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Climate change adaptation and land tenure: exploring pastoral adaptation strategies under communal and private land ownership in Kenya

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ABSTRACT

Climate change adaptation is critically important for communities in the Global South, especially for those depending on climate-sensitive resources for their livelihoods, such as pastoralist communities. Land is a key asset for the ability of such communities to adapt. However, our understanding of the ways in which pastoral adaptation strategies develop under different land tenure systems – and how such strategies shape local land tenure systems – remains limited. This article conceptualises the relationship between local climate change adaptation strategies and land tenure and examines how adaptation strategies develop under communal and private tenure systems in southern Kenya. The article draws on primary data from a household survey ($n = 160$) and in-depth qualitative interviews in Kajiado County, Kenya, where Maasai pastoralists are adapting under both communal and private land tenure systems. We find that adaptation strategies vary with the different land tenure systems and we show how the tenure systems shape and are shaped by local adaptation strategies. We further find that wealth and social status influence the ability of households to benefit from and influence land tenure systems. The article contributes to our knowledge on autonomous local climate change adaptation by adding insights on the role of land tenure as an important contextual factor. It further highlights the role of pastoralists' agency as they develop their adaptation strategies and adjust livelihoods beyond livestock and mobility, and how this interacts with communal and private land tenure.

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1. Introduction

Adaptation to climate change is critically important for many communities in the Global South. This includes communities who depend on climate-sensitive resources, such as pastoralists whose production systems traditionally evolve around livestock and depend on access to pasture and water (Tessema, Ingenbleek, and Van Trijp 2014; Kariuki, Willcock, and Marchant 2018). The climate change adaptation strategies of pastoral communities have been well documented in recent years and have shown how households actively seek to respond to changing climatic conditions (Napogbong, Ahmed, and Derbile 2021; Volpato and King 2019; Opiyo et al. 2016).

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However, climate change adaptation does not take place in a vacuum but interacts with the political, economic and institutional context (Smit et al. 1999; Thorn, Thornton, and Helfgott 2015; Funder, Mweemba, and Nyambe 2018). This includes changing land use and land tenure patterns (Akugre et al. 2021; Antwi-Agyei, Dougill, and Stringer 2015). Historically, pastoral societies have typically based their livelihoods on communally owned land with access regulated by common rules (Fernandez-Gimenez and Le Febre 2006). Yet in recent decades changing land use dynamics and land markets has affected pastoralists in many areas (Unks et al. 2023; John G Galaty 2016; Lind, Okenwa, and Scoones 2020a). Open rangelands have been reduced or fragmented as external actors have acquired or appropriated land, followed by land use change, fencing, infrastructure development and urban expansion – all of which pose challenges to conventional pastoral strategies of migrating livestock (Bekele et al. 2022; Liao et al. 2020).

Meanwhile, land tenure changes are also taking place within lands that are still under control by pastoralists themselves. In some areas, pastoralists have themselves elected to privatise their communal rangelands, or have otherwise reworked the rules and norms that regulate land use and – access in an attempt to adjust their livelihoods to changing circumstances (Mwangi 2007b; Jeppesen and Hassan 2022; BurnSilver and Mwangi 2007).

These developments raise questions about the interactions between pastoral climate change adaptation strategies and land tenure dynamics. As pointed out by Murken and Gornott (2022), our knowledge on connections between household adaptation and land tenure is dominated by econometric analysis of whether tenure security leads farmers to adapt or not (Akugre et al. 2021; Yegbemey et al. 2013), and studies where land tenure is only one among multiple factors examined (Alemayehu and Bewket 2017; Roco et al. 2014; Ullah et al. 2019). This work is important, but there is a need for more in-depth exploration of the ways in which farmers and pastoralists shape and evolve their often multi-faceted and evolving adaptation strategies under different land tenure systems (Murken and Gornott 2022). What kinds of adaptation strategies develop under communal and private land tenure respectively, how do these different tenure systems shape household adaptation options, and how, in turn, does adaptation affect development of local land tenure systems?

This is particularly relevant in the context of pastoralism. Much work on the relationship between pastoralism and land has – understandably – explored the devastating implications for pastoralists in terms of land loss and marginalisation (Liao et al. 2020; Lind, Okenwa, and Scoones 2020a; Scoones 2021). We know less about pastoralists' own agency at the intersection of climate change adaptation and land tenure. This includes situations where, as mentioned above, pastoralists remain in control of their land and are changing local land tenure systems on their own account. How do pastoral climate change adaptation strategies evolve under communal and private land tenure systems in such settings?

Our article aims to enhance insights on these issues. We conceptualise the dynamic relationship between climate change adaptation and land tenure, and present findings from mixed-methods fieldwork among Maasai pastoralists in Kajiado County, Kenya, from 2019–2022. In this area, both communal and private land tenure systems exist, making it possible to study pastoral adaptation strategies in both situations and gain insights on the connections between adaptation strategies and their change over time.¹

2. Conceptual framework

2.1. Climate change adaptation

We understand climate change adaptation as the adjustment of natural or human systems in response to actual or expected climatic stimuli or their effects that moderate harm or exploit beneficial opportunities (IPCC 2022). The literature distinguishes between *planned adaptation*, i.e. policies and projects typically initiated and funded by non-local actors, and *autonomous climate change adaptation* which are the everyday adaptation strategies undertaken by households and

communities on their own account (Castro and Sen 2022; Rahman et al. 2021; Tebboth et al. 2023). Our focus here is on the latter.

In order to operationalise autonomous climate change adaptation, we follow Agrawal & Perrin, whose typology of five overall adaptation strategies has been applied in studies of climate change adaptation elsewhere, including pastoral settings (Agrawal and Perrin 2009; Thorn, Thornton, and Helfgott 2015; Thornton and Manasfi 2010; Wang, Brown, and Agrawal 2013). These strategies are: (i) *Mobility*, e.g. migration in search of new/alternative sources of income, or changing movement patterns with livestock in search of alternative pasture and water; (ii) *Diversification*, including diversification of household incomes and/or diversification of crops and livestock types in order to spread increased risk across livelihood assets; (iii) *Storage*, i.e. of food, water, seeds, fodder etc for use in times of scarcity; (iv) *Communal pooling*, whereby capital, labour, natural resources and other assets are pooled by households in order to allow new options, e.g. joint boreholes, flood barriers, etc, and (iv) *Market exchange*, e.g. increasing sales of crops and livestock products to generate funding for irrigation systems, drought-resilient seeds or expensive new livestock breeds. Importantly, households often apply several of these strategies in combination.

This typology is useful for heuristic purposes as it allows the specific adaptation actions of households to be categorised at a higher level of abstraction. This in turn allows for analysis of how households in different settings may prioritise and combine the five overall adaptation strategies differently, making it useful for our analysis of adaptation strategies across different tenure settings.

