



Constraints, multiple stressors, and stratified adaptation: Pastoralist livelihood vulnerability in a semi-arid wildlife conservation context in Central Kenya



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ABSTRACT

The focus of this study is on how changes in formal and informal institutions have differential impacts across populations in terms of vulnerability of livelihoods to drought, and the unequal processes that shape adaptation to new conditions. Drought vulnerability occurs as a result of exposure and sensitivity to interrelated economic, social, political, and ecological dynamics. There is a need for approaches that can evaluate how the ability to reduce these exposures and sensitivities becomes socially stratified. Building on our understanding of institutional and biophysical constraints in one pastoralist group ranch, we use an approach that draws on quantitative and qualitative data to combine analyses of entitlements, access, and adaptive capacity. We asked how, in a context of changing herding institutions, the ability to adapt to drought and other stressors, is differentiated among actors. We found that herders with higher livestock wealth are more likely to have entitlement sets that include factors that enable access to secure cattle grazing on private wildlife conservation lands, and access to more distant areas with herds of sheep and cattle – two key means of reducing exposure to drought vulnerability, leading to greater coping ability during drought. Those with lower livestock wealth rely disproportionately on illicit, precarious access to external grazing resources. Higher livestock wealth families experienced disproportionately lower sensitivity to drought with smaller losses of cattle, and likely have decreased sensitivity to drought-related market fluctuations, while others are primarily reliant on small stock and/or precarious access pathways. However, rather than naturalize this differential ability as merely increased adaptive capacity for some that are better able to adapt to novel, local conditions, we argue this instead reflects the unequal footing that households find themselves on, in a shifting institutional landscape of structural and relational access constraints and reconfigurations of reciprocity, that are intertwined with interventions by state and non-state actors.

1. Introduction

The impacts of climate change are expected to be experienced unequally in many contexts (Bassett and Fogelman, 2013; Marino and Ribot, 2012), and there is a need for approaches that are attentive to implications for the livelihoods of those most likely to bear the brunt of climate change impacts (Ribot, 2010). Additionally, given how multiple stressors can structure vulnerability (Adger, 2006; McDowell and Hess,

2012; O'Brien et al., 2004; Räsänen et al., 2016; Turner et al., 2003), and the deep interdependence between development, ecological variability, and vulnerability (Adger, 2006; Nelson and Finan, 2009), it is vital to understand how factors such as global economics interact with climate change (Eakin, 2005; O'Brien and Leichenko, 2000). With numerous changes occurring in customary institutions that historically enabled rural land users to respond to environmental stressors in the past, there is a need to understand the ultimate causes of vulnerability

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(Ribot, 2014) and the ways that adaptation occurs today. Recent developments in interdisciplinary approaches merge perspectives of entitlements (Leach et al., 1999) and livelihoods (Scoones, 2009) to consider institutional, political, and economic factors explicitly (Eakin and Luers, 2006), and track how institutional changes can lead to an unequal ability of different people within a society to respond to hazards (Goldman and Riosmena, 2013; Ribot, 2010; Turner et al., 2003).

Mobility is essential to gain access to key resources that are highly spatially and temporally variable across semi-arid landscapes (Ash et al., 2002), and fragmentation of semi-arid lands can lead to limited response capabilities of herders, leading to decreased efficacy of subsistence by pastoralism alone (Hobbs et al., 2008). Pastoralist grazing institutions in Kenya strongly reflect semi-arid dynamics allowing for flexibility of access in relation to variation in rainfall, but have also been modified by a number of state interventions, beginning in the colonial era, including fragmentation of land use (Mwangi and Ostrom, 2009a). Pastoralists in semi-arid rangelands are expected to experience disproportionate impacts of climate change (Ericksen et al., 2013), potentially compounding the impacts of rangeland fragmentation. In fragmented landscapes, changing institutions can necessitate a new set of entitlements required to access forage at different spatial scales, shaping how livelihoods adapt to novel institutional conditions (Goldman and Riosmena, 2013). Previous analyses in Laikipia have documented changes in pastoralist livestock husbandry practices that have led to stratification in livelihoods, with large differences in herd sizes and market relations (Herren, 1987, 1991). In our own work, it has been shown that dispossession of lands and political marginalization, along with more recent privatization, conflict, formalization of group ranches, and conservation interventions have all contributed to limitations on grazing movements outside of Koiya since the early 1980's. Under these constraints, changes in livestock husbandry practices and norms of reciprocity have led to decreasing coordination between households, while inequality has increased (Unks et al., *In Press*).

In this context of institutional change, as drought and livestock markets together act as combined stressors on herder livelihoods, this paper analyzes multiple interacting dimensions of livelihoods that act together to shape an unequal ability to cope with drought and adapt to new conditions. We first review how extended entitlements approaches (Leach et al., 1999; Goldman and Riosmena, 2013), access (Ribot and Peluso, 2003), and critical accounts of adaptive capacity (Cote and Nightingale, 2012; Ribot, 2014) can be used to improve analysis of the structure of livelihood vulnerabilities. Then, after describing methodology, we present results from a case study in Laikipia that shows the distribution of types of access among households, what is required to achieve this access, and how these interact with multiple stressors related to drought events today. We discuss the structure of access as it relates to differential vulnerability, response capacity, the ability of individual households to sustain their livelihoods, and institutional change.

2. Entitlements, access, and stratified livelihood adaptation

A long line of scholarship has explored the context-specific factors that mediate complex human-environment interactions as they shape livelihoods and the ability to cope with and adapt to variable and/or changing climates. Much of this work can be traced back to early approaches in hazards, livelihoods, and political ecology (Adger, 2006). There has been a large amount of interdisciplinary borrowing and overlap between approaches to vulnerability analysis (Adger, 2006; Turner et al., 2003). The ability to cope and adapt to hazards is increasingly recognized as structured by the interaction of institutional, environmental, and household factors at multiple scales, leading to a complex biophysical and social basis of vulnerability with differential abilities to respond in different contexts (Agrawal, 2010; Blaikie, 1994; Eakin, 2005; O'Brien et al., 2007; Pelling, 1999; Watts and Bohle, 1993).

People's experience of stressors on their livelihoods and responses to changing environments are influenced by factors such as specific household assets and how those interact with institutions. Institutions, i.e. the “rules of the game”, refer to informal and formal rules and norms that can form constraints that shape human interactions (North, 1990; Ostrom, 1990). Institutions mediate interactions between livelihoods and ecological processes at different scales. These interactions can be mapped using an extended entitlements approach to understand how resource access is structured (Leach et al., 1999). Entitlements mediate a persons' ability to utilize other resources or endowments (Leach et al., 1999; Sen, 1984), and can be thought of as the gains that people are able to achieve, given their endowments, or assets (Bebbington, 1999), based upon their own production (Adger, 2006). Using this approach, one can examine resource use and exposure to stresses due to ecological change as experienced across social strata, revealing how vulnerability interacts with institutional and economic factors (Adger, 2006; Turner et al., 2003). The extended entitlements approach also expands beyond a strictly legalistic understanding of property and rights (Leach et al., 1999), making it compatible with understandings of legal pluralism, and diverse local systems of legitimation, to include structural and relational factors that shape access (Ribot and Peluso, 2003; Sikor and Lund, 2009).

