Regular Article

Journal of Peace Research

Access denied: Land alienation and pastoral conflicts

Journal of Peace Research
2025, Vol. 62(3) 643–659

DOI: 10.1177/00223433241252554
journals.sagepub.com/home/jpr


Cécile Richetta
Department of Political Science and International Relations, University of Geneva

Tim Wegenast
Department of Politics and Public Administration, University of Konstanz

Abstract
Conflicts involving pastoralists have been on the rise in the past two decades in West, Central and East Africa. This article argues that land alienation is a major source of this type of violence. We employ a narrow identification strategy of relevant pastoral conflicts based on the Armed Conflict Location Event Dataset and create a unique indicator of land alienation comprised of three types of land use changes (conversion of land into conservation areas, crop farms, and industrial mining projects). Relying on a disaggregated quantitative comparative design of 50 km-by-50 km cells covering the Sahelian region from 2002 to 2019, we find that land alienation is an underlying cause of pastoral conflicts. Moreover, we show that the impact of land alienation on pastoralist violence spreads over long distances and is influenced by state presence and climatic conditions. Our analysis further reveals an overlap between pastoralist violence and armed conflict. Bridging a gap between macro- and micro-level studies, we contribute to shed more light on the determinants of pastoral conflicts, a type of violence that has received scant attention in the geospatial quantitative literature.

Keywords
agriculture, conflict, industrial mining, land alienation, pastoralism, protected areas

Introduction

In December 2021, unsolved disputes over access to water banks between farmers and herders escalated dramatically, leading to the death of 22 people in Northern Cameroon (Kouagheu and Ramadane, 2021). The tit-for-tat violence prompted hundreds of residents to flee to Chad, which has also witnessed deadly clashes between nomadic Arab herders and sedentary indigenous farmers over the last years (Africanews, 2022). In fact, conflicts involving pastoralists (or pastoral conflicts) like these have been on the rise in West and Central Africa, where more than 15,000 deaths can be linked to farmer–herder violence between 2010 and 2021 (Brottem, 2021). Most pastoral conflicts occurred in Nigeria, creating the country's deadliest security crisis (Akinwotu, 2021).

With this unprecedented surge of violence involving pastoralists across Africa, peace and conflict researchers need to focus more intensively on common explanatory factors across these different contexts. Looking at the history of pastoral conflicts over the last years, we maintain that land alienation[1] deriving from various forms of land use changes (conversion of land into conservation areas, crop farms, or industrial mines) is a major determinant of this type of violence across large parts of Africa. We argue that land alienation increases the risk of pastoral conflict by intensifying ecological pressures (competition over scarce resources) and disrupting traditional social relations and local authority structures.

Corresponding author:
cecile.richetta@unige.ch

To test our claims, we employ a disaggregated quantitative comparative design based on 50 km-by-50 km grid cells covering West, Central and East African countries over the period 2002 to 2019 and rely on the Armed Conflict Event Dataset (Raleigh et al., 2010) to record events of violence involving pastoralists. We complement our analysis by focusing on additional important explanatory factors, including the proximity to armed conflicts, state infrastructures, local governance, and climatic conditions.

Our geospatial statistical analysis shows that land alienation is an underlying cause of pastoral conflicts and that its effects can spill over large distances. We further find evidence that the impact of land alienation is dependent on the local ecological conditions and state reach. More rain seems to mitigate the pervasive impact of land alienation on pastoralist violence, corroborating the hypothesis that competition over scarce resources may partly explain the alienation's conflict-enhancing effect. At the same time, state presence seems to aggravate the positive relationship between land use changes and pastoralist violence. We also demonstrate that pastoral conflict is more likely in border areas and regions affected by armed conflict.

To the best of our knowledge, this article is the first quantitative paper to concentrate on violence involving pastoralist groups using a narrow identification strategy of relevant events rather than intercommunal violence in general (e.g. McGuirk and Nunn, 2020). By doing so, it uncovers violence involving pastoralists across the subcontinent and its different determinants, lending external validity to previous qualitative research. Considering that pastoralists and their herds move across subnational and national borders (Homewood, 2008) and that land alienations affect Africa at large (Peters, 2013), a subcontinent scale approach is particularly warranted. Using different units or weight matrices, we further delve into the spatiality of the dependency between land alienation and pastoral conflicts.

Our investigation contributes to the literature on peace and conflict, pastoralism, land use changes, and African rural development. We stress the importance of the concept of land alienation and its inclusion in the analysis of communal conflicts. In addition, we further our understanding of various explanatory factors that have been stressed by qualitative research but have yet to be tested in a systematic manner.

Contemporary challenges to pastoralism

Pastoralist societies often inhabit remote arid and semi-arid regions at the margins of the modern state (Homewood, 2008: 50). Unless they have acquired property rights of enough land, they rely on movement (seasonal transhumance) and entitlement to the use of common-pool resources to keep their herds well-fed all year round (Basupi et al., 2017). Contingent on proper climatic conditions to feed their cattle, pastoral societies' viability and longevity depend on mobility, flexibility, negotiations, and exchanges with surrounding communities (McPeak and Little, 2018: 120; see also: Moritz, 2010; Turner, 2004). They have developed cultural rules regulating the use and share of communally held resources and have elaborated norms around the practice of cattle raiding, notably as a 'time-honored pathway for young men to establish themselves as herdowners and household heads, under the blessing of elders' (Homewood, 2008: 74).

Recent institutional, economic, and ecological changes have put enormous constraints on pastoralists' livelihoods. The literature review by Basupi et al. (2017: 88) found that 77% of papers on pastoralism identified land tenure insecurity and land expropriation as main problems in pastoral land development in sub-Saharan Africa. Climatic changes have also affected their livelihoods (Brottem, 2016). Despite co-existence strategies and coping mechanisms (e.g. Opiyo et al., 2015), pastoralists are increasingly victims and perpetrators of violence across West, Central and East Africa (Krätli and Toulmin, 2020). Pastoralist groups have been co-opted as militias by some states or drawn into civil wars, notably in South Sudan and the Horn of Africa (Homewood, 2008: 106–130; Wild et al., 2018). Traditional cattle raids have also shifted from redistributive to predatory practices: rebels and/or powerful pastoralist groups now use violent thefts of cattle at a commercial scale for enrichment and political power (Homewood, 2008: 74). States' (lack of) action is often pivotal in these conflicts. Further contributing to previous findings, we argue that land alienation can fuel conflicts while concurrently weakening the institutions and norms that used to regulate them.

Land alienation in sub-Saharan Africa

Considering the prevalence of customary regimes in sub-Saharan Africa and pastoralists' territoriality of access to resources (Yembilah and Grant, 2014), a theory of *access* (Ribot and Peluso, 2003), rather than property *rights*, is most appropriate to understand the effects that different types of land use changes can have on pastoralists' livelihoods and their relations with neighboring communities. We follow Ribot and Peluso's (2003: 153) definition of access as 'the ability to benefit from

things', determined by different bundles of powers that various people or groups hold within societies. The concept of *alienation*, recently used by Bluwstein et al. (2018), helps to explain the extent to which groups may 'benefit from things'. It captures the separation of people from resources they traditionally had access to. We consider alienation from the perspective of pastoralist societies, i.e., the removal of access they previously had.

We identify three different types of land use change that alienate pastoralists from material and social resources in rural Africa, and subsequently impact social relations that governed access to these resources.[2] First, we single out industrial mines, i.e., complexes for the extraction of mineral resources. Mitchell (2016: 1119) notably states that 'the sheer volume of concessions in many countries means that there are significant overlaps between concessions and areas of customary tenure', and thus overlaps with smaller-scale economic activities. Next, we select protected areas (PAs), which are geographical spaces managed to achieve specific conservation objectives (IUCN WCPA, 2019). The setting up of protected areas on customary land and associated problems are well-documented issues that we discuss later in this article (Butt, 2012; Dowie, 2011). Finally, we consider crop expansion. Between the years 2003 and 2019, the continent witnessed a cropland expansion of 34%, the largest increase worldwide (Potapov et al. 2022: 19–21). Medium-scale farms are notably on the rise, spurred by investments from urban dwellers (Jayne et al., 2016). This gradual transition within Africa's rural landscapes has been accompanied by large-scale land acquisitions that have encouraged land concentration, the enclosure of common land, substantive land-use changes, a shift from smallholder agriculture to commercial farming and competition over water access (Dell'Angelo et al., 2021).

All three types of land use changes have, in one way or another, led to conflicts that differ in scale, scope, determinants, and goals.[3] Hence, our specific focus is on these types of alienation. In the following paragraphs, we argue that, while their effects can differ in strength and size, all three types of land use changes deny access, increase pressures on the local environment and communities, and affect local authority structures and norms of dispute resolution. Consequently, they can be taken together in an analysis of the impact of land alienation on conflicts involving pastoralists.

