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ORIGINAL ARTICLE

Cattle, conflict, and climate variability: explaining pastoralist conflict intensity in the Karamoja region of Uganda

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Abstract

Conflicts between pastoralist groups in Africa are rampant and cause numerous deaths each year, but their intensity exhibits significant spatial and temporal variations. Under what conditions do some pastoralist conflicts turn more violent than others? Previous research has shown that climate variability may be a relevant explanatory factor under certain conditions, yet little is known about how specific combinations of conditions jointly affect pastoralist conflict intensity. Moreover, many studies have investigated the link between resource scarcity and conflict, but few have examined how asymmetrical distribution of resources between groups affects levels of violence. This article contributes to filling these gaps through a qualitative comparative analysis (QCA) of pastoralist conflicts in Karamoja, Uganda—a region characterized by cattle husbandry, communal conflict, and a highly variable climate. Five conditions that are related either to incentives for taking to violence or to opportunity structures are examined and three pathways to high-intensity conflict are identified. The results show that an asymmetrical distribution of resources between pastoralist groups during a drought incentivizes conflict, particularly in remote areas with nearby armed conflicts. The article highlights some implications for future research and policy. First, it shows that this type of conflict cannot be reduced to simple "resource scarcity conflicts" since climate variability only has an effect in combination with other conditions. Second, it emphasizes the need for policy approaches that consider both environmental variability and political contexts in addressing pastoralist violence.

Keywords Pastoralist conflict · Communal conflict · Climate variability · Drought · Uganda · Qualitative Comparative Analysis

Introduction

Pastoralism is practiced by an estimated 268 million people in Africa, occupying an area covering almost half of the continent (FAO 2018). This way of life has increasingly been associated with violent conflicts, particularly in regions like the Sahel and the Horn of Africa, where pastoralist conflicts have claimed many thousands of lives over the past three decades (UCDP 2023). A striking example is Uganda's Karamoja region, which in the early 2000s experienced an extreme surge in pastoralist conflicts as death rates reached 60 per 100,000 people, making it one of the most violent places on earth (Bevan 2008). Although a government-led disarmament effort contributed to a significant decline in violence after 2006 (Abrahams 2021), conflicts in Karamoja have escalated again since 2019 (Arasio and Stites 2022). However, even during particularly intense periods, there are large variations in the level of violence of pastoralist conflicts. For example, violent clashes between the pastoralist groups Dodoth and Jie in northern Karamoja resulted in over 200 deaths in March 2000, while a conflict involving Bokora Karimojong, Jie and Pian Karimojong, which started only a couple of months earlier some 150 km south, resulted in three fatalities without any further escalation (UCDP 2023). This example is illustrative for conflicts in pastoral areas of sub-Saharan Africa, where sporadic outbreaks of violence sometimes escalate but often do not. The variation in violence is puzzling given that these conflicts often take place in seemingly similar environmental and socio-economic contexts. This study aims to bring some clarity

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to this empirical and theoretical puzzle by asking: Under what conditions do some pastoralist conflicts turn more violent than others?

In the past decade, extensive research on communal conflict has examined the links between climate variability and violence (Fjelde and von Uexkull 2012; Hendrix and Salehyan 2012; Nordkvelle et al. 2017; Raleigh and Kniveton 2012; van Baalen and Mobjörk 2017; von Uexkull et al. 2023). Most studies on this topic mention pastoralists in one way or another, yet our understanding of pastoralist conflicts is limited. This study looks specifically at armed clashes between pastoralist groups, including agro-pastoralists who rely on a combination of livestock herding and farming. This specific type of conflict warrants attention as it typically results in more fatalities compared to farmer-herder conflicts (von Uexkull and Pettersson 2018). Previous research acknowledges the potential impact of environmental factors on the intensity of pastoralist conflicts but cautions against oversimplifying this complex relationship (Ayana et al. 2016; Benjaminsen and Ba 2021; Detges 2016; Seter et al. 2018; van Weezel 2019). An overemphasis on natural resources and rainfall risks simplistic and apolitical understandings of such conflicts, which essentially also deprives responsibility from political leaders (Verhoeven 2011). Thus, there has been a call for more complexity-oriented approaches that do not reduce pastoralist conflicts into "climate conflicts" (Adams et al. 2023; Detges 2014). Qualitative case studies are usually good for this purpose, but findings from single cases are difficult to generalize from. Large-*N* studies, on the other hand, allow for broad generalizations but do not account for intricate causal processes. A qualitative comparative analysis (QCA) offers a methodological approach that can bridge this gap between quantitative and qualitative analysis through a systematic comparison of a medium number of cases that account for causal complexity (Ide and Mello 2022; Ide 2023).