In attempting to bridge understandings of the interaction of ecological and social factors from a social-ecological systems perspective, the concept of adaptive capacity (Folke et al., 2002; Folke, 2006; Gallopin, 2006; Nelson et al., 2007; Smit and Wandel, 2006) is frequently used to conceptualize and analyze the underlying social conditions that shape the ability of a system to evolve to cope with greater environmental variability (Adger, 2006). However, the idea of adaptive capacity has faced criticism in its tendency to conceal the drivers of changes, leading to an attribution of vulnerabilities to a localized, proximate lack of response rather than to the ultimate underlying factors masking political, economic, and social factors that have historically shaped vulnerability (Bassett and Fogelman, 2013; Cote and Nightingale, 2012; Ribot, 2014). As crises are often rooted in historical and social factors, simply understanding the capacity to adapt and cope with vulnerability leads to a tendency to naturalize inequality in adaptation (Ribot, 2014). However, using an extended entitlements approach (Leach et al., 1999) to map access and benefits, can lead to a simultaneous understanding of the mechanisms by which benefit flows are “gained, controlled, and maintained” as well as the underlying relations that structure access and that ultimately impact the ability of a system to change (Ribot and Peluso, 2003). Synthesis of these approaches enables consideration of the differential ability of some to adapt, and the institutional constraints to adaptation that may also drive differential impacts, while simultaneously analyzing the ultimate political, social, and economic drivers of vulnerability (Ribot, 2010).

We drew from the above literature on vulnerability, entitlements, access, and adaptation to study recent changes in pastoralist livelihoods in central Kenya, where pastoralist livelihood shifts have occurred amidst a changing social, ecological, political, and economic context. In analyzing livelihood vulnerability at Koiya, a pastoralist group ranch in Laikipia, Kenya, we treat exposure as the inability to avoid drought conditions, and expect that exposure level will be a function of herding entitlements within a given multi-family household (Fig. 1). We treat sensitivity as the degree to which drought exposure will impact well-being, which is expected to vary as a function of household wealth or herd size, and the ability to buffer herd losses due to drought and diseases, as well as offtake for sales. Using this framing, some households, for example, may be better able to decrease their exposure to drought through mobility, while other households may be less sensitive to stressors, even though they are unable to mobilize to decrease their exposure (Fig. 1). These two factors can then interact to shape a given households' overall vulnerability (Fig. 1).

Previous analysis of changes in herding institutions indicated recent decreases in reciprocity of livestock husbandry at the same time as

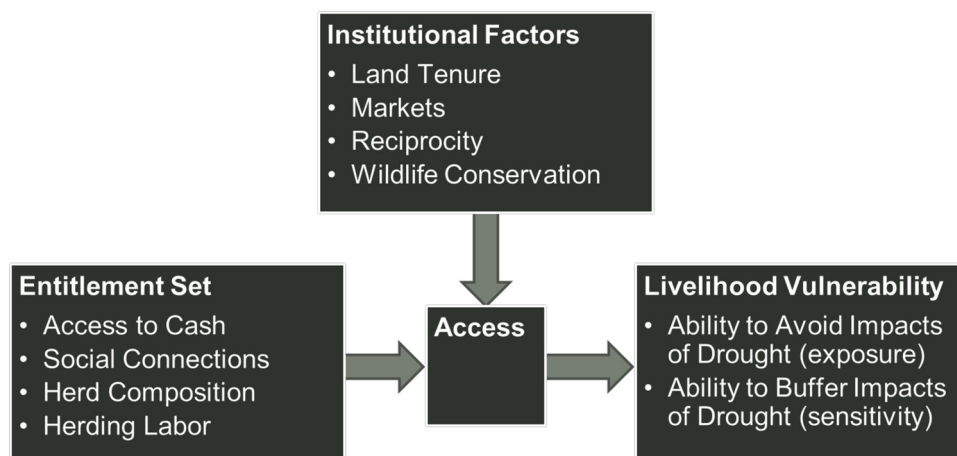


Fig. 1. Conceptual framework of example interactions between institutions and entitlement sets that shape access, in turn impacting household vulnerability to drought.

changes in access to forage and types of animals being kept had occurred (Herren, 1991; Unks et al., *In Press*). We built upon this understanding to determine the ways that access is secured, the differing levels of utilization of these types of access that are distributed among households, what underlying factors structure this distribution, and how this new system of access relates to vulnerability to stressors. We then related this structure of vulnerability to historical institutional changes in Laikipia. Our analysis is divided into the following analytical categories that detail the unequal structure of livestock husbandry as experienced through (1) patterns of household assets that enable reduced exposure to drought, (2) differential access to forage resources, (3) sensitivity to livestock markets, and (4) sensitivity to drought and disease. We consider these categories in terms of household factors that interact with formal and informal institutional constraints to impact access to forage resources and which we expect to affect exposure and sensitivity. Including consideration of cultural, political-economic, and biophysical factors, we use quantitative statistical analysis as well as qualitative accounts of relative and perceptual dimensions of vulnerability (Eakin and Luers, 2006). We combine a survey-based analysis of vulnerability, an in-depth ethnographic analysis of herding livelihoods, and quantitative analysis of trends informed by ethnographic accounts. We then analyze and discuss the structure of access inequality according to livestock wealth, and the interactions between entitlements at the household level with employment, livestock markets, and novel informal and formal herding institutions.

3. Historical changes in pastoralist subsistence practices in Laikipia

Prior to mass removals that occurred under the British colonial authority in the early 1900's, Laikipia was populated by both hunter-gatherers and Maasai pastoralists (Cronk, 2004; Hughes, 2006). In 1914, the Purko-Kisongo Maasai were forcibly relocated to southern Kenya (Hughes, 2006), while the remaining indigenous inhabitants of Laikipia were confined to the driest, most marginal land (Herren, 1987), in an area today known as Mukogodo Division. Following these relocations, a variety of complex interactions are thought to have resulted in increased intermarriage between various hunter-gatherers and remaining Maa-speaking pastoralists, and the predominant livelihood shifted from hunter-gatherer to primarily pastoralist between 1925 and 1936 (Cronk, 2004).

