeuw et al. 1991; Thompson 2002). Others have used the level of self-produced calories (Thornton, Boone et al. 2007) to compare wealth within pastoral groups and against other agropastoral communities. Grandin (1988) additionally pioneered the application of a wealth ranking technique to the pastoral Maasai in

Kenya, whereby locally-defined understandings of wealth became the basis of wealth groupings. These definitions of wealth were found to be more broad, as in addition to livestock abundance they included non-economic (i.e., cultural) components of well-being. The wealth ranking approach has since been applied by other researchers to defining wealth in agricultural societies (Grosvenor-Alsop 1989; Scoones 1995).

In a consumption and subsistence-oriented pastoral society, quantifying wealth according to livestock numbers was initially an effective way to represent household socio-economic status. However, change is now ubiquitous across pastoral societies in Africa and globally, and households are increasingly dependent on other sources of income for their livelihoods. I suggest that these traditional measures are now insufficient to reflect emerging constellations of wealth and poverty. There is a need for development of a diversified wealth measure that can quantify the value of both existing wealth stocks and new sources of income flows in pastoral societies. Additionally, what would a comparison of wealth ranking results across wealth grouping techniques for a single sample of pastoral households tell us about the nature of wealth in a changing economy? This comparative approach was used by Scoones (1995) for Zimbabwean farmers and Temu and Due (2000) for agropastoralists in Tanzania, but it has not been applied previously in a pastoral society.

The focal area of this study of pastoral wealth is southern Kajiado district Kenya – an area that in many ways is ideal to explore what new definitions of pastoral wealth and poverty might look like. The dominant land use in the region is transhumant Maasai pastoralism. However, a gradient of land use currently exists, extending from more traditional mobile pastoralism in core rangeland areas, to sedentary agropastoralism in areas with permanent water resources. Pastoral households also are engaged in a variety of economic activities and productive strategies throughout the Amboseli region (BurnSilver Ch. 1). This area surrounds Amboseli National Park (NP), a central focus of wildlife conservation efforts in Kenya. Therefore, many of the hallmarks of change outlined previously in pastoral societies more generally, land tenure change, conservation activities, human population growth, and economic diversification and intensification, are at play in this region.

The broad goal of this chapter is to go beyond baseline assertions that the pastoral economy of southern Kenya is diversifying, and make comparisons of pastoral wealth status using five wealth ranking methods. A sample of pastoral households is initially grouped into poor, medium and rich categories based on the traditional understanding of wealth as animals (TLUs per household), and this ranking is then compared to rankings of households based on four other wealth ranking methods which integrate other components of wealth:

1) TLUs per capita; when household size is factored into wealth,
2) Wealth Ranking; when local informants define wealth criteria and group membership,
3) TLUs; when larger, graded animals are factored into the calculation of animal numbers per household,
4) A new diversification index of wealth; which is calculated as a combination of wealth stocks and income flows.

These analyses will allow comparisons of how well pastoral households are doing under conditions of change when different parameters of wealth are taken into account. It is expected that the status of households will change when different criteria are applied. Wealth levels according to animal herd size through time are also compared in order to test the assertions of previous researchers that Maasai pastoralists are becoming poorer overall. Additionally, comparison of wealth ranking methods should illuminate differences in how the parameters of wealth combine across the study area for poor, medium and rich households based on different household capabilities, and distribution of available services and infrastructure. Previous researchers have pointed out that societies in transition are far from homogeneous in the choices available to them and their subsequent trajectories of change (Thornton, Boone et al. 2007). The implications of these changes for human well-being are also equally variable, and this variability itself emerges as an important consideration in targeting development interventions in pastoral areas.

Definitions of Wealth in Pastoral Maasailand

Since the early days of pastoral research in East Africa, Tropical Livestock Units (TLUs) have been the basis for grouping pastoral households by wealth status in areas where the dominant livestock species is cattle (Dyson-Hudson and Dyson-Hudson 1980; King, Sayers et al. 1984; Lybbert, Barrett et al. 2004). This applies to the pastoral Maasai, who are milk-based pastoralists (i.e. organize livestock production to maximize milk production as opposed to meat), maintain a majority of livestock biomass in their cattle herds, and attach significant cultural and economic value to these animals (Galaty 1993). In calculating TLUs, the average weights of different cattle age and sex groups are compared to a 250 kg female small African zebu cow (*bos indicus*), and calculated TLUs reflect overall numbers of animals standardized to an average size female. Commonly used conversion factors are: calves=.4, heifers=.7, immature steers=.68, mature steers=1.05, bulls=1.29 (Bekure, de Leeuw et al. 1991). Numbers of sheep and goats within a household herd are also standardized to TLU values using appropriate weights for young and adult, male and female animals. An alternative method uses Livestock equivalents (LE), based on a simplified conversion factor of .71 for cattle and .11 for sheep and goats, to arrive at a standardized number of animals per herd (McCabe 1987). This chapter uses TLUs to standardize animal numbers, and all other wealth measures are then compared against TLU values.

Pastoral Maasai are patrilineal and polygynous, so social and economic productive units historically were made up of a patriarch, his wives, young children, unmarried daughters, married sons, their wives and their offspring (Kituyi 1990; Rutten 1992). An animal herd potentially needed to support large groups of people. Consequently, researchers have reflected the ratio of this one:many, people:animal relationship by adjusting total TLUs by the number of people actually supported by a herd. People are standardized to Adult Units (AU), whereby age and gender classes are given weights relative to an adult man or woman (children 0-5=.25, children 6-18=.67, elderly over 60 yrs=.67) (Little 1985). The resultant ratio is TLUs per AU and reflects the number of animal units available to support each "person" in a household. Researchers have represented this ratio in various ways, for example; TLUs per AAME (Active Adult Male Equivalent, which differentiates between adult men and women) (Bekure, de Leeuw et al. 1991), or LE per Reference Adult (RA), which calculates standardized adult units based on different values for age/sex groups within the population (Adult male=1, adult female=.86, children 0-5=.52, children 6-10=.85, male child 11-15=.96, female child 11-15=.86) (Little 1980; Thompson 2002). This chapter uses the ratio TLU per AU to reflect the impact of the size of a household on the animal resources available for consumption.

A decline in pastoral household size has been identified previously as an outcome of processes of land tenure change and economic diversification in Maasailand (Rutten 1992). Both processes can contribute to the break-up of large, multi-generational households as younger and older generations split and move to occupy private parcels. Alternately, households may sedentarize for economic reasons, for example settling in agricultural areas after drought. Analyzing changes in wealth status associated with current household size relative to TLUs is important given these ongoing changes in Maasailand.

In a 1984 article, King et al. described the very beginning of a process of breed change in two group ranch areas in the north of the Amboseli region, whereby pastoral producers brought in improved breed Borana (Large East African Zebu) and Sahiwal bulls to cross with their Small East African Zebu cows. Similarly, producers began to integrate graded sheep and goat breeds to cross with their local animals. Graded animals are bigger, have the potential to produce both more milk and meat for consumption (and in the case of sheep, more fat), and are more valuable in the marketplace (Trail and Gregory 1981; Bekure and Tilahun 1983; Bradford, Burfening et al. 1989; Baker, Mugambi et al. 2002; Scarpa, Kristjanson et al. 2003). This process of breed change therefore reflects a household-level effort of producers to intensify their production strategies. Bekure et al. (1991) and Rutten (1992) then documented an increase in this trend for cattle and smallstock 10 years later in the same geographical area. The current study also gathered data on the extent of breed change in addition to household herd numbers, and quantified what seemed to be strong efforts on the part of producers to incorporate graded animals into their herds (BurnSilver Ch. 1). Herding households also simultaneously expressed strong reservations regarding these improved animals, as they are more vulnerable to disease and drought conditions – all in a region where significant drought events are frequent and mobility has been a strong component of Maasai production strategies. However, this crossbreeding is proceeding. Given its salience in the minds of producers, the numbers of grade animals observed and their significantly greater size and productive potential, the question emerged: How much larger would herds be if these animals' greater size was factored into the calculation of TLUs, and would this impact household wealth status? A Breed-adjusted TLU measure is calculated to gauge these potential differences.

Grandin (1988) originally described the technique of Wealth Ranking and applied it to pastoralists and smallholder agriculturalists in the Kajiado and Meru districts of Kenya. This effort was in response to an acknowledgement that researcher-defined, or "etic" concepts of wealth may be mismatched with local, or "emic" conceptions of wealth, and therefore may miss important characteristics defining how people are actually faring. According to Grandin, this is true because "wealth" is defined in terms of access to or control over important economic resources, and not just through income or expenditure levels, which may be characteristics of wealth, but do not constitute wealth in and of itself (1988:1).

Access to resources may be culturally-defined either by age, gender or culture (e.g. leadership roles or clan membership), so these subtleties matter in terms of who is considered wealthy or poor. Wealth ranking proceeds from local informants defining their own criteria for multiple wealth categories, and then placing all local households into these categories. When researchers compared wealth ranking results using multiple techniques, (e.g. comparing Wealth Ranking to either socio-economic surveys or rapid rural appraisal techniques), cultural components did emerge as important. For example, levels of respect and influence, larger family size, the ability to "give help" and support additional people, and the relative prestige associated with agricultural vs. livestock activities are all examples of non-economic components that were salient in the minds of local respondents as they ranked households into wealth categories (Grandin 1988; Grosvenor-Alsop 1989; Scoones 1995; AMREF 1998; Temu and Due 2000). Results also differed within groups depending on the gender of the informants carrying out the ranking exercise (Scoones 1995). Thus, despite researcher understandings that pastoral well-being is based largely on the size of household herds, the process of wealth ranking can elicit a broader conception of economic status which takes into account culturally-specific ideas of what constitutes wealth in the minds of local pastoralists. The process of eliciting wealth category criteria is also qualitative, so subtle details can emerge regarding changing perceptions of wealth through time.

So far none of the wealth ranking methods considered focus directly on the process of economic diversification occurring in Maasailand, and its potential effects on wealth or socio-economic status. Previous research with the goal of quantifying socio-economic status, has proceeded mainly in agricultural societies, and along two methodological pathways. Researchers have gathered data on household assets, consumption or expenditures, and then used these measures as proxies for total income, socio-economic status or poverty indicators (Morris, Calogero et al. 2000; Barrett, Reardon et al. 2001). A contrasting approach quantifies the productive assets and income flows of households per a unit of time based on current market prices, and uses these data directly to quantify socio-economic status (Barrett and Reardon 2000). The first approach recognizes problems associated with gathering data on net income flows; including substantial income variability through time and the time investment necessary to collect these data effectively (Glewwe and van der Gaag 1988). However, despite these difficulties, the asset and income-based approach is able to highlight explicitly the process of diversification, and the relative contribution of multiple household members to the different land-based and off-land activities that contribute to household wealth (Barrett and Reardon 2000). Applying this approach to pastoral societies, household wealth would consist of both assets (livestock, land and fixed capital) and income flows (net livestock-based income, and income from offland activities (wages or businesses), and agricultural activities (the net value of all consumed and sold products)). Homewood et al. (2006) used a qualitative wealth ranking to categorize Ilkisongo Maasai in Tanzania that combined TLUs with the presence/absence of assets and leadership positions. However, this work stopped short of explicitly valuing the income flows accruing from livestock, off-land activities, or existing household assets.

Two components of assets and income flows are not considered in the calculation of a Diversified Wealth measure in Maasailand. The rate of depreciation of capital assets is not integrated into the valuation of factor assets, as capital assets in Maasailand are literally repaired in perpetuity and can be resold almost regardless of condition (pers. obs. S. BurnSilver). Therefore they retain a large proportion of their initial "value" far longer than would otherwise be expected. As well, although some pastoral households in the Amboseli study region have been granted private rangeland or agricultural parcels, it is extremely rare for the owners to possess (as yet), the title deeds to these parcels. While researchers have stressed the importance of land valuation in quantifying wealth, there is general acknowledgement that there may be situations where no capital market for land exists (Dercon 1998, Barrett, Reardon et al. 2001). As well, the approach employed here to create a diversified wealth measure admittedly produces a snapshot of wealth during a particular time period in Kajiado. However, representing wealth as a combination of assets and income flows across a set of diversified activities is an initial step in creating a broader measure of wealth in a pastoral society under conditions of change.

Study Area

The focal area for this study is the Greater Amboseli Ecosystem (The GAE - approximately 8,500 km^2), located in the southeastern corner of Kajiado district, Kenya (Figure 1). The region encompasses the Amboseli Basin and swamps along the northern foot of Mt. Kilimanjaro, as well as the dry season dispersal areas of herbivores between the swamps of Amboseli National Park and neighboring rangelands (Western 1973; Katampoi, Genga et al. 1990). This region is also the cultural core of Ilkisongo Maasailand in Kenya. Two other Maasai sub-tribal sections (i.e., *ol-oshon*) adjoin Ilkisongo, Maatapato to the northwest and Kaputei to the north. The region is bracketed topographically to the south by Mt. Kilimanjaro, to the east by the Chyulu hills, by a gradual rise in elevation northward to the Athi-Kapithi plains, and the Pelewa hills to the west. Annual rainfall patterns in the GAE are bimodal, resulting in two dry seasons (Jan-Feb and June-October) and two wet seasons (March-May and November-December). However, rainfall is highly heterogeneous in space and time, drought is frequent, and failure of one or both rainy seasons is common. The rainfall coefficient of variation (CV) for the study region is 28.89% (Boone and Wang, 2007). There is a north to south rainfall gradient: annual accumulation in the Amboseli basin ranges between 250-300 mm/yr, while rainfall in the north can reach 500-600 mm. Vegetation communities in the area are linked to rainfall patterns and large-scale soil and topographic gradients, ranging from broad leaf dry tropical forests and woodlands on the Kilimanjaro and Chyulu slopes, to a combination of open grasslands, seasonally flooded plains, riverine forests, and scattered Commiphora and Acacia woodlands in the pastoral areas north and west of Amboseli NP (Katampoi, Genga et al. 1990). Critical forage and water resources for both pastoralists and wildlife conform to these gradients, and so vary in quality and quantity across the landscape. This heterogeneity was the ecological foundation of Maasai transhumance patterns, as herders used mobility to respond to resource patchiness in time and space.