From alienation to pastoral conflicts

The following paragraphs present intertwined pathways linking land alienation to pastoral conflict. Our conceptualization of land alienation is that of an underlying cause more than a proximate one.[4] Unless in exceptional cases, land alienation increases the likelihood of conflict through its effects on local ecological, demographic, economic and social environments, as we argue below.

Ecological pressure

We argue that all three types of land alienation promote pastoral conflicts by intensifying competition over scarce resources (in particular land and water) and furthering environmental pollution and degradation. Protected areas may intuitively sound like the least problematic of the three types of land alienation we are studying. However, the fencing of protected areas to keep wildlife inside, preserve local biodiversity and prevent trespassing means that pastoralists need to negotiate entry with park authorities and often lose access to land (Toutain et al., 2004). The extent to which local communities are integrated into park management determines how well pastoralists' interests are accommodated (Oldekop et al., 2016). Unfortunately, community-led protected areas make up only 16% of reserves set up in Africa since 2002,[5] and native peoples are thus often considered as trespassers and poachers on their ancestral lands and traditional grazing routes (Butt, 2012; Dowie, 2011; Toutain et al., 2004). Notably, the acts of ransoming or killing trespassing cattle degrade relations between park managers, rangers, and herders and make encounters prone to escalation into violence (Butt, 2012).

Agriculture and industrial mines also deny access while increasing pressures on local resources necessary for pastoral livelihoods. Several qualitative studies show that increasing mechanization, expansion of croplands, and the extension of land leases caused agricultural encroachment of pasturelands and traditional transhumance routes and fueled farmer–herder conflicts (Bukari and Kuusaana, 2018; Feldt et al., 2020; Penu and Paalo, 2021; Turner, 2004). Moreover, in a different way than protected areas, large-scale mining (Lange, 2011) and farming activities require a considerable amount of water. Investors therefore try to secure exclusive access to key water points in the area (Dell'Angelo et al., 2021). Besides hampering access to land and water, large-scale agricultural investments and particularly mining projects are a common cause of soil and water degradation, including contamination, erosion, and nutrient-leaching (Bekele et al., 2021; Timsina et al., 2022).

In summary, land alienation causes pastoralists to face the loss of good pastures and water to sustain their herds. They are also confronted with increasingly complicated transhumance routes, with more health hazards,

risks of breaching the law, and encounters with people with whom they have not negotiated access to resources (Brottem, 2016). Land available for subsistence farming and grazing is reduced and gets concentrated in key zones where farmers and herders encounter each other more frequently. This can lead to cattle herds damaging farmers' crops, or small-scale crops encroaching on land previously used for pastures (e.g. Yembilah and Grant, 2014). It also increases the opportunities for raiding and counterraiding between pastoralist groups as cattle are concentrated in smaller places, further exacerbating the risks that these events escalate into violence (Wild et al., 2018).

Disruption of social relations and overlapping authorities

Besides increasing competition over scarce resources, we claim that land alienation disrupts established social relationships, cultural norms, traditional exchange practices, and authority structures. The interdependence between farmers and herders has been the basis of a centuries-long symbiotic relationship. According to Moritz (2010: 139), these 'host–client' or 'host–stranger' relationships used to be characterized by complementarity of goals and livelihoods (see also Turner, 2004). Behavioral models of collective action show that trust, reciprocity, and communication are essential in communal resource governance (Agrawal, 2014). Contact theory has also demonstrated that intergroup positive contacts foster trust and forgiveness for transgressions and reduce prejudice (Pettigrew et al., 2011).

As previously outlined, PAs, farms and industrial mines put great pressure on affected groups and their ecological surroundings. Farmers tend to shift to more Western-style land leases to safeguard themselves from expropriation or encroachment, combine small-scale farming with herding, increase the relative size of their plots, and increasingly use pesticides and mechanization instead of manure (Moritz, 2010). Altogether, these shifts can render pastoralists' presence less beneficial for farmers, reducing opportunities for positive contacts. In a similar vein, the undermining of pastoralists' livelihoods propels predatory raids as viable, albeit dangerous, livelihood strategies, which itself affects how pastoralist groups perceive and interact with each other (George et al., 2021; Homewood, 2008: 74; Wild et al., 2018). In other words, positive contacts are less frequent, while negative contacts such as crop damage, disputes for access to water points, forest resources and grazing areas, and predatory cattle raiding are more frequent.

Land alienations also reconfigure authority structures and dispute resolution mechanisms. Decisions in pastoralist societies are made at the individual, household, or group level (Toutain et al., 2004), while in rural communities in sub-Saharan Africa, land-related decisions are most often the prerogatives of village or group-level customary chiefs (Logan, 2013). Land alienations introduce and legitimize new authorities governing land matters. For instance, the decision to switch land use to conservation most often stems from an agreement between international conservation actors and national governments (Toutain et al., 2004). Regarding industrial mines, Mitchell (2016: 1121) found that, by transforming communally managed resources into privately owned ones, companies profoundly affect the perceptions of authority over land as the company takes on the role of the chief land administrator. For transnational investments in agriculture, the literature has shown that they affect political orders and perceptions of authority and legitimacy, usually due to intense competition between the actors (i.e., investors, customary chiefs, local, regional, and national-level state representatives) that have some form of power in land regulation (Lavers and Boamah, 2016).

Consequently, authorities governing land-related resources multiply, and dispute resolution becomes increasingly more challenging. As Penu and Paalo (2021: 231) emphasize: 'where different rules govern access to the same resources, forum shopping leads to conflict about legitimacy'. In other words, if opposing parties seek the help of different authorities that all claim to have legitimacy over land matters, the dispute has more risks of not being solved and then escalating into violent events.

Conflict prevention

A more optimistic view on the various sources of land alienation would claim that the creation of parks as well as mining and agricultural investments may contribute to local livelihoods and possibly reduce the risk of pastoral conflict. Studies covering a large number of African countries, however, reveal that large-scale land investments and industrial mines have mostly failed to generate local employment and income (Kotsadam and Tolonen, 2016; Nolte and Ostermeier, 2017; Wegenast et al., 2019). And, while pastoral societies frequently use small-scale agriculture as an income-generating diversification strategy, it never fully replaces pastoralism as a livelihood (Achiba, 2018; Opiyo et al., 2015).

Nonetheless, our study seeks to explore two potential moderating variables that may mitigate the conflict-enhancing effect of alienation. First, well-developed state infrastructures and state capacity may alleviate

Table 1. Descriptive statistics.

Variable	*Mean*	*SD*	*Min.*	*Max.*
Incidents involving pastoralists (IIPs)	0.018	0.13	0	1
Land alienation	0.21	0.41	0	1
Rainfall deviation[(a)]	17	17	−0.057	94
Community protected area (PA)	0.002	0.045	0	1
State presence	0.013	0.13	0	6.7
Population[(b)]	11,695	32,623	0	1,353,954
Battles & VAC	0.13	0.34	0	1
Ethnic power	0.48	0.5	0	1
Permanent water cover[(a)]	3	14	0	100
Shared suitability index (SSI)	0.23	0.13	0.04	0.8
Historical mines	0.018	0.18	0	4
Country border	0.22	0.41	0	1

To facilitate table reading and interpretation: [(a)]Variables were rescaled by 10; [(b)]Variables were rescaled by 10,000.

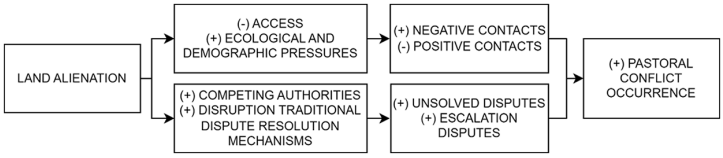

Figure 1. Diagram of theoretical pathways linking land alienation to pastoral conflict occurrence.
(-) indicates 'less/fewer'; (+) indicates 'more'.

grievances and conflict by providing a single institutional arena for dispute settlement and thus preventing forum-shopping and violent rent-seeking behavior (Berman et al., 2017; Wig and Tollefsen, 2016). Yet, pastoralists and their host states often have conflicted relationships (Homewood, 2008: 106–130); previous research has highlighted the marginalization and eviction of pastoralists by the state (Bukari and Kuusaana, 2018) and has shown how the state may aggravate tensions between pastoralists and other societal groups (Brottem, 2020). It is thus uncertain whether pastoralists would seek or receive help from state institutions, even more so if they are on an international transhumance. Still, the presence of police forces could potentially prevent violence from escalating into full-fledged conflicts. Second, we believe that protected areas can provide employment opportunities and accommodate pastoral interests (for example in regard to the use of transhumance routes) if they are community-led (Toutain et al., 2004).

Diagram and hypotheses

In the last two sections, we identified plausible causal pathways linking land alienation to pastoral conflict and presented two factors that may moderate this relationship. The pathways linking land alienation to pastoral conflict are summarized in Figure 1. In addition, our readers can find a summary table of the single effects of each subtype of land alienation in Online Appendix 1, Table 1.