The East Africa Royal Commission (also referred to as the Dow Commission) of 1952 deemed the common property regime of pastoralists to be the root cause of land degradation, and recommended that eventual subdivision should be the goal of policy (Mwangi and Ostrom,

2009b). This was in large part based upon an understanding of the pastoralist commons as areas with no regulatory institutions that would inevitably become degraded unless privatized (Rutten, 1992). Group ranches, or subdivisions within reserves (Group Representatives Land Act Chapter 287), were legislated in 1970, with the intention to reduce livestock and avoid land degradation (Rutten, 1992), based upon the rationale of conversion of livelihoods toward commercial beef production, with commercial ranching consistently being favored by official Kenyan policies (Broch-Due and Anderson, 1999). Subdivisions within Mukogodo Division were designated at the time, but group ranches here, as well as throughout Kenya, did not become commercial livestock producers for a variety of reasons (Waller, 2012), and the subdivisions were largely ignored (Kaye-Zwiebel, 2011). Prior to the early 2000's, government presence mostly involved enforcing the outside borders of Mukogodo Division to constrain cattle movements, encourage market integration (Herren, 1987), and extract taxes on cattle.

While the number of livestock units per household has decreased dramatically throughout East Africa from the colonial era to the present, Mukogodo Division has been shown to have very low levels of livestock wealth compared to other Kenyan pastoralists, and notably high numbers of small stock (sheep and goats) relative to cattle (Herren, 1991). These differences in herd composition are thought to be driven by a combination of loss of grazing access outside of Mukogodo Division, and the subsequent drought events, disease, and excessive offtake as herders sought to purchase grains to survive (Herren, 1991). Purchased maize now constitutes the majority of caloric intake, and diets are typically low-protein today (Hauck, 2013). Reciprocal networks of animal exchange, common among pastoralists, began to break down in the mid-1980's due to extreme stratification of the population following a series of droughts and increased market integration in the early 1980's (Herren, 1987, 1991). There is a continuum of wealth differences between families and between group ranches not just in terms of cattle (Herren, 1991), but in ability to subsidize pastoralism and engage in other activities that supplement wealth (Kaye-Zwiebel, 2011). Additionally, some households are able to utilize livestock markets under relatively beneficial conditions, while other producers sell animals under less favorable conditions (Hauck, 2013). Over the past 30 years, as the landscape has continued to become more fragmented, seasonal grazing access inequality between households has deepened, and a more individualistic approach to livestock husbandry has emerged (Unks et al., *In Press*). Where herding labor for large multi-family groups was historically provided by the *ilmurran* (unmarried males highly trained in cattle herding) collectively for the entire group, today this herding labor, as well as many other dimensions of livestock husbandry, has become increasingly individualized among households

(Unks et al., *In Press*). Decreased sharing of labor between households is also related to livestock markets and reduced reciprocity in animal exchanges (Herren, 1991), as well as continued loss of access to seasonal grazing, the biophysical constraints of herding small stock, rising inequality, and the relations of individuals with conservation actors (Unks et al., *In Press*).

The collapse of the Kenya Meat Commission at the end of the 1980's, coupled with decreased exports of animals to the Middle East, led to a decrease in the viability of commercial cattle-only ranches in Kenya (Heath, 2001), driving shifts to a new business model of pro-wildlife conservation ranching and ecotourism in Kenya. Livestock market prices today are mainly determined by private buyers and are highly variable, especially during drought. Following pastoralist claims to ancestral Maasai lands (Kantai, 2007), a number of community-based conservation (CBC) "trusts" were formed (Kaye-Zweibel, 2011; NAREDA Consultants Ltd., 2004; Lamers et al., 2014) between group ranches, private ranches, and a consortium of NGOs, primarily in the early 2000's. These CBC trusts resulted in the formal titling and adoption of statutory group ranch governance and management structures, as well as group ranch boundaries within Mukogodo Division being formally recognized, and growing authority of conservation actors within the internal management of group ranch affairs (Zaye-Zweibel, 2011; German et al., 2016).

As part of the formation of these CBC trusts, group ranches set aside wildlife conservation areas meant to exclude livestock and adopted land management zones (Fig. 2), while ecotourism enterprises were developed to generate revenues to be channeled toward employment, infrastructure, healthcare, and education services (Sumba et al., 2007). CBC trusts are known to have been motivated to incentivize livelihood shifts among pastoralists, to foster increased emphasis on landscape-level wildlife conservation, and create leverage against future land claims or grazing access demands by pastoralists (Sumba et al., 2007). As a result of these CBC trusts, new CBC trusts in nearby areas, and conflict between other pastoralist groups, access to dry season forage has reduced markedly in recent years, and has been accompanied by increasing inequality (Unks et al., *In Press*).

4. Case study

4.1. Study site

Koiya group ranch is approximately 7605 ha (Kaye-Zweibel, 2011) and home to at least 2761 people living in approximately 243 *nkangitie* (*nkang*, singular; a residential compound of an extended household of several nuclear families, usually of patrilineal descent). Most who reside at Koiya group ranch today trace ancestry to the LeUaso hunter-gatherer group, and in casual conversation speak of grandparents who primarily hunted, gathered, and kept bees for a living, with some also referencing Maasai, Samburu, and Laikipiak Maasai genealogy. Today, the main livelihood is livestock husbandry, but many people also keep bees. Koiya is located on the western edge of Mukogodo Division, bordering the Ewaso Ng'iro river and privately-titled ranches to the west, other pastoralist group ranches to the east and south, and Isiolo county to the north. It is at an elevation of ~1700 m, with a mean annual precipitation of approximately 450 mm, with a coefficient of variation of annual rainfall of about 40%, which is substantially higher variability and lower mean annual rainfall compared to the majority of Laikipia county (Franz et al., 2010). Rainfall is bimodal, with the highest amounts typically occurring in April-May and November, with long, unpredictable periods where rainfall is very low and consequently vegetation is highly variable seasonally. The landscape vegetation matrix is highly heterogeneous with patches of *Acacia* species mixed with grasses, herbaceous glades, areas of recent shrub and succulent encroachment, and areas with vertisol soils dominated by perennial grasses.

4.2. Methods

Beginning in 2013, we conducted eight focus-group discussions with elders (men and women), two within each of four areas where *nkangitie* are spatially grouped together at Koiya, to determine salient livelihood changes that have occurred over recent history. We then completed surveys (sampling all households) with an elder at each *nkangitie* who is involved with herding decisions (male or female, average age estimated at ~48.2 yrs.). Two brief follow-up surveys were done at each *nkang* in 2014 and 2015. We were unable to locate elders from 18 *nkangitie* to