Previous conflict research using QCA has demonstrated the interaction of various factors influencing ethnic violence (Bara 2014; Lindemann and Wimmer 2018) and environmental conflict (Ide 2015, 2023; Bretthauer 2015; Wiederkehr et al. 2022). For example, a combination of structural and triggering conditions related to dyadic power dynamics and attitudes during recent political change has been associated with violent escalation of resource scarcity conflicts (Ide 2015). While these studies have advanced our understanding of the complex interactions of conditions leading to violence in environmental conflicts, they have not fully explored the impact of varying resource availability since scarcity has been a scope condition. In this study, natural resource distribution is included as an explanatory condition, enabling a comprehensive analysis of both scarcity and abundance pathways. This is important, since the varying intensity of pastoralist conflicts is often linked to variations in weather and climate, although findings regarding this relationship remain inconclusive.

While some studies have found that resource scarcity and drought may trigger violent pastoralist conflict via changed mobility patterns and increased incentives for cattle raiding in order to replenish herds (Ember, Abate Adem, Skoggard and Jones 2012; Ember et al. 2014), others have found that rainfall and resource abundance is likely to provide more favorable conditions for cattle raiding (Adano et al. 2012; Witsenburg and Adano 2009). Additionally, it has been argued that both resource scarcity and abundance could lead to increased raiding when a certain rainfall anomaly threshold is reached (Schilling et al. 2014). Although environmental conditions may be relevant explanatory factors under certain conditions, they are never the only causes of violent pastoralist conflict (Detges 2016; Seter et al. 2018; van Weezel 2019). Other factors that have been argued to affect conflicts involving pastoralists are, for instance, proliferation of weapons (Gray 2000; Leff 2009), commercialization of cattle raiding (Agade 2010; Eaton 2008, 2010), resource asymmetry (Butler and Gates 2012), remoteness (Detges 2014), and groundwater levels (Döring 2020). Several studies have highlighted the complexity of pastoralist conflicts (Schilling et al. 2014; Seter et al. 2018; van Weezel 2019) and the limitations of quantitative methods in capturing the intricate and intertwined drivers of violence (Ayana et al. 2016). Yet, none has clearly demonstrated how variables interact and jointly affect the intensity of pastoralist conflicts.

This article addresses this gap through a QCA of all twenty-nine pastoralist conflict episodes in Karamoja between 1989 and 2006. Karamoja represents a typical pastoralist region of sub-Saharan Africa with a semi-arid climate, peripheral location, frequent cross-border movement of people, and intermittent conflict (FAO 2018). Since a lot of climate-conflict research has historically focused on East Africa, this regional focus allows me to draw on a rich empirical literature, which is beneficial when drawing on secondary sources for the QCA (Ide et al. 2014). The QCA analysis reveals intricate interactions of conditions and identifies three distinct pathways to high-intensity pastoralist conflict. Specifically, an asymmetrical distribution of resources between warring groups during drought is associated with high-intensity pastoralist violence, particularly in remote areas with nearby armed conflicts. These findings challenge the simplistic view of pastoralist conflicts as merely "resource scarcity conflicts" and highlight the multifaceted nature of these disputes. Furthermore, the results underscore the importance of considering political and environmental factors together to prevent future escalations of violence, as both remoteness and the presence of other armed conflicts are critical for explaining why some pastoralist conflicts turn more violent than others.

Conceptual framework

Previous research has yielded complex findings on the relationship between climate variability and conflict (Seter et al. 2018; van Weezel 2019; von Uexkull et al. 2023) and we know that multiple causal factors are likely to interact towards high-intensity violence (Ide 2015; Wiederkehr et al. 2022). In order to structure the analysis, this study utilizes the well-established concepts of incentives and opportunities from the civil war literature (e.g., Collier and Hoeffler 2004; Fearon and Laitin 2003). The theoretical starting point is that both incentives and opportunities matter in explaining high-intensity pastoralist conflicts. Therefore, four explanatory conditions that are assumed to work primarily via an incentive or an opportunity mechanism are presented in the conceptual framework below. These conditions are water resource asymmetry, cattle asymmetry, remoteness, and other armed conflicts. A fifth ambiguous condition—dryness—is also included in the analysis but due to inconclusive findings regarding its causal effect on pastoralist violence, it cannot be placed within the incentives-opportunity framework. The five explanatory conditions in this study have been included because of their variation at the local level. Other potentially relevant factors that previous literature has mentioned include the institutional set-up (Adano et al. 2012; Krätli and Swift 1999; Mussa et al. 2017), commercialization of cattle raiding (Agade 2010; Eaton 2008, 2010), and groundwater levels (Döring 2020). However, since these variables do not spatially variate within the study area, they are considered less probable explanations to local variations in pastoralist conflict intensity. Below, I elaborate on how each explanatory condition is causally linked to the outcome of interest in this study.

Incentivizing conditions

The first incentivizing condition is the asymmetrical distribution of water resources between pastoralist groups. While rainfall and vegetation data has often been used to examine whether high or low levels of rainfall are associated with violent communal conflict (Fjelde and von Uexkull 2012; Meier et al. 2007; Raleigh and Kniveton 2012; Theisen 2012), far less is known about how asymmetrical distribution of resources between conflict parties affects conflict intensity. This condition therefore aims to capture temporary resource asymmetries between pastoralist groups since asymmetrical distributions of natural resources between pastoralist groups have been argued to induce violent cattle raiding (Butler and Gates 2012; Schilling et al. 2012). Moreover, violent pastoralist conflicts have been found to spatially co-occur with areas of relative resource abundance compared to surrounding areas (Ayana et al. 2016; Detges 2014). This result indicates that the intensity level of pastoralist conflicts may increase when the territory of one pastoralist group has relatively scarce resources compared to a neighboring group. Such resource asymmetries are assumed to cause incentives for taking up violence among the less fortunate group.