With this diagram (Figure 1), we further reiterate that land alienation is an underlying rather than proximate cause of conflict occurrence. In other words, the immediate element catalyzing a conflict will not necessarily be the alienation per se, but rather the consequences that derive from it, such as crop damage, cattle trespassing, or forum shopping. Our main hypothesis can be formulated as:

> *H1*: Land alienation increases the likelihood of pastoral conflicts.

We further test the plausibility of our argument that alienation promotes pastoralist violence through an ecological pressure channel (competition over scarce resources) by investigating whether alienation drives conflict particularly under water shortage situations:

> *H2*: The effect of land alienation on pastoral conflicts is stronger when resources are scarcer (ecological pressure mechanism).

Finally, we formulate the following two hypotheses on the potential pacifying effect of state presence and communal park management:

H3a: The effect of land alienation on pastoral conflicts is weaker where state presence is stronger.

H3b: The effect of land alienation on pastoral conflicts is weaker where local communities participate in park governance.

Research design

Our analysis first evaluates whether land alienation increases the likelihood of pastoral conflicts (Hypothesis 1). To test one of our central theoretical mechanisms, we estimate whether alienation's effect is stronger when there is less rainfall compared to historic levels (Hypothesis 2). We further test how the impact of land alienation changes when there are local state infrastructures (Hypothesis 3a) and when protected areas are led by local communities (Hypothesis 3b).

Sampled countries

Given data availability, our analysis spans over the period 2002–19. We focus on West, Central and East Africa for two main reasons. First, these regions have seen a sharp increase in violence in the past decade (Krätli and Toulmin, 2020) and thus deserve close attention. Social scientists have repeatedly identified the Sahelian region as an essential case study area for violence linked to pastoralism. This explains why our theoretical framework is mainly grounded on scientific works that study (cases within) these three regions. Second, in a quantitative setting, a certain number of occurrences of a rare event need to be available for statistical models to be reliable (King and Zeng, 2001). When focusing on West, Central and East Africa, only 1.82% of our units experience a conflict. If we extend our sample to cover all of Africa,[6] this number significantly drops to 1.14%. Notwithstanding, we also report results for a sample containing all African countries as a robustness check.

Event selection

Data on pastoral conflicts come from the Armed Conflict Location and Event Dataset (ACLED 2022; Raleigh et al., 2010), which contains 'reported information on the exact location, date, and other characteristics of politically violent events in unstable and warring states' (Raleigh and Dowd, 2015: 3). Reproducing Krätli and Toulmin's (2020) strategy, we selected observations that involved pastoralists using the key terms *herd** | *nomad** | *cattle* | *transhuman** | *pastoral** in ACLED description of events. We set the following subevent categories: abduction/forced disappearance, armed clash, attack, looting/property destruction, mob violence, sexual violence, violent demonstration, peaceful protest, protest with intervention and others. Events were individually checked to ensure that they refer to intercommunal violence. Between 2002 and 2019, we identify 3,778 events that we call 'incidents involving pastoralists' (*IIPs*; Krätli and Toulmin, 2020).

Event description

Before proceeding with our quantitative investigation, we unpack the description of incidents to identify the main actors and proximate causes driving their occurrence. As land alienation is rather an underlying cause of conflict, it is unlikely to be directly identified in the event descriptions as such. Based on our reading of the descriptions, we created a classification to identify (1) the actors involved and (2) the proximate causes of the incidents. We also investigate whether events can be considered the results of an escalation of disputes. The full details can be found in Online Appendix 2. In brief, we uncover that, out of 3,778 events, non-state armed groups are involved in 790, farmers in 504, protected area workers in eight and mine workers also in eight of them. Pastoralists are the main actors in the rest of the events, indicating a predominance of herder-on-herder violence. We further find that the main focal point of incidents is cattle raids and counterraids (total of 1,704 events). While in smaller proportions, we also find that land (815 events) and movement (143 events) are drivers of incidents. Finally, about 17% of events are escalations from previous incidents. While this proportion is probably underestimated, it means that a considerable number of incidents are not adequately solved and actors resort to retaliation.

Quantitative empirical strategy

Unit of analysis. One of the major contributions of this article is the exploration of spatial characteristics of the relationship between land alienation and pastoral conflicts, which we explicitly model. There are two possible locations where *IIPs* caused by land alienation can manifest themselves: where alienation actually took place and

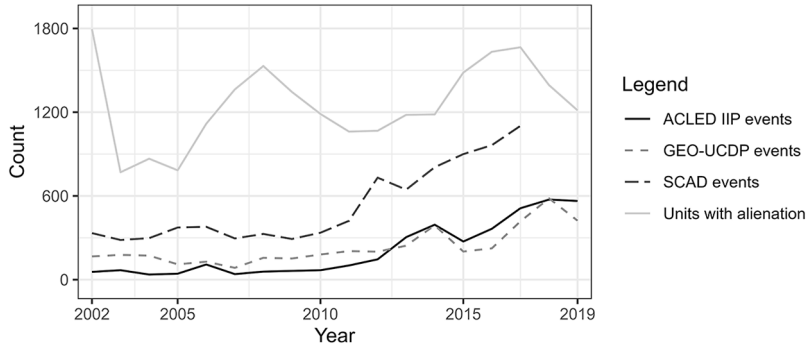

Figure 2. ACLED IIP events, SCAD events and UCDP events in the sampled countries.

at its margins. In our quantitative setting, this translates into effects within units and within neighboring units. Our main challenge is that the current quantitative literature on pastoral conflicts is very limited, which frustrates our choice for the appropriate size of a unit or of the spatial effects. In the most recent attempt, McGuirk and Nunn (2020) used 0.5° by 0.5° cells covering the continent for their analysis.

In our study, we rely on the PRIO-Grid (2021) cells, a 'spatio-temporal grid structure constructed to aid the compilation, management and analysis of spatial data within a time-consistent framework' (Tollefsen et al., 2012; Tollefsen et al., 2015: 364), as our units of analysis. The cell size is approximately 50 km-by-50 km at the Equator, for a mean area of 3,017 km^2. A smaller unit did not seem appropriate, considering that pastoralists have yearly seasonal movements of at least 100 km (Homewood, 2008: 103). For West, Central and East Africa, it sums up to 6,010 cells *i* over 18 waves *t*, for 114,190 units *it*. We further estimate a row-standardized queen contiguity matrix and spatial lags of our variables of interest to estimate effects at the spatial margins of land alienation. Since our results depend on our choice of units and of the weight matrix, we reproduce them with level-one administrative units (with an average area of 35,516 km^2; GADM, 2023) and with a 150 km inverse-distance weight matrix.

Dependent variable. We focus on explaining the occurrence of pastoral conflicts, so our dependent variable is binary. We matched the events' GPS coordinates to a PRIO-Grid cell. Our dependent variable, *Incidents involving pastoralists* (IIP), is a binary indicator of whether the event(s) occurred in a cell-unit *i* and year *t*. It is highly skewed zero: only 1,966 units *it* experience at least one incident (1.82%).

Figure 2 visualizes the number of ACLED's *IIPs* (black line) between 2002 and 2019 in the units in our main sample. It notably shows that, from 2011 onward, the number of events increases steeply. To ensure that the surge is not the result of a change in ACLED (2022) data collection, we plotted events from the Social Conflict Analysis Database (SCAD; Salehyan et al., 2012) and the geo-referenced Upsala Conflict Dataset Program (GEO-UCDP; Sundberg and Melander, 2013) on non-state violence. Both GEO-UCDP and SCAD show the same increase. Furthermore, according to ACLED's (2022) methodology, when new sources are included, they are traced back in time to avoid artificial surges. Finally, the fixed effects in our models will account for country- and year-specific factors that influence ACLED data (Berman et al., 2017: 1570). Figure 3 visualizes the units affected by an *IIP*.