Autonomous adaptation strategies rarely develop in isolation but interact with people's broader responses to perceived risks and opportunities in the surrounding context (Smit et al. 1999). Climate change adaptation strategies thus evolve in a dynamic relationship with wider aspirations to improve livelihoods (Thorn, Thornton, and Helfgott 2015) and changing contextual conditions such as market expansion, infrastructure development and urbanisation (Rotich, Funder, and Marani 2023a).

People's agency plays an important part in realising adaptation strategies, but also relies on their adaptive capacity, which in turn depends on the assets available to them (Ensor and Berger 2009; Yaro, Teye, and Bawakyillenuo 2015). These assets can be summarised as physical, social, human, or financial (Natarajan et al. 2022; Scoones 1998). Socio-economic differentiation means that these assets are distributed unevenly, which in turn implies that individuals and households have different opportunities to adapt (Brown et al. 2019).

Land is a key asset for adaptive capacity, especially in pastoral communities (Nassef, Anderson, and Hesse 2009; Owen 2020). Pastoralists may adapt through mobility strategies whereby livestock is moved between pastures, which may require them to negotiate land owned by others (Nassef, Anderson, and Hesse 2009). Pastoral adaptation strategies may also involve pooling land by setting it aside as communal "grass banks" that can be used in times of severe drought (Robinson et al. 2021), or land may serve as the basis for pastoral diversification strategies that complement livestock with increased crop production, as we shall see below in our study areas. All this requires, however, that pastoralists can access land.

2.2. Land tenure and access to land

Access to land and other natural resources depends on land tenure systems, which confer rights to access and benefit from land (Ribot and Peluso 2003). However, access not only depends on explicit tenure rules and arrangements but also on more implicit structural and relational mechanisms such as wealth, power and social networks (Peluso and Ribot 2020; Ribot and Peluso 2003).

Pastoral lands have customarily been characterised by communal tenure with shared access. Significantly, this does not automatically imply "open access" (Rose 2020; Ostrom 1990). Research has shown how communal tenure systems and customary norms support pastoral mobility in times of change and crisis, allowing them to exploit heterogeneous landscapes and seasonal variability (Fernández-Giménez et al. 2015).

Communal land tenure is, however, not a given in pastoralism, and pastoral tenure systems must be understood as dynamic and changing, driven partly by external pressures, and partly by the agency and aspirations of pastoralists themselves (Lind et al. 2020). In recent decades, private land tenure has become prevalent in some pastoral systems (Mwangi 2007a; Robinson et al. 2021). While this trend is sometimes influenced by state and business interests seeking to make land a tradeable good (Lind, Okenwa, and Scoones 2020b) it is also – as will be seen below – in some areas actively embraced by pastoralists themselves (Mwangi 2007b; BurnSilver and Mwangi 2007).

Private property rights can become an attractive tenure system to land users when they feel that communal land tenure fails to address threats to their livelihoods or deprives them of opportunities. This can include threats to their land access from other actors (Weldemichel and Lein 2019); perceived governance costs such as inefficient or unaccountable leaders (Mwangi 2007a); or perceptions that individual land rights are more productive and efficient because the owner does not depend on the behaviour of others (Mwangi 2007a).

As land tenure systems change, structural and relational pathways to access land may also change. For example, customary norms associated with communal land tenure – e.g. allowing poor households access to pasture during times of hardship – may erode where pastoralists elect to privatise their land (L. Robinson and Flintan 2022; Hassan, Nathan, and Kanyinga 2023). Yet some fundamental structural mechanisms of land access typically persist: Wealth and positions of power and influence provide platforms to access and control both communal and private land (Jepesen and Hassan 2022; Lind, Okenwa, and Scoones 2020b; Wachira et al. 2023).

2.3. The dynamic relationship between adaptation, land access and land tenure

We understand the connection between climate change adaptation and land tenure as a dynamic process, conditioned by the interaction of able actors and structural relations (Giddens 1984). Access to land for adaptation is determined by land tenure systems, which consist of land tenure rules and arrangements, but also of underlying structural and relational mechanisms such as wealth, power and social networks.

The land tenure system in a given location determines who can access land under what conditions (Figure 1, left side). This structures the scope of adaptation strategies for households, e.g.

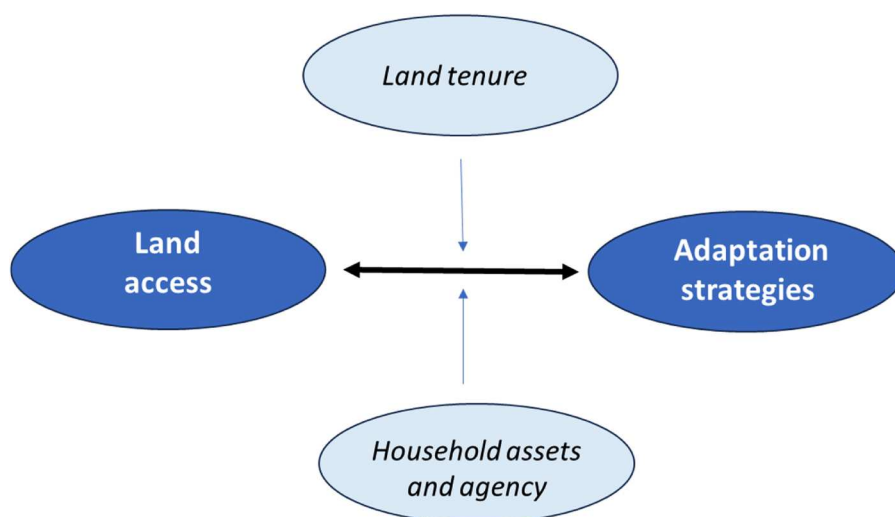


Figure 1. The relationship between adaptation and land access.

if a rangeland is divided into private fenced plots pastoral mobility strategies become harder. The prevailing land tenure system also structures the assets available to households for adaptation. E.g. if the system favours wealthy land-owners they will be better positioned to mobilise land and collateral for loans for new farming activities.

However, households possess agency and will also seek to change circumstances to enhance their adaptation strategies. As households adapt, their needs with respect to land access may change (Figure 1, right side). For example, they may require access to more land as a result of more extensive grazing or farming strategies, or less land as a result of more intensive livestock production or abandoning agricultural production in favour of paid labour. The type of land that they seek access to may also change, e.g. from rainfed rangelands for livestock production to irrigated fertile soils for crop production.

Such changing land needs may in turn affect household priorities in terms of land tenure. E.g. as shown in this paper a shift from pastoralism to crop farming may shift preferences from collectively managed rangelands to individually farmed plots with an emphasis on securing individual land titles. Individual and collective agency to address these new priorities may lead to efforts to change local land tenure, either through organised action or via a gradual undermining of the legitimacy of existing land tenure systems (Sikor and Lund 2009). Such efforts may fail or succeed, depending on the actors' assets and influence, and their ability to navigate tenure systems.

