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# Suburban pastoralists: Pastoral adaptation strategies at the rural-urban interface in Nairobi, Kenya

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## Abstract

How does urban expansion interact with pastoral climate change adaptation? This article explores pastoral adaptation strategies at the rural-urban interface. It examines how Maasai pastoralists in peri-urban Nairobi, Kenya, respond to climate hazards in the context of urban expansion, land use change, and land privatisation. Using mixed-method research, the study is informed by a household survey ( $n = 72$ ), 38 qualitative interviews, and 12 focus group discussions. Drawing on the literature on climate change adaptation, pastoral change, and peri-urban dynamics, we find that while urban expansion provides significant challenges for pastoral livelihoods in the study area, pastoralists also engage new opportunities in the peri-urban context and employ them in their adaptation strategies. We show how adaptation strategies related to mobility, diversification, market exchange, and storage are employed through a variety of efforts including engagement with urban land markets and demand for livestock products, and by capitalising on proximity to transport, trading facilities, water, and commercial fodder. Communal pooling, another adaptation strategy, is less used and perceived to be in decline. We further find that historical land ownership patterns play a significant role in adaptation strategies, as pastoralists who have benefitted from rangeland privatisation are able to convert high peri-urban land values into private rural land access and investments in, e.g. diversification. Poor households are in a more precarious position but draw on informal agreements to access land as part of their adaptation strategies. Our findings highlight how pastoral households at the rural-urban interface may draw actively on peri-urban opportunities in their adaptation strategies as part of their efforts to enhance livelihoods, and in so doing bridge peri-urban and rural space. More broadly, our study highlights the importance of understanding pastoral climate change adaptation in the context of wider changes in livelihoods, land use, and land rights, rather than as isolated actions.

**Keywords** Climate change adaptation, Urbanisation, Land use change, Land rights, Maasai

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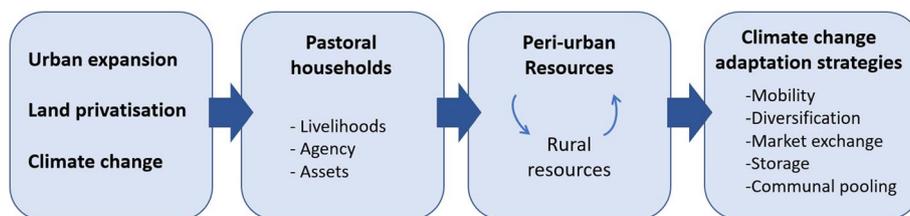
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## Graphical Abstract



## Introduction

Pastoral adaptation to climate change takes place in a context of continuous economic and social change. Urban expansion and investment in industrial, agricultural, and infrastructural development in the Global South have significant effects on land use, land markets, and rural-urban dynamics and thereby on the constraints and opportunities for adaptation in pastoralism<sup>1</sup>. This raises important questions for the study of climate change adaptation. How does rapid land use change affect the conditions for adaptation, and what does it mean for the adaptation strategies of rural and urban communities? This article explores one dimension of this issue through a study of the interactions between large-scale urban expansion, changing land markets, and pastoralist adaptation strategies in Kenya.

Past research has provided critically important insights into pastoralist adaptation strategies (Napogbong et al. 2021; Volpato and King 2019; Opiyo et al. 2015), but is often focused on responses to climate change itself, with less attention to how adaptation strategies are influenced by wider changes in land use and land markets. Other work discusses the effects of large-scale land investments and alienation on broader pastoral resilience, but with limited attention to how this interacts with pastoral climate change adaptation strategies and usually in the rural context (Bekele et al. 2022; Liao et al. 2020). Less is known about how and to what extent pastoralists seek to incorporate and benefit from changing land use and land markets in their climate change adaptation strategies, and how such strategies unfold at the frontline of urban and industrial expansion where land use change is particularly rapid, and where urban and rural economies intersect (Mbiba and Huchzermeyer 2002; Dadashpoor and Ahani 2019).

This article sheds more light on this issue through a study of pastoralist engagement with urban expansion

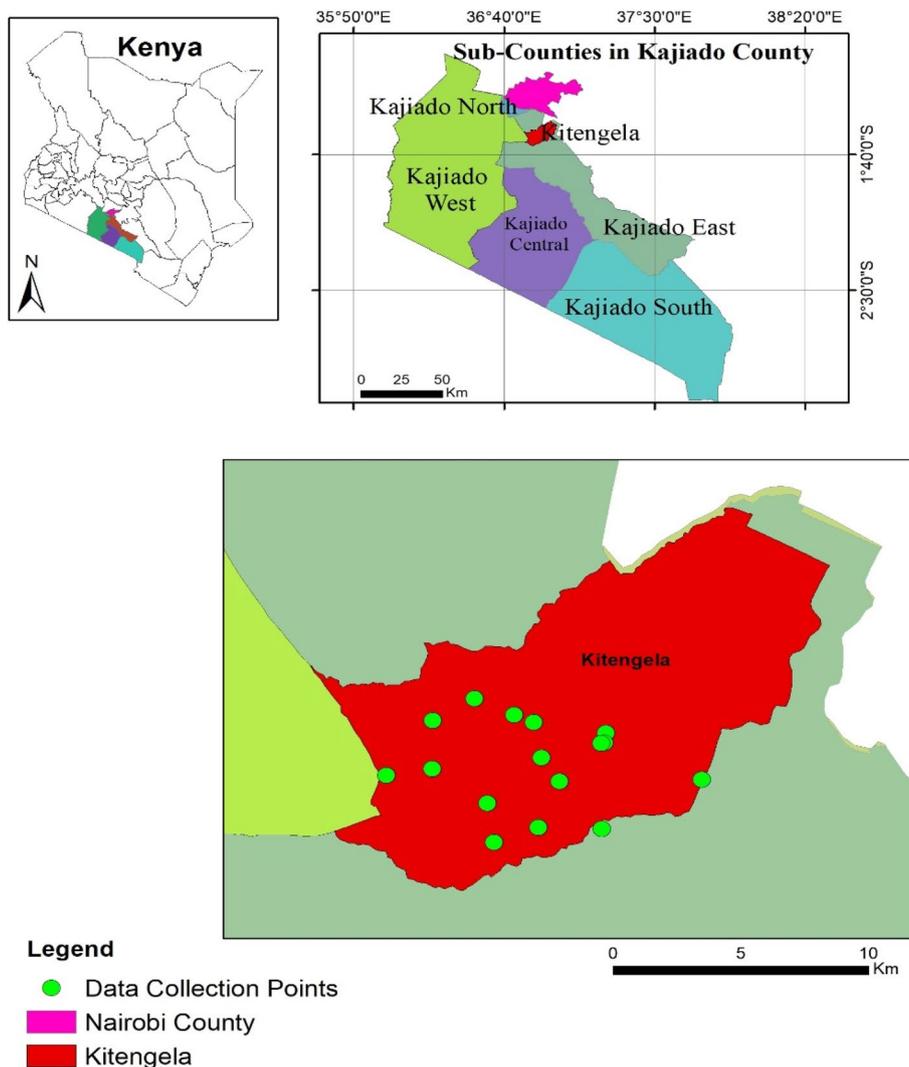
in peri-urban Nairobi and the opportunities and constraints that this provides for adaptation strategies. We do so using a conceptual framework that combines three bodies of literature on (i) autonomous climate change adaptation strategies, (ii) pastoral responses to land use change, and (iii) peri-urban areas as dynamic spaces for rural-urban interaction.