Independent variable. Our main independent variable *Land alienation* is operationalized based on the three subtypes of land alienation: *Crop farm expansion* (MODIS, 2024; Sulla-Menashe, 2019), a binary indicator that there is a positive difference between unit *it* and *it*–1 in the two-year moving average of cropland cover; *New mines* (Northern Miner Group, 2021), a binary indicator that at least one new industrial mine is set up in unit *it*; and *New Protected areas* (Bingham et al., 2019; UNEP-WCMC, 2019; UNEP-WCMC and IUCN, 2021), a binary indicator that a new protected area at least partially covers the unit *it*. The full description of the operationalization of the indicators of *Land alienation* is available in Online Appendix 3, Table 1. Using the three indicators of land use change, we finally operationalize our independent variable *Land alienation*. The variable is binary and takes the value 1 if (at least) *New mine*, *Crop change*, or *New protected area* is equal to

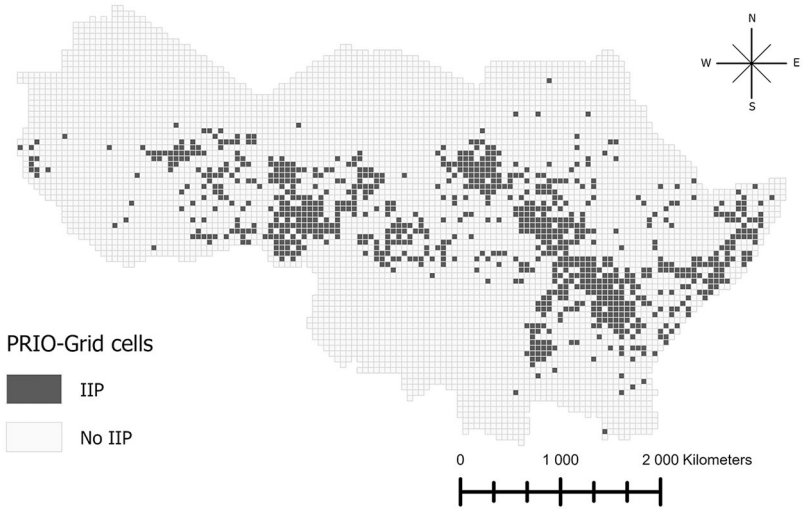

Figure 3. PRIO-Grid units that experience an incident involving pastoralists (IIP).

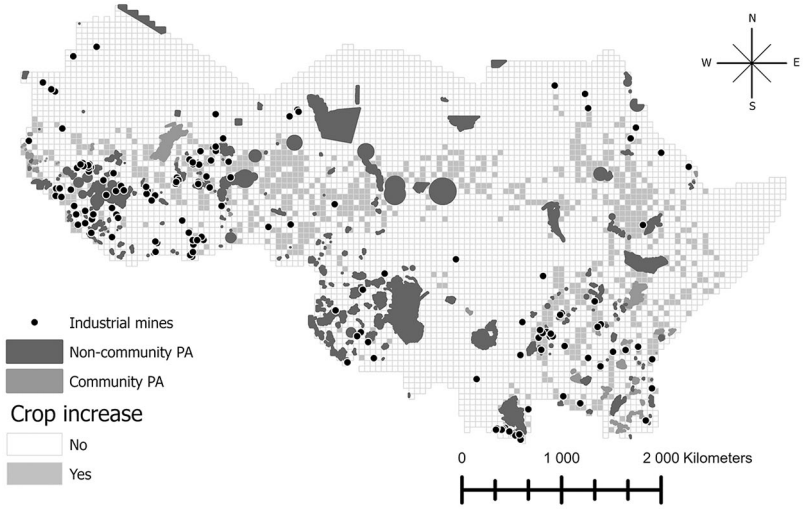

Figure 4. New mines, new protected areas, and units with average positive crop change over 2002–2019.

one in cell-unit *i* in year *t*. Figure 4 shows the subtypes of *land alienation*.

Figure 3 and Figure 4 reveal a considerable, but not absolute, spatial overlap between *IIPs* and *Land alienation*. Notably, West Africa and South-Central Africa experience land alienation with little to no incidents involving pastoral groups; this empirical puzzle deserves attention in future studies.

Mechanism variables. To test Hypotheses 2 and 3(a, b), we rely on three variables. *Rainfall deviation* is calculated from CHIRPS data (Funk et al., 2015) and measures rainfall deviation (in milliliters) from the mean of historical levels (1981 to 1999). *Community Protected Area* is a binary indicator of whether the protected area is under: collaborative; indigenous peoples'; joint; or local communities' governance (UNEP-WCMC and IUCN, 2021). Finally, *State presence* is calculated with nighttime light emissions (Chen et al., 2021), and is used as a measure of state reach in the form of public good provisions (Koren and Sarbahi, 2018).

Control variables. To avoid using cell-level fixed effects and instead disentangle the various determinants of *IIP*, we rely on variables that can be operationalized at the subnational level. In our regressions, we include *Population* (Oak Ridge National Laboratory, 2023), *Battles and violence against civilians (VAC)* (Raleigh et al., 2010),

Ethnic power (Vogt et al., 2015; Wucherpfennig et al., 2011), *Permanent Water cover* (MODIS, 2024) (all time-variant); *Shared suitability index* (Beck and Sieber, 2010), *Historical Mines* (Northern Miner Group, 2021), and *Country Border* (GADM, 2023) (all time-invariant). The justification and operationalization of our control variables is described in Online Appendix 3, Table 1.

Regression equations

We estimate five different models. First, we estimate the effect of land alienation on *IIP* with three different spatial relationships, based on a Spatial Autoregressive Model (SAR; Whitten et al., 2021):

$$y = X\beta + \rho W y + \epsilon$$

Model 1(a) includes only a spatial lag of the outcome variable (with a W queen contiguity weight matrix), Model 1(b) replaces the effect of *Land alienation* in units it by a spatial lag of *Land alienation* (also with W), to explore how *Land alienation* in neighboring units influence the outcome in it, and Model 1(c) includes both *Land alienation* and its spatial lag. The dependent variable is binary, so we use a logistic regression for our estimations.

$$IIP_{it}^{*} = \beta_0 + \beta_{LA} + \beta_{MV} + \beta_{CV} + \rho W_{IIP} + IIP_{t-1} + e_{jt[i]} + u_{it} \quad (1a)$$

$$IIP_{it}^{*} = \beta_0 + \rho W_{LA} + \beta_{MV} + \beta_{CV} + \rho W_{IIP} + IIP_{t-1} + e_{jt[i]} + u_{it} \quad (1b)$$

$$IIP_{it}^{*} = \beta_0 + \beta_{\mathrm{LA}} + \rho W_{LA} + \beta_{MV} + \beta_{CV} + \rho W_{IIP} + IIP_{t-1} + e_{jt[i]} + u_{it} \quad (1c)$$

The equations include: our binary outcome variable IIP_{it}^{*} operationalized in unit i at time t; the independent variable *Land alienation* with its β_{LA} coefficient and its ρW_{LA} spatial lag for the effects of *Land alienation* in neighboring units; the coefficients of our mechanism variables β_{MV} and control variables β_{CV}; a spatial lag of our outcome variable ρW_{IIP} to account for its clustered nature (Moran's I $p < 0.000$)[7]; a temporal lag (one year) of our dependent variable IIP_{t-1} to control for serial correlation; country-year jt fixed effects $e_{jt[i]}$; and finally an error term u_{it}. Standard errors are clustered at the cell-level to account for the panel format of our data. The independent and moderating variables are lagged for one year to circumvent endogeneity issues, except for *Rainfall deviation*, as it is unlikely that the occurrence of pastoral conflict influences rainfall. Due to $t-1$ effects, the analysis starts in 2003.

Next, starting from Model 1(c), we estimate the interaction effects between each moderating variable and *Land alienation*. In Model 2(a), we interact land alienation with the moderating variables ($\beta_{LA} * \beta_{MV}$) while in Model 2(b) we interact land alienation's spatial lag with the moderating variables ($\rho W_{LA} * \beta_{MV}$).

$$IIP_{it}^{*} = \beta_0 + \beta_{LA} * \beta_{MV} + \rho W_{LA} + \beta_{CV} + \rho W_{IIP} + IIP_{t-1} + e_{jt[i]} + u_{it} \quad (2a)$$

$$IIP_{it}^{*} = \beta_0 + \beta_{LA} + \rho W_{LA} * \beta_{MV} + \beta_{CV} + \rho W_{IIP} + IIP_{t-1} + e_{jt[i]} + u_{it} \quad (2b)$$

Discussion of results

Land alienation and the occurrence of incidents involving pastoralists

The results of Models 1(a), 1(b) and 1(c) are reported in Table 2.

The models corroborate Hypothesis 1: All coefficients for *Land alienation* and its spatial lags are positive, indicating that land alienation increases the odds of an *IIP*. In Model 1(a), the p value of *Land alienation* indicates a 1.6% probability of seeing our observed values (or more extreme values) under a random process (null hypothesis). In Model 1(b), the p value of *Land alienation*'s spatial lag indicates a 0.01% probability of observing our current values under a random process. And finally, Model 1(c) shows a 3% probability of our observed values under a random process for *Land alienation*'s spatial lag. Since the neighboring effect of *Land alienation* in Model 1(c) predicts the occurrence of an *IIP* with more accuracy and strength compared to the within unit effect, our model provides empirical support that the impact of land alienation is stronger at its (spatial) margins.[8] With marginal effects, we estimate that on average *Land alienation* in *nt*–1 significantly increases the probability of an *IIP* in *it* by 0.38%. This small effect is consistent with the very little proportion of units affected in our large sample (only 1.82%). Considering that our units measure at most 55.6 km by 55.6 km and we estimated the spatial lags based on a queen contiguity matrix, land alienation's effect can be felt anywhere up to 157 km away from its location. This implies that actors concerned by land alienation (including office holders, policymakers, investors, and development practitioners) need to consider that the

Table 2. Estimated log odds of the occurrence of incidents involving pastoralists.