3. Study areas and methods

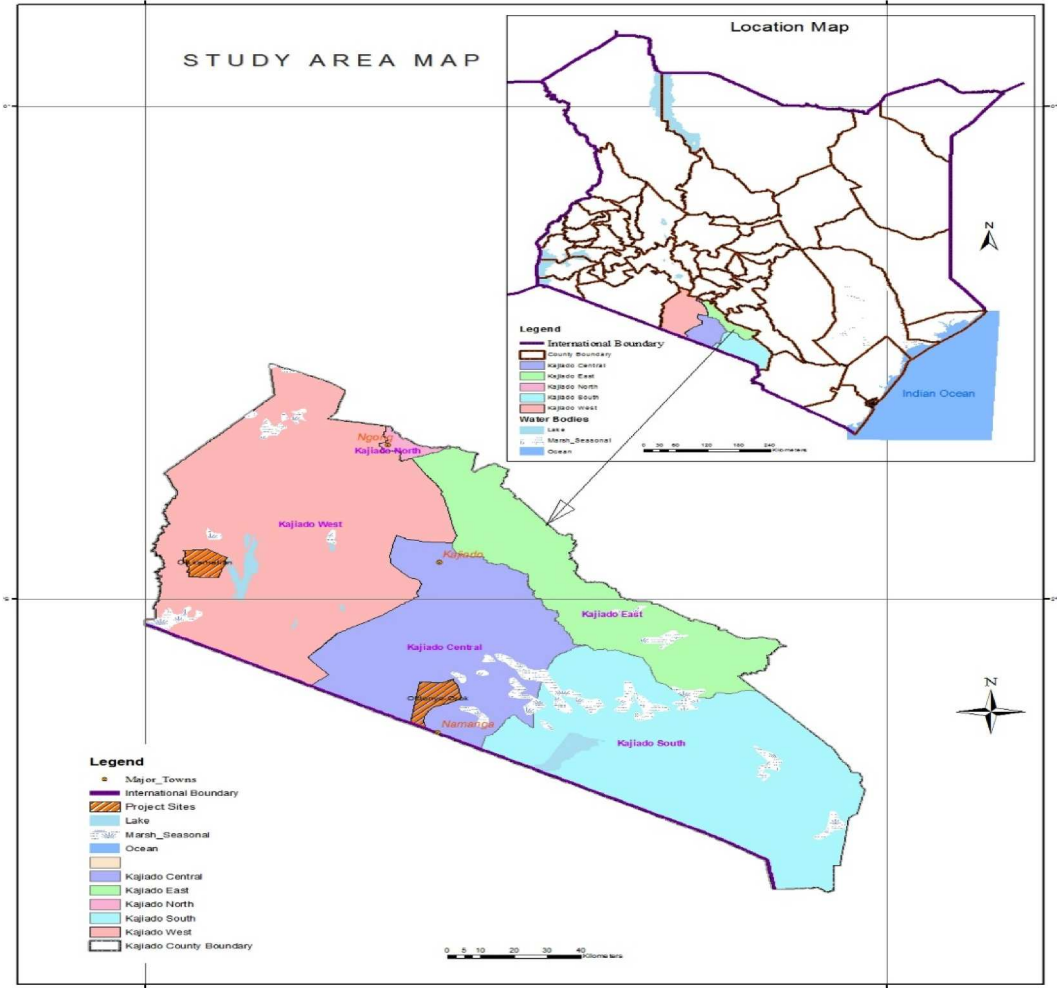
3.1 Introduction to study areas

This article draws on fieldwork carried out in two study sites in Kajiado County in southern Kenya from 2019–2022 (Figure 2). Kajiado County covers some 21,900 Km² of mixed vegetation dominated by grassland savanna, with an average population density of 51 per km². The northern part of the county borders on Nairobi and is dominated by expanding urban areas, while the southern part where our studies take place remains mainly rural with limited infrastructure. Maasai pastoralism – increasingly practiced as agro-pastoralism – is the predominant economic activity, contributing 79% of the county's GDP (CGK 2018). Traditionally, the Maasai have been livestock keepers with livelihoods largely dependent on herding cattle, sheep, and goats (D. Nkedianye et al. 2020; Campbell 1999).

Kajiado county has, like the rest of Kenya, in recent decades experienced growing impacts from climate change. This includes increased variability of rainfall patterns, reduced overall rainfall, rising temperatures and an increase in droughts and heat stress days during the main rainy season, while flood risk has increased in the secondary rainy season (ICAT 2017; Kogo, Kumar, and Koech 2021). This has led to increased livestock mortality for Maasai households and contributed to pasture loss in the rangelands. The growing seasonal unpredictability has made planning of livestock mobility and livelihoods difficult (Campbell 1999; Bobadoye et al. 2016; ICAT 2017).

Maasai communities in Kajiado county manage their land under two different types of land tenure, depending on location. In the 1960s Maasai rangelands in Kenya were transformed by the government into so-called Group Ranches in which land is owned collectively by households (Kimani and Pickard 1998). Some such Group Ranches still exist. However, since the 1980s Group Ranches have been allowed to subdivide their land into individual privately owned land plots allocated among Maasai households registered in the area (Galaty 2013; Rutten 1992). In some areas of Kajiado, Maasai households have voted to retain their Group Ranches and continue communal land ownership, while in other areas they have voted to dissolve Group Ranches in return for individual land plots with private title deeds (Mwangi 2007a).

Our two study areas within Kajiado have been chosen to represent a communal and private land tenure system respectively. Both areas are grassland ecosystems dominated by Maasai pastoralism and owned mainly by Maasai pastoral households, and both are within the overall administrative system of Kajiado County (Figure 2).



First Author: 2023

Figure 2. Study area map.

The study areas are:

- (i) *Olkiramatian Group Ranch* consists of 21,612 hectares of primarily savanna grasslands. The sub-location has 646 households.² Maasai households communally own the land and manage it according to a joint land use plan established in 2002. Unlike some Group Ranches in southern Kenya, households in the Olkiramatian Group Ranch have decided to retain their land under communal ownership.
- (ii) *Oldonyo-Orok* is a former Group Ranch of 28,701 hectares of mainly savanna grasslands. The sub-location has 617 households. Here, Maasai households have elected to dissolve the Group Ranch and subdivide the land into individually owned private plots, a process finalised in 2006. Households have received title deeds to their land and are allowed to sell it.

The history and details of land tenure in the two areas is described in section 4. The two different tenure systems allow us to examine connections between climate change adaptation strategies and land tenure under communal and private land ownership respectively.