Maasai pastoralism in this region was based historically on a combination of livestock species, primarily cattle, sheep and goats. Until the 1960s Maasai lands were held and used communally within sub-tribal sections, although access across *ol-oshon* boundaries was frequently negotiated under drought conditions. After 1960, the Kenyan government – with the financial backing of international donors – supported adjudication of communal rangelands into group ranches. Group ranches are areas of land held under freehold title by a group of incorporated individuals (Oxby 1982; Bekure, de Leeuw et al. 1991), and were thought of by policymakers as a vehicle to intensify and rationalize pastoral livestock production, foster a stronger orientation towards livestock marketing, reduce mobility and decrease stocking rates. Researchers have written exhaustively regarding how and why group ranches in Maasailand did not fulfill these goals (White and Meadows 1981). However, local dissatisfaction with their management, population growth and a national policy environment supportive of privatization of communal lands as a catalyst for economic growth, are some of the important factors that contributed to their dissolution (Rutten 1992; Mwangi 2003; Mwangi 2006). Since the 1970s, there has been a movement towards subdivision of group ranches down to the level of individual parcels. The only group ranches in Kajiado district, Kenya that remain intact currently, are those in the driest regions of the district where the productive capability of private parcels to support sedentary pastoralism is in the greatest doubt. This includes a majority of the group ranches in the GAE.

Research for this study took place in three current and one previously incorporated Maasai group ranch (Figure 1). Osilalei is part of Maatapato Maasai section and was subdivided in 1990. Osilalei ranch members have largely moved onto their individual parcels, although few had yet been able to afford the cost of retrieving their title deeds at the time research this took place. Imbirikani, Eselenkei and Olgulului/Lolarashi group ranches are part of Ilkisongo Maasai section. They are still intact, although agricultural parcels in rainfed highland areas in Olgulului/Lolarashi, and irrigated agricultural areas in Imbirikani and Olgulului/Lolarashi ranches have been informally subdivided. However, no title deeds have been distributed.

Infrastructure in the study region is concentrated along the N-S Loitokitok-Emali road; including a major water pipeline and livestock markets, schools, markets and health services (Figure 1). A line of swamps with permanent water also bisects the southern edge of the study region east to west, and households in these areas engage in substantial irrigated agriculture. Another all-weather road runs E-W to the north of Eselenkei and Osilalei group ranches, and additional infrastructure services (water pipeline, a smaller livestock market at Mashuru) are arranged along its length. Areas between these roads have limited access to services, although a Catholic mission at Lenkisim supports a health center and primary school. Olgulului/Lolarashi and Eselenkei group ranches, and the eastern part of Imbirikani are more isolated areas within the study region. It is in these zones where more extensive, mobile pastoralism is still practiced by a majority of households (see BurnSilver Ch. 2 for an in-depth discussion of mobility patterns). Households do engage in low-input rainfed agriculture in the wetter northern areas of the study region (Osilalei and Eselenkei). Emeshenani households also have access to highland rainfed agriculture in informally subdivided areas on the lowland slopes of Mt. Kilimanjaro (see BurnSilver Ch. 1 for a description of agricultural types).

Linked with available infrastructure and geographic characteristics across the four ranches, Maasai land use in the GAE currently extends along a gradient from agropastoralism to extensive, transhumant pastoralism. The GAE encompasses a gradient of land tenure types (communal and private/subdivided), land use types (agropastoral and extensive pastoral), access to infrastructure (Low to high) and agroclimatic potential (Low to high). This region is an ideal pastoral milieu in which to analyze patterns of diversification and wealth accumulation under conditions of change.

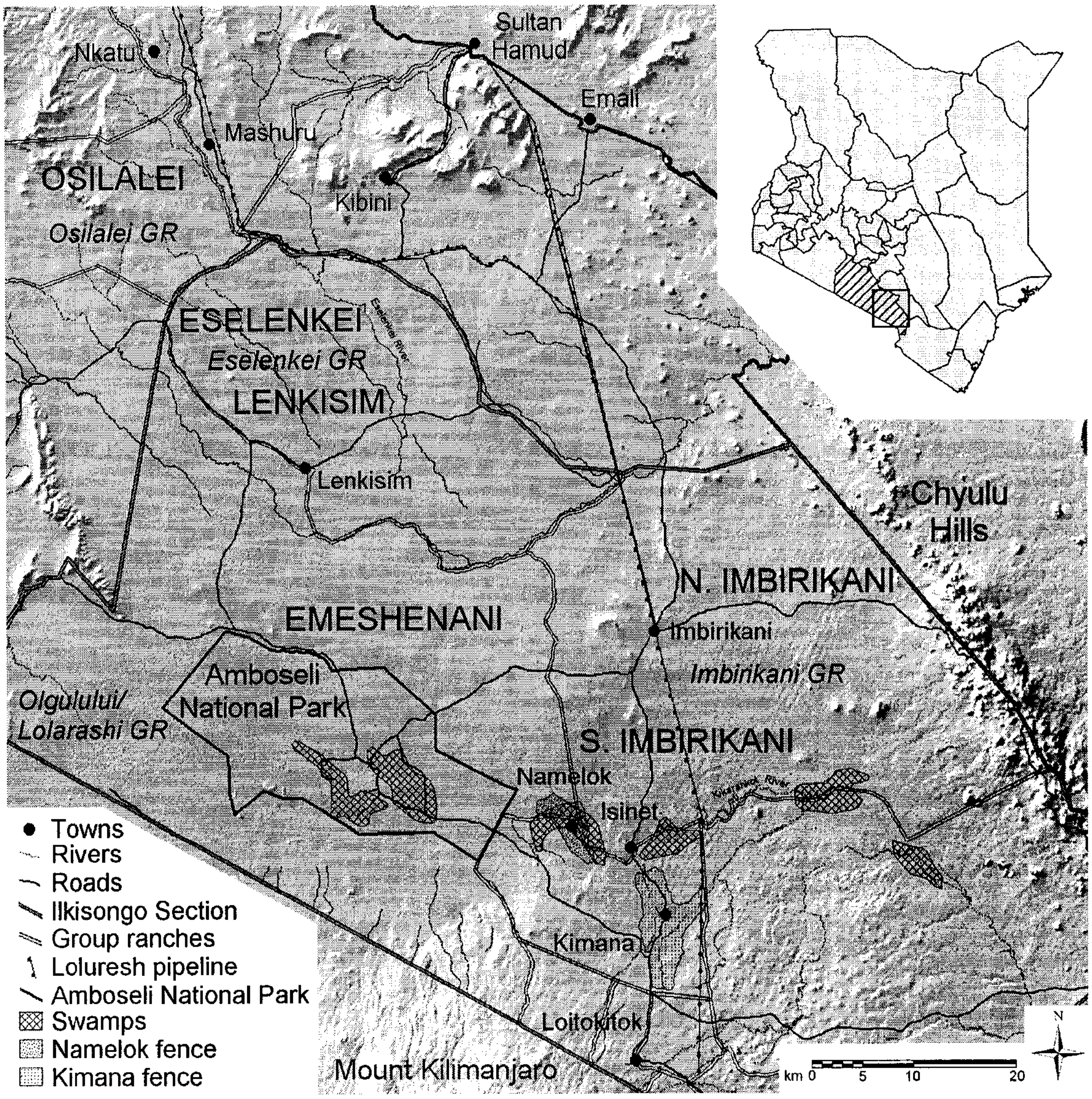

Figure 1. Study Area Map indicating the four Maasai group ranches (Capital letters), and six study sites (Lower case italicized) where

METHODS

Data Collection

Research for this study took place between November of 1999 and March of 2001. Annual rainfall in both 1999 and 2000 was below the long term mean for this area. Despite low rainfall, 1999 was considered "average", but 2000 was considered a "bad" (i.e., terrible) year by local respondents. Climate data supports this, as rainfall in 1999 was 467.50 mm (138.65 mm below the 1962-2003 long term average), while only 222.30 mm of rainfall fell in 2000 (383.85 mm below the long term mean) (Kenya Met station data 2003). Research occurred in six study areas across the four current and former group ranches (Figure 1). *Osilalei* is subdivided and households are engaged in rainfed agriculture. *Eselenkei* and *Lenkisim* are part of Eselenkei group ranch (some rainfed agriculture on a communal group ranch). *Emeshenani* is an area of extensive pastoralism and still communal, but households have access to irrigated and upland rainfed agricultural land. *S. Imbirikani* households are located close to irrigated swampland areas and the *N. Imbirikani* study area is an area of extensive pastoralism with some access to agricultural land to the south.

A team of trained local enumerators carried out a socio-economic survey of 184 households in the six study areas; 146 households were interviewed once, and 38 households were interviewed twice. For the purposes of this study, a household was defined as an "*olmarei*", a Maasai term which corresponds approximately to an independent male head of household and his dependents. The household sample was stratified by study area (a proxy for land use type) and by proportionally by wealth (Bernard 2005). The Wealth Ranking technique (Grandin 1988) was used to categorize all households from each study area (N=688) into locally-defined wealth groups from which the household sample was then drawn. Eight local informants (four between 25-30 years of age and four above 50 years old) across the six areas were interviewed initially to identify a set of criteria defining poverty vs. wealth. These informants then ranked all households from their areas into between three (rich, medium and poor) and five (very rich, rich, medium, poor and extremely poor) wealth groups. The number of groups was self-identified. Informants with five categories eventually collapsed their households into three groups, and a proportional number of rich, medium and poor households were randomly chosen to interview from each study area. Socio-economic surveys collected data on household demographics, labor availability, land size, herd size, livestock breeds, and income streams and input costs from all livestock-based, agricultural and additional off-land activities (wage labor and business) being pursued by each member of a household. Households were asked to recall the returns and costs associated with economic activities over the previous year (December 1999 to December 2000), according to the time steps (e.g. weekly, monthly, intermittently) which made sense for each activity. For example, animals were often purchased and sold based on need, while agricultural products were consumed and/or sold based on the harvest season, and returns from salary jobs or business efforts were received weekly, monthly or intermittently. The number of crossbred animals in household herds was documented based on respondents identifying the proportion of crossing that occurred within their herds. The following categories were used: 100% local 75/25% cross, 50/50% cross, 25/75% cross, and 100% improved animals. The specific types of cross breeds were also noted: for example the number of heifers that were 50% Zebu and 50% Borana.

Data on the value of fixed assets was gathered on a post-hoc basis. Once the economic activities of sampled households were established, local informants identified the purchase and construction costs in Kenyan Shillings associated with particular assets in each area (for example; the cost of purchasing a grain mill, or building a small shop).

Data Manipulation

TLU and TLU per Adult unit (AU) values per household were calculated from human demographic and herd composition data. TLU values were calculated in two ways however. Initial calculations assumed that all animals within a herd were Small East African Zebu cattle (*bos indicus*), Red Maasai sheep and small east African goat varieties. Then traditionally used TLU conversion factors for age and sex groups within household herds were applied to animals numbers (King, Sayers et al. 1984; Bekure, de Leeuw et al. 1991) (Table 1 (cattle), Table 2 (sheep) and Table 3 (goats)).

In order to adjust household TLUs by the proportion of grade animals in a herd, all the animal breeds mentioned by respondents were categorized as either local or improved (DAGRIS; Mwai 2007) (Table 4). New TLU conversion factors were then calculated based on body weights published in the literature for different breeds by age and sex category. Body weights of 100% improved Boran and Sahiwal (i.e., also *bos indicus* cattle, but of the Large East African Zebu breed group) mature cows, bulls and mature steers were published and available in the literature (King, Sayers et al. 1984; Trail, Durkin et al. 1984; Bekure, de Leeuw et al. 1991; Demeke, Neser et al. 2003; Demeke, Neser et al. 2004) and were averaged together to estimate the weights of 100% improved animals. Every effort was made to use published results from research stations in rural settings. Body weights for 100% improved calves, heifers and immature steers were unavailable, so these were extrapolated based on reported body weight differences between Zebu and Borana/Sahiwal female adult cows (i.e., body mass increased by 22%). These baseline body weights then were used to extrapolate new average weights for different levels of crossing between local Z ebu and graded cattle (75% local/25% improved, 50% local/50% improved, 25% local/75% improved). New conversion factors for animals at all levels of crossing and by age/sex categories were calculated based on comparisons of body weights to the classically used reference measure of a 250 kg female Zebu cow.

Table 1. Estimated cattle body weights and calculated conversion factors for levels of crossbreeding between East African short horn Zebu cattle and Borana/Sahiwal cattle. * Factor corresponds to the calculated conversion weights based on comparison of actual body weights to a 250 kg female Zebu cow (Bekure et al. 1991). This factor is multiplied by numbers of various crossbreed cattle in each household to calculate standardized TLUs for different age/sex classes of cattle.

Cattle	Zebu 100% (kg)	***Factor**	75% Zebu 25% improved (kg)	**Factor**	50% Zebu 50% improved (kg)	**Factor**	25% Zebu 75% improved (kg)	**Factor**	100% improved (kg)	**Factor**
Calves	100	**.4**	106	**.42**	111	**.46**	117	**.47**	122	**.48**
Heifers	174	**.70**	184	**.73**	193	**.77**	203	**.81**	212	**.85**
Immature Steers	171	**.68**	181	**.72**	190	**.76**	200	**.80**	209	**.84**
Mature Steers	262	**1.05**	303	**1.21**	345	**1.38**	386	**1.54**	427	**1.71**
Cows	250	**1.0**	273	**1.09**	296	**1.18**	319	**1.27**	342	**1.36**
Bulls	322	**1.29**	361	**1.44**	401	**1.60**	440	**1.76**	479	**1.91**

Body massess for 100% small east African zebu taken from (Bekure, de Leeuw et al. 1991; Rutten 1992). Body mass for Boran and Sahiwal mature female cows, calves, steers and bulls taken from King et al. 1984; Trail et al., 1984; Demeke et al., 2003; and Demeke et al., 2004. Body mass for 100% improved heifers and immature steers estimated from the same literature. Intermediate levels of crossbreeding were estimated as intermediate body mass points between 100% local and 100% improved animals.