Drawing on these approaches, we examine the implications of urban expansion and associated land use conversion and dynamic land markets for the adaptation strategies of Maasai pastoralists in Kitengela, a peri-urban area of greater Nairobi where middle-class residential areas, industrial estates, and infrastructural development are expanding across pastoral rangelands.

We find that these changes have both constraining and enabling effects for Maasai pastoralists' adaptation. On the one hand, pastoralists experience reduced availability of pasture, increasing limitations on conventional livestock mobility, and erosion of communal pooling and resource-sharing mechanisms. Yet at the same time, pastoralists perceive and engage peri-urban areas as spaces of opportunity that can help reduce risks from climate change hazards and enhance their livelihoods more broadly. This includes livelihood diversification through access to urban jobs, education, and markets for new products and securing livestock production through easy access to water, veterinary inputs, and fast vehicle transport to better pastures. Land-owning pastoralists furthermore benefit from rising peri-urban land values and use this capital to secure fodder and diversify income through activities such as hay production or buying or renting land and pasture in other parts of the country. Non-land-owning pastoralists are less privileged and must juggle the opportunities offered by peri-urban areas with the difficulties of accessing pasture. To do this, they employ creative strategies to informally access public and private grazing niches in the peri-urban landscape.

Our findings contribute new insights to the understanding of pastoral adaptation at the rural-urban

<sup>1</sup> In the following we use "adaptation" as shorthand for climate change adaptation.



**Fig. 1** Map of the study area

interface by highlighting the dynamic nature of this process, and how pastoral actors at the frontline of urban expansion may actively incorporate the opportunities vested in peri-urban spaces in their adaptation strategies. Our findings further show how pastoralists are not necessarily passive victims of rapid land use transformation but may actively and creatively engage with such processes as part of their efforts to adapt and innovate livelihoods, and in so doing bridge peri-urban and rural spaces. In an extension of this, we show how local land ownership histories position pastoral households differently in their efforts to adapt at the rural-urban interface.

**Study area**

Like most countries in sub-Saharan Africa, Kenya is undergoing significant urbanisation with the country’s urban population rising from 7% in 1960 to 28% in 2018

(UN-DESA 2018). This is particularly evident in the peri-urban areas of Nairobi where middle-class neighbourhoods, informal settlements, industrial development, and transport infrastructure have expanded substantially in recent decades (Bon 2021; Kinuthia et al. 2021). Much of this development has taken place in the dryland savannahs that surround Nairobi which also serve as rangelands for Maasai pastoralism (Wafula et al. 2022).

Here we focus on the peri-urban area of Kitengela, a 390-km<sup>2</sup> municipality south of central Nairobi in Kajiado County within the Greater Nairobi Metropolitan Region (Fig. 1). Kitengela forms part of the larger Athi-Kaputiei Plains rangeland ecosystem (2456 km<sup>2</sup>) that has historically been settled by Maasai pastoralists as important grazing grounds for pastoral production in southern Kenya (Morara et al. 2014; Kimani and Pickard 1998; Reid et al. 2008). The area is predominately semi-arid,

with limited and unreliable rainfall ranging from 500 to 800 mm annually (ICAT 2017). In recent decades, these rangelands have been subject to three significant changes: land privatisation, urbanisation, and climate change. The “Results” section elaborates on the historical evolution of these features.

### Conceptual framework

In the following, we bring together literature on climate change adaptation, pastoral studies, and peri-urban areas to clarify our conceptual understanding of (i) the nature of climate change adaptation strategies, (ii) the relationship between pastoral adaptation and land use change, and (iii) the nature of peri-urban areas.

#### The nature of climate change adaptation strategies

Climate change adaptation is understood here as “the process of adjustment to actual or expected climate and its effects in order to moderate harm or take advantage of beneficial opportunities” (IPCC 2022 p.35). Our focus is on so-called autonomous adaptation, i.e. actions that people undertake on their own account on an everyday basis (Smit et al. 1999; Thorn et al. 2015).

Autonomous adaptation practices are highly context-specific, but for heuristic purposes, we here follow Agrawal and Perrin’s overall typology of adaptation strategies (Agrawal and Perrin 2009; Thornton and Manasfi 2010; Wang et al. 2013). These strategies are as follows: (i) mobility, e.g. movement of livestock and/or people; (ii) diversification, e.g. diversifying subsistence- and income opportunities, or livestock and crop types; (iii) storage, e.g. storage of food, water, and seeds; (iv) communal pooling, e.g. shared access to resources across households; and (v) market exchange, e.g. increased use of market mechanisms to exchange products and services.

Autonomous adaptation strategies typically take place in response to multiple stimuli at the same time, where climate change is one factor alongside other changes (Smit et al. 1999). Moreover, adaptation strategies are closely linked to people’s broader efforts to improve livelihoods and are therefore often directed both at reducing climate hazards and at enhancing well-being more generally (Thorn et al. 2015). Recent work in the livelihood literature has emphasised the need to understand livelihoods as dynamic and evolving, sometimes over short periods of time (Natarajan et al. 2022).

People’s ability to carry out adaptation strategies is also conditioned by institutions and access to assets (Nelson et al. 2007). Institutions include the norms that influence adaptation actions, and mechanisms and rules such as land rights that mediate and regulate access to assets (Ribot and Peluso 2003). Drawing on wider livelihood

research, studies have emphasised the importance of natural, social, human, physical, and financial assets for people’s adaptive capacity (Brown et al. 2019; Natarajan et al. 2022). These assets are rarely equally distributed, meaning that some actors are better positioned than others to adapt (Brown et al. 2019).

#### The relationship between pastoral adaptation and land use change

A number of studies have examined pastoral adaptation strategies in rural settings, showing that pastoralist communities are well aware of changing climatic conditions and actively seek to adapt (e.g. Napogbong et al. 2021; Volpato and King 2019; Opiyo et al. 2015; Campbell 1999). However, pastoral climate change adaptation does not take place in isolation but should be understood in a context of wider livelihood and land use change. The broader literature on pastoral change in Africa and beyond has highlighted how long-standing processes of land alienation and political marginalisation have reduced available land for pastoral production and mobility (Lengoiboni et al. 2011; Liao et al. 2020). In some areas, changing land tenure and shifts from communally to individually owned land has further fragmented rangelands (BurnSilver 2009; Lind et al. 2020a; Mwangi 2007) and changed the social institutions and networks that customarily regulate access to land in pastoral communities (Scoones 2021).