The second incentivizing condition also relates to resource asymmetries between groups, but looks at the distribution of cattle—a vital resource to pastoralist communities. Despite the central role of cattle to pastoralists, both as a source of livelihood and as social and cultural symbols, previous research has not investigated any potential linkages between cattle resource distribution and communal conflict intensity or occurrence. However, rapidly rising livestock numbers have caused a growing pressure on land and conflicts over resources in several pastoral areas of sub-Saharan Africa (Pica-Ciamarra, Otte and Chilonda 2007), and in Nigeria, it has been found that areas with relatively high cattle densities experienced more pastoralist conflicts due to increased pressure on resources during dry seasons (Gefu and Kolawole 2002). A high concentration of cattle within one group's territory is assumed to incentivize neighboring groups with relatively lesser cattle to take up violence out of envy, greed, or retaliation, particularly in combination with other external shocks.

Opportunity conditions

The first opportunity condition is remoteness, or more precisely the presence of roads. Inaccessibility due to rough terrain or poor infrastructure has repeatedly been shown to increase the risk for violent insurgency (Collier and Hoeffler 2004; Fearon and Laitin 2003; Tollefsen and Buhaug 2015). The intervention capacity of a state is rarely evenly distributed across its territory, but significantly varies within its borders (Menkhaus 2010). For pastoralists, grazing resources that are close to administrative capitals are usually preferred because of the higher risk of cattle raiding at more distant pastures (Le Billon 2001). Although state intervention is not only contingent on accessibility, but also on its strategic interests (Elfversson 2015), it could be assumed that remote areas are less likely to see state intervention in pastoralist conflicts than more well-connected areas. This assumption is supported by Detges (2014), who found that the spatial distribution of violent pastoralist conflicts in northern Kenya was closely related to the spatial distribution of opportunities and that the likelihood of armed clashes between pastoralist groups grew with increasing distance to main roads where the state could not intervene (Detges

2014). Thus, remoteness is assumed to be linked to high-intensity pastoralist conflict via the opportunistic behavior of cattle raiders.

The second opportunity condition, other armed conflicts, refers to ongoing violent armed conflict. Armed conflicts at the state level can affect violence at the community level, for example, by exacerbating and deepening local cleavages, even in cases where causes for violence at the macro- and micro-level do not overlap (Kalyvas 2006). Moreover, armed conflicts may affect the intensity of pastoralist conflicts by increasing the availability of automatic weapons. While violent conflicts between pastoralist groups are far from a new phenomenon, they used to be fought with far less lethal weapons (Leff 2009). The proliferation of automatic small arms due to armed conflict is largely responsible for the high lethality of pastoralist conflicts (Gray 2000; Gray et al. 2003). This condition is therefore assumed to trigger violence primarily via an opportunity structure since the outbreak of other violent conflicts within or nearby a pastoralist territory could fuel violence among pastoralist groups by increasing the availability of weapons and by exacerbating existing cleavages between groups.

Ambiguous condition and combined effects

The explanatory condition dryness is difficult to categorize as predominantly an incentivizing or an opportunistic condition since the previous literature is ambiguous regarding its effect on communal conflict intensity. This ambiguity has similarities with the older debate on whether resource scarcity or abundance is associated with armed conflict (Le Billon 2001), and it is precisely this contradiction that makes this condition of particular interest to this study since we do not know how climate variability interacts with other factors. Moreover, as a proxy for climate change, which largely motivates the academic attention on pastoralist conflicts, it is also important to determine if and how dry and wet weather conditions affect pastoralist conflict intensity.

The causal relationship between dryness and violence among pastoralist communities could appear direct and clear: Prolonged droughts intensify competition over common resources, resulting in violent clashes between rival groups. Several studies confirm this relationship and argue that drought may increase the risk for high-intensity pastoralist conflict by causing grievances and altering motivations for cattle raiding in order to restock herds (e.g. Ember et al. 2012; Ember et al. 2014; Higazi and Abubakar Ali 2018; Leff 2009; McCabe 2004). However, there are certain dynamics in pastoralist conflicts, which might also be favored by opposite weather conditions, i.e., abundance of rain. Cattle raiding is a common practice among pastoralists in sub-Saharan Africa, which sometimes end up in massive losses of human lives. Such raids have been shown to increase during wet seasons, both in intensity (Witsenburg and Adano 2009) and in frequency (Meier et al. 2007). The explanation for this relationship is that well-fed and healthy animals and plenty of water and vegetation are necessary for long raiding treks, but also since warring pastoralist groups have been shown to reconcile during crises such as severe droughts (Adano et al. 2012; Theisen 2012). This means that wet weather conditions could create opportunities for violent cattle raiding. Thus, the previous literature is ambiguous regarding how dryness affects pastoralist conflict intensity—via an incentive-based mechanism or through opportunity structures.