Table 2. Estimated sheep body weights and calculated conversion factors for levels of crossbreeding between Red Maasai and Dorper, Merino, and Somali Blackhead sheep. * Factor corresponds to the calculated conversion weights based on comparison of actual body weights to a 250 kg Zebu cow. This factor is multiplied by numbers of various crossbreed sheep in each household to calculate standardized TLUs for different age/sex classes of sheep.

Sheep	100% local (kg)	***Factor**	75% local 25% improved (kg)	**Factor**	50% local 50% improved (kg)	**Factor**	25% local 75% improved (kg)	**Factor**	100% improved (kg)	**Factor**
Juveniles (6 mos.)	15.2	**0.06**	17.1	**0.068**	19.9	**0.079**	22.5	**0.09**	24.5	**0.098**
Adult Females	30.2	**0.12**	32.9	**0.134**	34.4	**0.137**	36.5	**0.146**	38.5	**0.150**
Adult Males	37.5	**0.15**	38.8	**0.155**	40.1	**0.160**	41.4	**0.166**	42.7	**0.171**

Body masses for 100% Red Maasai sheep taken from (Haas, Murage et al. 1975; Wilson 1991; Baker, Mugambi et al. 2002; Baker, Mugambi et al. 2004). Weights for 100% Dorper, Merino and Somali Blackhead sheep synthesized from (Chemitei, Makara et al. 1975; Wilson 1991). Body weights for intermediate levels of crossing were then estimated from all sources.

Table 3. Estimated goat body weights and calculated conversion factors for levels of crossbreeding between Small East African goats and Galla/Long eared Somali goats. *Factor corresponds to the calculated conversion weights based on comparison of actual body weights to a 250 kg Zebu cow. This factor is multiplied by numbers of various crossbreed sheep in each household to calculate standardized TLUs for different age/sex classes of goats.

Goats	100% local (kg)	***Factor**	75% local 25% improved (kg)	**Factor**	50% local 50% improved (kg)	**Factor**	25% local 75% improved (kg)	**Factor**	100% improved (kg)	**Factor**
Juveniles (6 mos.)	15.5	0.062	16.1	0.064	16.8	0.067	17.4	0.070	18.0	0.072
Adult Females	31.0	0.12	32.4	0.13	33.8	0.135	35.2	0.14	36.6	0.15
Adult Males	40	0.16	40.7	0.162	41.2	0.164	41.6	0.166	42.3	0.170

Body Masses for 100% small east African goat varieties taken from (Haas and Chemitei 1973; Wilson 1991; FARM 1996). Weights for 100% improved Galla and Long eared Somali goats calculated from (Githae, Kitivo et al. 1975; Wilson and Light 1986; Wilson 1991). Intermediate body weights estimated from all sources.

Table 4. Local and Improved Grade Animal Breeds.

Animal Species	Cattle	Sheep	Goats
Local Breeds	Small East Africa Zebu	Red Maasai	Akamba Chagga Small East African
Improved Grade Breeds	Large East African Zebu: Borana Sahiwal Simental	Dorper Merino Somali Blackhead	Galla Long Eared Somali

A similar approach was used to identify base body weights for graded sheep and goats, and convert proportions of crossbred smallstock to new TLU conversion factors (Wilson and Light 1986; Bradford, Burfening et al. 1989; Ruvuna, Kogi et al. 1995; Mugambi, Bain et al. 1997; Baker, Mugambi et al. 2002; Nguti, Janssen et al. 2003; Baker, Mugambi et al. 2004). These calculated conversion facts are shown in Table 1 (cattle), Table 2 (sheep) and Table 3 (goats). These conversion values were then multiplied by the numbers of animals within each age/sex class and level of crossing per household to yield new TLU values. This Breed-adjusted TLU value takes into account the number of graded animals within the herd.

The new measure of diversified wealth was calculated based on the sum of household assets and income flows as:

$$DW = A + IF$$

Equation 1

Household assets (A) were parameterized as the additive value of 1) household herds based the number of animals multiplied by the average selling price of each age/sex class of animals documented throughout the study period, and 2) the value of a household's combined capital assets (livestock and fixed capital assets. Examples of fixed assets are productive machinery (grain mills), business or residential plots for rent, or water spanner connections.

Income flows (IF) were parameterized as:

$$IF = LS_{net} + \text{Wages/salaries} + \text{Business} + A_{net}$$

Equation 2

where the value of net LS (livestock) production is a function of,

$$LS_{net} = \text{Gross LS income} - \text{LS Costs}$$

Equation 3

Gross LS income was calculated based on the summed value of livestock sold, livestock received as gifts, livestock consumed (slaughtered), combined with hides and skins sold, and milk consumed and sold. LS costs were calculated as the summed value of livestock purchased, livestock given as gifts, livestock mortality, and all livestock expenditures (e.g. water, acaracides, veterinary drugs, feed supplements, pasture rental, hired herding). The difference between gross livestock income and livestock production costs is net LS income (equation 3). The values of animals and milk was calculated in Kenyan Shillings based on the average value of animals for each age and sex class sold in the market and the average value of milk per quantity sold documented during the study period.

The annual value of wages and salaries was calculated as the summed value of activities accruing to all members of a household at whatever time step was reported. This value includes remittances coming into the household from members working in other locations, but sending money home. Income flow from business activities was calculated as income accruing from rental activities (houses, agricultural land or business plots) combined with the annual income from all other self-employed activities (see BurnSilver Ch. 1 for a detailed description of all off-land activities).

Net agriculture income was calculated as:

$$Ag_{net} = (Ag_{consumed} + Ag_{sold}) - Ag_{costs}$$

Equation 4

the net value of all harvested agricultural crops over the one year period. The crops of some households were still in the ground at the end of 2000. These crops were not counted in calculations of agricultural income (either output or costs), so agricultural income is undervalued for these households. Gross agricultural income was calculated based on the market value of consumed agriculture ($\mathbf{Ag_{consumed}}$)(primarily corn and bean crops) and sold agricultural products ($\mathbf{Ag_{sold}}$)(tomatoes, onions, peppers, and some beans). Values for consumed products were calculated based on self-reported local market prices per crop. All the costs ($\mathbf{Ag_{costs}}$) accruing to the household based on ground preparation, labor, pesticides, fertilizer and seed costs were then subtracted from gross agricultural income to arrive at net income per household from cropping activities ($\mathbf{Ag_{net}}$, Equation 4).

The value of all assets and income flows were then summed for each household, yielding a measure of Diversified Wealth per household for the annual cycle from November 1999 to December 2000 (Equation 1). See Appendix One for an example of this calculation for two households, one rich and one poor.

Data Analyses

The broad goal of this chapter is to identify how the wealth rankings of households change according to the traditional versus new wealth criteria by which households are ranked into categories. For each wealth ranking method (TLUs, Adult Units per household, Wealth Ranking categories, TLUs based on graded animals, and the Diversified Wealth measure), the sample of households was split into equal terciles, so that households were ranked lowest to highest on each wealth indicator (Dercon and Krishnan 1996). The lower third of the data for each ranking were labelled poor (n=61), the middle third "medium" (n=62), and the upper third of households were called "rich" (n=61). The exception to the criteria of equal size is the Wealth Ranking method, as the wealth categories in the original sample were close in size but not equal based on proportional representation within the community-size sample of households (poor=64 (34.7%), medium=68 (36.9%), rich=52 (28.4%)).

TLUs per household is the measure of wealth most often applied in the pastoral literature, so this wealth ranking method was used as the reference category against which changes in wealth status were quantified. Correlation matrices were produced for the comparison of TLUs/household with each other wealth ranking method, and Cohen's Kappa statistics produced for each comparison using SPSS version 15.0. Cohen's Kappa measures the agreement between two rating methods when both methods are rating the same object – in this case, membership in 3 wealth categories (poor, medium and rich).

Three additional strands of data are presented as results, all of which are meant to expand on aspects of pastoral wealth under conditions of rapid economic change. The distribution of households within the TLU per AU ranking based on the current data set is compared to the TLU per AAME wealth ranking results initially identified by Bekure et al. (1991) for areas within Amboseli in the 1980s. This comparison should identify if and how the distribution of wealth in this region has changed through time. The wealth criteria identified by the eight informants during the Wealth Ranking exercise is also organized by age category and discussed, as the qualitative description of wealth by individuals of different ages indicates if perceptions of wealth are changing through time. Finally, the constellations of wealth that emerge from the application of the new Diversified Wealth measure are compared graphically across the study areas by wealth category. One additional variable is added to the representation of household assets in these analyses. The area that each household is exploiting for agriculture in hectares is included, although since these parcels are largely granted to individuals informally, no monetary value is associated with the physical pieces of land being used. However, they can be rented out, and therefore function as household assets.

RESULTS

Changes in pastoral household wealth through time are discussed initially based on a comparison of historical data from Amboseli group ranches and data from the current study. Results comparing pastoral household rankings across wealth methods are then presented in the form of correlation matrices with Cohen's Kappa statistics for each comparison. Cohen's Kappa statistics range between 0 and 1, where a value of 1 indicates perfect agreement, and a value of 0 indicates that agreement is no better than chance. Additional results which contribute to understanding each comparison are presented in relevant sections.

Pastoral Wealth through Time

The seminal study of pastoral livestock production carried out by Bekure et al. (1991) in Imbirikani, Merueshi and Olkarkar Maasai group ranches defined wealth according to the measure of TLU per active adult male equivalent (AAME). Imbirikani group ranch is part of the current study as well, but Merueshi and Olkarkar are part of Kaputei *oloshon* to the north of the current study area. However comparison of wealth indices across these samples is still relevant given base similarities between pastoral land use strategies in the two areas. The sample of households in the Bekure et al. study was chosen, and then wealth ranks assigned based on the relative distribution of TLUs per AAME found within the sample overall. These wealth rank categories were based on researchers' understanding of the number of reference animals necessary nutritionally to support a subsistence pastoral lifestyle (FAO 1974). Households with 0-4.99 TLU/AAME were poor, between 5 and 12.99 TLU/AAME were medium and >13 TLU/AAME were ranked as rich. To compare animal wealth holdings through time, the current sample of Amboseli households was ranked according to the same TLU per reference adult ranges, but Adult Units (AUs) are substituted for AAME. The TLU/AU calculation underestimates the number of TLUs per adult unit compared to the TLU/AAME method because women and men are both considered as 1 unit, as opposed to the AAME calculation which uses a .75 value to account for women in family size. However, differences are small and comparisons should be valid. Table 5 presents the distribution of households within wealth rank by study.

Table 5. Comparison of pastoral wealth in animals through time. Columns compare animal holding per reference adult across the Bekure et al. study of Merueshi, Olkarkar and Imbirikani Group ranches in the 1980s, with animal holdings for the six current study areas (Imbirikani, Olgulului/Lolarashi, Eselenkei and Osilalei GRs). Merueshi and Olkarkar are Kaputei Maasai group ranches to the north of the current study area.

		Bekure et al. 1991 TLUs per AAME			Current Study TLUs per AU	
Wealth Groups	Wealth Criteria	No. of Hshlds	Mean TLUs per hhld per rank	Wealth Criteria	No. of Hhlds	Mean TLUs per hhld per rank
Poor	<5 TLU/AAME	56 (29%)	32.7	<5 TLU/AU	110 (60%)	10.7
Medium	5-12.99 TLU/AAME	79 (41%)	87.0	5-12.99 TLU/ AU	58 (31%)	31.8
Rich	≥ 13 TLU/AAME	58 (30%)	356.7	≥ 13 TLU/ AU	16 (9%)	141.1
Totals		**193**	**158.8**		**184**	**61.6**

Strong differences in relative wealth across the two time periods emerge in two ways; comparison of the average TLUs per wealth rank, and the distribution of households within each rank. According to both criteria, households in the 1980s – regardless of wealth rank - were on average clearly richer in animals per person, and more households were better off 25 years ago than is currently true in these areas. Poor households with fewer than 5 TLUs/AU increased 96% over the 20 year period, while rich households declined 72%. Numbers of medium households also declined, but not as precipitously. When household TLU/AU figures are represented as the average TLUs per household within the three wealth ranges, the average TLUs per household were 3 times, 2.7 times and 2.6 times greater in the past than is currently true for poor, medium and rich households, respectively.

Wealth Ranking Methods Compared

Distributions of households within terciles across all the wealth ranking techniques are shown in Table 6. A wealth ranking based on TLUs per household is the reference group against which changes in wealth status are compared. The mean values of TLUs (either per household or per AU) associated with each method are also indicated. TLU values for poor, medium and rich wealth groups do not differ dramatically across wealth ranking categories. Two notable exceptions are greater mean TLU values for poor and medium households based on the Wealth Ranking method than the TLU-based method, and a jump in mean TLUs for rich households for the Breed-adjusted TLU measure versus the TLU-based measure. Correlation and Kappa statistics are presented below for each comparison.

TLUs versus TLUs per AU

A TLU per AU measure of wealth takes into account herd size relative to family size. Table 7a shows a correlation matrix comparing agreement between TLU/AU and TLU-based wealth measures. Thirty households of 184 dropped in wealth status when membership in data terciles was compared, while 28 households gained in wealth status (Total change=58/184 households, 31.5%). Positive changes in wealth status occur when households have smaller families relative to herd size, while declines in status occur for households with many members relative to the animals they have. The Kappa statistic for this comparison was .527 ($p<0.000$), indicating that a TLU/AU measure of wealth shows moderate agreement with a purely TLU-based measure (Table 8).

Table 6. Comparison of wealth distributions across wealth ranking methods. Mean TLU values per household associated with each method per wealth group are also presented. Standard deviations are in parentheses.