These developments pose major challenges for pastoral adaptation and livelihoods, yet it is important to avoid essentialising pastoralism. Firstly, pastoral livelihoods are not static but have historically adjusted to changing environmental and social conditions (Hauck and Rubenstein 2017; Campbell 1999; Homewood et al. 2009). Secondly, recent work has highlighted how pastoralist livelihoods do not necessarily respond uniformly as circumstances change, and how differentiated access to markets and resources in East Africa influence whether households wholly stay in pastoralism, supplement it with new livelihood activities, or “drop out” of pastoralism (Lind et al. 2020b). The recent literature thus suggests a need to understand pastoralist actors as more than just victims of changing land use patterns and market dynamics and to examine their agency and innovation as they respond to these changes. Here we bring this understanding into our study of pastoral adaptation in the context of urban expansion.

#### The nature of peri-urban areas

Conventional hard distinctions between rural and urban areas have in recent decades been challenged by studies that point to complex economic and social interactions between city and countryside (Rauws and de Roo 2011;

Simon 2008). This has included a growing research interest in peri-urban areas. Initially, research on peri-urban areas was mainly focused on planning and regulatory aspects such as how to control “urban sprawl” (Mbiba and Huchzermeyer 2002). More recently, attention has turned to a more dynamic understanding of peri-urban areas as sites of two-way interaction between urban and rural actors, institutions, and economies, from which unique hybrid practices and land use dynamics may evolve (Mbiba and Huchzermeyer 2002; Rauws and de Roo 2011). Following this latter approach, we understand peri-urban areas as “a city’s transitional zone, amalgamating the functions and features of both urban and rural landscapes” (Mngumi 2021).

Peri-urban areas differ but some characteristics are common. They are typically zones of rapid transformation with dynamic flows of people, goods, and capital (Karg et al. 2019). Allen emphasised three features of peri-urban areas, namely (i) a heterogenous mosaic of different types of land use including agricultural, industrial, service, and residential areas; (ii) changing social structures and a wide mix of actors and interests; and (iii) a complex and often fragmented institutional landscape where organisations and tenure systems intersect and are in flux (Allen 2003). A common feature of peri-urban areas is the substantial reshaping of human-land relations, typically involving major shifts in the ownership of and access to land, and high levels of competition between actors in this regard (Dadashpoor and Ahani 2019; Kinuthia et al. 2021).

In pastoral studies, past work has highlighted the importance of urban markets for rural livestock production (Gautier et al. 2016), pastoral migration to urban areas (Wafula et al. 2022), and how pastoral sedentarisation may itself lead to the growth of rural towns (Fratkin 2013; McPeak et al. 2011). Some studies have also examined the impacts of urban expansion on pastoral livelihoods (Wenjun and Yupei 2021; Aberra 2012). This literature suggests a need to avoid a deterministic perspective and pay attention to how pastoral livelihoods may evolve rather than inadvertently disappear in the face of urban expansion (McPeak et al. 2011; Wenjun and Yupei 2021).

### Analytical implications

The above conceptual discussion implies that:

- (i) Climate change adaptation strategies can be categorised into five overall types (mobility, diversification, storage, communal pooling, and market exchange). These are linked to broader livelihood changes and conditioned by institutions—including

ing access rights to land and other resources—and household assets.

- (ii) Pastoral adaptation strategies must be examined in the broader context of land use change, and pastoralists must be understood as able actors who actively respond to and engage in such change.
- (iii) Peri-urban areas must be understood as dynamic sites of rural-urban interaction where land use and ownership are contested and in flux, offering both opportunities and constraints for pastoral livelihoods.

Our study operationalises this by (a) identifying pastoral climate change adaptation practices in the study area and categorising them according to Agrawal and Perrin’s (Agrawal and Perrin 2009) five main types of adaptation and (b) examining how these strategies connect to broader pastoral efforts to negotiate challenges and opportunities in the changing land use context of a peri-urban setting.

### Study design

The field research for this article forms part of the wider collaborative Rights and Resilience research programme (RARE). The findings are based on field research in Kitengela in peri-urban Nairobi which has undergone considerable land use change in recent years.

Using a mixed-methods strategy, we collected quantitative data from a questionnaire survey of 72 Maasai pastoralist households and qualitative data from 38 in-depth semi-structured interviews and 12 focus group discussions (FGDs).

The questionnaire survey explored household adaptation practices, livelihood activities, and land histories. The sampling frame for the survey was a list of all 234 Maasai households in the study area obtained from Maasai leaders. From this, a simple random selection of 72 households was done. Trained enumerators administered the questionnaire in Maa language using K-macho phone-enabled data collection software, under the supervision of the principal researcher.

The in-depth interviews elaborated on the survey and explored perceptions of change, rationales for adaptation and livelihood choices, and included mapping of 14 life histories. The FGDs were done separately for original landowners and settlers (6 FGDs each) and divided into groups of elders, men, and women. Each session had 6–10 participants and lasted 60–90 min.

The questionnaire and qualitative interviews were complemented with supporting information on the land ownership and wealth status of the interviewed

households. A local register allowed us to determine whether the household was an original landowner (defined as members of the historical Kitengela-Kaputei Group Ranch) or subsequent settler (defined as pastoralists who settled in the area after the Group Ranch was disbanded in 1988). In addition, we used the Wealth Ranking method to determine the wealth status of the interviewed households (Grandin 1988; Scoones 1995). A group of 12 local informants discussed and identified five key local parameters of wealth (land size, livestock numbers, property ownership, wage income, and education level) and on this basis assigned households into high, middle, and low wealth categories.

Household survey data were cleaned, coded, and analysed using SPSS Version 21, using descriptive statistics for survey data presentation. The qualitative data were thematically coded and analysed using thematic analysis with NVivo 12 software. Interviewees were promised full confidentiality before interviews, as land issues (e.g. sales) can be sensitive.

## Results

### Historical context: Land privatisation, urbanisation, and climate change in peri-urban Nairobi

In the late 1960s, Kenya's national land policy sought to transform communal pastoral rangelands into so-called Group Ranches with fixed and legally recognised boundaries in which land was collectively owned by registered household heads. Later, the government opened for voluntary subdivision of Group Ranches into privately held land plots in the 1980s (Galaty 1992; Mwangi 2006). While some Group Ranches chose to remain collectively owned, the majority of those in southern Kenya have elected to subdivide their land into private land holdings (Mwangi 2007). The Kitengela Group ranch—established in the mid-1970s—was subdivided in 1988 following a membership vote, giving the 215 households (all Maasai) title deeds for approximately 101 hectares each (Nkedianye et al. 2009). During our interviews, former members of the Group Ranch explained that their initial interest in land privatisation was driven by a desire for individual title deeds that could be used as collateral for loans, and a belief that individual ownership enhanced tenure security vis-à-vis a growing immigration and government land acquisition in the wake of urban expansion.