3.2 Data collection methods

Fieldwork in the two study sites applied a mixed-methods approach using both qualitative and quantitative methods. Phase 1 consisted of a household questionnaire survey ($n = 160$), using a multiple-choice format, including an open response option for alternative responses. The survey examined household climate change adaptation actions, livelihoods, land-use and land access. Climate change was operationalised as changing rainfall patterns and more frequent and severe droughts and floods. Respondents were household heads, selected using simple random sampling based on a list of registered Maasai households. The questionnaire was piloted in 2019 to ensure it made sense to respondents and identify issues not considered. The main survey was implemented in both study areas in 2021. A one-day training course including pre-tests was conducted for all research assistants. The survey was conducted in the Maa language and enumerators were local Maasai. In total, 160 households were surveyed, 82 in Olkiramatian 78 in Oldonyo-Orok. The research assistants collected data using Kmacho, a phone-enabled data collection software.

Phase 2 involved 24 individual semi-structured interviews, 20 individual life story interviews and 24 Focus Group Discussions (FGDs). Participants in these methods included but were not limited to survey respondents. Participants in the individual interviews were identified through snowballing (Noy 2008), with an emphasis on pastoralists who had (i) stayed long in the study areas, (ii) had witnessed changing land tenure systems and climate hazards and (iii) represented different wealth groups. The individual semi-structured interviews explored how climate change variabilities and tenure systems shape individual choices and adaptation strategies, and the perceived pros and cons of communal and private land tenure. The individual life story interviews (Atkinson 2007) explored the lives of participants in order to understand changes and choices over time, and actions vis-à-vis specific drought events. Trained Maasai research assistants undertook the interviews under supervision of the first author. Interviewees were promised anonymity as land issues can be sensitive.

The FGDs (Nyumba et al. 2018) were undertaken with household representatives from low, medium and high wealth categories, determined through wealth ranking (Grandin 1988). FGDs had 8–10 members. In each study site, four FGDs were undertaken per wealth category, two with women and two with men. The FGDs expanded on the household survey and explored adaptation strategies, associated advantages and disadvantages of land tenure, and how assets were employed or lacking vis-à-vis adaptation. Each FGD session lasted 60–90 minutes using a Maasai moderator.

Quantitative data was cleaned and analysed using SPSS version 2. Qualitative data was analysed using NVIVO version 14.

4. Findings

In the following we examine the relationship between land tenure and adaptation strategies in each of the two study areas, i.e. under communal land ownership in Olkiramatian, and under private household land ownership in Oldonyo-Orok.

Figure 3 and Figure 4 show current and previous adaptation strategies among pastoralist households in the study areas. Current adaptation strategies are those applied by questionnaire respondents at present, while previous adaptation strategies are those used by respondents 30 years ago, when communities in both study sites debated the future of pastoralism and initiated efforts to revise land tenure (see below). Our questionnaire asked households to list specific adaptation actions with which they responded to changing weather patterns using a multiple-choice format (see Table 1 and Table 2). We then assigned their actions to Agrawal's five main types of adaptation strategies.³

As can be seen, strategies have changed in both areas, with similarities but also differences across the two sites. In the following we discuss this in detail, examining first the communal land tenure site, then the private land tenure site.

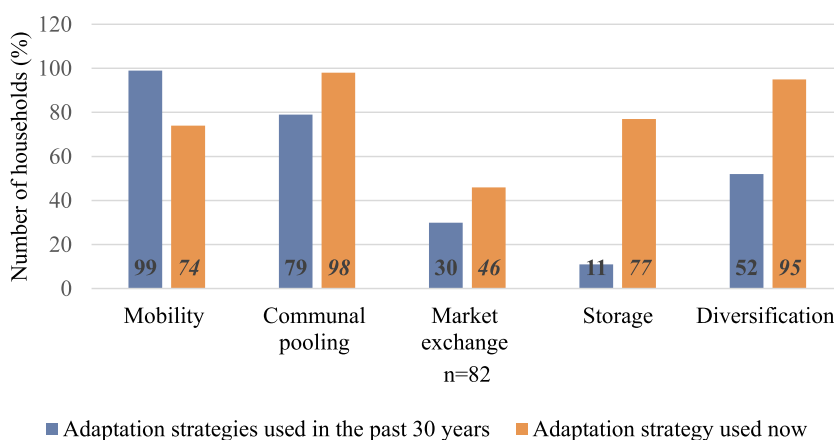


Figure 3. Adaptation strategies used by Maasai Pastoralists of Olkiramatian.

Source: Results from household survey in Olkiramatian group ranch in Kajiado.

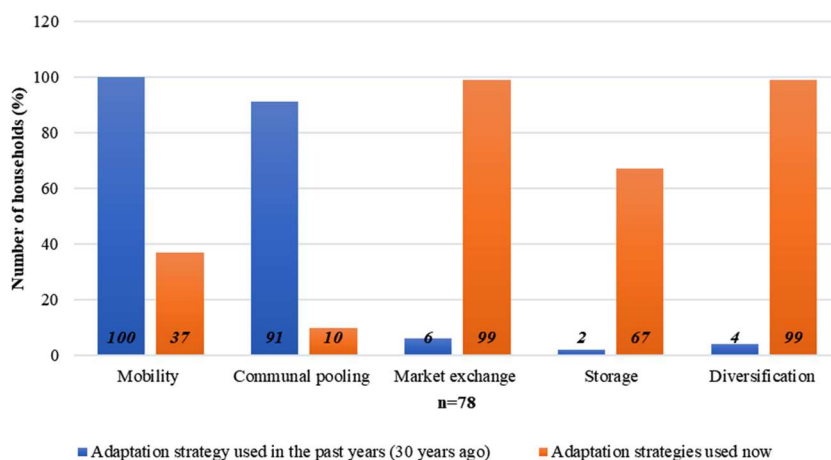


Figure 4. Distribution of adaptation strategies in the private land tenure system of Oldonyo-Orok.

Source: Results from household survey in the private land tenure system in Kajiado.

4.1 Adaptation under communal tenure: Olkiramatian

4.1.1 Communal land ownership and land use

The Olkiramatian Group Ranch is collectively owned by community members within the ranch and has elected not to subdivide its land into individual household ownership. A key factor has been a strong Group Ranch leadership who have argued that land subdivision will undermine the pastoral production system by fragmenting land and restricting livestock movement. As one member of the Group Ranch Committee said:

If we divide this land [among households] our way of life will disappear. [...] People will be tempted to sell, or they will put up fences [...] The livestock will have nowhere to go. There will be conflicts. We will suffer.⁴

The Group Ranch in Olkiramatian thus remains communally owned and managed land. However, in the early 1990s concerns developed among households over the viability of pastoralism in the area. Of particular concern was (i) overstocking and growing competition for sparse pasture; (ii) a

Table 1. Adaptation under communal tenure: Pastoralists' strategies and perceptions.