Ranking Methods	TLUs per household		TLUs per AU		Wealth Ranking			Improved Breed TLUs		Diversified Wealth	
Wealth Categories	Hshld No.	Mean TLUs per rank	Hshld No.	Mean TLUs per AU per rank	Hshld No.	%	Mean TLUs per rank	Hshld No.	Mean TLUs per rank	Hshld No.	Mean TLUs per rank
Poor	61	10.7 (4.9)	61	1.6 (0.8)	64	28.3	16.4	61	11.4 (5.4)	61	11.5 (6.6)
Medium	61	31.8 (6.8)	62	4.3 (1.0)	68	37.0	41.0	63	34.8 (8.2)	62	33.1 (11.18)
Rich	62	141.1 (153.9)	61	12.9 (9.7)	52	28.3	143.4	60	155.5 (160.5)	61	140.8 (155.8)
Total	**184**	**61.6 (105.9)**	**184**	**6.3 (7.4)**	**184**	**100**	**61.4**	**184**	**66.4 (110.9)**	**184**	**61.6**

Table 7. Correlation matrices comparing standard wealth measures against additional measures of wealth. Four comparisons are presented, a: TLUs per AU, b: Wealth Ranking, c: Breed-adjusted TLUs, d: Diversified Wealth. Households that appear on the diagonal agree with the TLU-based measures of wealth. Households positioned off the diagonal have changed their wealth status.

a.		TLUs per AU			Total
		Poor	Medium	Rich	
TLUs	Poor	45	15	1	61
	Medium	16	33	12	61
	Rich	0	14	48	62
Total		61	62	61	184

b.		Wealth Ranking			Total
		Poor	Medium	Rich	Poor
TLUs	Poor	45	15	1	61
	Medium	19	32	10	61
	Rich	0	21	41	62
Total		64	68	52	184

c.		Breed-Adjusted TLUs			Total
		Poor	Medium	Rich	1.00
TLUs	Poor	60	1	0	61
	Medium	1	58	2	61
	Rich	0	4	58	62
Total		61	63	60	184

d.		Diversified Wealth			Total
		Poor	Medium	Rich	Poor
TLUs	Poor	56	5	0	61
	Medium	5	50	6	61
	Rich	0	7	55	62
Total		61	62	61	184

TLUs versus Wealth Ranking

The Wealth Ranking technique places households into categories based on locally-defined perceptions of wealth. Sixty-six households (35.8%) changed their wealth status based on a comparison of TLU terciles and Wealth Ranking (Table 7b) methods. Twenty six households improved their wealth status, while 40 households became poorer. This result seems to support the idea that the Wealth Ranking technique integrates additional factors into assigning wealth status than does a purely animal-based measure like TLUs per household. The Kappa statistic for this comparison was .462 ($p<0.000$), the lowest measure of agreement associated with any of the wealth rank comparisons (Table 8).

The criteria used by eight informants to rank Amboseli households in wealth categories is synthesized in Table 9. The criteria for 5 wealth ranks (very poor, poor, medium, rich and very rich) are listed here for discussion, however the bottom and top two categories were collapsed when wealth ranking was applied to household selection and the wealth ranking comparison used here (i.e.,. very poor + poor = poor, and very rich + rich = rich). The responses of younger versus elder informants are separated into two columns. Responses that appear in the younger respondent's column were substantively different than those provided by older respondents.

Qualitative descriptions of the criteria for "wealthy" versus "poor" households support that numbers of animals is an integral component of Maasai wealth, as ideal numbers of cattle, sheep and goats rise with each wealth strata. However, younger respondents gave the caveat that someone could still be called of "Medium" wealth even if they had only 20 cows but were engaged in additional activities. Similarly, the animal threshold cited by younger respondents for rich households was dramatically lower than that cited by older respondents (>100 cattle vs. 150-400 cattle) – a sign that younger respondents may recognize that numbers of household animals are declining, and the threshold of animal wealth is now lower. There is strong agreement across age groups that as households increase in wealth, they engage progressively in other activities (e.g. building houses, owning plots, vehicles, businesses or have sons working). Both groups labeled richer households as either having a "future focus", or while they might focus on livestock, they "put those livestock to work" (i.e., selling them to invest in other activities). Poorer households in contrast might have sons working for others. Both medium and richer households were described as doing agriculture, but a richer household might have purchased a plot or a water pipeline connection, and have both a livestock compound in one zone and an agricultural compound in another. These households are able to pursue both strategies simultaneously. Other critical differences by wealth status are the degree to which families are taken care of, and engagement in education. Younger and elder respondents agreed that the health and well-being of poorer households was lower. Poor households could have a household member that abuses alcohol, and the poorer a household is, the more chance that they are being supported by richer households (either with animals or financial help). Without exception all key informants mentioned that rich households help poorer households. More elder respondents suggested that wealth was linked to larger families and more children. Younger respondents stated unequivocally that poor households were large with few animals, but wealthy households could be either large or small. Education was a feature of wealth cited only by younger respondents. Poorer households might have children in school, but they are supported and less likely to finish, while medium and rich households are educating their children.

Table 8. Statistical results for all wealth comparisons. Cohen's Kappa statistics and the number of households that changed position are shown for each wealth comparison.

Wealth Comparisons	No. hhlds changing positions	Cohen's Kappa Statistic	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
TLUs x TLUs/AU	58	.527	.051	10.114	<0.000
TLUs x Wealth Ranking	66	.462	.053	8.899	<0.000
TLUs x Breed-adjusted TLUs	8	.935	.023	17.936	<0.000
TLUs x Diversified Wealth	23	.813	.037	15.587	<0.000

These wealth criteria emphasize that being considered "rich" or "poor" in Maasai society is a reflection of more than just animal numbers. What one does with those animals is also important – either investing them economically or helping other poorer households to get by. When the sentiment "richer households help those in need" is expressed, there are aspects of both prestige and cultural expectation inherent in the stateement. Large families that are well-taken care of is an aspect of pride – and consequently, wealth. Differences in the wealth criteria mentioned by younger vs. older respondents also give some indication that ideas on wealth are also changing by generation. Elder respondents cited that poorer households 'had no future prospects", but younger respondents articulated this difference specifically as "having no employment" or "businesses" to engage in. Education as a characteristic of wealth for younger respondents emerged here. This result provides additional rationale for creation of a diversified wealth measure.

Table 9. Local criteria for wealth categories of households identified during the Wealth Ranking process. Responses by wealth category are arranged by age category (elder vs. younger respondents). When responses appear in the younger respondent's column, they differ substantively from those offered by older respondents.

Wealth Groups	Older Respondents: 50 years+ (N=4)	Younger Respondents: 25-30 years (N=4)
Very Poor	No animals, or very few	You have land – but it is clear that you will sell it in the future (Osilalei)
	Supported by others	
	No wife, no children	
Poor	10-80 cows	
	10-30 shoats	
	No "future prospects"	No employment
	Sons working for others	No businesses
		Do not have "things"
	No agriculture	
	Family small or large, but not well taken care of	Large families with few animals
	Physical wealth lower (clothing, and health)	Children in school, but may be assisted (by group ranch) and do not go far
	May be supported by others	
	Someone may be drinking	
Medium	80-200 cows	20+ cows/30+ shoats if still young and doing other things in addition to livestock
	40-200 shoats	
	Some have small businesses or employment, but focusing on LS	
	Doing agriculture -May or may not be working your shamba (N. Imbirikani) -Will be working shamba (Osilalei)	Some have built houses, but sold livestock to do it
	Organized families, well taken care of	Educating children
	Can support one's own family	
Rich	150-400+ cows	>100 cows, 200+ shoats
	100-400+ shoats	
	Have built houses	Sons are working – but still concentrating on livestock
	Have purchased a water pipeline connection	
	Purchased plots for business or agriculture – Are "future focused"	Using their animals - "putting them to work"
	Have 2 bomas (livestock and agriculture)	Purchasing Vehicles, other businesses – Doing only livestock is "risky"
	Many wives, many children	Families can be big or small
		Kids are schooling
	Takes care of others (food, clothing or animal gifts for milking or marriage)	
Very Rich	500+ cows, "too many shoats to count"	
	"Using" their animals	
	Supporting others with their wealth	

There was also an element of change running through informants' descriptions of wealth that is not immediately clear in the list of wealth criteria in Table 9. Both younger and elder informants expressed that wealth status can change abruptly. Droughts and family tragedies (sickness or death) may mean the loss of significant numbers of animals, and a decline in wealth status. So for example – some of the households cited as poor because they had few animals but large families, *used to* be rich, but had lost significant portions of their herds.

TLUs versus Breed-adjusted TLUs

Only eight households (4.3%) changed their wealth status based on the recalculation of household TLUs to account for cross-bred animals in herds (Table 7c). Five households dropped in wealth status, while 3 households rose in wealth rank. The Kappa value for the comparison of TLUs and Breed-adjusted TLUs was .935 ($p<0.000$), suggesting that the two measures are in almost perfect agreement (Table 8).

The above results provide ammunition for a position that adjusting TLU levels by changes in animal breeding has little effect on individual household wealth status. Results show that accounting for the greater productive potential of larger animals does increase the mean TLU holdings of households. Seventy seven percent of households in the study sample (n=140) had at least some cross-bred animals in their herds. On average, TLU holdings increased by 7.8% (St. Dev. 8.2%) across the study region when these animals were factored into calculation of household TLUs. However, these increases were not equivalent across the study areas (Table 10). The TLU holdings of households in Osilalei rose on average 11.7%. Increases in TLUs in Eselenkei, N.

Imbirikani and Lenkisim areas were between 8.0 and 10.0%, while mean TLU holdings in S. Imbirikani rose almost 7.0%. Emeshenani TLUs rose, but only by a marginal 1.5% per household. This pattern of observed increase generally follows the rainfall gradient: Osilalei is the wettest area of the study region, while Emeshenani is the driest.

Table 10. Increase in mean TLUs per household by study area when degree of breed improvement is factored into the calculation of TLUs.

Study Area	Mean % Increase	N	Std. Dev.
Osilalei	11.7	29	8.2
Eselenkei	9.0	30	6.1
Lenkisim	8.2	30	9.1
Emeshenani	1.5	29	2.5
S. Imbirikani	6.8	34	9.0
N. Imbirikani	1.0	31	8.7
Total	7.8	185	8.2

These results also indicate that cross-breeding efforts are being carried out by households across all wealth categories, and not just wealthy vs. poor households. However, the greatest change in average TLU holdings when traditional TLUs are compared to Breed-adjusted TLUs (Table 6) does occur in the richest wealth category (an average rise of 141 to 156 TLUs/household), suggesting that richer households are engaged in cross-breeding to a greater degree than poorer households.

TLUs versus Diversified Wealth

Only twenty three households (12.5%) changed wealth status when the TLU-based ranking was compared to a new diversified measure of wealth (Table 7d). Eleven households increased their wealth status, while 12 households declined in status. The

Kappa statistic for this comparison was .813 ($p<0.000$), indicating strong agreement between the two wealth ranking techniques (Table 8).

The Diversified Wealth ranking calculated a wealth status for each household based on a combination of assets and net income flows. The size of a household's standing livestock herd at the end of 2000 was considered an asset, while net livestock income through the year period was calculated as part of a household's overall income flows. Interestingly, the average base levels of TLUs per wealth rank are essentially the same comparing the TLU-based and Diversified Wealth ranking methods (Table 6). This suggests that regardless of how diversified a household becomes, base levels of animals within a household do not change. Poorer households have fewer animals on average regardless of their level of diversification, while richer households have more, and medium wealthy households are somewhere in the middle. So, while 78.3% (n=140) of all households are engaged in additional activities outside of livestock, the additive value of these activities alone does not seem to be enough to positively change the wealth status of diversified households. These results suggest the question: If animal wealth as assets remains important across wealth strata, what is the structure of other non-livestock assets and flows across wealth categories in the GAE?

Parameters of Diversified Wealth

A comparison of wealth parameters across levels of assets and income flows by study area is integral to understanding the new faces of economic diversification and wealth emerging across Maasailand. The Diversification Wealth measure was used as the basis for these analyses.

Table 11 presents mean values across all parameters used to calculate assets and income flows, with the addition of a new "Cropping Area" variable. It is immediately clear that the wealth ranks are not distributed evenly across the study region. According to the Diversified Wealth tercile rankings, N. Imbirikani and Emeshenani study areas have higher proportions of medium and rich households and proportionally very few poor households. In contrast, the S. Imbirikani study area consists of predominately poor households, with relatively few either medium and rich households. This result echoes the sentiments of agropastoralist households in this area, who consistently communicated that they were "poor" compared to other areas, in spite of strong diversification into agriculture (pers. obs. S. BurnSilver). Osilalei and Lenkisim study areas trend toward more poor and medium households than rich, while Eselenkei study area has predominately either poorer or richer households, but relatively few households of medium wealth status.

Figure 2 charts the average value of different wealth parameters (4 assets and 4 flows) by wealth status for all six study areas combined. The spider graph represents graphically the shape of wealth across the GAE and the differences between the relative values associated with each economic flow and type of asset. The shapes of poor and medium households' economic strategies mirror each other closely. Medium households have more livestock TLUs (cattle in particular) and incomes accruing from business and wage labor are marginally greater, but agricultural land holdings, capital assets and agricultural income are almost equal (Table 11). Therefore, poor and medium

Table 11. Mean assets and income flows for wealth ranks by study areas. Cropping area was added as a component of assets. Monetary values are means in US$.