The combination of conditions is likely to affect whether dry or wet weather is associated with high-intensity conflict. During periods of drought, an asymmetric distribution of water and pasture resources among groups is more likely to precipitate conflict through incentivizing mechanisms, as compared to periods of wet weather (Ember et al. 2012, 2014). Conversely, in times of abundance, an unequal distribution of cattle among groups may create conditions for violent cattle raids (Witsenburg and Adano 2009; Adano et al. 2012). Consequently, I hypothesize that dry weather, when coupled with an asymmetrical distribution of water resources, will be associated with high-intensity conflict. Moreover, wet weather is posited to be associated with high-intensity violence when cattle distribution is asymmetric between groups. The opportunity conditions, remoteness and other armed conflicts, are presumed to facilitate violence in any configuration that also involves incentivizing conditions. This is predicated on the understanding that both motivation and conducive circumstances are needed for the emergence of violent conflict (Bara 2014; Lindemann and Wimmer 2018).

Method and research design

Empirical context and case selection

Karamoja is a sub-region located in northeastern Uganda with a total population of approximately 1.2 million (Uganda Bureau of Statistics 2017). The study area also incorporates pastoralist groups whose territories extend over the international border into Karamoja and who regularly migrate into this region in search for water and pasture (IRIS 2017). The total area is 117,499 km^2 and spans the border region between Uganda, Kenya, and (present-day) South Sudan. This region is in many ways a typical pastoral area of sub-Saharan Africa in regard to climate, livelihoods, and hinterland location (FAO 2018). A particularly violent outbreak of pastoralist conflicts occurred in Karamoja during the years around the turn of the millennium. This came to an abrupt end in 2006 following a government-led disarmament of the

Table 1 All pastoralist conflict episodes in Karamoja 1989–2006, sorted by number of fatalities

Conflict	Conflict ID	Conflict onset date	Number of events	Fatalities	Fuzzy score (intensity)
Matheniko—Pian	Ma-Pi04	2004–06-25	1	1	0 (low)
Bokora, Pian—Pokot	BoPi-Po04	2004–10-01	1	2	0 (low)
Matheniko, Pian—Pokot	MaPi-Po01	2001–11-09	1	2	0 (low)
Bokora, Jie – Pian	BoJi-Pi00	2000–01-14	1	3	0 (low)
Matheniko—Pokot, Tepeth	Ma-PoTe99	1999–01-01	1	3	0 (low)
Jie – Turkana	Ji-Tu04	2004–08-15	1	4	0.33 (semi-low)
Pian – Pokot	Pi-Po98	1998–04-13	1	4	0.33 (semi-low)
Bokora – Matheniko	Bo-Ma92	1992–01-01	2	4	0.33 (semi-low)
Bokora, Pian, Matheniko—Turkana	BoPiMa-Tu00	2000–04-29	1	5	0.33 (semi-low)
Bokora – Pokot	Bo-Po06	2006–01-16	2	8	0.33 (semi-low)
Bokora, Pian—Matheniko	BoPi-Ma03	2003–12-16	1	14	0.66 (semi-high)
Bokora—Jie, Matheniko	Bo-JiMa03	2003–09-10	2	14	0.66 (semi-high)
Bokora – Matheniko	Bo-Ma03	2003–03-02	4	14	0.66 (semi-high)
Jie – Tepeth	Ji-Te03	2003–08-15	1	21	0.66 (semi-high)
Dodoth—Jie, Matheniko	Do-JiMa00	2000–07-21	1	33	0.66 (semi-high)
Dodoth—Toposa, Turkana	Do-ToTu00	2000–01-31	1	43	0.66 (semi-high)
Jie – Matheniko	Ji-Ma05	2005–03-01	3	43	0.66 (semi-high)
Bokora—Jie, Matheniko	Bo-JiMa00	2000–07-01	1	48	0.66 (semi-high)
Bokora, Pian, Matheniko—Pokot	BoPiMa-Po03	2003–01-06	1	53	0.66 (semi-high)
Matheniko – Pokot	Ma-Po99	1999–02-06	3	59	0.66 (semi-high)
Pian – Pokot	Pi-Po02	2002–06-11	6	59	0.66 (semi-high)
Bokora—Matheniko, Turkana	Bo-MaTu00	2000–07-02	1	60	0.66 (semi-high)
Dodoth – Turkana	Do-Tu00	2000–06-11	2	71	0.66 (semi-high)
Bokora – Pian	Bo-Pi01	2001–01-24	8	95	0.66 (semi-high)
Bokora, Pian, Matheniko—Pokot	BoPiMa-Po98	1998–04-01	4	141	1 (high)
Bokora – Jie	Bo-Ji03	2003–01-10	11	155	1 (high)
Bokora—Jie, Matheniko, Turkana	Bo-JiMaTu00	2000–07-11	3	213	1 (high)
Dodoth – Jie	Do-Ji00	2000–03-19	16	241	1 (high)
Bokora – Matheniko	Bo-Ma99	1999–07-29	8	371	1 (high)

region, which fundamentally changed conflict dynamics in Karamoja (Abrahams 2021). Therefore, this study focuses on conflicts that started during the period 1989 to 2006—the start year being the earliest year for which reliable conflict data is available. Although this flare-up in violence was of unusual proportions, it was not unprecedented; similar intensity levels have been observed in many other parts of Africa and violence is again increasing in Karamoja after a period of relative stability (Arasio and Stites 2022).