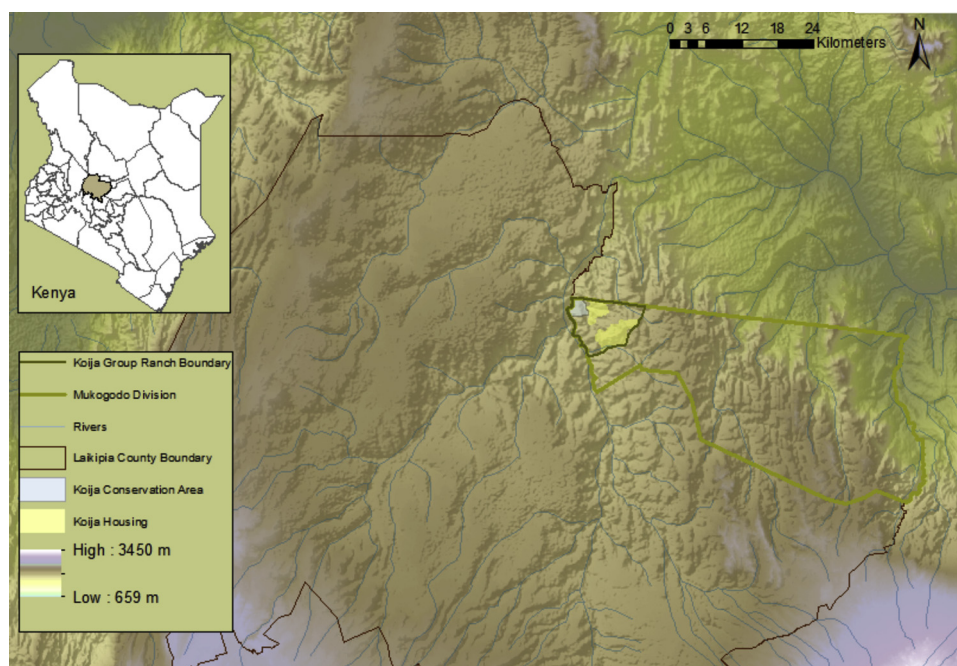


Fig. 2. Map of study site. Sources: ASTER Digital Elevation Model. ILRI Streams Layer.

complete surveys, and between 2013 and 2014 four *nkangitie* relocated to areas outside of Kojja, so follow-up surveys were not completed for these *nkangitie*. Twenty in-depth key informant interviews were done in 2013–2014 with senior elders about herding ecology and livelihood changes over the previous 30 years. Survey data included information on livestock and *nkang* wealth, income, and herding labor to analyze household entitlements in relation to herding practices, seasonal herding location place names, and included livestock sales as a measure of access in the changing institutional context (Fig. 1). Survey data and key-informant interviews were then used together to evaluate exposure to and sensitivity to drought (Fig. 1). All focus-groups, surveys, and interviews were translated and transcribed from Maa to English. Trends were coded and analyzed using NVIVO software (Version 11).

To enable statistical analysis of the herding characteristics of *nkangitie*, we analytically grouped *nkangitie* according to both composition and size of herds using livestock numbers from a count the authors conducted in 2016. We considered 214 out of 244 of Kojja's *nkangitie*, excluding those with no livestock or for which we had incomplete surveys. We grouped *nkangitie* using a two-stage hierarchical clustering approach (Ward's method, standardized data, JMP, 2016), with numbers of cattle, goats, and sheep per average adult male equivalents (Nestel, 1986) within each *nkang* as input variables. We achieved maximum separation between groups with 5 clusters. By analyzing the graphical representation of clusters, as well as the average numbers of each livestock species in each cluster, we then determined that three clusters all represented higher overall holdings, and these three groups were merged to enable statistical comparison. This resulted in three final groupings with $N > = 50$ per group, which we refer to as low, medium, and high clusters in the results. Average livestock holdings within these three clusters are shown in Table 1. For each household asset analyzed, we tested whether the proportion of households with access to that asset differed between clusters using chi-square contingency tests. We tested whether continuous variables such as household income differed between clusters using one-way ANOVA. Statistical analyses of all survey data (ANOVA, multivariate clustering, t-tests, contingency analysis, correspondence analysis, and analysis of means for proportions, spearman correlations) was completed using JMP software (2016).

4.3. Results

The results are organized into four analytical categories that track the structure of exposure and sensitivity to livelihoods observed at Kojja, and conceptually link to our analysis of vulnerability. These include:

- 1 Patterns of household assets that enable reduced exposure to drought
- 2 Analysis of seasonal forage access (exposure to drought)
- 3 Sales and herd offtake (sensitivity to livestock markets)
- 4 Household sensitivity to drought, and the interactions of drought with livestock diseases (sensitivity to drought)

4.3.1. Patterns of household assets that enable reduced exposure to drought

In this section, we describe the underlying factors that facilitate the different types of access to grazing resources, and examine how these

factors were distributed according to each livestock cluster. These factors include: outside income required to pay for herding costs, household assets that allow for certain types of access, household labor that supports increased livestock mobility, and social relations that can secure access. In interviews, respondents most frequently emphasized that an additional house and cattle enclosure located in a grazing area outside of Kojja, and the herding labor to be able to travel and/or split *nkangitie* – were closely related to use of informally accessed areas outside of Kojja. When asked why some herders may avoid these areas, it was commonly said that in order to exploit these areas, in addition to having a house and enclosure there, additional medicines for diseases that are more common there, and the ability to split *nkang* herding labor are required. Another factor that was sometimes emphasized was the aid of a motorbike to carry necessary items such as building materials, food, and water, to purchase medicine, salt, and grains at lower prices in nearby cities, as well as to transport family members and newborn and juvenile animals, and to scout for forage during droughts.

When we analyzed these reported patterns quantitatively, we found that *nkangitie* in the high livestock cluster were significantly more likely to have an additional house and livestock enclosure outside of Kojja compared to medium livestock *nkangitie*, and both were more likely to have an additional house and livestock enclosure compared to low livestock *nkangitie* (Table 2). High livestock *nkangitie* were also more likely to own motorbikes compared to medium livestock *nkangitie*, and both high and medium livestock *nkangitie* were more likely to own a motorbike compared to low livestock *nkangitie* (Table 2).

The ability to move to informally accessed areas was reported to largely depend on the *nkang* labor required for herding, as well as for building and maintaining a house and cattle enclosure. The changing institutional norms of labor sharing, as well as many young people being in school, have influenced patterns of labor, which took a stratified shape. To manage and meet labor demands, high livestock *nkangitie* were more likely than medium livestock *nkangitie* to combine their herds when migrating, and both were more likely to combine when migrating compared to low livestock *nkangitie* (Table 2). Herders in the high livestock cluster were also more likely to hire *ilmurran* from neighboring families to herd compared to medium livestock *nkangitie*, with both being more likely than low livestock *nkangitie* to hire (Table 2). Finally, high and medium livestock *nkangitie* were more likely to express confidence in herders than low livestock *nkangitie* (Table 2). These patterns demonstrated that access to key assets mentioned by interviewees to enable external grazing were positively associated with household livestock holdings.