			Household Assets				Net Income Flows			
Study Areas	Wealth Ranks		Cattle TLUs	Smallstock TLUs	Cropping Area (ha)	Capital Assets ($)	Cropping Income ($)	Business Income($)	Wages Income ($)	Livestock Income($)
Osilalei	Poor	(n=11)	8.7	3.7	1.0	12.4	35.6	143.5	40.8	-28.1
	Medium	(n=10)	19.4	12.9	1.3	84.4	105.9	108.8	24.5	64.2
	Rich	(n=8)	61.9	15.0	1.1	2636.1	81.7	714.3	20.4	90.0
	Total		27.1	10.0	1.1	761.0	72.5	289.0	29.6	36.3
Eselenkei	Poor	(n=10)	9.7	2.5	0.2	0.0	24.4	70.2	73.5	-217.8
	Medium	(n=7)	20.4	8.5	0.3	19.4	46.5	362.5	37.3	364.1
	Rich	(n=13)	104.3	18.9	0.1	0.0	12.4	659.3	25.1	608.7
	Total		53.2	11.0	0.2	4.5	24.4	393.7	44.1	276.1
Lenkisim	Poor	(n=11)	10.3	2.6	0.0	12.4	0.5	127.4	71.7	-655.3
	Medium	(n=12)	27.0	7.3	0.0	24.9	0.0	163.3	337.9	-403.3
	Rich	(n=7)	157.7	17.6	1.9	35.0	312.5	509.5	338.2	-700.7
	Total		51.3	8.0	0.5	22.7	73.1	230.9	240.4	-565.1
Emeshenani	Poor	(n=1)	11.9	2.1	0.0	0.0	0.0	0.0	0.0	219.5
	Medium	(n=15)	28.7	6.9	0.6	83.9	73.7	92.1	0.0	98.6
	Rich	(n=13)	170.8	21.5	1.5	89.0	15.0	235.2	73.3	2150.7
	Total		91.8	13.3	1.0	83.3	44.8	153.0	32.8	1022.7
S. Imbirikani	Poor	(n=21)	8.0	1.5	1.0	4.3	207.3	49.0	91.4	-133.0
	Medium	(n=7)	29.9	5.4	0.7	34.0	46.9	128.3	314.9	-879.9
	Rich	(n=6)	91.5	10.0	2.1	2312.9	770.9	466.2	10.2	-850.6
	Total		27.2	3.8	1.2	418.0	273.7	138.9	123.1	-413.4
N. Imbirikani	Poor	(n=7)	9.5	3.2	0.2	97.2	3.3	93.3	296.2	-226.8
	Medium	(n=11)	25.9	4.4	0.5	37.1	173.7	197.9	227.6	-239.1
	Rich	(n=14)	128.1	17.3	1.0	213.8	143.8	343.1	819.8	1996.1
	Total		67.0	9.8	0.7	127.6	123.3	238.5	501.7	741.5
Total	Poor	(n=61)	9.1	2.5	0.6	17.2	82.2	87.9	97.8	-227.1
	Medium	(n=62)	25.6	7.5	0.6	51.4	76.3	162.0	149.5	-144.5
	Rich	(n=61)	123.2	17.6	1.2	645.3	161.2	467.4	251.6	893.9
	Total	= 184	52.5	9.2	0.8	236.9	106.4	238.7	166.2	172.4

households do engage in off-land and agricultural activities, but their relative contribution to household wealth is lower. In contrast, the shape of Diversified Wealth for rich households reflects greater returns across every parameter. This is particularly true for cattle TLUs, size of agricultural area, fixed capital assets and business and livestock income.

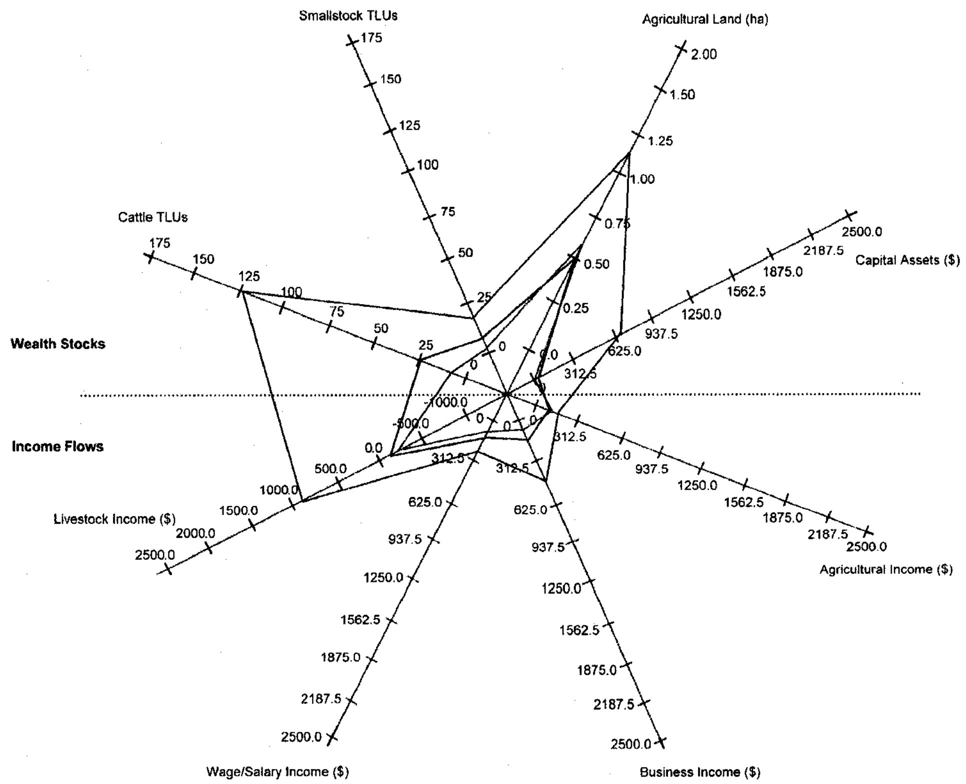

Figure 2. Mean wealth parameters of poor, medium and rich households for the entire study region. Households are categorized according to the diversified wealth ranking method. The mean value of income and wealth stocks of poor households is outlined in red, medium households in green, and rich households in blue. Parameters above the center horizontal line are mean wealth stocks (cattle and shoat TLUs, area of agricultural land and capital assets). Parameters below the center line are mean net income flows (livestock, wages, business and agriculture).

Looking first at the trends within study areas (Figure 3), the shape of productive strategies is again generally consistent moving from poor, to medium households, with the greatest changes in strategies and associated values occurring at the level of rich households. The only exception to this pattern is Emeshenani where poor households concentrate almost entirely on livestock, but medium households have significant average agricultural land and marginally greater agricultural income. The relative size of the shaded areas for each wealth rank increases from poor to medium households, but the shape of wealth does not change dramatically. In contrast, rich households seem to explode into new activities with an additional set of returns contributing to household wealth. For example, rich S. Imbirikani households have dramatically greater fixed capital assets than poor and medium households in the area. Similarly, rich Lenkisim households engage in far greater agriculture and business activities than their poor and medium counterparts.

These results illustrate that parameters of wealth differ across wealth rankings, but do all poor, all medium and all rich households look alike within each wealth strata across the study areas? Figure 3 suggests that this in fact is not the case. The relative size of the shaded areas for each wealth strata across study sites are very similar. However, comparing the shapes of wealth parameters within wealth strata (moving top to bottom in Figure 2), the activities of poor households and the values accruing from those activities differ depending on their location. The same is true for medium and rich strata. So, for example, Emeshenani is an area isolated from most infrastructure services. Households have many livestock, but little engagement in business or wage labor relative to other areas. However, Emeshenani households do have access to agricultural areas and rich households seem to be heavily diversified in this direction. In contrast, rich Eselenkei households who are also more isolated, engage in some small scale (rainfed) agriculture, but have a substantial flow of income from business activities – primarily livestock trade and small shops. And, rich S. Imbirikani households expand into extensive and high value agriculture, combined with investment in fixed capital assets such as business plots (i.e., building a shop to rent out) and grain mills. These differences make sense given that study areas differ strongly in terms of their levels of access to specific resources and infrastructure types.

The messages to emerge from these results are four-fold. Livestock remain an integral component of wealth at every wealth level, but animal numbers increase steadily with wealth. Second, the differences between poor, medium and rich households within study areas is generally a question of scale of returns associated with a set of common activities. Third, households within one wealth strata but located in different production and resource zones are not homogeneous in terms of the specific activities they engage in, although they are similar in the scale of their activities. Last, richer households seem dramatically different from poorer and medium households in terms of both scale and shape of their productive strategies.

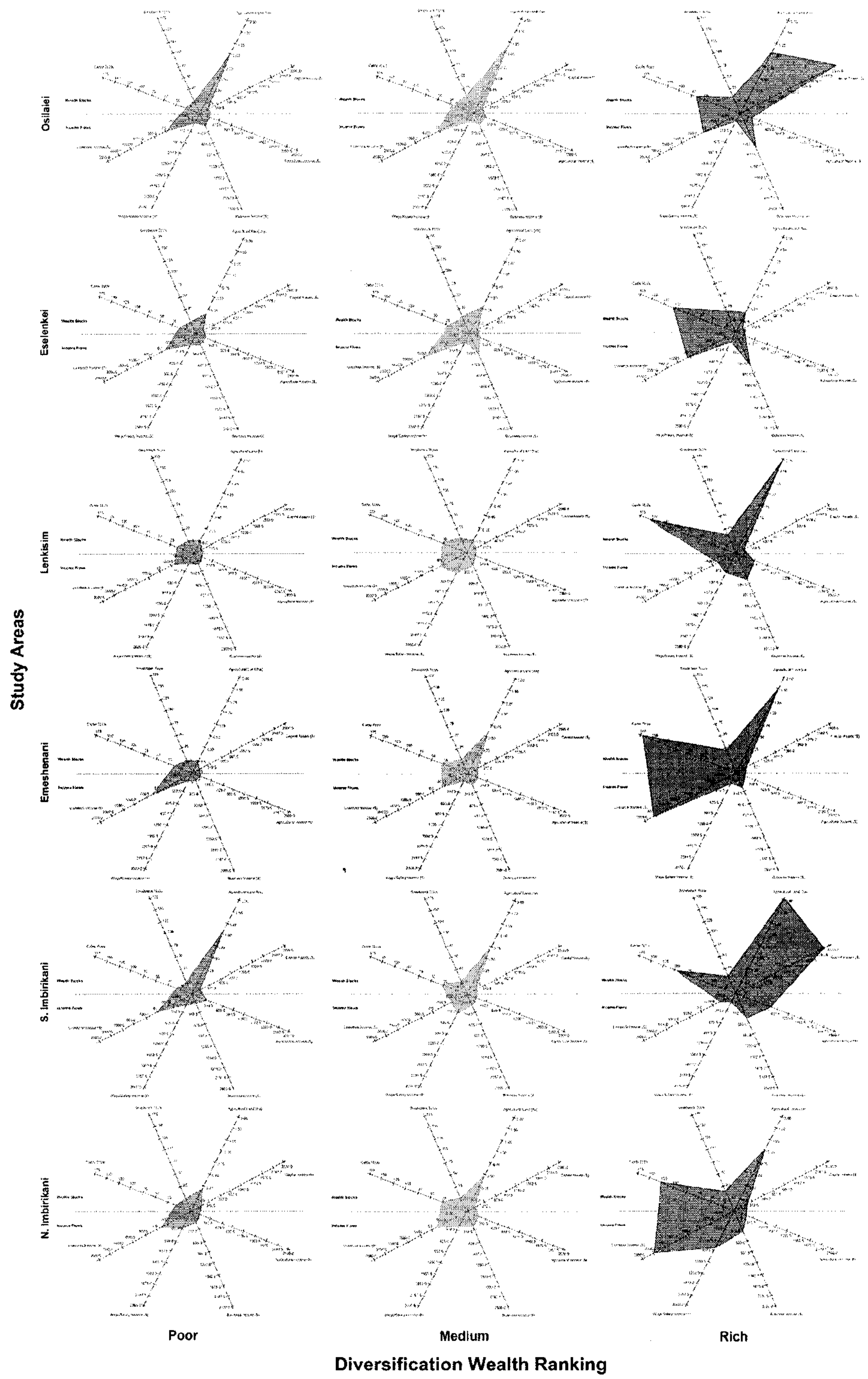

Figure 3. Mean wealth parameters of poor, medium and rich households across six study areas in the GAE. Households are categorized according to the diversified wealth ranking method. The parameters above the center horizontal line in each small figure are mean wealth stocks (cattle and shoat TLUs, area of agricultural land and capital assets). Parameters below the center line are mean net income flows from livestock, wages, businesses and agriculture.

DISCUSSION AND IMPLICATIONS

The goals of this chapter were to expand understanding of pastoral wealth given that economic diversification and intensification have become the norm in Maasailand rather than the exception. Previous methods used to portray wealth and poverty status in pastoral societies have continued to be based almost entirely on some calculation of animal units available on a per capita or per household basis within these systems, but have not explicitly accounted either for intensification strategies (e.g. breed improvement efforts) or the economic value of non-livestock activities to household livelihoods. A linked goal was to interweave other available strands of data to provide a picture of how concepts of wealth have changed through time in Maasailand. Comparison of household wealth status using multiple wealth ranking techniques, qualitative data on wealth criteria, and comparisons of animal wealth across previous and current study populations were the methods used to approach these goals.

In comparing animal-based wealth in Maasailand, indications are that Maasai are much poorer now in livestock than previously. Analysis of the animal holdings documented by Bekure et al. (1991) for the study area in 1984 and GAE households in 2000, illustrates that the distribution of households within wealth strata has shifted substantially towards the poor end of the spectrum (Table 5). As well, the mean TLU holdings per household within wealth categories are dramatically lower now than in the 1980s. The first result supports the idea that there are now more poor households within this pastoral region, or that income stratification is increasing – a trend that has been pointed out by a number of researchers working in pastoral areas (Rutten 1992; Hodgson 1999; Thompson 2002). However, the second result is more suggestive that *all* pastoralists are less wealthy now than in the past – both poor and wealthy households. This is a view articulated by Broche-Due and Anderson (1999), whereby they suggest that based on a combination of factors; recurrent drought, land tenure change and increasing population pressure on resources, all pastoralists are being squeezed, and so have become less well-off overall. Both trends may actually be occurring in Kenyan Maasailand, but it is important to differentiate between them for purposes of identifying the root causes and processes of wealth change through time. Another implication of these trends towards greater poverty in terms of animal wealth, is to think about the role of diversification in alleviating poverty itself. If base levels of animal wealth are declining, then can the addition of non-livestock activities through a process of economic diversification make up the difference in pastoral livelihoods lost over the preceding two decades? This question looms large – even before recognizing that pastoral populations in Kenya and elsewhere, are often poor relative to other ethnic groups (Blench 2001; UNDP 2001; Akcura 2002; Adelzadeh, Alvillar et al. 2003; ADF 2003). The value of off-land activities for rich households is substantial, but this is not the case for poor households. Even with additional activities, they are still poor.