The unit of analysis is the pastoralist conflict dyad, defined as two opposing actors that are organized along a shared communal identity (Brosché 2014). I aggregate all conflict events in a dyad into a conflict episode, using UCDP conflict event data. UCDP is the best available dataset for studying conflict intensity through fatality counts, and although the number of deaths is conservative, it is reliable and superior to any alternative datasets (Eck 2012). If a conflict has been inactive for 2 years (i.e., no battle-related deaths) and then restarts, I consider it a new conflict onset since 2 years of inactivity is enough time for an episode of violence to be of new character rather than merely a continuation of previous incompatibilities (Bara 2014). There are seven pastoralist groups which have their home territories in Karamoja, and which have been involved in violent conflicts with other pastoralist groups during the period 1989–2006 (UCDP 2023). These are Bokora Karimojong, Matheniko Karimojong, Pian Karimojong,[1] Jie, Dodoth, Ik, and Tepeth. Moreover, three pastoralist groups that are primarily based in Kenya and South Sudan are included in the sample; these are the Turkana, Pokot, and Toposa. These ten groups are inter-related and are collectively sometimes referred to as the Ateker people since they share a common ancestry,

[1] Hereafter, these three groups are referred to as Bokora, Matheniko, or Pian, without their suffixes "Karimojong.".

livelihood, and speak different variants of Nilotic languages (Seligman 2012). This selection process resulted in twenty-nine pastoralist conflict episodes (Table 1).

Data on the explanatory conditions are tied to the pastoralist conflict dyad via the geographical area where these groups have their permanent settlements and they are measured at the conflict onset. The exact location and demarcation of these territories are difficult to determine which is why several different sources have been used in order to triangulate and piece together the pastoralist territories (Bevan 2008; Bevan and Leff 2007; OCHA 2006, 2020). Despite the uncertainty about the exact delineations of the territories, this geographical unit is believed to be superior to using administrative units since several pastoralist groups may inhabit a single district, and because it allows for partial overlap of territories. All pastoralist territories and conflict events are illustrated in Fig. 1.

Operationalization of outcome and explanatory conditions

The outcome to be explained in this study is the intensity level of pastoralist conflicts, and more precisely, why some pastoralist conflict episodes turn more violent than others. The intensity of a conflict episode is considered high if the dyad has reached a fatality threshold of ten battle-related deaths. Although twenty-five deaths is a commonly used threshold for armed conflicts (UCDP 2023), I use ten, which is more appropriate considering the lower number of fatalities caused by this type of warfare compared to state-based conflicts and one-sided violence (Brosché and Elfversson 2012). The intensity variable is further calibrated into four fuzzy-set categories in order to capture variation on both sides of the 0.5 threshold, which means, for instance, that conflict episodes that have ended in fourteen deaths are seen as qualitatively different from those that have ended in hundreds of deaths. This calibration process results in five low-intensity conflicts, five semi-low, fourteen semi-high, and five high-intensity conflict episodes (Table 1). The exact location of the qualitative thresholds is based on conflict intensity levels of communal conflicts in Africa. However, since the calibration process is inevitably subjective, these thresholds were also subjected to a series of robustness tests, which showed that their exact location had a marginal effect on the QCA solution term but caused a lower coverage (see Supplementary Materials, Table S1).

Table 2 presents a summary of the explanatory conditions, their theoretical links to the outcome, calibration methods, qualitative thresholds, and data sources. The Standardized Precipitation Evapotranspiration Index (SPEI) is used to measure the conditions dryness and water resource asymmetry. Dryness is operationalized as the mean SPEI value across the study area at conflict onset while water resource asymmetry captures differences between territories. Thus, this condition only measures differences in SPEI values between pastoralist territories, but not absolute dryness or wetness. Cattle asymmetry is defined as the difference in average cattle density within the territories of the conflicting parties based on sub-national statistics from The Gridded Livestock of the World (Gilbert et al. 2018). Remoteness is operationalized as the percentage of a pastoralist territory within 10 km of a "primary road" (OpenStreetMap 2018). For calibration, the combined percentage of the dyad is used, which means that lower figures indicate fewer roads in both territories. Lastly, the condition of other armed conflicts is defined as the number of deaths in state-based and one-sided violence within 20 km from the parties' territories within 1 year prior to the pastoralist conflict onset.

Fuzzy-set qualitative comparative analysis

This study employs a fuzzy-set QCA, which in contrast to crisp-set QCA allows for gradation and partial inclusion of cases in a set. Fuzzy-set QCA was developed in order to overcome the limitations of working with simple binary categories when studying intricate social processes and complex causal patterns (Ragin 2000).