It was frequently emphasized in interviews that outside income, usually from work on a conservation-oriented private ranch, allows individuals to offset the costs of herding and allocate money directly to food purchases and other costs, and in previous work we found that there was a greater likelihood of cattle and sheep herd increases between 2002 and 2016 for *nkangitie* with a member that was employed (Unks et al., *In Press*). While there was no significant difference between the three livestock clusters in prevalence of outside employment (Pearson $\chi^2 = 0.087$, $p = 0.9572$), high livestock *nkangitie* had significantly higher levels of income due to jobs located outside of Kojja, typically on neighboring private ranches (ANOVA, $F_{2, 211} = 4.1379$, $p = 0.0173$).

We assessed the costs of herding and the role of access to cash in

Table 1

Three clusters of households representing average livestock holdings divided by active adult male equivalents (AAME). Means for clusters are shown with standard error in parentheses.

Cluster	Livestock cluster	N	Cattle/AAME	Goats/AAME	Sheep/AAME	Camels/AAME
1	high	50	3.25(0.25)	15.45(1.17)	13.96(2.75)	0.34(0.10)
2	medium	82	1.19(0.08)	7.37(0.35)	2.97(0.25)	0.04(0.02)
3	low	82	0.24(0.3)	2.51(0.17)	0.67(0.12)	0.02(0.01)

Table 2
Percentages of households in each livestock cluster that reported access to key herding assets, as reported in 2014 surveys (*indicates cluster significantly differs from all others in chi square contingency analyses).

Livestock Cluster	Additional House and Livestock Enclosure	Owned Motorcycle	Combines Herds When Migrating	Hire <i>ilmurran</i>	Confidence in herder
High (n)	34.00* (50)	58.00* (50)	36.73* (49)	24.00* (50)	97.96 (49)
Medium (n)	10.98* (82)	28.57* (77)	25.61* (82)	3.70* (81)	95.12 (82)
Low (n)	1.22* (82)	8.00* (75)	13.41* (82)	0.00* (82)	81.58* (76)
Pearson χ^2 (df)	30.578 (2)	37.035 (2)	9.624 (2)	29.555 (2)	12.602 (2)
Probability	< 0.0001	< 0.0001	0.0081	< 0.0001	0.0018

facilitating herding success. Reported costs incurred were subsequently coded into categories. In Table 3, we report the assets as ranked by the number of times mentioned by *nkangitie* within different livestock clusters, and also according to the number of times that factor was volunteered first, as a proxy for salience. *Nkangitie* in the low cluster were less likely to mention costs in all categories except medicine and salt. Medium livestock *nkangitie* were less likely to indicate the costs of paid grazing, the costs of herder payments, and the costs of paying for food for herders compared to high livestock *nkangitie*, but were at the same time more likely to indicate the costs of illicit grazing (Table 3), a factor that was frequently emphasized in interviews.

In summary, while interviewees often emphasized that herding outcomes are a result of luck or skill of herders, we found that individuals with greater abilities to maneuver access in external areas with reserve grazing for cattle and sheep, are also often able to allocate *nkang* resources in ways that facilitate splitting of *nkangitie* to multiple locations, to allocate funds in different ways for livestock care, and to manage herds in times of drought. Higher livestock *nkangitie* had greater access to many of the assets that provide such abilities.

4.3.2. Analysis of seasonal forage access

In this section, we report the institutional structure of current seasonal forage access pathways outside of Koiya and analyze how access, as a key element of successfully sustaining sheep and cattle herds, and thus a pinch-point of livelihood vulnerabilities during drought, is distributed among the three livestock clusters. Goats typically remain at Koiya and can survive by browsing woody vegetation except during extreme drought. Cattle rely on grasses and require mobility as soon as the herbaceous forage is exhausted, while sheep require an intermediate level of mobility, surviving for longer on diminishing perennial grass resources than cattle. To access forage outside of Koiya, four main pathways exist. One of these is through areas that have been open to all Koiya residents over recent decades and are typically either formerly government lands or lands that were granted to absentee landholders in the post-independence era, and that have a recent history of being

Table 3

Herding costs according to if they were ever mentioned, or mentioned first, and contingency analysis if ever mentioned (N = 214 households total; n = 50, 82, and 82 for high, medium, and low livestock clusters, respectively).

	Number of times mentioned	Number of times mentioned first	High cluster % mentioned	Med cluster % mentioned	Low cluster % mentioned	Pearson χ^2	Prob > ChiSq
Medicine	211	136	98	98.78	92.68	4.79	0.091
Salt	198	5	90	95.12	87.80	2.82	0.245
Paid Grazing	101	46	86.00*	53.66*	17.07*	61.44	< 0.001
Cost of Illicit Grazing	58	14	28.00*	36.59*	17.07*	7.93	0.019
Herder Payments	23	10	28.00*	7.32*	3.66*	20.82	< 0.001
Food for Herders	10	0	16*	2.44*	0*	19.34	< 0.001

accessed again by pastoralists seasonally. These are referred to as informally accessed sites from here on. Another type of access is through paid grazing arrangements, where neighboring privately-titled conservation ranches set a quota for cattle that can enter to graze for a fee. The third is access granted through relationships with employers on these same conservation ranches to employees or people with close relations. Both of these, which we refer to together as permitted grazing arrangements, have large beneficial impacts for these animals during drought. The final pathway is through illicit access, where herders access areas that either they or elders had access to historically, but for which no legal access rights exist today. In this final case, if the area is formally privately-titled, the authority to enforce exclusion is conferred by the state to private title-holders, despite this concept of exclusive ownership being locally contested by Koiya residents. Permitted grazing is rarely made available on privately-titled conservation ranches for sheep and goats, so small stock utilize informal and illicit access pathways alone.

Goats rarely leave Koiya, but sheep were frequently stated by many to be largely dependent on informally accessed areas with different ecological conditions, including areas with vertisol soils and large amounts of *Pennisetum mezianum* (*Igurume*) grass. It was stated in interviews that informally accessed areas are only suitable for cattle following consistent rains that make this grass suitable for cattle grazing and create sufficient surface water pools in ephemeral ponds, rock catchments, or seasonal streambeds. Therefore, cattle access to external grazing is dependent on either permitted grazing on private ranches, or in illicit areas for long periods when no surface watering points are available. All members of Koiya are thought to be permitted to access resources in the informally accessed areas, and no one indicated in interviews that anyone from Koiya was ever denied access. While it is commonly said that there is no practice of exclusion limiting access at these places, when questioned why they did not visit them, interviewees responded that they avoided these areas due to density of livestock and risk of disease.