	Dependent variable: Incident involving pastoralists		
	Model 1(a)	*Model 1(b)*	*Model 1(c)*
Independent			
Land alienation (t—1)	0.146* (0.067)		0.058 (0.081)
Spatial lags (queen W)			
Land alienation (t—1)		0.329* (0.104)	0.276† (0.128)
Mechanisms			
State presence (t—1)	0.041 (0.119)	0.051 (0.118)	0.053 (0.118)
Rainfall deviation	−0.006 (0.004)	−0.006† (0.004)	−0.006† (0.004)
Community PA (t—1)	0.078 (0.632)	0.076 (0.633)	0.057 (0.632)
Control			
Population	−0.001 (0.001)	−0.001 (0.001)	−0.001 (0.001)
Battles & VAC	1.992** (0.082)	1.992** (0.082)	1.991** (0.082)
Ethnic power	0.064 (0.100)	0.047 (0.100)	0.046 (0.100)
Permanent water cover	−0.019** (0.003)	−0.018** (0.003)	−0.018** (0.003)
Shared suitability	1.230** (0.310)	1.161** (0.314)	1.160** (0.314)
Historical mines	−0.290† (0.171)	−0.293† (0.170)	−0.292† (0.170)
Country border	0.314** (0.077)	0.317** (0.077)	0.316** (0.077)
Dependent variable lags			
Spatial (queen W)	4.631** (0.197)	4.608** (0.198)	4.609** (0.198)
Temporal (t–1)	1.243** (0.091)	1.248** (0.091)	1.246** (0.091)
Constant	−5.824** (0.315)	−5.869** (0.319)	−5.871** (0.318)
Country and year fixed effects	Yes	Yes	Yes
Akaike Inf. Crit.	11,637	11,633	11,634
Observations	102,170	102,170	102,170

n = 6,010, T = 17, N = 102,170; †p < 0.1; *p < 0.05; **p < 0.01.

impact of land alienation on conflict spreads over large distances. Unfortunately, it also means that tracing land alienation's negative effects is particularly difficult given their geographic scope, and that it is likely that communities who have no leverage over land alienation are sometimes bearing the consequences of it.

Moving on to the test of our mechanisms, we estimate equations 2(a) and 2(b); the results are reported in Table 3, Models 2(a) and 2(b).

The interaction terms coefficients partially substantiate our hypotheses. In Model 2(a), we find no significant interaction effects. The probabilities of our dependent variable *IIP* predicted by *Land alienation* and the moderating variables are plotted in Figure 5, on the left panel.[9] The three figures clearly show a horizontal trend, with little to no differences in the predicted probabilities of an *IIP* occurring when there is *Land alienation* or not in the unit *it*–1. Since *Land alienation* had a small and insignificant effect in Model 1(c), it is coherent that the interaction terms are neither large nor significant in Model 2(a).

In Model 2(b), we interact the spatial lag of *Land alienation* (i.e., alienation happening in *nt*–1) with the moderating variables. In this specification, we find significant interaction terms. As Model 1(c) indicates that *Land alienation* impacts *IIP* mainly at its margins, it is consistent that we find stronger and more significant interaction effects in Model 2(b). It is also the model with the lowest AIC (11629), indicating the best fit for our data.

We notably find that the spatial lag of *Land alienation* has a positive and significant effect on *IIP* when *State presence*, *Rainfall deviation*, and *Community PA* are equal to zero ($\beta = 0.556^{**}$). When *State presence* increases, the effect of the spatial lag of *Land alienation* gets larger, as visualized in the top right panel of Figure 5. We see that, when there is no alienation in *nt*–1, *State presence* has a horizontal effect. On the contrary, when the spatial lag of *Land alienation* is equal to 1 (meaning that all neighbors have experienced alienation in *t*–1), the predicted probabilities of *IIP* are larger as *State presence* increases: between the minimum and maximum value of *State presence*, the

Table 3. Estimated log odds of the occurrence of incidents involving pastoralists: testing of the theoretical mechanisms.

	Dependent variable: Incident involving pastoralists	
	Model 2(a)	*Model 2(b)*
Independent		
Land alienation (t–1)	0.181 (0.132)	0.058 (0.081)
Spatial lags (slag queen W)		
Land alienation (t–1)	0.268* (0.127)	0.556** (0.196)
Moderating effect		
State presence (t–1)	0.053 (0.173)	−0.483 (0.340)
Rainfall deviation	−0.004 (0.004)	−0.0003 (0.005)
Community PA (t–1)	*N.A.*	*N.A.*
Interaction effect within unit		
State presence (t–1) X Alienation (t–1)	−0.006 (0.005)	
Rainfall deviation X Alienation (t–1)	−0.006 (0.219)	
Community PA (t–1) X Alienation (t–1)	0.035 (0.631)	
IInteraction effect with neighboring unit		
State presence (t–1) X Alienation (t–1, lag W)		1.024* (0.467)
Rainfall deviation X Alienation (t–1, lag W)		−0.015* (0.007)
Community PA (t–1) X Alienation (t–1, lag W)		−0.204 (0.912)
Control		
Population	−0.001 (0.001)	−0.001 (0.001)
Battles & VAC	1.987** (0.082)	1.988** (0.082)
Ethnic power	0.045 (0.100)	0.046 (0.100)
Permanent water cover	−0.018** (0.003)	−0.018** (0.003)
Shared suitability	1.128** (0.315)	1.084** (0.319)
Historical mines	−0.286† (0.170)	−0.274† (0.166)
Country border	0.316** (0.077)	0.319** (0.078)
Dependent variable lags		
Spatial (queen W)	4.618** (0.198)	4.614** (0.198)
Temporal (t–1)	1.247** (0.091)	1.246** (0.092)
Constant	−5.829** (0.315)	−5.851** (0.317)
Country and Year Fixed Effects	Yes	Yes
Akaike Inf. Crit.	11,637	11,629
Observations	102,170	102,170

n = 6,010, T = 17, N = 102,170; $^{\dagger}p < 0.1$; *p < 0.05; **p < 0.01; *Community PA (t–1)* does not have an independent effect because it is always zero when *Land Alienation (t–1)* is zero; for more information see the Research Design.

average predicted probability that an *IIP* occurs changes from approximately 0.01 to 0.10 (a ten times increase), with a confidence interval up to 0.6. We can explain this effect by previous evidence stressing the marginalization of pastoralists and their poor relations with their host states (Brottem, 2020; Bukari and Kuusaana, 2018; Wild et al., 2018).[10] Another reason for this positive and significant effect could be that the impact of land alienation is more pronounced for pastoral groups in less remote areas, where the state has already altered rules about access to common pool resources (McPeak and Little, 2018). Our results corroborate previous findings from the peace and conflict literature highlighting that state reach may promote the risk of armed conflict (Koren and Sarbahi, 2018; Ying, 2021). We need to sound a note of caution on our operationalization of state reach though: employing nighttime light emission, we cannot assess the overall quality of the local infrastructures or their overall ability to hamper and solve conflict. We are unfortunately unable to pick up on the kind of state capacity that, for example, prevents resource and food shortage, cattle raiding, forum-shopping, and rent-seeking behavior (Berman et al., 2017; Wig and Tollefsen, 2016).

Next, if we look at the coefficient of the interaction term *SLAG Land alienation X Rainfall deviation* ($\beta = -0.015^{**}$) and its visualization (middle right panel of Figure 5), we deduce that units *it* that