In QCA, distinction is made between necessary and sufficient conditions. Necessary conditions are those that are practically always present when the outcome of interest is observed, and otherwise not, while sufficient conditions refer to those that are present whenever the outcome occurs (Ide and Mello 2022). The relevance of a QCA solution is measured in consistency and coverage, indicated by a value between 0 and 1. A high consistency score indicates a good fit between the solution and the data and a high coverage shows that the solution covers, or explains, most of the cases with the outcome of interest. The consistency score tells us whether a subset relation exists or not and the conventional lower threshold for truth table rows to be considered sufficient is 0.75 (Mello 2022). For coverage, there is no widely accepted lower threshold since conditions that cover only a small part of the outcome may still be of great theoretical importance (Schneider and Wagemann 2012). However, the aim is often to cover at least half the observations, which means that a coverage around 0.60 and above is usually preferable (Mello 2022).

The first step of a QCA is to look for necessary conditions, which usually means a consistency value of 0.9 or higher since that would indicate that nearly all cases with the outcome of interest shares the presence or absence of a condition (Schneider and Wagemann 2012 p. 143). However, the primary purpose of QCA is to analyze sufficiency by producing a truth table, which is a matrix used for identifying combinations of causal conditions that are sufficient for a certain outcome. The truth table is then subjected to a

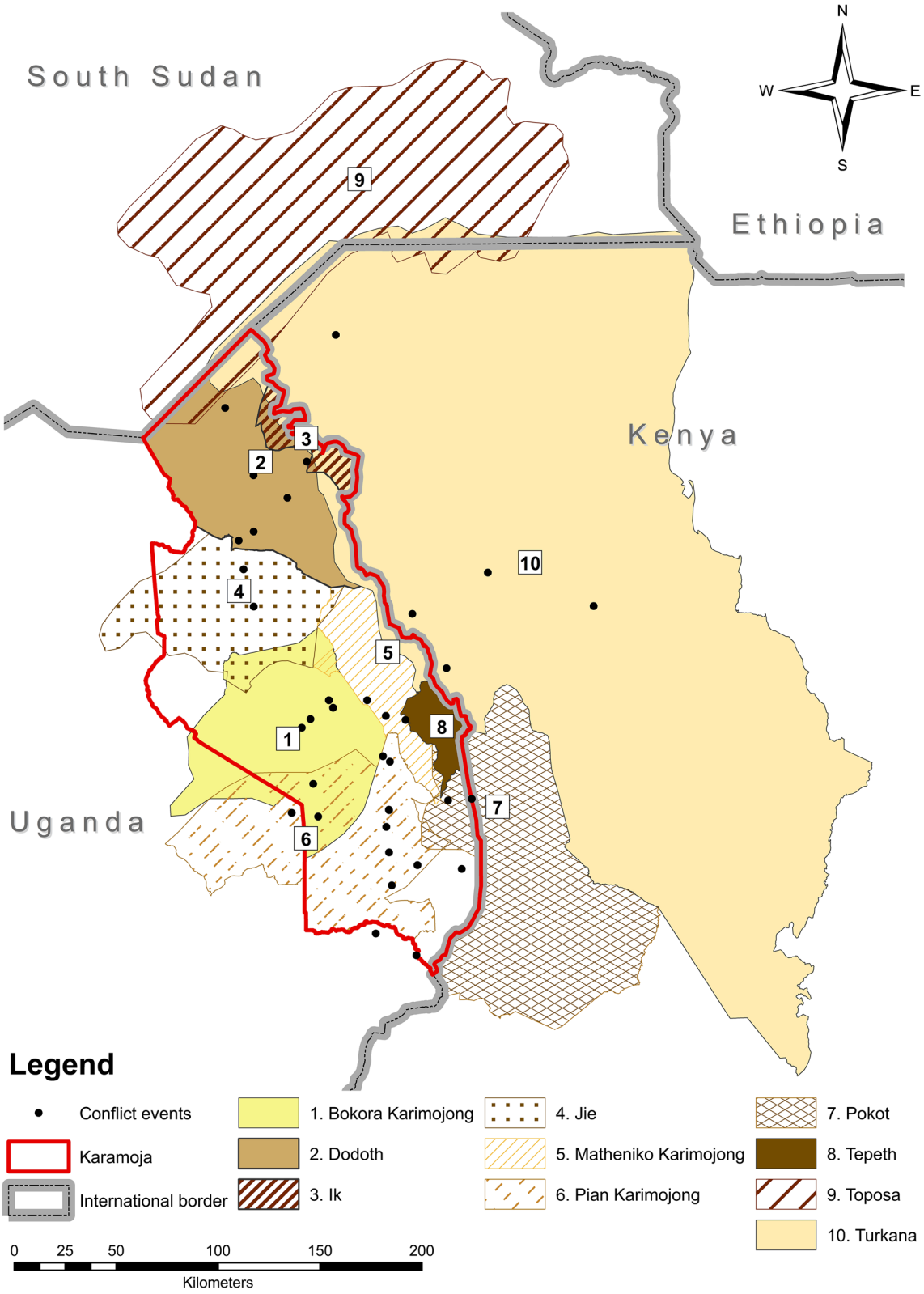

Fig. 1 Study area with pastoralist group territories and all conflict events

Table 2 The explanatory conditions included in the Qualitative Comparative Analysis (QCA), their theoretical link to the outcome, calibration procedure, qualitative thresholds, and data sources