With privatisation came the ability for Maasai pastoralists to sell land individually, a feature that developed dramatically from the 1990s onwards in the rangelands around Nairobi, as land prices rose substantially in the wake of residential and industrial expansion (Nkedianye et al. 2009; Bon 2021). For some pastoralists, land sales were the result of a decision to abandon pastoralism altogether in favour of

wage labour or other economic ventures deemed more profitable or attractive. For others, land sales provided a means to repay loans, typically incurred during severe droughts (Galaty 1992; Nkedianye et al. 2020). More recently, selling parcels of land became a means to raise capital for expanding livelihood portfolios and securing access to pasture elsewhere in the country. We return to this below.

The expansion of Nairobi and concurrent sale of pastoral land has contributed to substantial land use change and urbanisation in our study area Kitengela. During the period 1984–2010 alone, rangelands in Kitengela declined from 104,740 to 71,828 hectares (Morara et al. 2014). From 2009 to 2019, Kitengela's population increased from 58,000 to more than 154,000 residents (Kenya National Bureau of Statistics, 2019), and the area's central conurbation grew from a small township to a sprawling commercial centre featuring malls, a university, an industrial zone, and expansive residential areas whose middle-class inhabitants typically work in Nairobi (Osano et al. 2013; Nkedianye et al. 2020).

Alongside these changes, southern Kenya—including Kitengela—has experienced rising average temperatures, greater rainfall variability, and reduced overall precipitation, with a particular increase in drought and heat stress days during the main rainy season (ICAT 2017; Kogo et al. 2021). Conversely, the secondary rainy season has seen an increase in rainfall and overall flooding risk (ICAT 2017). Pastoralists in our interviews perceived these climatic changes as highly problematic and reported how they experienced increased livestock emaciation and mortality from drought, while reduced and erratic rainfall patterns made it more difficult to plan livestock movement, trading, and breeding practices. This is compounded by flooding which leads to livestock displacement and temporary pasture loss.

### Challenges for pastoralism in the peri-urban setting

For pastoralism, the combination of land privatisation, urbanisation, and climate change has had significant implications. Firstly, the conversion of land to housing and industrial estates has significantly reduced available grazing land in the area. The escalating land prices furthermore mean that, for most pastoralists, the option of expanding pasture or herds by obtaining new land in the peri-urban area is either economically unviable or simply not affordable.

Secondly, conventional means of mobility have been constrained. Land use conversion and the emergence of fencing, roads, and other infrastructure interrupt traditional pathways for livestock mobility, as herders must weave their way across increasingly fragmented and inaccessible lands. Thirdly, the individualisation of land ownership has contributed to an erosion of customary social

institutions for regulating and managing land, water, and other natural resources. This has been gradually weakened since Group Ranch subdivision, but the recent fragmentation and reduction of grazing land have made it particularly difficult to engage in collective resource management efforts.

These changes interact with the worsening climatic conditions for customary pastoral practices in the area and raise questions among pastoral households about the best ways forward. As one interviewee put it:

*“We used to be able to go anywhere [...] now there is less pasture, and the rains are not steady [...] We can’t do it like before, we are trying to do things in new ways to deal with this situation.”*

A fourth challenge is thus that the changing land use context affects customary means of responding to unpredictable weather patterns. As will be discussed below, urban expansion complicates conventional mobility practices during droughts and dry spells, while the individualisation of land ownership and decline of customary mechanisms constrain traditional collective responses to resource scarcity.

**Pastoral land access in contemporary Kitengela**

The historical trajectory of Kitengela illustrates the interacting dynamics of land privatisation, rapid land use change, and climatic stress which pastoralists must navigate at the rural/urban interface of Nairobi’s peri-urban areas.

The changing circumstances have led some households to abandon practising pastoralism in the area altogether. In some cases, this is a result of a strategic assessment, whereby the rising value of peri-urban land is seen as a means to finance a full shift to new livelihood forms, such as engaging in crop farming or business ventures or investing in expensive higher education for children. In other cases, departure from practising pastoralism in the area has been less voluntary. Some households have sold all land because of high debt burdens, health emergencies and/or disease, and drought. They have typically moved to informal settlements to seek out low-paid urban wage labour, or to family in rural areas where they might work as herders.

Overall, however, pastoralism remains an important land use in Kitengela, and this paper focuses on the Maasai households who are currently settled in the area and continue to practise pastoralism (Table 1). In this respect, a distinction can be made between two different types of households, with different historical connections to the area and its land:

One group consists of Maasai households whose families were former members of the original Kitengela

**Table 1** Selected attributes of household survey participants (n = 72)

Age (years)	
30–44	39%
45–60	54%
65+	7%
Highest education level	
Tertiary	39%
Secondary	3%
Primary	18%
No formal education	40%
Largest single income source	
Sale of livestock and farm products	68%
Business ventures (e.g. real estate, transport, trading)	15%
Wage employment	8%
Remittances	1%
No major cash income (subsistence herding)	8%
Mean herd size per household	
Cattle	20
Goats	18
Sheep	25
Distance to nearest urban centre	
0–5 km	76%
6–10 km	24%
Household distribution in wealth ranking categories	
High	28%
Middle	60%
Low	12%

Group Ranch, and to whom individual land was allocated when the Group Ranch was subdivided in 1988. The following quote illustrates how this land has typically been further divided within families in this group, but remains under one formal title:

*“My father was a beneficiary of Kitengela Group Ranch sub-division [...He...] later sub-divided it equally among his four wives. Each of the wives further subdivided the land among their sons. [...] Even though the land is sub-divided among the sons in our family, the title deed retains my father’s name.”*

A second group is Maasai households who have settled in the area after the subdivision of the Group Ranch. Of these, some purchased land from other pastoralists while prices were still affordable, while others do not own land and only have temporary land access. The latter either lease land from other pastoralists or negotiate land access on a temporary and informal basis. Households in this group may still have social ties to their original birthplace but have relocated to Kitengela on a permanent basis because of perceived

opportunities in the area. The following quote provides an example:

*“In the year 2002 I left Ildamat and moved to Kitengela following a drought [...]. I knew about Kitengela since 1996, when I came to visit my brother who settled here in the year 1994. Then, Kitengela had plenty of grass and water [...] Kitengela has provided good marketing opportunities for our livestock and livestock products and [...] education centres and health centres.”*

A further group of pastoral land users is Maasai households settled outside the Kitengela rangelands who temporarily access the area, typically in search of grazing and water during drought or in transit to other areas. These are not the subject of the current study, although we discuss their reciprocal relationships with the Kitengela pastoralists.

**Pastoral adaptation strategies in the peri-urban context**

In the following, we examine how pastoral households settled in Kitengela engage the peri-urban space as part of their climate change adaptation strategies and changing livelihood preferences. We discuss this by drawing on the five categories of adaptation discussed by Agrawal, i.e. mobility, diversification, market exchange, storage, and communal pooling (Agrawal and Perrin 2009).