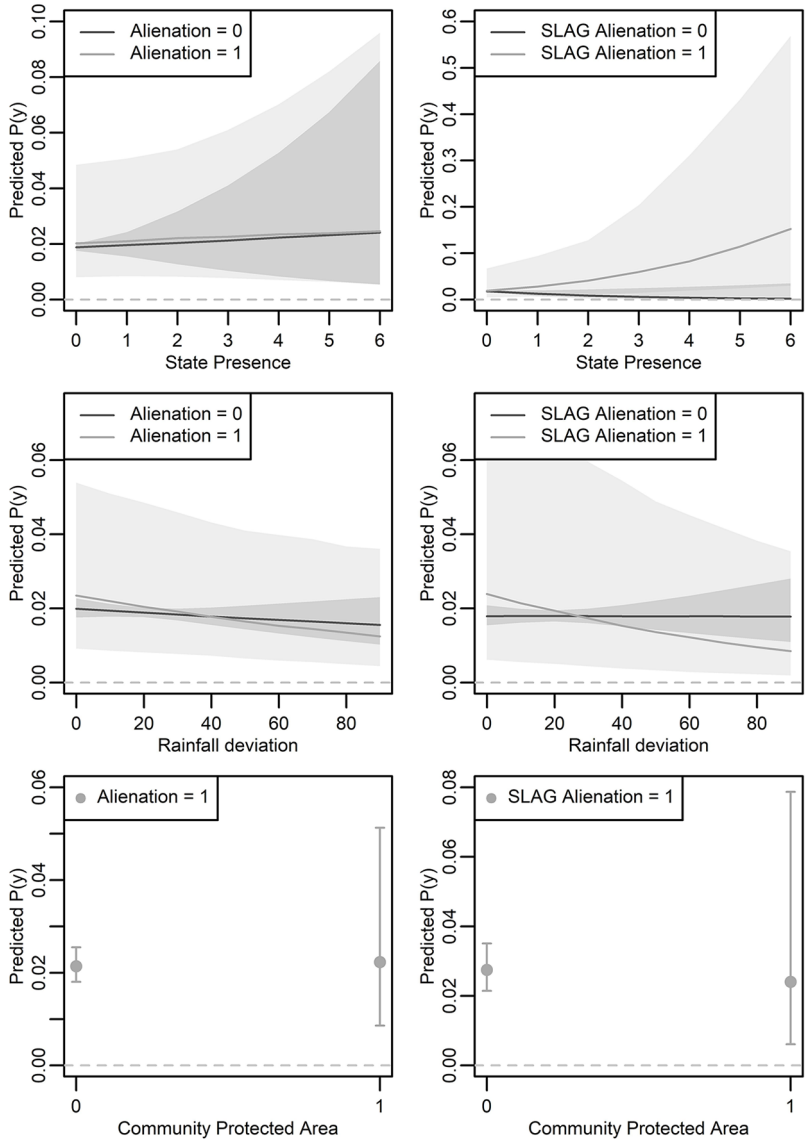

Figure 5. Predicted Probabilities of incident involving pastoralists (IIP).
P(y) = probability of *IIP*; 'SLAG' = 'Spatial lag', queen contiguity matrix.

experience more rainfall than their historical levels and land alienation in their neighbors *nt*–1 have lower predicted probabilities of an *IIP* than comparable units that experience historic (average) rainfall levels. This finding supports our theoretical mechanism of 'ecological pressures' (Hypothesis 2): when there is an increase in rainfall, which implies better grazing, better crops, and less stress on the ecological surroundings of local communities, then *Land alienation* is less problematic. Alienation may thus impact pastoralist violence by increasing the competition over scarce resources. In the current context of climate change, with more frequent droughts and the desertification of some parts of the Sahelian region, this also means that local communities will be put under more pressure, and conflicts will be more likely to arise.

Finally, looking at the interaction of *SLAG Land alienation X Community* PA, we find a negative non-significant effect ($\beta = -0.204$). The bottom right panel in Figure 5 evidences that the impact of land alienation on pastoralist violence does not seem to be contingent on a park being managed by the local community. While the coefficient shows the expected direction, the standard error is too large to allow substantial inference. Due to a lack of better data on local types of governance, we have to rely on this very coarse measure of bottom-up governance, which focuses solely on protected areas at their year of implementation.

Control variables

We finally find significant effects for some of our control variables that are consistent throughout our models. *Battles and VAC* is a positive and significant determinant of pastoral conflict, coherent with previous findings on the impact of geopolitical conflicts and automatic weaponry (Homewood, 2008; Wild et al., 2018), as well as terrorism (George et al., 2021; Krätli and Toulmin, 2020) on the intensity of pastoral conflict. We further find that *Country border* increases the odds of an incident occurring. This suggests that pastoralists seem most vulnerable to violence when crossing or being located near national borders, which is a worrisome finding considering the necessity for some of these groups to move across national frontiers. Alternatively, this could be due to the same mechanisms inherent to subnational communal borders (Detges, 2014: 61): cattle snatched during raids are more challenging to trace once they have crossed a border, raiders can share the booty with local corrupted officials and police to protect themselves, and finally herders might hesitate to cross borders to look for their stolen cattle out of fear of local communities' reactions to seeing them, usually armed, roaming their territories. The final quite predictable finding is that *Shared suitability*, a variable indicating that land is appropriate for both agriculture and cattle grazing, increases the risk of pastoral violence. This is coherent with the growing evidence of farmer–herder conflicts we have reviewed, and the issue of competition over scarce resources.

Robustness checks

Readers interested in the disaggregated effects of each subtype of land alienation can refer to the relevant models in Online Appendix 3, Table 1. The models show that cells experiencing crop farm expansion and the creation of parks have a greater risk of experiencing pastoral conflicts, while new mining projects seem to reduce the conflict potential (within unit effects). All spatial lags have positive coefficients consistent with our main findings. However, only the effect of *Crop Farm Expansion*'s spatial lag is statistically significant. Again, we find the impact of land use change to be considerably larger in neighboring cells. Model 1(c) reveals that a unit *it* bordering a cell that experienced crop farm expansion shows a 0.4% higher probability of experiencing pastoralist conflict.[11]

To ensure that our main finding on the effect of land alienation on pastoralist violence is robust to alternative specifications, we perform a series of additional robustness checks. The results can be found in Online Appendix 5, Table 1. We estimate the equivalent of Model 1(c) of Table 2: (1) with Firth's (1993) biased reduced logistic regression; (2) with a 150 km inverse distance weight matrix; (3) with level-one administrative regions as units; (4) separating the two periods 2002–11 and 2012–19; (5) with Northern and Southern Africa included, excluding the Republic of South Africa; and finally (6) with SCAD intercommunal conflict events as our dependent variable.

Overall, these robustness checks confirm our main findings: in almost all specifications, *Land alienation* (and/or its spatial lag) systematically and significantly increases the odds of *IIP*. Two findings diverge from our main results. First, in the specification where we keep only the years 2002–11 (Online Appendix 5, Table 1, Model 4), we find positive coefficients for *Land alienation* and its spatial lag, but they are not significant. Therefore, it seems like *Land alienation* has become more problematic in the past decade. Second, we find that the spatial lag of *Land alienation* decreases the odds of an *IIP* when units are level-one administrative regions (the coefficient is non-significant; see Online Appendix 5, Table 1, Model 3). This, however, makes sense since units in this specification are about ten times the size of our PRIO grid-cells, and neighbors are drastically different in size depending on the country, so the coefficient is hardly interpretable. Altogether, these robustness checks, combined with our main results, support our argument that land alienation is a major predictor of conflicts involving pastoralists.

Concluding remarks

Relying on a narrow identification strategy for measuring conflicts involving pastoralists, our study is the first to quantitatively assess the geospatial effect of land encroachment on this type of violence. Our analysis demonstrates that land use changes driven by agricultural expansion, the establishment of conservation areas and the implementation of mining projects are an underlying driver of violence involving pastoralists. We thereby lend external validity to previous qualitative work linking land enclosure to the increasingly dire situation of pastoral livelihoods in the Sahelian region of Africa. Our geospatial examination further reveals that the effect of land alienation on pastoral violence seems to spread over long distances: conflicts often occur far away (up to 150 km) from the actual alienation source.

In addition to presenting evidence on the link between alienation and pastoralist violence, our study shows that competition over scarce resources may plausibly explain this relationship. Our statistical analysis demonstrates that pastoral conflicts become more likely in regions simultaneously affected by land use change and rain shortage. We also show that state presence increases the conflict potential of alienation. In areas with high state reach, pastoralists are more likely to become perpetrators or victims of violence when facing land use change. Instead of de-escalating conflict, the state seems to contribute to a spiral of violence by, for example, discriminating against pastoralists and promoting overlapping competencies that hamper more effective dispute resolution processes. Our indicator of state presence is, however, limited, since we cannot measure the quality of the local infrastructures. We could also not alleviate the possibility of a reverse effect, where the states invest more heavily in areas that are deemed problematic. Our finding thus deserves closer scientific attention, so we can untangle what is at play behind our coefficient.

Our analysis further contributes to the literature on the determinants of violence involving pastoralists by highlighting the intertwining of armed rebel movements with pastoralists. As described by the qualitative literature, local herders have been increasingly armed and instrumentalized by armed groups, leading to more cattle raiding and intercommunal violence in countries such as Sudan and Nigeria (George et al., 2021; Wild et al., 2018). Our quantitative results indicate that, in fact, the risk of pastoral conflict increases in areas hosting armed groups. We also provide evidence that countries' border regions are more prone to experiencing pastoralist violence.

Some policy recommendations and venues for future research can be derived from the reported results. Our finding that state presence is a catalyst, rather than an inhibitor, of violence is daunting, considering that peace building is mainly contingent on the state and its institutions (e.g. for providing more tenure security and better land governance, protecting grazing routes and common land, guaranteeing judicial fairness). The positive impact of local peace committees in curbing pastoral conflicts reported by some authors (e.g. van Tongeren, 2013) may be a reason for hope and warrants more scholarly attention. Notwithstanding, we should further our understanding of when and how states may either prevent or promote this type of violence. More focus should be spent on state–pastoralist relations, which are often characterized by mutual suspicion and distrust.