Explanatory condition	Theoretical expectation	Calibration procedure	Qualitative threshold (0.5 cutoff)	Data source
Water resource asymmetry	Presence of asymmetrical water resource distribution between warring groups will *incentivize* violence	A wetness/dryness classification scheme (Li et al. 2015) was used for guidance and the exact location of the qualitative threshold was placed at a "natural gap" in the data series	0.6 difference in SPEI values between territories	Peng J, Dadson S, Hirpa F, Dyer E, Lees T, et al. (2020) A pan-African high-resolution drought index dataset. Earth Syst Sci Data 12:753–769
Cattle asymmetry	Presence of asymmetrical cattle distribution between warring groups will *incentivize* violence	The calibration was guided by national cattle density figures from East Africa. The country average for Uganda is 25 cattle per km^2 and this was used as the 0.5 cutoff	25 cattle per km^2	Gilbert M, Nicolas G, Cinardi G, Van Boeckel TP, Vanwambeke, S et al. (2018) Global cattle distribution in 2010 (5 min of arc). Harvard Dataverse, V3
Remoteness	Remoteness, defined as the absence of primary roads, will create *opportunities* for violence	National figures of paved road densities in East Africa were computed using OpenStreetMap (2018). The 0.5 cutoff was set at a road density of 18%, between the national average of Kenya (19%) and South Sudan (15%), and well below Uganda's 28%	18% of territory within 10 km from a paved road	OpenStreetMap (2018) Uganda Road Network. World Food Programme (WFP)
Other armed conflicts	Presence of other armed conflicts in the nearby area will create *opportunities* for violence	The widely accepted threshold of 25 battle-related deaths (Sundberg and Melander 2013) was used as the 0.5 cutoff	25 battle-related deaths	Sundberg, R, Melander E (2013) Introducing the UCDP Georeferenced Event Dataset. J Peace Res 50: 523–532
Dryness	Ambiguous condition. Dry weather may *incentivize* violence while unusually wet weather may create *opportunities* for violence	The wetness/dryness classification scheme by Li et al. (2015) classifies values around zero as near normal and positive/negative values indicate unusually wet/dry weather. A SPEI value of − 1 indicates a moderate drought and this was used as the 0.5 cutoff	-1 SPEI at conflict onset	Peng J, Dadson S, Hirpa F, Dyer E, Lees T, et al. (2020) A pan-African high-resolution drought index dataset. Earth Syst Sci Data 12:753–769

logical minimization procedure, resulting in a solution term, and according to the current standards of good practice in QCA, three different solution terms are produced—the conservative, parsimonious, and intermediate solution (Schneider and Wagemann 2012). What differentiates these solution terms is how they handle the logical remainders, i.e., combinations of conditions without any empirical observations for the outcome of high-intensity pastoralist conflict. The intermediate solution is, as the name suggests, a middle way in terms of complexity where theoretical expectations on how single conditions are related to the outcome are added to the minimization process (Schneider and Wagemann 2012). The majority of QCA applications focus their analysis on the intermediate solution (Ide and Mello 2022).

Results

The necessity analysis found none of the explanatory conditions included in this QCA to be necessary for high-intensity pastoralist conflict. This was not surprising since the premise for this study is to identify combinations of explanatory variables that interact towards the outcome of interest. In the analysis of sufficient conditions, the truth table

Table 3 Intermediate QCA solution. Black circles indicate the presence of a condition while blank spaces indicate that the condition is irrelevant

	Intermediate solution pathways		
	1	2	3
Conditions			
Dryness	●	●	
Remoteness	●	●	●
Other armed conflicts			●
Water resource asymmetry	●		
Cattle asymmetry		●	●
Covered cases:	Bo-MaTu00; Do-Tu00, Bo-JiMa00, Bo-JiMaTu00	Do-Ji00, Do-JiMa00; Do-Tu00, Bo-JiMa00, Bo-JiMaTu00	Bo-Ji03, Bo-JiMa03, Ji-Tu04, Ji-Ma05; Ji-Te03
Consistency	0.892	0.902	0.902
Raw coverage:	0.354	0.395	0.395
Unique coverage:	0.042	0.062	0.167
		Solution consistency:	0.901
		Solution coverage:	0.604

(Supplementary Materials, Table S2) resulted in sixteen logical remainders, i.e., rows without any empirical observations. Three different solution terms were produced, and like most QCA researchers, I opt to focus my analysis on the intermediate solution, which is presented in Table 3. The conservative and parsimonious solutions are available in Table S3 and Table S4 in the Supplementary Materials. In line with the conceptual framework, the presence of the conditions water resource asymmetry, cattle asymmetry, and other armed conflicts is expected to be associated with high-intensity conflict. Conversely, the condition remoteness, defined as the absence of paved roads, is expected to increase risk for high-intensity violence. Since the previous research is inconclusive regarding whether high or low rainfall levels are associated with high-intensity pastoralist conflict, I did not specify any directional expectation of the explanatory condition dryness. In the creation of the intermediate solution, six logical remainders were included in the analysis since they were in line with my theoretical expectations.