Results of step by step comparisons of TLU-based wealth with other wealth ranking methods illuminated important aspects of wealth and poverty in pastoral Maasailand. The comparisons of TLUs with TLUs per capita and Wealth Ranking techniques yielded the greatest changes in wealth status across the sample population. However, a surprisingly small number of households changed their wealth status based on integration of new representations of wealth, specifically the Breed-adjusted and Diversified Wealth ranking methods. Implications of these results are discussed below.

The size of a household relative to the size of a herd available to support it emerged as important in ranking households by wealth. Given the trajectory towards smaller household sizes linked to ongoing processes of land tenure change in the GAE (i.e., towards subdivision and occupation of private parcels), this translates potentially into fewer people to support with a given animal herd. However, this is true only if animal numbers per capita do not continue to decline system-wide into the future – an occurrence which is not guaranteed by any means given current conditions in Maasailand. Additionally, many households expressed reservations concerning the effects of privatization (BurnSilver 2005) in that they would be forced to decrease their herd size in order to subsist year-round on small individual parcels – when and if private boundaries were enforced by parcel owners in the future.

The largest number of households changed wealth status when TLU-based and Wealth Ranking methods were compared. This result is similar to those documented by Scoones (1995) for agropastoral households in Zimbabwe, and suggests that quantifications of wealth in Maasailand that are only limited to animals, overvalue livestock relative to other, broader conceptions of wealth. These broader understandings of who is "wealthy" or "poor" are emic in nature, and integrate non-economic criteria into local definitions of well-being, such as prestige and the cultural values associated with having large families. The work of Homewood et al. (2006) and Thompson and Homewood (2002) also considers the wealth potential associated with households holding "gatekeeper" positions which open economic avenues for households. In the current chapter, qualitative comparisons across age categories provided some indication that Maasai definitions of wealth may also be changing, as younger local informants were more specific about the need for other economic assets and activities outside of livestock than older informants when identifying their criteria for wealth ranking (Table 9). Understanding of these emic criteria for wealth and poverty are important, as they emphasize that pastoral households may act according to non-economic considerations.

Very few households changed wealth status when TLUs were adjusted by the degree of animal cross-breeding occurring within household herds. One reason for this seems to be that mean TLUs increased across all wealth levels (poor, medium and rich) based on the new calculation method (Table 6). The greatest mean changes in TLUs occurred in the rich category however, with two implications: 1) richer households may be putting more resources into cross-breeding efforts, and 2) if larger animals do translate into higher returns in terms of meat, milk and prices in the marketplace, richer households will enjoy the largest share of these returns if the trend continues. Another explanation for the low significance of the TLU-based and Breed-adjusted comparison may be a question of timing. The process of cross-breeding is one that is only just beginning for many pastoral producers, although there is every indication that this is a direction in which many herders plan to move, and I would suggest that retrying this comparison in another 5 years will yield very different results.

In line with this observation, substantial increases in Breed-adjusted TLUs were documented, but these increases were highly linked to location within the GAE (Table 10). The greatest change occurred in Osilalei (11%), an area which receives the most rain of the six study areas, and the one with the closest proximity to Kaputei Maasai *ol-oshon,* where efforts to crossbreed local Zebu with graded cattle first began in the region during the 1970s. King et al. (1984), Bekure et al. (1991), Rutten (1992) and BurnSilver

(Ch. 1) have all documented previously that herders in drier areas have been more hesitant in cross-breeding their animals, so the geographical differences in TLU change across study areas are not unexpected. This caveat however, also emphasizes the potential trade-offs for herders associated with raising these larger breeds of animals. Herders themselves express (pers. obs.), and research bears out that grade animals are heavier, require more forage and more frequent access to water, are more prone to disease and are generally less able to weather the requirements of mobility in a drought-prone environment than are local Zebu cows or local varieties of sheep and goats (ILRI; Trail and Gregory 1981; Rege and Bester 1998; Rege and Tawah 1999). One additional difficulty associated with Borana or Sahiwal cattle specifically is that their size often precludes literally "lifting them up" during drought periods, an action often taken with local Zebu cows to keep them going from dawn to dusk during drought. On the positive side of the bigger animals are greater milk and meat yields, and better market values (Bekure and Tilahun 1983; Bekure, de Leeuw et al. 1991; Rutten 1992; Scarpa, Kristjanson et al. 2003), outcomes which are important given greater pastoral needs for cash as sources of expenditure rise (i.e. school fees, veterinary fees, foodstuffs and consumer goods) (Zaal 1999). Therefore, Amboseli herders are actively experimenting with the correct stopping point for cross-breeding at which the strengths of local breeds are maintained, but additional benefits accrue (Boone and BurnSilver 2006). However, the substantial risks associated with improved breed animals suggest that they may represent more *potential*, rather than *actual* returns for households. All it takes is one bad drought to kill these large animals and households return to square one. These substantial trade-offs are not represented in a straightforward Breed-adjusted calculation of TLUs per household, but they should be borne in mind as pastoralists continue to move forward with cross-breeding efforts.

This chapter also documented surprisingly few households changing wealth status when TLU-based and Diversification Wealth methods were compared. Poor households seemed to stay poor and rich households, rich when the two wealth ranking methods were applied to Amboseli households. Additionally the mean sizes of household livestock herds per wealth strata changed minimally across methods. Two important implications emerge from these results. First, while previous studies of diversification in pastoral areas have suggested that the importance of livestock would decline as households diversified, this study suggests otherwise. Based on the methods applied here, there is no strong indication that households poor in animal wealth can end up categorized as "wealthy" based on the ability of other activities to fill the productive gap. This result was unexpected. There are however, indications that the opposite may be true: households with relatively large animal herds, but no other activities can certainly be poor (BurnSilver Ch. 1).

The second implication of these results emerged from a comparison of the values associated with additional economic activities for households in different wealth strata. Diversification is clearly occurring across all wealth strata in Amboseli (Figures 2 and 3 and see BurnSilver Ch. 1). However, the returns to households associated with fixed assets, off-land and agricultural activities are dramatically larger for richer households than for poorer. In other words, while the shapes of household wealth parameters were very similar for poor and medium households within study areas, the scale of returns rose from poor to medium households, and then both scale and shape changed precipitously for richer households. Rich households seem to be qualitatively and quantitatively different in terms of their economic potential and trajectories. Other researchers have pointed out these differences in agricultural and agropastoral systems, and hypothesized a relationship between the size of initial resource endowments, and continued wealth accumulation and greater well-being (Dercon 1998; Barrett, Reardon et al. 2001). A key point here is that profitable diversification requires "lumpy", or high-value investments (Dercon 1998), which richer households are able to make. In contrast, the resources poorer households are able to bring to bear on diversification efforts steer them towards lower risk, lower return activities, which are often not sufficient change to jump their status forward dramatically (Temu and Due 2000). This pattern seems to be true in the GAE as well. Results from Amboseli also show that average animal herd size increased consistently from poor to medium to rich households, and herein lies the potential link between large livestock herds and wealth rank trajectories. Livestock in Maasai society – as is true in most pastoral societies – are considered a wealth store, and as qualitative results from the Wealth ranking exercise show, livestock are also now increasingly considered as a source of investment (Turner 2000). This result suggests why no mean differences in TLUs per household were documented in the TLU-based and Diversified Wealth comparison, and why so few households changed wealth status when the TLU-based and Diversified wealth were compared. Livestock continue to be important across the GAE in spite of significant diversification occurring within the system. This conclusion also supports a gradual widening of the gap between between rich and poor pastoral households in Amboseli through time – a pattern with significantly negative implications for well-being at the low end of the economic ladder (Thornton, Boone et al. 2007).

This study has also confirmed for a pastoral population what researchers have documented for other groups previously; the categories of rich, medium and poor are not homogeneous. They pursue very different constellations of activities – and by association – there are different definitions of wealth and poverty emerging in the GAE. The importance of baseline investment resources defining economic potential was touched on previously. As well, similar to results found by Coast (2002) in Kenya and Tanzania Maasailand, and Thompson et. al. in the Mara ecosystem (2002), combinations of activities pursued by Amboseli households reflected local ecological and infrastructural conditions (Figure 3). These conditions represent both barriers and opportunities for households. So households pursue agriculture where agriculture is an option. And returns from wage labor are strongest in areas where infrastructure access is greatest. These differences are one source of the heterogeneity in activities within even wealth strata.

There are some methodological challenges which emerged in this study of wealth. Gathering sufficiently detailed data on household assets and income flows was very time intensive. Yet, under the methodology followed here to quantify Diversified Wealth, the measure represents a "one-off" view of wealth at a particular point in time. Data were gathered during a drought period when livestock mortality was high, and these factors decrease the generalizability of the wealth measure. This study ranked the same set of households five different ways based on changes in definitions of the parameters of pastoral wealth. However, it would be extremely interesting to apply various wealth measures to a cohort of pastoral households over time to see how, and if, individual households are actually changing their economic status in real terms as economic activities adjust to changing climatic, land tenure and market conditions.

This chapter was however, able to highlight emerging aspects of wealth and poverty in a pastoral system in transition. Different wealth measures captured aspects of wealth that were linked to both economic intensification and intensification of pastoral production strategies. The new Breed-adjusted and Diversified Wealth measures were not significantly different in the way they ranked households, but their importance will only increase with time given the current trajectories of change in pastoral areas. The drivers of economic change and conditions of pastoral production in Maasailand are unique to some extent, but they are equally representative of the broader challenges facing most pastoral societies globally (Blench 2001; Fratkin and Mearns 2003; Steinfeld, Gerber et al. 2006). If the broader goal for those working in pastoral areas is to improve well-being, then a first step must be to define poverty in order to alleviate it. Equally important is to understand wealth and its characteristics – both cultural and economic. In an era of finite development dollars, and under the twin looming spectres of climate and land tenure change in rangeland zones globally, the results of this study should contribute to identifying relevant interventions for different sub-groups within pastoral societies. It is not sufficient to speak of economic diversification or intensification in terms of its general economic potential in pastoral areas, as strong differences in household objectives and constraints are reflected across different wealth strata (Thornton, Boone et al. 2007). The challenges facing pastoral populations under conditions of rampant change are significant and complex. Their solutions must be equally grounded in detailed understandings of processes of change – for poor, intermediate and rich alike.

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APPENDIX

APPENDIX 1. Calculation of the Diversified Wealth Index

The value of Diversified Wealth is calculated for two households (one rich and one poor) below as an illustration of the methodology followed.

Diversified wealth (DW) is the sum of household assets (A) and income flows (IF):

$$DW = A + IF, \qquad \text{Equation 1}$$

where the value of household assets was calculated as:

$$A = \text{Assets Livestock}_{(\text{cattle + smallstock})} + \text{Assets}_{\text{capital}} \qquad \text{Equation 2}$$

Income flows (IF) were parameterized as:

$$IF = LS_{net} + \text{Wages/salaries} + \text{Business} + Ag_{net} \qquad \text{Equation 3}$$

The value of net LS (livestock) production was calculated as:

$$LS_{net} = \text{Gross Livestock Income} - \text{Livestock Costs} \qquad \text{Equation 4}$$

And agricultural net income was calculated as:

$$Ag_{net} = (Ag_{consumed} + Ag_{sold}) - Ag_{costs} \qquad \text{Equation 5}$$

The values of wages/salaries and business activities were calculated directly, without accounting for associated travel or business-related costs.

Diversified Wealth Calculation for households No. 77 and 1020

Household 1020: Wealth category - Rich Study Area - N. Imbirikani

This household has a relatively large herd of livestock (108 TLUs) and is diversified into agriculture and wage labor. The household head has a bachelor's degree, and is 46 years old (Ilkishimu age-set). He has 11 children, 10 of whom are in school. He has "borrowed" two nephews from a brother who look after his livestock. Both the household head and one of his wives are employed. She is a school matron and he is a water development officer for the Kenyan Ministry of Water. The household is diversified spatially as well. Livestock are kept in N. Imbirikani in one compound, where a second wife engages in cash-crop agriculture (tomatoes and onions) using water from the main N-S water pipeline. She also sells milk. A second compound is at Oloitokitok, where highland, rainfed agriculture occurs, and both jobs are located. The household's main livestock herd was categorized as highly mobile in both 1999 and 2000. The household head travels back and forth often between each compound.

Household 77: Wealth category - Poor Study Area – Lenkisim

This household has very few livestock (10 TLUs), but is diversified into small-scale business (a small in-home shop selling tea, sugar and corn), and one son is employed as a teacher. Both these activities make small monthly contributions to the household budget. The household head is 68 (Iseuri age-set), has never been to school, and has three wives and 13 children. Eight of these children attend school. The household head also has one capital asset, as he invested in a water connection to the E-W water pipeline. This household suffered very high livestock mortality during the drought of 2000 (60% of his animals died). Before losing these animals his herd was highly mobile.

The values of economic assets and income flows for each household are shown in the table below. Equations were applied in reverse order from above in order to build calculations towards a final measure of diversified wealth. Gross livestock and livestock costs are calculated separately in an extra step. All livestock figures include transactions of both cattle and smallstock. The timing of calculations is also shown. All table values are in US dollars.

Table 1. Calculation of Diversified Wealth index values for two households.