Our results also point to the necessity of shedding light on how pastoralists are driven to armed struggle, particularly as part of transnational rebel and terrorist movements. Furthermore, considering that pressure on land and water will increase due to the climate crisis, it will be imperative to assess the effectiveness of particular adaptation strategies, including pastoral livelihood diversification, and explore meaningful recognition of pastoralist customary systems and the harmonization with statutory law. As pastoralist violence often occurs in border areas, we also highlight the need for more international and regional declarations to facilitate pastoralists' cross-border movement. Our key finding further stresses the importance of better regulating the various sources of land alienation, for example, by more inclusive governance of protected areas or by better compliance with the Voluntary Guidelines on the Responsible Governance of Land, Fisheries and Forests (VGTT). Finally, as the effect of land alienation may spread over long distances, we need better theoretical and empirical models to more accurately predict the location of communal conflicts.

Replication data

The Online appendices, datasets, R scripts and run file for the empirical analysis in this article can be found at http://www.prio.org/jpr/datasets.

Acknowledgements

The authors thank Simon Hug, Ueli Staeger, Peter Morgan, Aya Kachi, Corinne Bara, Robert Huber, Viktoria Jansesberger and the participants of the workshop 'Spatial Conflicts – Conflicts in Space' at the Technische Universität Berlin for their excellent comments on previous manuscript versions. The authors further thank the anonymous reviewers and the editor for their valuable insights that greatly improved the quality of this article.

Funding

Subscription by the corresponding author to the Mining Intelligence Database was funded by the Fondation Ernst et Lucie Schmidheiny, based in Geneva, Switzerland.

ORCID iDs

Cécile Richetta https://orcid.org/0000-0001-8804-7863
Tim Wegenast https://orcid.org/0000-0001-8904-0372

Notes

1. We define land alienation as the separation of people from land (and land-related resources) they traditionally had access to and the removal of (at least some of) their rights (Bluwstein et al., 2018).
2. Bluwstein et al. (2018) also identify these three subtypes of land alienation in Tanzania. Although the extent of their presence differs between African countries and regions, we show that they can be found across the continent.
3. For conflicts associated with large-scale commercial agriculture, see: Dell'Angelo et al. (2021). For conflicts related to mines, see: Denly et al. (2022). For conflicts associated with protected areas, see: Dowie (2011).
4. For a discussion of underlying and proximate causes and how they tie into conflict prevention, see: Ackermann (2003). For an example of land alienation as an underlying tension, see: Turner (2004: 882).
5. Own calculations; see our Research Design for further explanations.
6. Excluding the Republic of South Africa: 90% of its land is under private property. Thus, our theoretical mechanisms linked to customary land regimes and tenure insecurity are not applicable.
7. For a discussion on spatio-temporal parameters in binary outcome estimations, see: Franzese et al. (2016).
8. This result is largely in line with recent findings indicating that the effect of droughts on intercommunal violence is more pronounced in neighboring cells compared to cells in which the climatic shock actually occurred (see Dörring and Mustasilta, 2023).
9. Predicted probabilities are calculated through three steps: (1) simulating 1,000 times the model parameters; (2) for each quantile of each 1,000th model, predicted probabilities of the variable of interest are estimated at specific values of the independent variable (i.e., 0 or 1), and of the moderating variable, while other variables are at their observed values; and (3) the resulting probabilities are averaged across the 1,000 simulations. The predicted probabilities are then plotted with their 95% confidence interval.
10. It is unlikely that this effect is due to an urban bias in ACLED reports; if this were the case, *State presence* would be positive even when *Land alienation* is equal to zero, but here its associated coefficients are negative and insignificant $\beta = -0.483$.
11. The probability is calculated using average marginal effects.

References

Achiba GA (2018) Managing livelihood risks: Income diversification and the livelihood strategies of households in pastoral settlements in Isiolo County, Kenya. *Pastoralism* 8(1): 20.

Ackermann A (2003) The idea and practice of conflict prevention. *Journal of Peace Research* 40(3): 339–347.

ACLED (2022) Resources – ACLED: FAQS sourcing methodology. Available at: https://acleddata.com/resources/ (accessed 19 February 2024).

Africanews (2022) Chad: Nine dead in new clashes between herders and farmers. Available at: https://www.africanews.com/2022/08/22/chad-nine-dead-in-new-clashes-between-herders-and-farmers/ (accessed 19 February 2024).

Agrawal A (2014) Studying the commons, governing common-pool resource outcomes: Some concluding thoughts. *Environmental Science and Policy* 36(February): 86-91.

Akinwotu E (2021) Trail's end: The days of roaming free are numbered for Nigeria's herders. *The Guardian*. Available at: https://www.theguardian.com/global-development/2021/oct/27/days-of-roaming-free-are-over-for-nigeria-herders (accessed 19 February 2024).

Basupi LV, Quinn CH and Dougill AJ (2017) Pastoralism and land tenure transformation in sub-Saharan Africa: Conflicting policies and priorities in Ngamiland, Botswana. *Land* 6(4): 89.

Beck J and Sieber A (2010) Is the spatial distribution of mankind's most basic economic traits determined by climate and soil alone? *PLoS One* 5(5): e10416.

Bekele AE, Drabik D, Dries L, et al. (2021) Large-scale land investments, household displacement, and the effect on land degradation in semiarid agro-pastoral areas of Ethiopia. *Land Degradation and Development* 32(2): 777–791.

Berman N, Couttenier M, Rohner D, and Thoenig M (2017) This mine is mine! How minerals fuel conflicts in Africa. *American Economic Review* 107(6): 1564–1610.

Bingham HC, Juffe Bignoli D, Lewis E, et al. (2019) Sixty years of tracking conservation progress using the world database on protected areas. *Nature Ecology and Evolution* 3(5): 737–743.

Bluwstein J, Lund JF, Askew K, et al. (2018) Between dependence and deprivation: The interlocking nature of land alienation in Tanzania. *Journal of Agrarian Change* 18(4): 806–830.

Brottem L (2016) Environmental change and farmer–herder conflict in agro-pastoral West Africa. *Human Ecology* 44(5): 547–563.

Brottem L (2020) Pastoral resource conflict in the context of Sudano–Sahelian security crises: A critical review of research. *African Security* 13(4): 380–402.

Brottem L (2021) *The Growing Complexity of Farmer–Herder Conflict in West and Central Africa*. Washington DC: Africa Center for Strategic Studies.

Bukari KN and Kuusaana ED (2018) Impacts of large-scale land holdings on Fulani pastoralists' livelihoods in the Agogo traditional area of Ghana. *Land Use Policy* 79(December): 748–758.

Butt B (2012) Commoditizing the safari and making space for conflict: Place, identity and parks in East Africa. *Political Geography* 31(2): 104–113.

Chen Z, Yu B, Yang C, et al. (2021) An extended time series (2000–2018) of global NPP-VIIRS-like nighttime light data from a cross-sensor calibration. *Earth System Science Data* 13(3): 889–906.

Dell'Angelo J, Navas G, Witteman M, et al. (2021) Commons grabbing and agribusiness: Violence, resistance and social mobilization. *Ecological Economics* 184(June): 107004.

Denly M, Findley MG, Hall J, et al. (2022) Do natural resources really cause civil conflict? Evidence from the new global resources dataset. *Journal of Conflict Resolution* 66(3): 387–412.

Detges A (2014) Close-up on renewable resources and armed conflict: The spatial logic of pastoralist violence in northern Kenya. *Political Geography* 42(September): 57–65.

Dörring S and Mustasilta K (2023) Spatial patterns of communal violence in sub-Saharan Africa. *Journal of Peace Research*: https://journals.sagepub.com/doi/10.1177/00223433231168187 (accessed 20 June 2024).

Dowie M (2011). *Conservation Refugees: The Hundred-Year Conflict Between Global Conservation and Native Peoples*. Cambridge: MIT Press.

Feldt T, Karg H, Kadaouré I, et al. (2020) Growing struggle over rising demand: How land use change and complex farmer–grazier conflicts impact grazing management in the Western Highlands of Cameroon. *Land Use Policy* 95(June): 104579.

Firth D (1993) Bias reduction of maximum likelihood estimates. *Biometrika* 80(1): 27–38.

Franzese RJ, Hays JC and Cook SJ (2016) Spatial- and spatiotemporal-autoregressive probit models of interdependent binary outcomes. *Political Science Research and Methods* 4(1): 151–173.

Funk C, Peterson P, Landsfeld M, et al. (2015) The climate hazards infrared precipitation with stations: A new environmental record for monitoring extremes. *Scientific Data* 2(1): 1–21.