In 2013, when it was not considered drought, but there was reportedly insufficient cattle forage on Koiya, high livestock *nkangitie* had 756 head of cattle from 44 *nkangitie* on private ranches; medium livestock *nkangitie* had 397 head of cattle from 59 *nkangitie* on private ranches, and low livestock *nkangitie* had 141 head of cattle from 39 *nkangitie* on private ranches. The 10 *nkangitie* with the largest numbers of cattle, who also notably did not mention using illicit areas, had 347 out of their 891 head of cattle (38.98%) on the private ranches, making up 26.82% of the overall permitted access on private land at this time. We then analyzed rates of access to external forage areas during severe drought in March-April 2015 as a proxy for the exposure component of vulnerability. At this time, there were no cattle remaining at *nkangitie* on Koiya, there was very little herbaceous vegetation remaining, and animals of all livestock breeds were frequently dying of starvation. During this time, recording the number of cattle in specific locations outside of private ranches was difficult as herds were often split and frequently shifted between locations according to forage and water availability. However, we were able to assess household level strategies,

Table 4

Percentages of *nkangitie* reporting use of different areas for cattle grazing during the 2015 drought (n = 154, excluding *nkangitie* with no cattle, df = 2, * indicates cluster significantly differs from all others).

Livestock Cluster	Cattle on Private Ranches Grazing	Cattle in Informally Accessed Grazing	Cattle in Illicit Areas
High	72.34*	61.70	85.11*
Medium	50.00	56.06	95.45*
Low	41.46	26.83*	70.73*
Pearson χ^2	9.38	12.35	12.64
p	0.009	0.002	0.002

and found stratification in the ways that cattle owners were utilizing different access pathways during the drought. High livestock families were more likely to report they had cattle on private ranches, through paid access and through employment access pathways (Table 4). Use of informally accessed areas was also higher by *nkangitie* within the medium and high livestock categories (Table 4), with only 11 of the 82 low-livestock *nkangitie* using these areas. At the same time, medium livestock families were most likely to report they were reliant on illicit areas for at least some cattle, which was greater than either high or low livestock families during this time (Table 4). Some interviewees emphasized that illicit access was accompanied by high risks in terms of danger due to buffalo, elephants, lions, and leopards, in addition to potential monetary penalties or jail sentences, but indicated this was their only available option to keep their cattle from dying.

All livestock categories differed in their reporting of sheep in informally accessed areas, as well as in the likelihood of sheep remaining at *nkangitie* on Koiya (Table 5), with high livestock *nkangitie* being most likely to use informally accessed areas, and low livestock *nkangitie* being most likely to have their sheep at Koiya. Medium livestock families, similar to patterns of cattle access, reported greater use of illicit areas for sheep during the drought (Table 5). The lowest livestock *nkangitie* expressed a greater tendency for goats to remain at Koiya, as well as being less likely to use informally accessed or illicitly accessed areas (Table 6). Among low livestock *nkangitie*, 35.37% indicated their livestock, which were primarily small stock, could survive on Koiya, compared to just 4.00% and 7.32% in high and medium livestock *nkangitie*, respectively (Pearson $\chi^2 = 30.614$, $p = < 0.001$).

To assess potential exposure to continued drought, we asked representatives of *nkangitie* if they had alternative plans for grazing access if the 2014 drought continued into 2015. High livestock *nkangitie* were more likely to indicate they had backup plans compared to medium livestock *nkangitie*, and both were more likely to have a backup plan compared to low livestock *nkangitie* (Pearson $\chi^2(2, N = 142) = 14.508$, $p = 0.0007$).

In summary, three clear access patterns are apparent for different livestock clusters. The differential use of informally accessed areas for sheep and cattle forage indicates that herders with higher livestock utilize informal and formal areas to reduce their exposure to drought to a greater extent than medium and low livestock *nkangitie*. Grazing

Table 5

Percentage of high-, medium-, and low-livestock *nkangitie* with sheep using different areas during drought in 2015 (n = 167 *nkangitie*, df = 2).

	Sheep in Informally Accessed Areas 2015	Sheep in Illicitly Accessed Areas 2015	Sheep Remained at <i>Nkang</i> 2015
High	56.00%*	30.00%	14.00%*
Medium	32.43%*	39.19%*	28.38%*
Low	18.60%*	32.56%	48.84%*
Pearson χ^2	19.86	19.86	19.86
p	< 0.001	< 0.001	< 0.001

Table 6

Percentage of high-, medium-, and low-livestock *nkangitie* with goats using different areas during drought in 2015 (n = 208 *nkangitie*, df = 2).

	Goats in Informally Accessed Areas	Goats in Illicitly Accessed Areas	Goats Remained at <i>Nkang</i>
High	14.00%	52.00%	34.00%
Medium	13.41%	43.90%	42.68%
Low	5.26%*	21.05%*	73.68%*
Pearson χ^2	23.76	23.76	23.76
p	< 0.001	< 0.001	< 0.001

quotas available to a cross-section of Koiya constituted a small proportion of access required to support cattle, and the ability to secure additional access requires cultivation of relations with private conservation ranches, who offer direct grazing privileges to *nkangitie* with employed members, close confidants, who sometimes inform on others for illicit grazing and hunting.

4.3.3. Sales and herd offtake

Another salient theme mentioned by key informants was the interaction between need for cash and herd size, where larger herds can buffer the strain of selling animals to buy food, maintain cattle, and pay medical bills or school fees, if one has no outside income. Here we consider herd size and market relations to contextualize the balance that families must strike between expenses and trying to avoid offtake as it closely relates to the ability of *nkangitie* to buffer themselves from, and thus reduce their sensitivity to, negative impacts of droughts. In 2014, high livestock *nkangitie* sold on average 14.91% (+/-1.26 SE) of their small stock (sheep and goats) and 11.82% (+/-1.67 SE) of their cattle per year, while medium livestock *nkangitie* sold 25.41% (+/-3.31 SE) of their small stock, and 12.25% (+/- 1.44 SE) of their cattle. On the other hand, low wealth *nkangitie* sold 61.36% (+/-11.08 SE) of their small stock and 16.53% (+/-3.76 SE) of their cattle. Also, *nkangitie* with high and medium livestock levels were less likely to sell livestock for food (18.37%, 20.00%, respectively) than low livestock *nkangitie* (66.67%) (Pearson $\chi^2(2, N = 201) = 44.71$, $p = < 0.001$). Analyzing interactions with market institutions, there were also differences in the specific markets where individuals sold animals, which interviewees emphasized as highly important because of differences in the prices paid and their proximity. The most local market was in Ewaso, the trade center on Koiya group ranch, with low prices offered compared to the government sanctioned auctions in nearby centers. Some key informants mentioned in informal discussions that individuals would commonly buy animals from others who lacked the ability to travel, and in turn sell at more distant markets where higher prices were obtained.