		Components of Diversified Wealth					Timing of calculations
Two households	**(e) Ag_{net} =** Net Agricultural Income	($Ag_{consumed}$ +	Ag_{sold}) -	Ag_{costs}			Combined values of multiple household harvests in 2000
Rich (1020)	**$967 =**	**(802**	**+ 552)**	**- (- 387)**			
Poor (77)	**$0 =**	**(0**	**+ 0)**	**- (0)**			
	Gross Livestock = income Gross Livestock income	Livestock sold +	Livestock + received as gifts	Livestock + consumed (slaughtered)	Hides and + skins (sold)	Milk (consumed and sold)	Values of all transactions in 2000 – calculated at market selling prices for livestock age/gender classes
Rich	**$2,574 =**	**(1022**	**+ 69**	**+ 104**	**+ 0**	**+ 1379)**	
Poor	**$145 =**	**(83**	**+ 0**	**+ 41**	**+ 21**	**+ 0)**	
	$Livestock_{Costs}$ = Livestock costs	Livestock + purchased	Livestock + given as gifts	Livestock + mortality	All livestock expenditures		Values of all transactions in 2000 – calculated at market selling prices for livestock age/gender classes. All costs tallied for the year 2000.
Rich	**$2,045 =**	**(16**	**+ 114**	**+ 723**	**+ 1224)**		
Poor	**$442 =**	**(50**	**+ 0**	**+ 282**	**+ 110)**		
	(d) $Livestock_{net}$ = Net Livestock Income	Gross LS income -	LS_{costs}				For the year 2000: LS costs include herding labor, veterinary, water, forage
Rich	**$529 =**	**(2,574**	**- 2,045)**				
Poor	**$-297 =**	**(145**	**- 442)**				
	(c) IF = Income Flows	LS_{net} +	Wages/ + salaries	Business +	Ag_{net}		
Rich	**$5,741 =**	**(529**	**+ 4,245**	**+ 0**	**+ 967)**		
Poor	**$30 =**	**(-297**	**+ 163**	**+ 82**	**+ 0)**		
	(b) A = Assets	$Assets_{Livestock}$ + ($_{cattle + smallstock}$)	$Assets_{capital}$				Standing market value of household herd at end of 2000. Fixed assets valued at purchase or construction cost
Rich	**$12,235 =**	**(12,235**	**+ 0)**				
Poor	**$1,051 =**	**(915**	**+ 136)**				
	(a) DW= Diversified Wealth	A + Assets	IF Income Flows				
Rich	**$17,976 =**	**(12,235**	**+ 5,741)**				
Poor	**$1,081 =**	**(1,051**	**+ 30)**				

CHAPTER 5

CONCLUSIONS AND IMPLICATIONS

INTRODUCTION

This study of Maasai pastoralism has been an attempt to quantify trajectories of both change and continuity in the economic and productive strategies of pastoral households within the Greater Amboseli Ecosystem. Three processes were the focus of these analyses; economic diversification, intensification of livestock production strategies and mobility as a mechanism for herders to avoid risk and access forage in sufficient quality and quantity for their animals.

To state at this point that change is occurring in Maasailand is almost a truism. Change is certainly ubiquitous, and the degree to which all aspects of pastoral society and their environment are being affected is unprecedented. Ongoing climatic variability, land tenure change, policy agendas, economic need and new livelihood expectations all drive pastoral households towards change. Two questions ran through all analyses, 1) what are the household-level strategies (both new and old) currently used by pastoralists in order to respond to these changes, and 2) how are these choices affecting pastoral well-being?

In analyzing patterns of responses, the goal was to get beyond simply documenting diversification, intensification and mobility patterns in Maasailand, and to illustrate some of the complexities and subtleties inherent in these processes. It is in understanding these complexities that we can see the implications of current trajectories for pastoral well-being and resilience in the face of ongoing change.

I will summarize important results from each of the three data chapters, and then speak to wider themes in pastoral development in a final section.

Chapter Two

Pathways of Continuity and Change: Maasai Livelihoods in Amboseli, Kajiado District, Kenya

The goals of Chapter two were to quantify patterns of diversification and intensification in the GAE, and link these processes to questions of pastoral well-being. Wildife-based income was considered as a special case of diversified income generation, and the role of these activities in contributing to pastoral livelihoods was treated as an important question for the Amboseli region given that this landscape combines unique attributes of pastoral land use, biodiversity, Maasai culture and ecology.

Diversification analyses, both by study area and by activity clusters, highlighted that diversification is well-established in Maasailand. Non-livestock activities (i.e. agriculture, wage labor/salaries or business) represented between 14 and 55% of average gross household income, depending on location. Only 21% of sampled households in the GAE were dependent fully on their livestock for their livelihoods. However, the flip side of these numbers enlarges the picture of diversification in the economic livelihoods of Maasai. All households kept livestock, and the range of dependence on livestock in terms of gross income was between 45 and 86% depending on location. Dependence was greatest in more isolated areas of the study region (e.g. Emeshenani), and lowest in S. Imbirikani where almost all households were heavily engaged in irrigated agriculture. However, livestock still generated greater than 50% of gross income for almost 70% of sampled households. The implication is that regardless of ongoing diversification, livestock still remain critical to the livelihoods of a majority of Maasai pastoralists.

It is interesting to then link activities to economic well-being. On the one hand, cluster analyses showed that the poorest two groups of households were those who were only dependent on livestock. The other very poor group however, was those households who were most heavily engaged in irrigated agriculture. The *most* well-off households were the most diversified, combining significant livestock numbers with wage labor/salary jobs, or livestock with off-land activities and agriculture. Consequently, a second important theme to emerge is that not all diversification activities are the same in terms of value. Returns from agriculture were highly variable depending on location and type, and the returns associated with off-land activities were closely linked with levels of associated predictability and required skill. Wildlife-based activities were not widespread across the GAE study sample, and returns from those activities were highly variable. In other words, type of diversification itself *matters,* and results showed that richer clusters seem to have a stronger investment base from which to engage in higher value diversification activities.

Results indicated that greater age, engagement in highland agriculture, larger herd size (TLUs), and more off-land income sources, were predictors of higher gross incomes for households. In contrast, significant predictors of herd size were mobility during critical drought periods, larger households (AUs), *greater* distance from services, and greater income from livestock and off-land income sources. It is interesting to note that engagement in off-land income activities was an important predictor of both success in livestock and overall economic success. This suggests that livestock may then be both a source of investment for diversification, and a reflection of successful previous diversification. However, being more isolated from services (i.e. being in more core rangeland areas), mobility and larger household size are unique predictors of greater herd size for households in extensive rangeland zones. The connection between greater herd size on the one hand and gross income on the other should be studied more extensively in order to understand these dynamics of change.

The discussion of diversification pathways through time in Amboseli ended with another caveat – one which pointed out that the process of diversification is neither unidirectional nor static. Results show that movement of individual household heads in and out of activities throughout their economic lifetime is common. Some activities, such as agriculture, show less elasticity over time. Others, for example livestock trading, are activities undertaken for shorter, defined time periods to satisfy particular goals. Results show overall that decisions to begin and especially to end economic activities were more likely to be made for negative reasons (e.g., economic need) than positive ones (e.g., responding to growth and success), pointing out that diversification is undertaken in many cases under conditions of economic duress.

This study also quantified household level efforts to intensify particular aspects of livestock production strategies. Indications are that households are trying to change the breeds of their animals to raise the possibility of better prices in the marketplace, and selling of livestock is increasing in most areas of the GAE. Yet, it is not clear whether greater selling of livestock is to offset economic need (i.e. households are being pushed to sell animals to satisfy costs), or if these sales are timed to take advantage of good prices in the market. The latter would indicate a more formal orientation towards the market, while the former is indicative of a subsistence orientation. As well, strong challenges to livestock marketing in the GAE remain in place, and very few households are accessing credit resources or using banks. Infrastructure and development inputs in the GAE are notoriously low. Cultural dispositions towards distrust of formal banking and the need to hold on to animals to offset risk may be playing into these trends as well. However, the intensification paradigm of livestock development requires that pastoralists increase the level of inputs they apply to livestock production in order to raise efficiency and outputs. If access to these inputs remains low or non-existent, it is important to question policy makers advocating intensification as to how pastoralists at the household level can move beyond these limitations.

This chapter identified that economic diversification and livestock intensification are *parallel* trajectories of change occurring in Amboseli, and they both link strongly to livelihoods and pastoral well-being. Results clearly highlight that diversification is a well-entrenched process in Maasailand. However, livestock continue to represent a significant component of livelihoods in this area, and large livestock herds were a significant predictor of well-being. The dramatic transition towards intensified livestock production envisioned by policy planners in the 1970s does not seem to have occurred. Yet, while households were not intensifying their production strategies according to every criteria of intensification measured, there are strong indications that households are thinking about how to get more from the livestock they do have.

Recent poverty mapping efforts in pastoral areas globally shows that 25-35% of the population in Kajiado District, Kenya is below the international poverty line, defined as subsisting on less than 1$/day (Thornton, Kruska et al. 2003). Pastoralists themselves as well as researchers working with them have documented declines in herd sizes per capita (Bekure, de Leeuw et al. 1991; Rutten 1992; BurnSilver 2005), so there are indications that herding households are becoming poorer. The time period of the Thornton et al. (2003) study cited above corresponds to the time that data for the current study were gathered. Wildlife-related income was not a significant component of returns for economic diversification, and this has strong implications for the community conservation approach in Amboseli. But even more importantly, the overall question of whether economic diversification and livestock intensification have the potential to raise pastoral households above this poverty threshold over the long term remains unanswered.

Chapter Three

Pastoral Mobility in the Context of Change: A Case Study of Four Group Ranches in Maasailand, Kenya

The starting point of Chapter three was the continued economic importance of livestock within the diversifying economy of the Greater Amboseli Ecosystem. The primary mechanism by which Maasai pastoralists have coped with the substantial climatic variability characterizing the region, and the resultant spatial and temporal patchiness of resources, has been through the mobility of their livestock herds. Yet, there are significant ongoing pressures for pastoralists to privatize communal grazing lands and sedentarize livestock production existing in the GAE. Given the juxtaposition of the critical importance of livestock to Amboseli livelihoods on the one hand, but looming pressures to subdivide rangelands on the other, this chapter quantified how widespread mobility was across the GAE in 1999 and 2000, what were the predictors of household mobility, and what were the benefits of mobility for households in terms of access to resources? The results of these analyses give an idea of the proportion of pastoral households who are currently dependent on mobility (to greater and lesser degrees) as a critical coping strategy in this semi-arid landscape, and therefore who would be affected by a decline in their ability to be mobile in the future. In quantifying the forage that is accessed through mobility, results also speak to the resources that would have to be made up in some other way under scenarios of subdivision.

Results indicate that in spite of ongoing economic diversification, sedentarization and pressures to subdivide, mobility is still widespread as a component of the current livestock production system in the region. Sixty-two percent of households moved their main cattle herds at least once in 1999, and almost 86% moved their animals in the drought year of 2000. Analyses of movement patterns showed that herds in core rangeland zones (where livestock also remain most critical to livelihoods) move more often and spend more time away from their permanent settlements. More households in subdivided and agropastoral areas were sedentary in a normal year of rainfall, however in the drought year of 2000, a majority of households from these areas also became mobile. When these households made the decision to become mobile, they moved on par with other households for whom mobility was more common.

These results point to differences between customary and practiced mobility on the one hand, and drought-induced mobility on the other. It seems that sedentarization does decrease mobility for some households, but they currently retain the ability to become mobile in this system when necessary. One crucial point to emphasize here however, is that when the rate of drought-year mobility increased so dramatically in Osilalei (the subdivided study area), a majority of the movement that occurred was onto an unsubdivided group ranch (i.e., Imbirikani). This dynamic illustratives some challenges that are mounting to the principle of grazing reciprocity, as grazing areas are subdivided. A group of private Osilalei parcel holders negotiated access to Imbirikani rangelands with senior elders from N. Imbirikani. But pastoralists themselves are asking – how will communal herders gain access to private parcels if (and *when*) the situation reverses and rains occur in subdivided areas and not in communal ones?

The *emparnat/enkaron* grazing system is a cultural and institutional set of rules and norms within each group ranch that regulates grazing through time in the GAE. NDVI analyses indicate that the *emparnat/enkaron* system acts to maintain herder access to forage *quantity* through time. Detailed NDVI analyses of individual herd movements at dekadal time steps indicated that the grazing stages system seems to allow mobile herds to access greater standing biomass throughout the long dry season. However, herder movements are no longer predicated on maximizing animals' overall access to high *quality* green forage. There do seem to be controlled time periods when herders are able to access high quality green forage, particularly after the rains arrive and depending on the chosen timing of herd movements between grazing areas and their permanent settlements. A herder can choose to remain out at a distant grazing settlement and let animals graze on high quality forage and abundant standing water, but inter-household characteristics such as labor availability, the agricultural calendar, or the need to get children back home for the beginning of school (e.g. in January) also play a role in whether a herder stays mobile or returns home. Methodological issues associated with defining access to forage resources based on the used of SPOT NDVI data emerged in the course of analyses, however the approach taken in this study was effective in pointing out methodological areas that must be improved in the future.

In terms of variables that play a significant role in defining which households made the decision to move, sixty-three percent of the variability in first movement in the normal year of 1999 was explained by three variables: NDVI conditions at a household's *emparnat*, the size of the mobile cattle herd, and the number of hired herders brought into a household. However, in 2000, the explanatory power of the binary logistic model declined to 27%, based only on number of hired herders and gross income. These results again point to the difference between mandatory mobility, when everyone must move regardless of household characteristics, inclination or habit, and customary mobility, which seems linked to a clearly defined set of variables.

A second set of regressions using classification and regression tree analyses identified the variables that predict how mobile a household would be once they already had made the decision to be mobile. These analyses were carried out by study area and strong differences emerged across locations in terms of which socio-economic, economic and geographic variable explained mobility levels. Labor was not a strong predictor, but larger herd size predicted greater mobility in most cases. Household gross income and NDVI conditions were also strong predictors, but there was more complexity in terms of directionality of the relationships. One clear result was that gross income and mobile animal TLUs were correlated, as was gross income and household involvement in additional economic activities. Therefore, even with greater economic diversification, the larger a household herd is, the stronger remains the need to remain mobile. Previous research has also reported that owning a private parcel in a subdivided area was a strong predictor of declines in mobility (Kabubo-Mariara 2003). Results in this study support this conclusion in a normal year, but are strongly contradictory in a drought year.