Adaptation strategies	Adaptation actions employed by community members	Perceived advantages of communal tenure for adaptation	Perceived disadvantages of communal tenure for adaptation
Mobility	Rotational seasonal grazing within Group Ranch (wet and dry-season zones)	- Intact, unfragmented rangeland - Facilitates rangeland regulation through joint zonation and rotation - Promotes a sense of civic responsibility (group ranch members feel obligated to one another)	- Large herd owners benefit more from joint pasture - Large herd owners put more pressure on joint pasture
Communal Pooling	- Pasture sharing (see above) - Communal "grass banks" - Communal irrigation system - Jointly owned conservancy - Joint restoration activities (e.g. against invasive species)	- Facilitates sharing of pasture, grass banks, water, conservancy revenues - More equal access to resources - Labour and knowledge sharing - Organised joint access to external funding for projects etc	- Joint initiatives require Group Ranch approval - Complicated and slow decision-making - Risk of corruption in leadership
Diversification	- Crop farming - Conservancy incomes	Zoned land uses allow diversification of livelihoods	- Competing land use for crops and livestock - Resource-based conflicts-during droughts and periods of water scarcity.
Market exchange	- Destocking and restocking of livestock during droughts and restocking during onset of rains. - Exchanging livestock for fodder/pasture/grazing areas	- Group Ranch leadership can pressure middle-men - Enables community members to access modern markets and important capital.	Over-exploitation by middle men
Storage	- Storage of pasture and fodder, (maize stalks, plant pods; Acacia and Prosopis Juliflora pods), hay and water - Storage of foodstuffs	- Avails pasture resources as pastoralists awaits moving their livestock to other grazing zones. - Saves time that can be used on other activities of economic production. - Increases food security, an important factor in the pursuance of adaptation.	- Difficulties in harvesting fodder from shared land. - Hinders establishment/ construction of permanent storage structures. - Stored resources cannot sustain large livestock herds for longer periods of droughts.

Source of information: Field work data.

perception that rainfall patterns were becoming increasingly erratic, and (iii) insufficient means for households to expand crop production in order to diversify incomes. In order to address these concerns, the Group Ranch leadership in Olkiramatian initiated development of a communal land use plan for the area with NGO support. The plan – developed gradually but fully implemented in 2001 – maintained communal ownership of the Group Ranch but divided the land into three main land use zones, namely:

- A communal grazing zone used for wet-season grazing by Group Ranch members, with joint water infrastructure facilities.
- A community conservation zone, watered by a perennial river and used only for dry-season grazing, as well as for wildlife conservation and associated tourism revenues. The conservation area furthermore includes "grazing banks" set aside for droughts.
- A cultivation zone for individual household crop production, with a communal irrigation system drawing on water resources from a nearby escarpment. Livestock is allowed in the cultivation zone at certain times of the year to feed on crop remains and stored hay.

Table 2. Adaptation under private tenure: Pastoralists' strategies and perceptions.

Adaptation strategies	Adaptation actions	Perceived advantages of private tenure for adaptation	Perceived disadvantages of private tenure for adaptation
Mobility	• Livestock mobility – herd splitting	• Combining mobility to/through other Group Ranches with benefits from privatisation • Paddocking land to manage pasture blocks	• Fragmentation of land, difficult to move herds/overgrazing, Locked migratory routes • Costs of leasing and paying for access to pasture
Communal Pooling	• Livestock transport • Joint storage of hay	• Those with initiative can join together (not burden of large group) • Absolute freedom to make own decisions.	• Difficult to coordinate • “Free riding”
Diversification	• Crop production • Schooling • Fattening and dairy (paddocking) • Re-investing in businesses	• Land sales generate income for diversification • Crop production • Exchange of land for schooling • Diversification of production system (paddocking, intensification)	• Reduced herd sizes (reduced social status) • Increased schooling creates labour costs and loss of culture
Market exchange	• Increased selling and buying of land • Increased selling and buying of livestock • Increased selling of livestock produces (milk)	• Generates income for other purposes • Direct income/benefits • Own decision-making • Growing market from non-pastoral communities/land buyers	• Risk of becoming landless if tempted to sell all land • Theft of livestock (no communal relationships/guarding) • Increased cost of accessing grazing and inputs • Loss of tradition for support to restocking
Storage	• Production and storage of hay • Storage of food produce from crop farming	• Allows paddocking and massive hay production • (intensification) • Personal decision-making on storage	• Prolonged droughts make it unsustainable • Individual loss cannot benefit from joint storage

Source: Field work data.

Within this scheme livestock is rotated between the grazing and conservation zones according to a jointly regulated seasonal schedule, which in principle avoids overgrazing, allows vegetation to recover and regulates use of water resources. The cultivation zone is divided into 7-acre plots, one per household. The plots are individually farmed and managed by each household, but they cannot be sold or otherwise transferred away from the collective ownership of the Group Ranch. The land use system is governed by the elected Group Ranch committee and associated subcommittees.

4.1.2 Adaptation strategies under communal tenure

Our findings show that households in Olkiramatian currently engage in a variety of adaptation strategies at the same time (Figure 3). Indeed, four of the five strategies are used by 74% or more of the households. The survey also shows a shift over time, with initial dominance of mobility and pooling strategies being extended to include more households engaging in market exchange, storage and diversification-strategies.

4.1.1.1. Mobility under communal tenure. As appears from Figure 3 mobility remains an important adaptation strategy in Olkiramatian, despite a drop in recent decades. The land-use plan and zonation of the group ranch has allowed households to continue livestock mobility, regulated through collectively agreed schedules that determine when livestock is shifted from one zone to the other. The system is based on customary mobility practices, but seeks to optimise grazing management and allows households to also follow other adaptation strategies in the form of crop production in the agricultural zone, and income diversification through tourism in the conservation zone. Unlike many other conservation areas in Kenya, the conservation zone is community-managed and an integral part of the livestock movement cycle.

4.1.1.2. Diversification under communal tenure. Diversification strategies increase the portfolio of livelihood incomes, thereby spreading the risks of climatic unpredictability across multiple income sources. Faced with significant livestock losses from recurring drought an increasing number of pastoralists in Olkiramatian have sought to diversify their household economy, to the extent that 95% of households now engage in diversification activities (Figure 3). In particular, many households have turned to crop farming as a means to diversify their traditionally pastoral livelihoods. This includes subsistence farming and, for some households – horticultural production for sale to urban centres. This take-up of crop production is facilitated and managed through the land use planning system discussed above, including the zone set aside specifically for crop farming with equally sized plots allocated to households. An important related activity has been the development of a collective irrigation system (hand dug canals) which allows previously free-flowing streams to be managed and used more effectively for farming through a quota system in which all households receive equal amounts. A further diversification activity is income from high-end tourism in the conservation zone, whereby tourist operators pay lodge rents and visitor's fees to the community. These funds are either allocated to households or used for communal purposes. This includes education facilities and – bursaries which provide young household members with a basis for seeking jobs or higher education in urban areas, a further income diversification activity.