Another salient aspect of livestock sales is that people with larger herds or outside income, were said to be able to sell animals at their convenience when prices are high, while others are often forced to sell regardless of current prices, to obtain cash for day to day living expenses. Due to having only one year of sales data and the high fluctuation in prices between years, we were unable to quantitatively analyze the direct impact of offtake on herd dynamics. However, high and medium livestock *nkangitie* were less likely (10.00% and 14.63%, respectively), compared to low livestock (28.05%) to sell at Ewaso (Pearson $\chi^2(2, N = 214) = 8.10$, $p = 0.017$). Comparing only families with cattle, high livestock *nkangitie* were also more likely to sell cattle at the more distant and larger market in Rumuruti town (26.00%), when compared to medium livestock *nkangitie* (10.8%), and both high and medium livestock *nkangitie* were more likely to sell there than low livestock *nkangitie* (0.00%, Pearson $\chi^2(2, N = 172) = 15.68$, $p = < 0.001$). No significant differences were found between livestock holding categories and sales rates at other markets or to nearby ranches. Confirming the greater strain of sales on lower livestock *nkangitie*, they

were more likely (22.67%) compared to high (6.00%) and medium (8.64%) livestock *nkangitie* to say that they were unable to sustain herds without another source of income to supplement their livelihood (Pearson $\chi^2(2, N = 206) = 9.654, p = 0.008$). Goats were reported as crucial to keeping cattle during times of drought, especially in terms of being able to sell or exchange goats to pay penalties when caught grazing within illicit areas or to pay fees for paid grazing arrangements during these times. Finally, it was also frequently mentioned that these factors were compounded during drought, as market prices decreased dramatically. In summary, external employment appears to enable some to forego livestock sales that are otherwise necessary for meeting basic needs. Additionally, those with larger herds have lower percentages of offtake in their herds and are more likely to sell under favorable conditions, which likely translates into decreased strains on livelihoods and decreased sensitivity to drought.

4.3.4. Sensitivity to drought and interactions with livestock diseases

Finally, we explored herd losses due to drought in 2015. A total of 2479 sheep reportedly died during this time. Sheep had higher reported rates of death when herded outside Koiya (26.49%), compared to animals located within dry season grazing areas within Koiya (18.63%), with both differing from the lowest rates of death which were seen for sheep located at the *nkangitie* (7.27%). ($F_{2, 155} = 15.22, p = < 0.001$). A similar pattern applied to the 2092 goats that died, with higher percentages dying outside Koiya in either informally or illicitly accessed areas (14.68%, 11.29%, respectively), compared to 4.30% of those that remained at *nkangitie* on Koiya ($F_{2, 206} = 11.4016, p = < 0.001$). Based upon key informant interviews, these differences in rates of death appeared to be related at least in part to the higher exposure to disease for animals outside Koiya, but also due to animals being weakened by overall lack of forage consumed during drought. Some key informants characterized these as combined risks experienced when leaving Koiya that they had no choice but to take, while others (typically with fewer livestock) felt that there was less risk involved in staying at Koiya rather than leaving. Supporting the high risk of loss to disease, 92.59% of medium livestock *nkangitie* reported that disease was a dominant barrier to successful herding, compared to 86% and 77.33% of high and low livestock *nkangitie*, respectively (Pearson $\chi^2(2, N = 206) = 7.31, p = 0.026$).

The deaths of cattle and sheep appear to have been disproportionately borne by those with the smallest herds, with the bottom 49.26% of *nkangitie* ($N = 148$) ranked according to cattle holdings experiencing 154 losses (62.85% of total losses), while the top 51.74% ($N = 26$) experienced 91 losses (37.15% of total losses) in cattle. A similar pattern held for sheep, where by rank of size of herd, those with smaller herd size (49.6%, $N = 159$) experienced 61.55% of the deaths, while the 20 *nkangitie* that held the other approximate half of the sheep experienced just 38.45% of the deaths. However, the deaths of goats were shared much more equally, with the bottom 49.45% of *nkangitie* ($N = 174$) experiencing 49.67% of the goat deaths, and the 40 largest *nkangitie* holding 50.55% of the goats experiencing 50.33% of the deaths.

To further evaluate whether animals from smaller herds experienced higher individual mortality rates, we first had to account for the higher likelihood of sampling error if mortality rates are calculated for small herds individually (for example, if a *nkangitie* only owns 2 head of cattle, the mortality rate can only be 0%, 50%, or 100%). To overcome this, we first ranked all *nkangitie* from highest to lowest cattle holdings, then devised a binning procedure to create bins of multiple *nkangitie*, such that each bin contained about the same total number of cattle. The largest bin was made up of the two *nkangitie* with the largest cattle herds, adding up to 340 head total. We then binned the next largest *nkangitie* until the bin contained approximately 340 head total. This procedure was repeated, working down the list of ranked *nkangitie*, resulting in 10 bins, each of which contained a set of *nkangitie* whose total cattle holding were about 340 head, but who were from

households with different herd sizes. Survey data for each of the *nkangitie* indicated the number of cattle that died in the drought. We could therefore calculate the mortality rate within each bin, and the average cattle herd size for *nkangitie* within that bin. There was a strongly negative correlation between average cattle herd size rank and mortality rate (Spearman $\rho = -0.70, p = 0.025$). A similar approach to analyzing deaths of sheep, resulted in 17 bins that each contained a total of about 600 sheep, with a non-significant negative correlation (Spearman $\rho = -0.43, p = 0.082$). This same approach when applied to goats (39 bins, bin size of 415 goats) also yielded a non-significant relationship (Spearman $\rho = 0.23, p = 0.159$).

5. Discussion

Previously documented changes in herding practices have led to less collective coordination among households over time in accessing increasingly limited dry season forage resources outside of Koiya (Unks et al., *In Press*). In the past, entitlements to access off-site forage resources would have largely been coordinated amongst households, but today, shifting norms of reciprocity have led to the costs and benefits of mobility being borne individually (Unks et al., *In Press*). The current study shows that bundles of assets and endowments at the *nkangitie* level map onto different access pathways: those of the employed and relatively wealthy who access private lands legally and also rely on informal sites; those who somewhat successfully rely on precarious, illicit access; and those who rely primarily on small herds of goats herded within Koiya alone.

Elucidating the deeper historical origins of wealth disparities among specific families in the study area was beyond the scope of this research. However, our results do bring to light factors that are causing, or at least reinforcing stratification today. The drought event we document here indicated that overall losses are disproportionately borne by families with lower livestock holdings who also have heightened sensitivity to these losses. Sensitivity to drought is related to factors of herd sizes and access to cash, which interact in complex ways. Higher livestock *nkangitie* appear to have decreased sensitivity, and to be better able to strategically use market interactions. For those unable to buffer sales or offset sales with access to outside cash, market factors have a disproportionately negative impact, as herders are forced to sell animals to buy grains to feed their families, decreasing the reproduction of herds. These factors likely interact to create a threshold of constraints whereby goat herding remains the most viable strategy for many that lack other adaptive options. Coupled with low market prices during droughts, this likely leads to a positive, reinforcing feedback on already marginal livelihoods. While animal species differ in their sensitivity, the amount of sensitivity at the *nkang* level then is also a function of herd size and income, both of which relate to the ability to buffer herd losses in drought and reduce offtake of animals for sale in livestock markets. Consideration of mobility must then also be balanced against the risks of mobility including disease, fines, and predation. Taken together, stratified access to seasonal grazing, market interactions, and exposure to disease when migrating constitute multiple stressors that interact and shape vulnerability. These interacting factors appear to, at least in part, explain the sharp divergences in livelihoods observed at Koiya. In sum, those that lack the assets and endowments required for avoiding exposure under current institutional norms of access (including illicit pathways), appear to adapt to external access constraints by reducing their sensitivity to drought and stressors that occur during external access through keeping small herds of goats, despite heightened sensitivity due to less advantageous market interactions. On the other hand, herders that have enhanced entitlement sets due to relations with private conservation ranch actors, access to cash, allocation of herding labor, maintenance of second *nkangitie*, and transportation, appear to simultaneously be able to avoid exposure to drought and to be better able to negotiate market interactions to further reduce their sensitivity.