Table 2 shows the extent to which households in our questionnaire survey engaged in four of these strategies. Interviews showed that respondents considered activities under the fifth strategy—communal pooling—so integral to other adaptation activities that they could not meaningfully be separated out in a questionnaire. However, our qualitative interviews and FGDs provided insights into this strategy (discussed below).

Significantly, most households apply the strategies in combination, with 25% engaging in two of the overall strategies, 39% in three, and 32% in four of the strategies.

**Table 2** Household engagement in overall adaptation strategies. *N* = 72. The questionnaire asked households to list their responses to changing weather patterns using a multiple-choice format. Their responses were then assigned to the respective adaptation categories

Adaptation strategy	Share of surveyed households (n=72)
Mobility	59%
Market exchange	65%
Storage	58%
Diversification	54%
Communal pooling	Cross-cutting

In the following, we discuss how the five strategies relate to peri-urban space.

**Mobility: Bridging peri-urban and rural space**

Mobility is the distribution of risk across space and time (Agrawal and Perrin 2009). Customarily, pastoralists in Kitengela have addressed drought and prolonged dry spells in the area by moving livestock on foot over short or long distances to secure water and pasture. However, during interviews, pastoralists explained that urban expansion and land privatisation has constrained customary mobility practices. Alternative grazing options in nearby locations have been reduced as pasture is converted to other land uses. Moreover, customary pathways are increasingly obstructed by the fencing that accompanies housing, roads, industrial estates, and efforts to avoid encroachment.

Yet despite these constraints, mobility remains an important feature of how pastoralists in Kitengela navigate their changing socio-environmental context. Mobility is not abandoned but reconfigured. We identified three main practices in this respect:

Firstly, in times of drought, livestock is still relocated to other parts of the country where pasture is better, but often this is now done using trucks rather than on foot. Although this must be paid for, it avoids the physical barriers created by urban expansion, allows livestock to be shifted quickly, reduces risks of emaciation, and does away with uncertainties and informal access costs associated with livestock movement across other people’s rangelands. In the peri-urban setting, transport is easily available and affordable, and Nairobi’s position at the centre of the national road network provides quick access to all parts of the country. This practice thus not only overcomes the physical barriers created by urban infrastructure expansion, but also directly exploits it.

Secondly, some pastoralists in Kitengela have turned to private land acquisition in rural areas outside the peri-urban context, where pasture remains intact and cheap and is available for purchase as a result of the privatisation of many former Group Ranches as discussed above. These households rotate livestock between their remaining peri-urban land and newly acquired rural land, thereby spreading the risk of drought impacts and reducing overgrazing. This may involve herd-splitting across peri-urban and rural land. In some cases, livestock has been shifted permanently to rural land. As one interviewee explained:

*“I have 2.8 hectares of land in Kitengela, I have exchanged one acre of land for 8 hectares with my friend from Mashuruu. During droughts, I transfer*

*most cattle to Mashuruu [but] remain with a manageable stock for milk [sales]. Apart from grazing my livestock [there] during droughts, I have cattle that permanently stay there since they are more tolerant to droughts."*

This practice allows households to retain their base in Kitengela and exploit peri-urban livelihood benefits while at the same time continuing livestock production elsewhere, through either young household members or hired herders. During interviews, pastoralists in Kitengela further explained that the acquisition of private rural land was a good long-term investment, because rural land would also eventually increase in price.

A key element in this practice is the capital vested in the household's peri-urban land, which due to its escalating prices can be exchanged or sold off in small parcels to mobilise capital for purchase or rental of cheaper and greater parcels of rural land.

*"I have sold 0.8 hectares of my land to buy 40 hectares to graze my livestock in Emali. My livestock are grazing there comfortably."*

However, such practices require that one has land to sell. An alternative is to lease land in rural areas, as some households do. Poor households, who typically have no land and primarily own goats and sheep, employ a third mobility practice: They exploit available grazing niches in the peri-urban landscape that are not owned or allocated for pastoral use, but nevertheless offer opportunities in times of drought. This includes making informal arrangements with absentee landlords on idle land that has been purchased for speculation. Pastoral households offer to guard the land and ensure that others do not occupy it, while being allowed to graze livestock as payment.

Some interviewees from the poorest group or households further explained that they had informal arrangements with nearby industrial estates to graze livestock there around and between industrial plants. For the involved companies, this helps maintain good relationships with pastoral communities and acts as a security measure. A further common approach during drought is to exploit public land for pasture and fodder, such as roadsides. Since the late 1990s, this practice has expanded even to unbuilt spaces of central Nairobi in particularly bad drought years. Households also move livestock by foot to surrounding rural areas and seek out access to pasture there. While these solutions are not ideal, they constitute a means for households without formal land ownership to exploit available grazing opportunities within the peri-urban landscape, while simultaneously drawing on advantages of the peri-urban setting such as piped water supply and livelihood diversification.

Common to these practices is thus an active response to the mobility constraints offered by the changing socio-environmental context, by exploiting the opportunities that the peri-urban context also offers, e.g. road transport, high land value, and informal grazing niches. As rural land is also incorporated into these practices, they are effectively a means of bridging peri-urban and rural spaces and their respective opportunities.

#### **Diversification: Engaging urban demand and livelihood opportunities**

Diversification allows households to distribute risk across different livelihood assets. When asked how they were responding to changing climatic conditions for pastoral production, 54% of respondents in our household survey named activities that involved diversification of livestock or non-livestock incomes. In addition to this, education is considered a key asset for income generation.

Two main diversification practices were evident in Kitengela. Firstly, some households seek to expand their income portfolio by engaging urban markets for livestock products including milk and meat. Households also increasingly engage in fattening, i.e. rearing livestock for a brief period for sale as heifers or steers. The peri-urban setting provides an easily accessible and profitable market for this approach. When asked about the risks of erratic rainfall for milk production and fattening, interviewees explained that the peri-urban availability of piped water, commercially available fodder, and easy access to markets helped reduce such risks. Alongside this, most households also have more drought-tolerant goats and sheep. This in turn may be complemented by livestock located in rural areas as discussed above. Opportunities and risks are thus spread across livestock products, species, and incomes.

For households in the poorest group, the urban milk and meat market is less easily accessible, as they lack financial capital to cover entry costs to expand milk production and fattening, and mainly have goats and sheep. However, the ability to convert the latter livestock to cash via urban markets was considered important by these households.