4.1.1.3. Storage under communal tenure. Storage of resources provides buffers against droughts and other unpredictable climate hazards. In Olkiramatian, storage has increased significantly as an adaptation strategy and is now practiced by more than 75% of the surveyed households (Figure 3). This takes three main forms, related to the development of agricultural – and conservation zones within the overall communal land use plan. Firstly, it allows households to produce a surplus of subsistence crops (cereals) that are stored for difficult times. Secondly, plant remnants from crop production are stored and used as important fodder for livestock during the dry season and during droughts. Thirdly, the setting aside of collective grazing “banks” in the conservation zone preserves pasture for emergency use during drought.

4.1.1.4. Communal Pooling under communal tenure. The surveyed households in Olkiramatian almost universally (98%) engage in communal pooling as one of their climate change adaptation strategies (Figure 3). This strategy extends customary pastoral practices of shared grazing and rangeland management among the Maasai, but with the adoption of the collective zoned land use plan, households expressed that additional means of pooling resources had developed further, explaining the increase in communal pooling observed in Figure 3. Pooling practices include (i) the conservation zone which is seen by households as a communal pooling of land and water resources that helps sustain the area's livestock economy; (ii) funding from tourism in the conservation area, pooled for public purposes including boreholes that provide water for livestock; and (iii) the irrigation system in the farming zone, towards which households contribute time and labour to maintain and monitor water use.

4.1.1.5. Market exchange under communal tenure. Here, the market exchange strategy refers to pastoralists engaging markets to sell livestock, livestock products, crops and other goods as an adaptation strategy. In Olkiramatian, 30% of households engaged in this strategy 30 years ago, whereas 46% do so now (Figure 3). According to individual interviews and FGDs, efforts to adapt have contributed to this development in two ways: Firstly, sales of livestock to the meat industry or other pastoralists generates funds that can be used to invest in the diversification strategy, e.g. buying different breeds of livestock or investing in crop farming implements. Secondly, selling livestock provides a means to generate cash during hard times, e.g. if crops fail. Thirdly, some households use livestock sales as a way to remain flexible in the face of unpredictable rainfall patterns, i.e. selling when they perceive that rains will be scarce and buying in anticipation of good rains. Despite a

growth in such approaches, however, the area is not well served in infrastructural terms, and major livestock trading markets are far. Sales of livestock and horticulture products to urban markets is mainly done by better-off households who are able to maximise benefits from the communal land use system. The strategy thus remains the least widely adopted in Olkiramatian (Figure 3).

4.1.3 Household perceptions of communal tenure vis-a-vis adaptation options

Table 1 summarises the adaptation strategies of households in Olkiramatian, and how interviewees in this area perceive advantages and disadvantages of the communal land tenure system with respect to adaptation.

The table shows how households perceive a variety of benefits of communal tenure vis-à-vis adaptation, and exploit this in their adaptation strategies. However, interviews and FGDs also brought up concerns. Here we highlight two issues:

Firstly, poor households pointed out that better-off households gain relatively more from the communal land use system as they often possess large herds who consume more joint pasture and put more pressure on the ecosystem. Moreover, as poor households typically have little capital to invest in livestock they increasingly focus on crop cultivation in the agricultural zone where all households have been allocated land, and feel it should be expanded. This is resisted by some wealthy households with much livestock, including members of the Group Ranch Committee. The allocation of farming plots in the communal agricultural zone is furthermore contested, as some households have secured extra plots in the name of their children while others have not. Moreover, young families struggle to access fertile plots already allocated to older generations. Social stratification and other structural relations thus influence access to land in the area and thereby household's ability to adapt.

Secondly, the communal tenure system as such is increasingly disputed. There is growing debate among households about whether the communal system should be abandoned and subdivided into individual privatised land plots, as per our other study area. This is driven partly by perceived injustices in the current system as described above, and partly by the prospects of securing individual capital from land ownership. It is fuelled further by recurrent severe droughts which have led even some better-off households to turn increasingly to crop production, and now wish to expand by buying land from other households – which is not possible under communal tenure. The relationship between adaptation and land tenure in the area is thus contested and dynamic.

4.2 Adaptation under private tenure: Oldonyo-Orok

4.2.1 Private land ownership and land use

Oldonyo-Orok was originally a Group Ranch with communal land ownership. However, in 1991 its members voted to dissolve the Group Ranch and subdivide the land among the 900 households into private ownership. Titling of the land was a drawn-out process, but by 2006 most members had been provided with title deeds, with allotted land shares ranging from 270–500 acres depending on family composition. The deeds confer full private ownership, allowing the owner to do what they wish with the land, including selling or leasing.

In our interviews and FGDs, the rationale for privatisation was explained as (i) perceived benefits of individual land management, in which each household can make their own decisions and are not affected by other people's resource use practices; (ii) dissatisfaction with Group Ranch leaders, perceived as corrupt and autocratic; and (iii) title deeds as a means to secure household land in a context of a growing population and concerns over land grabbing by outside or local elites. These explanations correspond well with Mwangi's findings in nearby areas (Mwangi 2007a).

Amongst these rationales, the benefits of individual decision-making were emphasised by interviewees as an important factor and linked to the changing context for pastoralism. As one man explained:

Under the Group Ranch, conditions were difficult. [...] There were more and more people and livestock, and not enough pasture, and the rains were becoming unreliable [...] With subdivision we could try new things and each person could make up their own mind about the way forward [...]⁵

As in our other study area, households in Oldonyo-Orok thus had concerns over the future viability of pastoralism, and environmental change played a role in this. But here, individual rather than collective land ownership was seen as the solution, allowing households to develop livelihood portfolios independently of the perceived problems of collective land management.

During communal land tenure system, no one was allowed to fence land and harvest hay/fodder, fencing of land was perceived as denying other pastoralists the opportunity to graze their livestock. With private tenure systems, we can make individual decisions on land use and store resources for future use.⁶

4.2.2. Adaptation strategies under private tenure

In extension of these rationales, the household survey data from this area shows a substantial shift in household adaptation strategies over the past thirty years, from mobility and communal pooling strategies towards market exchange, storage and diversification (Figure 4).