Similar to other pastoralists experiencing recent institutional change

(Goldman and Riosmena, 2013), a suite of novel clusters of assets and endowments, including the ability to split *nkangitie*, to have transportation, to supplement labor, and to access cash, allows for enhanced ability among households with higher holdings to decrease their exposure to drought. Studies of wealth among East African pastoralists have often shown how factors such as production (Grandin, 1988), ability to invest in agriculture (Little, 1985), and risk (McPeak and Barrett, 2001) is differentially structured in important ways under shifting conditions such as sedentarization in post-colonial settings. Also, others have documented how increasingly, outside sources of income are being used as a supplement to livestock keeping (McPeak and Little, 2005) and how shifting institutional configurations of pastoralist commons differentially benefit certain actors (Lesorogol, 2008; Mwangi, 2007). It is also well documented how pastoralist elites differentially benefit financially from conservation (Homewood et al., 2009). Our results further show that exposure to drought is also directly related to relational elements of access (see Ribot and Peluso, 2003), and that these relational elements themselves are stratified, where wealthier herders tend to have much greater access to seasonal grazing on private wildlife conservation ranches through employment and other relations with actors. These results point to important influences of institutional changes due to CBC trusts and the recent creation of a limited, commodified system of access that requires either relational or illicit pathways to supplement paid access and sustain cattle during drought, that is in turn reinforcing abilities to cope with drought. As these same actors on private ranches are directly involved in other recent institutional changes that are aimed at transforming livelihoods and fostering wildlife conservation (Unks et al., *In Press*), our analysis of structural and relational dimensions of access revealed important insights into the differential adaptive capacity and processes that feedback on and shape livelihood stratification.

The extended entitlements approach to understanding access that we built upon (Ribot and Peluso, 2003) also yielded a more pluralistic account of rights beyond understandings of legal rights of access alone, to include structural and relational factors as well as historical drivers of changes in livelihoods. The unequal ability to decrease exposure to drought, coupled with heightened sensitivity to drought and market offtake in *nkangitie* without income or with small herds, creates an unequal structure of vulnerability, where the ability to adjust responses to drought and ecological change is socially stratified, and some *nkangitie* are differentially favored by the institutional context. While these changes in the institutional landscape, and the possibilities for adaptive capacity are intertwined with changes in access to seasonal resources, markets, norms of reciprocity, governance, and inequality (Unks et al., *In Press*; Herren, 1991; Huho and Kosonei, 2013; Letai, 2013), our analysis specifically indicated that control of grazing access is structured in a patron/client manner between conservation actors and herders in the context of shifting contours of power that have occurred under CBC trusts. These changes are embedded in shifts in economics and land use driven by the global push for large mammal conservation and Kenya's emphasis of wildlife conservation on private lands (Little, 2014; Western et al., 2009), where many state functions have been delegated to wildlife conservation NGOs (DePuy, 2011; Kaye-Zwiebel, 2011). While CBC trusts influenced both norms of reciprocity and access pathways (Unks et al., *In Press*), current projects are introducing market-based incentives to shift livestock husbandry toward "better production systems" that offer market access as a reward for compliance with conservancy performance standards (Northern Rangelands Trust, 2016). These programs also, at the time of writing, have begun to provide drought access on private ranches for a small subset of cattle from Koiya and other group ranches within Mukogodo Division with a commercial cattle production focus. Further research is critically needed to understand how these interventions will interact with stratification of households across group ranches by creating even more exclusive access to both dry season forage and favorable market conditions.

6. Conclusion

Herders at Koiya are repositioning themselves to adapt to changing institutional conditions where norms of reciprocity and norms of access to seasonal forage have shifted. These shifts, in the wake of historical colonial and independence-era state interventions, have catalyzed numerous political, economic, and social changes that have influenced patterns of access and interacted with herders' norms of reciprocity. We found that in this new institutional context, herders with higher livestock wealth are more likely to have entitlements that enable access to secure cattle grazing on private wildlife conservation lands, and to also be better able to access other more distant areas with herds of sheep and cattle. These families experienced disproportionately lower losses of cattle to drought, and also likely have decreased sensitivity to market influences. Those with lower livestock wealth rely disproportionately on illicit, precarious access to external grazing resources, while others are primarily reliant on small stock and/or precarious access pathways. The stratified outcomes of the ability to adapt cannot be explained by *nkang* characteristics alone at Koiya, and do not simply indicate a setting where some have adapted and some have not. To explain these unequal outcomes required a methodology that was sensitive to the structural and relational elements of access and inter-related livelihood changes. This approach helped to clarify systemic causes of vulnerability, where people have adapted in stratified ways to complex changing institutional conditions of access, markets, individualization of herding practices, and personal relations with conservation actors.

It is common in Laikipia for wildlife conservation actors to interpret current pastoralist livelihood barriers as occurring due to internal constraints within group ranches such as population growth or lack of grazing management (Alexovich et al., 2012; Fennessy, 2009; Lent et al., 2002; NAREDA Consultants Ltd., 2004; Sumba et al., 2007). While these narratives tend to focus attention on internal management of Koiya in isolation, we showed that the current capacity of extended families to reduce their exposure and sensitivity to drought is stratified by the interaction of household assets with changes in institutional norms of reciprocity, external access pathways, and market interactions. Given the primacy of livestock husbandry as a livelihood at Mukogodo, without robust plans that consider both the stratified state of livestock husbandry and mobility, it is unclear how other ongoing market interventions (e.g. Northern Rangelands Trust, 2016) will account for the community-wide ability to adapt to changing conditions. Further, our study reiterates the need for both research and policy approaches that are genuinely participatory and inclusive in their construction of knowledge, deliberation, and decisions about land-use management (e.g. see Goldman, 2011; Goldman and Milliard, 2014). This is of especially high concern given more recent tensions over illicit grazing and large cattle herds from Samburu county creating additional social and ecological pressures (see Pellis et al., 2018). The approach we have taken in this study indicates both the importance of multiple measures to determine the ultimate, historically-contingent drivers of vulnerability, and the need for a more pluralistic consideration of the interests of overlapping pastoralist livelihoods and wildlife conservation.

Declarations of interest

None.

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