A second diversification practice involves non-livestock incomes. For households in the wealthiest category, this includes investing in business ventures through social relations in the Nairobi business sector, or in cash crop production on privately owned land in rural areas. Capital for such investments is mobilised from the piecemeal sale of the valuable peri-urban land. For other households, non-livestock income diversification includes employment in the peri-urban service sector and industrial complexes or in central Nairobi. Women further

explained how they seek to enhance incomes by engaging in small-scale trade in herbal medicine, honey, manure, clothes, and beadwork. This income is used as a buffer for small everyday household purchases which typically suffer when droughts affect other household incomes. The result is a diversified income portfolio spread across multiple household members, as exemplified in the following quote:

*“Apart from keeping livestock, my household relies on other income sources [...] I work as a security guard in a company; my wife is a businesswoman, she sells milk and Maasai clothing in Kitengela town. Two of my daughters who have studied in Kitenge a have secured employment [...] as a primary school teacher and a supermarket attendant.”*

FGDs and individual interviews highlighted that children’s education was considered a core aspect of adapting to the changing conditions for pastoral livelihoods. Interviewees explained that with more unpredictable rainfall and shrinking rangelands in the area, education had become more important, partly to secure jobs for additional incomes, but also to practise livestock rearing:

*“School is important for the young ones. Before we picked what we needed to know from our fathers. Now it is more complicated, even livestock [...] The rain is different, you need to be smart, get fast information about the weather and market prices [...] and...] those new breeds.”*

The ease of access to education facilities and jobs in Kitengela was considered a significant advantage of the peri-urban setting by interviewees, and one that was actively exploited. For example, a woman from a poor household explained:

*“I don’t want to leave this place. [...] Here we can stay close to school. There are jobs in town and the factories [...] The grazing can be difficult, but we manage and there is water in town during dry season [...]. It is better here than away from town.”*

#### **Market exchange: Seeking enhanced flexibility in unpredictable times**

In connection to the diversification practices discussed above, pastoral households draw on peri-urban market exchange opportunities in their efforts to adapt. There are two key aspects of this:

Firstly, the good marketing opportunities in Nairobi and nearby urban centres provide a means to exchange livestock, milk, meat, and other products easily and quickly for cash or services. Quick access to cash is important to pastoralists in Kitengela. It provides a response strategy

in emergency situations such as health problems, and a means to purchase fodder and water during times of drought. On a more daily basis, cash availability allows households to purchase household consumables and veterinary products and services that are easily available in peri-urban areas. Livestock is also used in direct barter in some instances, e.g. payment for temporary access to pasture on private land during times of scarcity.

Secondly, the peri-urban setting provides proximity to important physical livestock markets in Nairobi’s environs. During interviews, households said that the growth of—and ease of access to—physical livestock markets in peri-urban areas allowed them to act quicker and be more flexible in responding to drought and erratic rainfall patterns. This included regulating the size of herds during times of water and pasture scarcity or exchanging types of livestock according to the situation. For example, during prolonged dry spells or drought, fattened livestock are often sold quickly as their upkeep—including purchase of fodder—becomes costly and their value may decrease. Proximity to markets also reduces livestock emaciation and loss *en route* to major markets, a significant risk in times of drought which reduces sales value. An interviewee who had previously lived in a rural location said:

*“Before we had to walk far [to get to the livestock market] and when the livestock was weak it became even weaker. Here it is close, the livestock does not suffer.”*

#### **Storage: Securing access to fodder and water**

With storage, resources are stored for an opportune time and/or to provide a buffer for periods of scarcity (Agrawal and Perrin 2009). Storage is by no means a new phenomenon among Maasai pastoralists, as seen in for example pasture set aside for dry season and/or times of drought.

Customarily, such storage has often been collectively managed and accessed, but with the advent of private land ownership more individualised solutions are developing. Storage of hay for use as fodder has developed significantly in recent years, and a market has developed which allows pastoral households to purchase hay, sometimes from quite distant places, when supplies are insufficient. Wealthy households furthermore drill boreholes, store water in tanks or when necessary, and purchase from the private water providers and mobile water lorries which have followed from urban expansion. During interviews, respondents said they found this a more reliable means of accessing water than relying purely on natural water flows in rural areas.

Households from the poorest category also grow hay for storage, if possible, for example by negotiating small plots of vacant land from absentee landowners, paid through services such as guarding the land in question. In interviews, households in this group also emphasised the importance of public water infrastructure in peri-urban areas, including water taps piped from reservoirs and boreholes, which are used for domestic needs, lesser livestock, and gardening. This allows households more permanent access to public and natural water storage during dry spells and droughts than in rural areas.

**Communal pooling: Reciprocity and individualisation**

Historically, Maasai pastoralism has centred on the communal sharing of pasture, watering points, salt licks, etc. With the subdivision of the Kitengela Group Ranch and individual land titling since 1988, the conditions for communal pooling arrangements have changed significantly.

However, some customary norms remain in place or have been innovated. As in other areas of Kenya where Group Ranches have been privatised, pastoralists in Kitengela consider it legitimate to move livestock temporarily across another pastoralist’s private land *en route* to other pasture, as long as it is unfenced. Mobility is thereby jointly facilitated despite individualised land ownership. Moreover, permission to graze on another pastoralist’s land for a longer period can be obtained based on kinship relations or other social ties. Figure 2 shows the primary means whereby household survey respondents access pasture during droughts within and outside Kitengela. It shows the importance of privately held land, but also how access to pasture through kinship ties or social relations remains significant for many households.

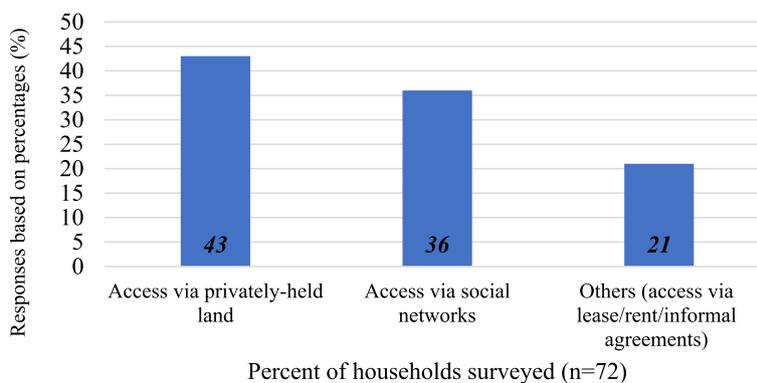
During droughts or other crisis situations, a request for free access to grazing on another pastoralist’s unfenced privately owned land will customarily be granted even if social relationships are not close. Interviews showed that this latter norm is still upheld on unfenced private land in peri-urban Kitengela, including during recent major droughts.

Since these norms are based on principles of reciprocity, they can be seen as a means of pooling pasture and water across space and time. This includes the rural space: Interviewees recounted that when their own privately held land was subject to dry spells or drought, they drew on kinship ties and social networks to gain access to privately or communally held pasture and waterpoints elsewhere in Kenya. Pooling thereby extends across peri-urban and rural settings.