4.2.2.1. Mobility under private tenure. As in our other study area, the mobility strategy in Oldonyo-Orok consists of seasonal movement of livestock in search of pasture. Of our surveyed households, 37% still practice this strategy. However, in this area the mobility strategy has declined substantially in recent decades (Figure 4). Subdivision of the Group Ranch has confined herds to smaller, individual parcels of land. Households are allowed to transit livestock across neighbouring private land, but cannot utilise the pasture and are constrained by fencing and crop farms. This contrasts our other study site (Olkiramatian), where the mobility strategy has also declined but less so as the communal land use system there was developed to accommodate it (Figure 3). Instead, households under the private land tenure scheme in Oldonyo-Orok have increasingly turned to more intensive forms of livestock rearing, i.e. paddocking. This is facilitated by the private ownership of land which allows households to fence land, control pasture and grow fodder.

4.2.2.2. Diversification under private tenure. Similar to our communal tenure study area, diversification of livelihood sources under private land tenure in Oldonyo-Orok has expanded significantly and is now practiced by virtually all surveyed households in this area (Figure 4). Crop farming has become widespread, enabling households to spread risk between livestock and agricultural products, for consumption and sale to local and outside markets. During interviews, households said they felt individual land ownership gave them an advantage compared to areas with communal tenure, as privatisation of land provides access to monetary capital, either as collateral for loans or by selling sections of their land. This capital is reinvested in farming, or in intensive forms of livestock production, including fattening livestock for commercial sale. Profits are further invested in children's education, aimed at securing jobs and thus further income diversification.

4.2.2.3. Storage under private tenure. Household use of storage for adaptation has also increased in the area (Figure 4). This again echoes developments in our other study area, but with different tenure dynamics. Here, the individualisation of land ownership has allowed households to fence land and thereby produce hay as dry-season fodder, facilitating non-mobile livestock rearing and fodder sales to pastoralists elsewhere. Interviewees said that with individual ownership they felt more secure making long-term investments in water tanks and – for the better off – even private boreholes, thus enhancing water storage for prolonged dry spells and droughts. However, privatisation has also constrained collective solutions, such as setting aside communal grazing banks which forms part of the storage strategy in our other study area.

4.2.2.4. Communal pooling under private tenure. While pooling resources has grown to become an almost universal adaptation strategy under communal tenure in Olkiramatian, it is employed by just 10% of surveyed households under private tenure in Oldonyo-Orok, declining sharply in recent decades (Figure 4). Households who do practice this strategy include small groups of neighbours who pool private funds or labour to enhance water infrastructure or transport livestock to markets to avoid emaciation during droughts. The decline in communal pooling can be expected given the individualisation of land ownership and dissolution of communally managed rangelands, but it is nevertheless notable that so few households pursue the strategy. Interviewees explained that privatisation had led to a decline in customary norms of collective action, echoing similar findings in other privatised Group Ranches in southern Kenya (Rotich, Funder, and Marani 2023a; Mwangi 2007b).

4.2.2.5. Market exchange under private tenure. By contrast, market exchange has grown to become a favoured adaptation strategy among households in Oldonyo-Orok. Unlike our communal tenure study site, this strategy is now adopted by virtually all households (Figure 4). The area has thus shifted from a traditional pastoral economy based on accumulating livestock as a measure of wealth to a far more market-oriented local economy. Households market livestock, meat, milk, fodder and crops, and some engage in commodity trading. This is facilitated by the proximity of a major highway and various market towns. Land is furthermore sold to generate capital as discussed above, which has led to a growth in land markets. Some households also rent out land for grazing. During interviews households explained how engaging markets was a way to spread risk across income portfolios, secure funds for investing in more profitable and resilient livestock and crops, and if possible set aside savings for difficult times. Individual land ownership was seen as a key feature in this.

The rains are worse, but at least now we can each do what we like with the land [...] If there is demand for this [crop] I can say: Yes, let me try.⁷

4.2.3 Household perceptions of private tenure vis-a-vis adaptation options

Table 2 summarises the adaptation actions of pastoralists in Oldonyo-Orok and how interviewees in this area perceives advantages and disadvantages of the private land tenure system in relation to adaptation.

As in the communal tenure system, social differentiation affects household perceptions. During individual – and focus group interviews, poor households said that they preferred private land ownership because it enhance their tenure security and made them less dependent on the local elites who ruled communal decision-making before the Group Ranch was dissolved. However they also pointed to the erosion of social “safety nets” under private tenure. Under the collective tenure system of the past, droughts and floods had been a communal challenge and jointly addressed. Social norms furthermore dictated that in times of crisis, anyone could access pasture and water anywhere, including in other Group Ranches. By contrast, poor households now felt that crop failure and lack of pasture was considered an individual problem – a generally shared perceptions among households.

For households with sufficient capital, this issue is overcome by investing in water infrastructure and/or leading pasture from each other or elsewhere in the region. Poor households lack this opportunity, although they may sell sections of their land. Some households have however been either tempted or forced by circumstances to sell of all or most of their land, effectively leaving them landless and dependent on other households for e.g. labour opportunities in fields or as herders.

5. Discussion

5.1. Adaptation strategies vary across time and space

Our findings show how pastoral communities in the study areas are actively responding to climate change by changing their livelihoods and pastoral practices (Table 1 and Table 2). This echoes other

studies that also found agency and creativity as pastoralists respond to climate change (Napogbong, Ahmed, and Derbile 2021; Volpato and King 2019; Opiyo et al. 2016). Our study adds further insights by showing how the adaptation strategies employed by pastoral communities may vary over time and space. In both study areas people have been adapting to changing climatic conditions for several decades, but their strategies for doing so have evolved and changed, with a growing emphasis on market exchange, storage, and diversification.

Yet the changing adaptation strategies are not identical in the two study areas. In Oldonyo-Orok the shifts are more pronounced and the emphasis on market exchange is greater, while in Olkiramatian traditional strategies – including communal pooling – remain important. Although less than 80 km apart, which is close in pastoral terms, communities in the two study areas thus configure their adaptation strategies differently. These findings highlight the importance of understanding adaptation strategies as evolving and localised. Universal assumptions that “all pastoralists adapt the same way” must be avoided.

5.2. Land tenure systems and adaptation strategies interact

Our findings show how different tenure systems may provide different adaptation options for pastoral households. In Olkiramatian, communal tenure supports a locally innovated pastoral livestock rotation system based on communal pooling of pasture and water, supplemented with crop farming on communal land for diversification and market exchange. In Oldonyo-Orok, private land ownership allows households to pursue highly individualised land management decisions in support of market exchange, diversification – and storage strategies.

The findings further show that households in the study areas actively reflect on the merits and drawbacks of their tenure systems vis-à-vis adaptation and align their adaptation strategies to suit (Table 1 and Table 2). In our study areas, land tenure thus plays a distinct role in household rationales as they evolve their adaptation strategies. This echoes the findings of Akugre et al. (2021) in Ghana, and contributes to our understanding of factors that influence pastoralists' adaptation strategies.