GADM (2023) GADM maps and data. Available at: https://gadm.org/index.html (accessed 19 February 2024).

George J, Adelaja A, Awokuse T, et al. (2021) Terrorist attacks, land resource competition and violent farmer–herder conflicts. *Land Use Policy* 102(March): 105241.

Homewood K (2008) *Ecology of African Pastoralist Societies*. Oxford: James Currey.

IUCN WCPA (2019) *Guidelines for Recognizing and Reporting Other Effective Area-Based Conservation Measures*. Gland, Switzerland: IUCN.

Jayne TS, Chamberlin J, Traub L, et al. (2016) Africa's changing farm size distribution patterns: The rise of medium-scale farms. *Agricultural Economics* 47(S1): 197–214.

King G and Zeng L (2001) Logistic regression in rare events data. *Political Analysis* 9(2): 137–163.

Koren O and Sarbahi AK (2018) State capacity, insurgency, and civil war: A disaggregated analysis. *International Studies Quarterly* 62(2): 274–288.

Kotsadam A and Tolonen A (2016) African mining, gender, and local employment. *World Development* 83(July): 325–339.

Kouagheu J and Ramadane M (2021) North Cameroon violence between farmers, herders kills 22; residents flee. *Reuters*. Available at: https://www.reuters.com/world/africa/violence-between-farmers-herders-kills-least-22-northern-cameroon-2021-12-09/ (accessed 19 February 2024).

Krätli S and Toulmin C (2020) *Farmer–Herder Conflict in sub-Saharan Africa?* London, UK: International Institute for Environment and Development (IIED).

Lange S (2011) Gold and governance: Legal injustices and lost opportunities in Tanzania. *African Affairs* 110(439): 233–252.

Lavers T and Boamah F (2016) The impact of agricultural investments on state capacity: A comparative analysis of Ethiopia and Ghana. *Geoforum* 72(June): 94–103.

Logan C (2013) The roots of resilience: Exploring popular support for African traditional authorities. *African Affairs* 112(448): 353–376.

McGuirk EF and Nunn N (2020) *Transhumant pastoralism, climate change, and conflict in Africa.* Report for the National Bureau of Economic Research. Working paper w28243.

McPeak JG and Little D (2018) Mobile peoples, contested borders: Land use conflicts and resolution mechanisms among Borana and Guji Communities, Southern Ethiopia. *World Development* 103(March): 119–132.

Mitchell J (2016) Pulling the rug out from under: The land tenure dynamics of mining concessions in sub-Saharan Africa. *The Extractive Industries and Society* 3(4): 1117–1129.

MODIS (2024) MODIS land cover type/dynamics. NASA MODIS: Moderate Resolution Imaging Spectroradiometer. Available at: https://modis.gsfc.nasa.gov/data/dataprod/mod12.php (accessed 19 February 2024).

Moritz M (2010) Understanding herder–farmer conflicts in West Africa: Outline of a processual approach. *Human Organization* 69(2): 138–148.

Nolte K and Ostermeier M (2017) Labour market effects of large-scale agricultural investment: Conceptual considerations and estimated employment effects. *World Development* 98(October): 430–446.

Northern Miner Group (2021) Data: Mining Intelligence. Data accessed with subscription. Available at: https://glacierrig.com/ and https://www.miningintelligence.com/ (accessed 19 February 2024).

Oak Ridge National Laboratory (2023) LandScan global citations. Available at: https://landscan.ornl.gov/citations (accessed 19 February 2024).

Oldekop JA, Holmes G, Harris WE, et al. (2016) A global assessment of the social and conservation outcomes of protected areas. *Conservation Biology* 30(1): 133–141.

Opiyo F, Wasonga O, Nyangito M, et al. (2015) Drought adaptation and coping strategies among the Turkana pastoralists of northern Kenya. *International Journal of Disaster Risk Science* 6(September) 295–309.

Penu DAK and Paalo SA (2021) Institutions and pastoralist conflicts in Africa: A conceptual framework. *Journal of Peacebuilding and Development* 16(2): 224–241.

Peters E (2013) Land appropriation, surplus people and a battle over visions of agrarian futures in Africa. *Journal of Peasant Studies* 40(3): 537–562.

Pettigrew TF, Tropp LR, Wagner U, et al. (2011) Recent advances in intergroup contact theory. *International Journal of Intercultural Relations* 35(3): 271–280.

Potapov P, Turubanova S, Hansen MC, et al. (2022) Global maps of cropland extent and change show accelerated cropland expansion in the twenty-first century. *Nature Food* 3(1): 19–28.

Raleigh C and Dowd C (2015) Armed Conflict Location and Event Data Project (ACLED) Codebook. Available at: https://www.acleddata.com/wp-content/uploads/2016/01/ACLED_Codebook_2016.pdf (accessed 19 February 2024).

Raleigh C, Linke A, Hegre H, et al. (2010) Introducing ACLED: Armed Conflict Location and Event Data. *Journal of Peace Research* 47(5): 651–660.

Ribot JC and Peluso NL (2003) A theory of access. *Rural Sociology* 68(2): 153–181.

Salehyan I, Hendrix CS, Hamner J, et al. (2012) Social conflict in Africa: A new database. *International Interactions* 38(4): 503–511.

Sulla-Menashe D, Gray JM, Abercrombie SP, et al. (2019) Hierarchical mapping of annual global land cover 2001 to present: The MODIS Collection 6 Land Cover product. *Remote Sensing of Environment* 222(March): 183–194.

Sundberg R and Melander E (2013) Introducing the UCDP georeferenced event dataset. *Journal of Peace Research* 50(4): 523–532.

Timsina S, Hardy NG, Woodbury DJ, et al. (2022) Tropical surface gold mining: A review of ecological impacts and restoration strategies. *Land Degradation and Development* 33(18) 3661–3674.

Tollefsen AF, Bahgat K, Nordkvelle J, et al. (2015) *PRIO-GRID v.2.0 Codebook*. Oslo: Peace Research Institute Oslo.

Tollefsen AF, Strand H and Buhaug H (2012) PRIO-GRID: A unified spatial data structure. *Journal of Peace Research* 49(2): 363–374.

Toutain B, Visscher MND and Dulieu D (2004) Pastoralism and protected areas: Lessons learned from Western Africa. *Human Dimensions of Wildlife* 9(4): 287–295.

Turner MD (2004) Political ecology and the moral dimensions of 'resource conflicts': The case of farmer–herder conflicts in the Sahel. *Political Geography* 23(7): 863–889.

UNEP-WCMC and IUCN (2021) Protected planet: The World Database on Protected Areas (WDPA). Cambridge: UNEP-WCMC and IUCN. Available at: https://www.protectedplanet.net (accessed 19 February 2024).

UNEP-WCMC (2019) User manual for the world database on protected areas and world database on other effective area-based conservation measures: 1.6. Cambridge: UNEP-WCMC. Available at: http://wcmc.io/WDPA_Manual (accessed 19 February 2024).

van Tongeren P (2013) Potential cornerstone of infrastructures for peace? How local peace committees can make a difference. *Peacebuilding* 1(1): 39–60.

Vogt M, Bormann NC, Rüegger S, et al. (2015) Integrating data on ethnicity, geography, and conflict: The ethnic power relations data set family. *Journal of Conflict Resolution* 59(7): 1327–1342.

Wegenast T, Krauser M, Strüver G, et al. (2019) At Africa's expense? Disaggregating the employment effects of Chinese mining operations in sub-Saharan Africa. *World Development* 118(June): 39–51.

Whitten GD, Williams LK and Wimpy C (2021) Interpretation: The final spatial frontier. *Political Science Research and Methods* 9(1): 140–156.

Wig T and Tollefsen AF (2016) Local institutional quality and conflict violence in Africa. *Political Geography* 53(July) 30–42.

Wild H, Jok JM and Patel R (2018) The militarization of cattle raiding in South Sudan: How a traditional practice became a tool for political violence. *Journal of International Humanitarian Action* 3(1): 1–11.

Wucherpfennig J, Weidmann NB, Girardin L, et al. (2011) Politically relevant ethnic groups across space and time: Introducing the GeoEPR dataset. *Conflict Management and Peace Science* 28(5): 423–437.

Yembilah R and Grant M (2014) The political ecology of territoriality: Territorialities in farmer–herder relationships in Northern Ghana. *GeoJournal* 79(3): 385–400.

Ying L (2021) How state presence leads to civil conflict. *Journal of Peace Research* 65(2–3): 506–533.

CÉCILE RICHETTA, b. 1995, PhD in Political Science (University of Geneva, 2024); post-doctoral researcher (University of Geneva, 2024–present); research interests: state power, violence, and prosocial behavior.

TIM WEGENAST, b. 1976, PhD in Political Science (University Pompeu Fabra, 2008); interim full professor, University of Konstanz (2020–present); current research interests: sustainable development, natural resource and land governance, environment and conflict, climate adaptation.