Despite these practices, individual interviews and FGDs also showed a common perception that communal pooling was in decline in the peri-urban setting. Interviewees said urban expansion and associated land fragmentation had made it difficult to pool pasture and water resources and that the subdivision of Group Ranches had resulted in individualised decision-making and resource allocation. In our household survey, 14% of respondents said they were fencing off parcels of their land for hay production, for fattening of livestock, or for leasing to other pastoralists as grazing land. During interviews, households involved in these practices explained that fencing was necessary to protect their land in a situation where urban expansion and uncertain rainfall increased the competition for land and pasture. As one interviewee put it:

*“It is against our customs [...] but the situation is different now, we must protect ourselves.”*

The decline of customary pooling mechanisms was particularly lamented by the poorest households, whose



**Fig. 2** Primary means of access to pasture during droughts among surveyed pastoralists

**Table 3** Pastoralist's use of peri-urban resources in adaptation strategies

Adaptation strategy	Use of peri-urban resources	Adaptation rationale
<b>Mobility</b>	<ul style="list-style-type: none"> <li>• Converting peri-urban land capital to finance rural land acquisition</li> <li>• Using easy access to transport for road movement of livestock</li> <li>• Exploiting grazing "niches" on non-pastoral land</li> </ul>	<ul style="list-style-type: none"> <li>• Expands access to private pasture and water in both peri-urban and rural context</li> <li>• Allows herds to be rotated/split according to rainfall patterns</li> <li>• Facilitates livestock movement to opportune pasture</li> <li>• Provides informal access to unexploited pasture in a peri-urban context</li> </ul>
<b>Diversification</b>	<ul style="list-style-type: none"> <li>• Engaging urban markets for milk, meat, and other livestock products</li> <li>• Drawing on land capital to undertake non-pastoral business ventures</li> <li>• Seeking employment in the service sector/industrial complexes</li> <li>• Engaging markets for small-scale sale of non-livestock products</li> <li>• Investing in children's education</li> </ul>	<ul style="list-style-type: none"> <li>• Spreads climate risk across livestock products, incomes, and breeds</li> <li>• Expands income portfolio and provides short- and long-term alternatives when climate hazards and other factors impact livestock</li> </ul>
<b>Market exchange</b>	<ul style="list-style-type: none"> <li>• Using urban demand to convert livestock products to cash, consumables, veterinary inputs</li> <li>• Exploiting proximity of markets to quickly sell/buy livestock at opportune time</li> <li>• Benefitting from proximity of markets to minimise risks and costs of moving livestock</li> </ul>	<ul style="list-style-type: none"> <li>• Allows quick/flexible response to household and livestock emergencies</li> <li>• Enhances flexible herd management as drought response</li> <li>• Reduces risks and emaciation during long-distance livestock movement to market</li> </ul>
<b>Storage</b>	<ul style="list-style-type: none"> <li>• Using easy access to markets for hay and other fodder</li> <li>• Using private water providers and mobile water lorries</li> <li>• Drawing on public water supply for household and livestock</li> </ul>	<ul style="list-style-type: none"> <li>• Enhances access to fodder during drought/insufficient pasture</li> <li>• Enhances permanent/alternative water supply during drought and dry season</li> </ul>
<b>Communal pooling</b>	<ul style="list-style-type: none"> <li>• Pooling of pasture and water across peri-urban/rural space through reciprocal relationships</li> </ul>	<ul style="list-style-type: none"> <li>• Enhances scope for access to rural pasture and water while also benefitting from peri-urban resources</li> </ul>

access to pasture in the area is dependent on ad hoc negotiation, social relationships, and customary norms such as free access to pasture in times of drought. During interviews, they said it was harder to argue for access to someone else's land when it was fenced and/or intended for individualised purposes.

## Discussion

### Peri-urban land dynamics provide challenges but also opportunities for pastoral adaptation

Our study shows a variety of interconnected strategies as pastoralists respond to the dynamics of land privatisation, urban expansion, and climate change in Kitengela. In this respect, the peri-urban setting provides significant challenges, including reduction and fragmentation of pasture and land availability because of land use conversion; obstruction of conventional mobility practices because of land use conversion and fencing; and erosion of communal pooling and resource-sharing mechanisms, which is particularly problematic for households in the poorest group.

However, our findings also show that pastoralists seek to draw on opportunities in the peri-urban context as they seek to respond to changing circumstances. Table 3

summarises the main strategies and practices discussed above and our condensation of the climate-related rationales that emerged during interviews. Again, it should be noted that the strategies often overlap and are mutually re-enforcing. For example, with the purchase or rental of private rural land for pasture, households can retain their base in the peri-urban area and benefit from opportunities there while also securing private rural pasture.

These adaptation strategies cannot be seen in isolation from wider changes in pastoralist livelihoods. The perceived opportunities offered by peri-urban areas contribute to climate change adaptation, but they also form part of broader efforts by pastoralists to respond to change and enhance livelihoods. In this respect, our findings align with studies of pastoral sedentarisation and livelihood change elsewhere. For example, pastoral livelihood diversification has also been shown in the context of sedentarisation around rural towns in northern Kenya (Fratkin 2013; McPeak and Little 2005) and southern Ethiopia (Aberra 2012).

Our findings from a peri-urban area of a major conurbation complement these studies, showing how households may also perceive peri-urban opportunities as a means to adapt to climate change. As such, they echo studies of peri-urban climate change adaptation among

non-pastoral households, which also show creative use of urban resources (Mngumi 2021; Thorn et al. 2015).

#### **Pastoral adaptation strategies bridge rural-urban space**

Our findings show how the surveyed households actively engage the changing land dynamics in peri-urban Nairobi. Historically, this has included decisions by Group Ranch members to subdivide their land into private land titles, and subsequent land sales by households, a dynamic also documented elsewhere in southern Kenya (Mwangi 2007; BurnSilver 2009). Our findings add to this work by showing how these dispositions are carried forward in climate change adaptation strategies through piecemeal sales of high-value private peri-urban land to raise funds for purchasing land elsewhere, or for diversifying the livestock economy and livelihood portfolios.

Non-land-owning households are in a more precarious situation and must continuously balance the advantages of the peri-urban setting—including livelihood diversification and easy access to water—with the challenges of insecure access to grazing. In so doing, they employ creative strategies to access grazing niches in the peri-urban landscape, such as making informal agreements with absentee landowners or industrial estates. At the same time, they seek out more rural pastures for their livestock and seek to retain social ties in rural areas. The situation in Kitengela thereby shows how pastoral adaptation strategies not only respond to but also contribute to land dynamics at the rural-urban interface.

The adaptation strategies found in our study are furthermore notable by reaching across peri-urban and rural space, seeking to draw on available resources and perceived advantages of the peri-urban space while at the same time drawing on pasture, water, and social relations in rural areas. This resonates with recent literature on the role of farmers in rural-urban dynamics, which also highlights how a spatio-temporal perspective understanding is needed to understand their agency (Follmann et al. 2021). In pastoral studies, research in China has shown how pastoralists living in urban areas depend on both urban and rural resources for their livelihoods (Wenjun and Yupei 2021), while work in northern Kenya shows how sedentarisation around rural towns does not necessarily lead to abandonment of pastoralism, but rather an expansion of livelihood portfolios (McPeak et al. 2011).