It should be added that we cannot on this basis say that particular tenure systems automatically lead to particular adaptation strategies. Determinism must be avoided, and the decision-making of households may be affected by a variety of additional local factors. This is also evident from econometric studies of whether tenure security leads farmers to take up coping and adaptation actions, which have had varying findings in different settings (Murken and Gornott 2022; Roco et al. 2014; Ullah et al. 2019).

5.3. Adaptation can play a role in shaping pastoral land tenure

The land tenure systems in our study areas were not historically given. In both areas, pastoral communities have actively worked to change land tenure rules and arrangements, which has been possible because the land was under their control. While communities in Olkiramatian have opted to innovate communal ownership through land use zonation, communities in Oldonyo-Orok have chosen to subdivide communal land into privately owned land plots.

As discussed in Section 4, communities have adopted these changes for several reasons, including efforts to accommodate growing populations (both areas), concerns over land grabbing, elitist decision-making and intergenerational inequalities (Oldonyo-Orok) and concerns over land fragmentation and disruption of pastoral culture (Olkiramatian). Climate change has compounded these rationales by adding to concerns over pasture – and water availability, competition over land and other natural resources, and the long-term viability of pure pastoralism.

Climate change adaptation has thereby formed part of the rationale as communities have sought to reshape land tenure rules and arrangements in the study areas, alongside other concerns. This

highlights a little explored dimension of the relationship between adaptation and land tenure, namely that while land tenure may influence adaptation strategies, adaptation may also influence land tenure (Murken and Gornott 2022).

5.4. Differentiation affects adaptation benefits from land tenure

The adaptation options available to households under the different land tenure systems in our study areas are however not equally available to all but are influenced by structural inequalities. The wider literature on pastoralism has shown how the combination of market expansion and lack of land rights can marginalise poor pastoralists (Lahiri-Dutt and Dondov 2017; Lind, Okenwa, and Scoones 2020a; Scoones 2021). Research on pastoralism in Kenya has furthermore highlighted how community elites benefit more from land use systems and dominate decision-making (Opiyo et al. 2016; Nkedianye et al. 2019; Unks et al. 2023).

Our study shows how such inequalities can affect the relationship between land and adaptation. The privatisation in Oldonyo-Orok means that access to land for adaptation is no longer based on belonging but requires capital. Households with more land also benefit more from rising land prices and are able to get better loans for investments in adaptation. In the communal regime in Olkiramatian land cannot be sold, but here differentiation asserts itself in other ways: The adapted rotational livestock system does not take herd sizes into consideration, meaning that wealthy households with large herds benefit relatively more. Likewise, local elites dominate decision-making on communal land use. In both study areas, well-off households are furthermore better positioned to invest in crop farming, private boreholes and other ventures that support adaptation. This is in line with Snaibi *et al.*, who found that wealthier pastoralists employ a broader and more lucrative range of adaptation strategies than poorer pastoralists (Snaibi et al. 2021). Our findings show how differentiated access to and benefits from land can contribute to this.

5.5. Recognising the importance of land tenure for everyday adaptation

These findings speak to the wider literature on autonomous and everyday adaptation, which has shown the multitude of highly localised responses that communities undertake to adapt (Castro and Sen 2022; Tebboth et al. 2023; Rahman et al. 2021). Our findings show that efforts to align with and reshape land tenure arrangements can form an important part of the “work” of everyday adaptation that households and communities do. Our findings further show that in this process, households actively work to adjust and change their adaptation strategies and land tenure systems. This resonates with other studies which have highlighted how people’s everyday adaptation agency is characterised by experimentation and learning (Anh Tran 2020; See, McKinnon, and Wilmsen 2022). The importance of inequality and differentiated options for pursuing adaptation is however also clear in the literature (Nixon et al. 2023; Tebboth et al. 2023), and our study shows how land access may limit adaptation options for poor households.

Policies and funding that seek to support adaptation must take these factors into account. Too often, externally devised adaptation interventions have ended up interrupting everyday adaptation rather than supporting it (Lindegaard and Sen 2022; Clay 2023). Instead, policies and funding must take an outset in people’s own adaptation strategies. This includes devolving adaptation funding and decision-making to local actors and institutions as per the Locally Led Adaptation principles (Bedelian et al. 2024; Rahman et al. 2023). But it also entails supporting communities in maintaining control of their land, ensuring that poor households are able to access land for adaptation, and building on people’s own efforts to align adaptation and land tenure systems successfully (Rotich, Marani, and Funder 2023b).

6. Conclusion

Adaptation strategies do not develop in isolation but are shaped by and interact with a variety of contextual factors. Here we have focused on the role of land tenure. Our findings show how pastoral household adaptation strategies may interact with local land tenure systems. Households in our Kenyan study areas have developed multi-faceted portfolios of adaptation strategies, crafting each strategy to optimise benefits from communal and private tenure systems respectively. At the same time, concerns over the viability of pastoralism under changing environmental conditions have – alongside other factors – contributed to community efforts to remake their land tenure systems, either by innovating communal land use or by privatising communal land.

This suggests the need for a dynamic understanding of the relationship between climate adaptation and land tenure and highlights the need to pay more attention to the agency of pastoralists as they negotiate the intersection between climate change and land tenure. Importantly, however, the relationship between adaptation and land tenure also includes structural processes that variously constrain and enable people's adaptive capacity. Social and economic differentiation means that some households find themselves poorly positioned to benefit from prevailing land tenure systems vis-à-vis adaptation, a feature that we found under both communal and private tenure.

In extension of this, we found that households were well aware of the benefits and drawbacks of both communal and private tenure vis-à-vis adaptation, and actively reflected on it. Efforts to support local adaptation would do well to keep this in mind. Rather than impose externally conceived solutions, local experiences and settings must be the point of departure, including – as we have found – the connections between adaptation strategies and land tenure.

Notes

1. Note that this article does not aim to assess the efficiency of the adaptation strategies and tenure systems under study, but rather the nature of their interactions.
2. Registration is by households, total census not available at this level. Our study indicated average household sizes of 12–15 including children. This is consistent with a demographic study of Maasai households in the region (D. Nkedianye et al. 2020).
3. Surveys interviewees were household heads. If too young to remember 30 years they were asked to compare with parents' practices. Maasai have strong intergenerational knowledge transfer practices, so respondents did not find this hard. Survey findings were triangulated with FGDs and life history interviews.
4. Group Ranch member, Olkiramatian. Focus Group interview, 19th November, 2021.
5. Household head, Oldonyo-Orok, Focus Group interview, November 15, 2019.
6. Elder, Oldonyo-Orok, Key informant interview, 14th July, 2021.
7. Household head, Oldonyo-Orok, Focus Group interview, November 14, 2019.

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