The debate over mobility in the Amboseli system specifically, and across many pastoral systems globally continues to take place within a context of changing land tenure systems and policy drivers that tacitly promote the paradigm of livestock intensification. These drivers continue to push pastoralists to sedentarize and privatize their communal rangelands (Banks 2003; Behnke 2007; Reid, Galvin et al. 2007). Yet, infrastructure access and productive inputs remain low in Maasailand. And while the assumptions promoting strong linkages between private property rights, greater productive efficiency and investment are often stated loudly – these assumptions have not been well-tested in pastoral areas, where climatic variability and poor infrastructure are the norm. Therefore, pastoralists in the GAE are currently stuck in an untenable position between ongoing intellectual and development funding debates over communal vs. private property rights, the basis for economic productivity, and the key to pastoral well-being. This chapter highlighted that transhumance of household herds in the Greater Amboseli Ecosystem allows animals to access more, and in some cases better, forage. Mobility thus remains a critical strategy to preserve flexibility and resilience in the face of the twin challenges of economic change and ecological variability. Pastoralists in the GAE are currently deciding how and to what extent subdivision of their rangelands should occur. There is little doubt that the mechanisms of mobility will change as herders make these decisions and engage increasingly in a diversifying pastoral economy. But the results presented here should be taken into account as the debate over the importance of pastoral mobility in development continues.

Chapter Four

Use of Multiple Indices to Compare Wealth in a Changing Pastoral Economy

The goals of this chapter were to expand understanding of pastoral wealth given that economic diversification and intensification have become the norm in Maasailand rather than the exception. Previous methods used to portray wealth and poverty status in pastoral societies continue to be based almost entirely on some calculation of animal units available on a per household basis within these systems, but have not explicitly accounted either for intensification strategies (e.g. breed improvement efforts) or the economic value of non-livestock activities to household livelihoods. A linked goal was to interweave other available strands of data to provide a picture of how concepts of wealth have changed through time in Maasailand. Two wealth ranking techniques that took into account diversified activities and level of crossbreeding of livestock were created. Household wealth status was compared across time and across five wealth ranking methods (TLU-based, TLU per capita, Breed-adjusted TLUs, Wealth Ranking and Diversified Wealth). How wealth status changed based on the criteria applied was the outcome of interest. Results of the new Diversified Wealth index were applied to the Amboseli sample of households, and the shape and scale of diversification patterns in the GAE were defined based on this measure.

Comparison of animal-based wealth in Maasailand indicated that Maasai are much poorer now than previously. Analysis of the animal holdings documented by Bekure et al. (1991) for the study area in 1984 and GAE households in 2000, illustrated that the distribution of households within wealth strata had shifted substantially towards the poor end of the spectrum. As well, the mean TLU holdings per household within wealth categories were dramatically lower now than in the 1980s. These results suggest that there are now more poor households in the Amboseli region, or in other words, that income stratification is increasing. However, the second result is more suggestive that *all* pastoralists are less wealthy now than in the past – both poor and wealthy households. Both trends may actually be occurring in Kenya Maasailand, but it is important to differentiate between them for purposes of identifying the root causes and processes of wealth change through time.

Results of step by step comparisons of TLU-based wealth with other wealth ranking methods illuminated important aspects of wealth and poverty in pastoral Maasailand. The comparisons of TLUs with TLUs per capita and Wealth Ranking techniques yielded the greatest changes in wealth status across the sample population. The size of a household relative to the size of a herd to support it remains important in defining wealth. The TLU and Wealth Ranking comparison indicated that emic definitions of wealth differed from researcher-defined (i.e. etic) wealth criteria. Results showed that large, well-taken care of families, and the ability to help poorer households, remain locally important wealth criteria in Maasailand. However, qualitative comparisons of wealth characteristics across age categories provided some indication that Maasai definitions of wealth are changing, as younger local informants were more specific about the need for other economic assets and activities outside of livestock than older informants.

A surprisingly small number of households changed their wealth status based on integration of new representations of wealth, specifically the Breed-adjusted and Diversified Wealth ranking methods. Looking at results for the TLU-based vs. Breed-adjusted comparison, one explanation for the small changes in wealth status is that mean TLUs increased across all wealth levels (poor, medium and rich). TLUs for richer households increased slightly more than medium and poor rankings, but it seems that at this point households from all wealth strata are experimenting with improved breed animals in their herds. However, study area analyses also showed that breed improvement efforts are closely linked with agroecological potential. This highlights that pastoralists themselves seem to be well-aware of the positive and negative trade-offs associated with depending on these larger animals. There is a strong sense that pastoralists are on the front lines of experimentation with crossbreeding, and although the potential benefits are large (i.e. greater selling prices), there is significant risk associated with getting these more fragile animals through drought periods.

Another explanation for the low significance of the TLU-based and Breed-adjusted comparison may be a question of timing. The process of cross-breeding is one that is only just beginning for many pastoral producers, although there is every indication that this is a direction in which many herders plan to move (BurnSilver 2005). Retrying this comparison in another five years may well yield very different results.

This chapter also documented surprisingly few households changing wealth status when TLU-based and Diversification Wealth methods were compared. Poor households seemed to stay poor, and rich households stayed rich when the two wealth ranking methods were compared. Implications of these results are important. While previous studies of diversification in pastoral areas have suggested that the importance of livestock would decline as households diversified, this study suggests otherwise. There were no households poor in livestock, who then were classified as rich based only on their agricultural or off-land activities.

Applying the Diversified Wealth index to the GAE sample illustrated additional important patterns of wealth based on analyses of household assets and income flows. Average animal herd size increased consistently from poor to medium to rich households, and highlights the potential link between large livestock herds and few changes in wealth rank trajectories mentioned above. This result also suggests why no mean differences in TLUs per household were documented in the TLU-based and Diversified Wealth comparison, and why livestock continue to be important across the GAE in spite of significant diversification occurring within the system.

Diversification is clearly occurring across all wealth strata in Amboseli. However, rich households seem to be qualitatively and quantitatively different in terms of their economic potential and trajectories. The shapes of household wealth parameters were similar for poor and medium households within study areas, and while the scale of returns rose from poor to medium households, both the scale and shape of wealth changed precipitously for richer households. The returns to households associated with fixed assets, off-land and agricultural activities are dramatically larger for richer households than for poorer. Wealthy households have greater economic capabilities from which to continue investing, while poorer households are limited to engagement in lower value diversification options. This provides additional support for the possibility that income stratification in Maasailand will increase in the future.

Results also confirmed for a pastoral population what researchers have documented for other groups previously; the categories of rich, medium and poor are not homogeneous. Wealth groups pursue very different constellations of activities – and by association – there are different definitions of wealth and poverty emerging in the GAE. As well, combinations of activities pursued by Amboseli households reflected local ecological and infrastructural conditions that represent both barriers and opportunities for households.

This chapter was able to highlight emerging aspects of wealth and poverty in a pastoral system in transition. The baseline question behind the analyses was to ask, "What is wealth"? The answer I identified is that how wealthy vs. poor a household is, depends on how wealth is defined. Obvious perhaps, but very important to recognize given how much the basis for wealth and well-being in Maasailand is changing. Different wealth measures captured aspects of wealth that were linked to both economic intensification and intensification of pastoral production strategies. The new Breed-adjusted and Diversified Wealth measures were not significantly different from a traditional TLU-based measure of wealth in the way they ranked households, but their importance will only increase with time given the current trajectories of change in pastoral areas.

The drivers of economic change and conditions of pastoral production in Maasailand are unique to some extent, but they are equally representative of the broader challenges facing most pastoral societies globally (Blench 2001; Fratkin and Mearns

2003; Steinfeld, Gerber et al. 2006). If the broader goal for those working in pastoral areas is to improve well-being, then a first step must be to define poverty in order to alleviate it. Equally important is to understand wealth and its characteristics – both cultural and economic. In an era of finite development dollars, and under the twin looming spectres of climate and land tenure change in rangeland zones globally, the results of this study should contribute to identifying who is poor vs. rich, what that poverty or wealth is based upon, and what the ramifications of both conditions are for pastoral groups.

IMPLICATIONS OF RESULTS

The Maasai pastoralists are facing a difficult time. Changes are taking place in their area at a very high rate of speed, influencing their daily environment. The lessons and experiences of the past, on which they could rely for so long, are becoming less and less applicable in today's changing world. Nevertheless, choices have to be made today, which will have consequences for the future. With little relevant historical experience to go by in making these choices, and with no interest or insight in the possible future, the danger looms of decisions being taken without really caring for the likely consequences.

-Excerpt of conference opening remarks by M.K. van Klinken. Programme officer ASAL (Arid and Semi-arid Lands). The future of Maasai pastoralists in Kajiado District (Kenya). May 1989.

.... Although privatization would be expected to minimize the amount of common land, and therefore reduce the potential for herders to migrate, the immediate consequence would be pressure on trust land and conflict with wildlife and farmers. This argument is based on the fact that the community in question is very aggressive.... Maasai have been seen in the city center and also invading private farms in search of pasture, due to severe drought.

-Kabubo-Mariara, J. Kenyan Economist at the University of Nairobi. Taken from: Environment and Society 2003 v8: p634

Given the rate and scale of the changes facing Maasai pastoralism in Kenya, predictions for the future currently run the gamut from, They all will become agropastoralists (i.e. something other than pastoralists), to, When subdivision occurs the Maasai will sell their land to non-Maasai and become the landless poor, to, Pastoralists will modernize and diversify their production strategies, and although pastoralism will not look the same, it will still be there. Where the future of Maasai pastoralism actually lies is beyond me to say, but some comments regarding important trajectories are warranted.

One broad result of this dissertation was to identify aspects of Maasai pastoralism that are changing, but also those that are continuing. This study has pointed out exhaustively those aspects of Maasai social, economic and political life that are in transition. The first quote above makes the case that in this changing world, the previous experiences of pastoralists are less relevant. I would disagree strongly with this. Some aspects of Maasailand remain constant. Livestock continue to be critical to livelihoods in spite of ongoing diversification. Drought and ecological variability are constant fixtures of pastoral life, and resources are still highly variable in space and time. Access to development infrastructure and productive inputs is still unpredictable and low. Therefore, some of the coping mechanisms that have worked effectively to offset risk for the Maasai in the past, for example; mobility and strong social capital mechanisms (Galvin 2007), are still extremely relevant today in spite of economic change and trajectories towards sedentarization and subdivision of land. Notwithstanding the comment above on Maasai "aggressiveness", the sentiment does illustrate that regardless of land tenure change, herders are still pushing to get their animals to forage wherever and however necessary. Some have suggested (Evangelou 1984; Galaty and ole Munei 1999) that subdivision may promote the decline of social capital and networking mechanisms among pastoralists. However, the case of subdivision might argue just the opposite (Ngaido 2000; Galvin 2007). Maintaining strong social ties with herders from other agro-ecological zones, and across parcel boundaries, may be the key to maintaining access to critical resources (BurnSilver and Mwangi 2007).

The recent work of Banks (2003) and others (Boone and Hobbs 2004; McAllister, Gordon et al. 2006; BurnSilver and Mwangi 2007; Stokes, McAllister et al. 2007; Wen, Ali et al. 2007) looks at the characteristics of production and mobility that pastoral groups themselves are using to cope with land tenure change and variability. This work emphasizes that some form of collective management – even within the framework of privatized rangeland parcels – represents a critical way for pastoralists to maintain *or regain* (in post-privatization situations) the flexibility to move their animals in response to ecological imperatives, as well as to preserve the social assurance networks that are an integral component of human well-being in these systems. Examples here include the cooperative management of multiple private parcels and pasture sharing or trading seen in Maasailand Kenya, and Northern China (Banks 2003; BurnSilver and Mwangi 2007; Wen, Ali et al. 2007). Cooperative efforts are even seen in input-intensive western ranching contexts, such as agistment (a commercial swapping arrangement between pastoralists who have more forage than they need with those who have less) in Australia (Curtin, Sayre et al. 2002; McAllister, Gordon et al. 2006; Stokes, McAllister et al. 2007) and grass banks in the southwestern United States (Curtin, Sayre et al. 2002). The fact that some of these coping mechanisms are emerging in post-subdivision or privatization situations is indicative that the historical knowledge and experience of pastoralists can be adapted, and is relevant to new contexts.

As well, while subdivision does seem inevitable in the GAE, there is active and ongoing debate at the level of the group ranches over how subdivision should occur

(BurnSilver 2005; Boone and BurnSilver 2007). Should all rangelands be subdivided, or should households receive private parcels in settlement zones and rangelands remain communal? Pastoralists themselves are posing these questions. And it is first-hand local knowledge of the challenges inherent in raising livestock in dryland environments that is pushing this debate forward. So yes, the context of Maasai pastoralism is changing, but local experience remains critical to charting a path forward that makes sense for local conditions. There are small indications as well that development resources are being put into supporting these localized decision-making efforts (ILRI 2007), although the legacy of top-down pastoral development policy in Kajiado is still strong.

Both intensification and diversification processes are clearly ongoing in Maasailand. However, pastoralists are growing poorer. Results from this study suggest obvious questions: Is either process in its current form effectively addressing the challenges of pastoral development in the GAE? Is diversification filling the gap in livestock wealth between current conditions and where pastoralists were in the 1980s? And are household level efforts to intensify livestock production in the absence of substantial development inputs getting pastoralists more from the livestock they do have? The answer seems to be negative. Diversification is widespread, but it is not adding significantly to livelihoods in many cases. Intensification efforts are piecemeal and occurring at the household level without strong institutional or funding support.

So at the household level pastoralists in the GAE are responding to change by pursuing both strategies according to their own capabilities. In the recently released report "Livestocks Long Shadow: Environmental Issues and Options" (Steinfeld, Gerber et al. 2006), the authors speak of both opportunities and costs associated with livestock production: Opportunities for better livelihoods, and potential costs for the environment if it is done incorrectly. High profile reports such as this one highlight that much greater resources are needed to jump-start development in rural areas where producers depend on livestock. If policy makers and funding donors focus on the activities and needs that are emerging at the local level, and work with pastoralists to identify solutions that make sense in local contexts, these development resources may be better spent now than in the past.

This study also attempted to highlight that the processes of mobility, intensification and diversification in the context of change manifest in Maasailand in complex and sometimes subtle ways. The Greater Amboseli Ecosystem is a unique environment that combines challenges of human well-being, livestock production, wildlife conservation, and the maintenance of ecosystem services. This study focused on the first of these two components, but there are interconnections between all system components which defy easy explanations and understandings. A recognition of the complexity inherent in processes of change in this pastoral system and others globally, is crucial if the goal is a clearer understanding of what current changes will mean to future pastoralists.

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