#### **Peri-urban opportunities for adaptation are unevenly distributed**

Importantly, however, pastoralists in Kitengela do not pursue the opportunities offered by peri-urban areas on equal terms. For the poorest households with fewer assets, options to draw on peri-urban resources are more limited, as also found in other studies of adaptation in

general (Nelson et al. 2007) and among pastoralists specifically (Silvestri et al. 2012). This includes land: In our study, the benefits of escalating peri-urban land prices are restricted to those who were allocated land when the Group Ranch was subdivided. For households without land titles, the high land values make land ownership in the area almost impossible. This is particularly problematic for households in the poorest group, whose access to land is further impacted by the erosion of collective institutions and practices for pooling and sharing resources. This is compounded by their restricted economic means, which restrains their opportunities to, e.g. engage urban livestock markets, or purchase fodder in times of drought.

Historical membership of Group Ranches thereby plays a major role in the adaptation options available to pastoral households in Kitengela, even though these Group Ranches have long since ceased to exist. The ability of pastoral households to exploit the benefits of peri-urban areas for adaptation is thus influenced by their historical position vis-à-vis a given local land market, alongside their general socio-economic status. This highlights not only the centrality of land access and rights in pastoral adaptation, but also how historical land dynamics may contribute to differentiation in today's pastoral adaptation options.

This is compounded by the way in which the adaptation actions of some households limit the options for other households in the study area. By converting high-value peri-urban land to rural land and/or fencing peri-urban land for, e.g. fodder production, land-owning households inadvertently contribute to the fragmentation of rangelands and erosion of communal pooling and sharing options, thereby constraining the ability for non-land-owning households to move livestock by foot and accessing pasture with reference to customary norms.

#### **The importance of a dynamic view**

What do these developments imply for the future of pastoral livelihoods in the study area? It is beyond the scope of the current paper to investigate the longer-term effectiveness of the investigated adaptation strategies. Overall, however, it is clear that the interaction of climate change, urban expansion, and associated land use change has significant impacts on pastoralism in the area and that pastoral livelihoods are transforming rapidly as households seek to respond and adapt.

Yet we would warn against assuming that these changes lead to a sweeping abandonment of pastoralism at the rural/urban interface. Rather, a diversity of futures is likely. Some land-owning households perceived that they would be able to sustain a dual model of peri-urban and rural livestock production for the foreseeable future.

Others planned to sell their remaining peri-urban land and relocate to affordable land at the edge of peri-urban areas to combine pastoral and non-pastoral livelihoods.

Households without land were less confident of a future with livestock, given their reliance on informal access to private and public lands which may eventually be built over or converted. When asked what they would do if this happened, some non-land-owning households said they would simply shift their base to nearby areas and continue as before. Others said that if grazing became impossible, they would sell their livestock and rely on wage labour and/or incomes from children.

These potentially different futures remain to be seen in practice, but echo the overall trends in East African pastoralism observed by Lind et al., whereby some households are able to benefit from commercialised pastoralism and high-return alternatives, while others supplement pastoralism with alternative income-generating activities or “drop out” of pastoralism into low-return alternative incomes (Lind et al. 2020b).

Similar social differentiation has been found in the ability of pastoral households to deal with the ecological impacts of climate change, land fragmentation, and land use change. Studies from elsewhere in Kenya show that well-off households are better positioned to deal with the negative ecological impacts of these changes and innovate pastoral strategies in response (Hauck and Rubenstein 2017; Ng’ang’a and Crane 2020). This is also evident in our peri-urban context, e.g. when better-off land-owning households seek to overcome declining pasture and overgrazing by relocating herds to private land in rural areas. The extent to which households can adapt effectively—and the extent to which pastoralism remains a viable part of their adaptation strategies—will thus likely be differentiated, depending on the aspirations but also very much the assets of individual households.

## Conclusion

Urban expansion and associated land use change pose significant challenges for pastoral economies and adaptation in peri-urban Nairobi, including reduction of pasture, obstruction of conventional mobility, and erosion of communal resource-sharing mechanisms. Unpredictable rainfall patterns and drought interact with these challenges and compound them. However, our findings show that pastoralists in peri-urban Nairobi do not act passively in the face of urban expansion, but actively seek to engage and benefit from it as they respond to environmental change and attempt to enhance their livelihoods.

Our findings thereby add new insights to the literature on pastoral climate change adaptation by showing how pastoralists—typically portrayed as rural actors—may draw actively on resources and opportunities vested in

peri-urban spaces as part of their adaptation strategies. By capitalising on peri-urban land values, engaging urban demand for livestock products, seeking out jobs and education, and drawing on availability of transport, trading facilities, water infrastructure, and commercial fodder, they seek to enhance or innovate their mobility, diversification, market exchange, and storage options.

Our study further points to the importance of understanding rural-urban dynamics in pastoral adaptation. In peri-urban Nairobi, pastoral households draw on both urban and rural resources, thereby exploiting opportunities and spreading risk across rural-urban space. Land-owning households sell off parcels of high-value peri-urban land to buy or rent cheaper private land in rural areas to expand grazing options. Other households have no land to sell yet seek to remain in peri-urban areas by combining peri-urban grazing niches and water access with rural rangelands.

Our findings thereby also highlight how pastoral households are differently positioned in terms of access to assets for adaptation in the context of urban expansion, and in particular how a pastoral household’s position vis-à-vis historical land dynamics and private land tenure may influence its abilities to benefit from peri-urban opportunities. Adaptation strategies in peri-urban Nairobi thus interact with broader pastoral land dynamics and patterns of differentiation. Nevertheless, our study shows how both well-off and poor households seek to creatively engage and benefit from peri-urban opportunities, emphasising how pastoralists may not only respond actively to changing rural-urban dynamics, but also contribute to them.

Policy-makers and practitioners can support these efforts to adapt by engaging pastoralists as legitimate actors in the planning of urban and industrial expansion, incorporating their strategies into spatial planning, and ensuring that poor pastoral households in particular have access to land, resources, and livelihood diversification at the rural-urban interface. Researchers can contribute to this by co-producing knowledge with pastoralists on their aspirations and agency in rural-urban dynamics, and the sustainability of different strategies. This can also help to shift conventional perceptions of pastoralists as purely rural actors towards a broader perspective that sees them as active agents in rural-urban dynamics.

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## Authors’ contributions

S.R. is the first author and corresponding author. S.R. was main responsible for preparing the data collection, carrying out the data collection, analysing the data, reviewing the literature, conceptualising the paper, and writing the

paper. M.F. and M.M. contributed to the preparation of the data collection, took part in some of the data collection, and contributed to the analysis, literature review, conceptualisation, and writing of the paper. The author(s) read and approved the final manuscript.

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#### Availability of data and materials

The anonymised data used in the study are available from the corresponding author on reasonable request.

#### Declarations

##### Ethics approval and consent to participate

The research included survey and interview data. All participants gave their informed consent prior to the interviews. The data was fully anonymised before analysis. The nature of the research does not require further ethics approval from the involved departments.

##### Consent for publication

Not applicable.

##### Competing interests

The authors declare that they have no competing interests.

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