The QCA solution presented in Table 3 has a high overall consistency of 0.901, which means that nearly all conflict episodes that share this configuration have resulted in a high-intensity conflict, and the coverage of the solution is 0.604. The solution covers one deviant case (Ji-Tu04) and in the "Discussion" section I will elaborate on what impact this has on the analysis.

The QCA solution presented in Table 3 could be interpreted as three different pathways to high-intensity pastoralist conflict. All three pathways contain both incentive- and opportunity-based explanatory conditions. More specifically, the first and second solution paths could be interpreted as this: An asymmetrical distribution of water resources (pathway 1) or asymmetrical distribution of cattle (pathway 2) during a drought causes incentives among the affected pastoralist groups to take up violence, which was possible due to the remoteness of the area. In the third pathway, there was an asymmetrical distribution of cattle resources, which may have incentivized the conflicting parties to engage in violent conflict and this was enabled due to other armed conflicts in the vicinity and the remoteness of the area.

These results were subjected to 22 robustness tests, collectively suggesting a robust solution term. The alternative solutions produced through the robustness tests consistently involved similar sufficient conditions, maintaining roughly equivalent consistency and coverage scores throughout the various model specifications, which indicates a robust solution term (Schneider and Wagemann 2012). Each robustness test is outlined in further detail in the Supplementary Materials (Table S1).

Discussion

A key finding from the QCA is that both incentive- and opportunity-based conditions are present in all three pathways to high-intensity pastoralist conflicts. This is in line with theoretical expectations, since previous studies have argued that both incentives and opportunities are needed for violent conflict to erupt (Bara 2014). Yet, the relative importance of incentives versus opportunities remains debated in regard to how climate variability affects pastoralist conflict intensity: via incentives caused by scarcity of resources (Ember et al. 2012, 2014) or opportunities caused by abundance (Adano et al. 2012; Witsenburg and Adano 2009). Obviously, environmental factors are only part of the explanation, as clearly demonstrated by the QCA, which did not find any conditions necessary or sufficient on their own.

However, three configurational pathways were found to be sufficient for high-intensity pastoralist conflicts and these will be disentangled and discussed below.

Remoteness, drought, and asymmetrical resource distribution

The first two configurations of the QCA solution cover nine conflict episodes, characterized by remoteness, drought, and uneven distribution of water or cattle. These scenarios suggest that drought and resource asymmetry have incentivized violence, which was possible due to the remoteness of the area. The Karamoja sub-region is geographically and culturally distant from the capital Kampala, but some pastoralist areas are still better connected to infrastructure, which allow state intervention to prevent conflict escalation. The Ugandan government's previous responses to violence in Karamoja include disarmament, livestock branding, amnesties, paramilitary formations, and peace meetings (Agade 2008).

Previous research has been unable to establish a definitive link between the lack of infrastructure and communal violence (Elfversson 2015; Detges 2016). However, a more pronounced connection emerges when focusing specifically on pastoralist conflicts, as shown by Detges (2014) in his study from northern Kenya, where the likelihood of pastoralist violence increases with distance from main roads. The QCA results add to these findings by proposing that the intensity also tends to increase at remote locations. This trend might be attributed to cattle raiding, a distinct feature of pastoralist conflicts, since raiders might take factors like policing into account when planning their attacks. The lack of governance in Karamoja has been singled out as the main issue exacerbating insecurity in the region by local organizations since people are forced to protect themselves with arms in the absence of law and order (Akabwai and Ateyo 2007).

One of the most striking findings from this QCA is that drought, rather than wet weather, is associated with high-intensity pastoralist conflict. This is in stark contrast to the conclusions of some well-cited articles, which have found that pastoralist conflicts risk turning more violent during wetter months and years (Adano et al. 2012; Meier, Bond and Bond 2007; Raleigh and Kniveton 2012; Witsenburg and Adano 2009). However, the generalizability of these results has been questioned in a replication study that also found a significant relationship between rainfall variability and pastoralist conflict intensity—but in the opposite direction (Ember et al. 2012). The main explanation for these contradictory findings is that factors like migration strategies and reliance on rain-fed agriculture differ between pastoralist groups, but for most groups, high-intensity conflict is more common during droughts (Ember et al. 2014). This QCA study applies a disaggregated approach, and the results support the findings of Ember et al. (2012) and Ember et al. (2014) that drought is associated with high-intensity pastoralist conflict. It should be noted, though, that the robustness tests outlined in the Supplementary Materials (Table S1) reveal that when intergroup power dynamics are significantly changed, the strategic advantages of attacking during periods of abundance appear to outweigh those motivated by water scarcity. One aspect related to water resources that this study does not address because of insufficient data is the availability of wells and access to groundwater, which has been shown to affect patterns of pastoralist violence (Detges 2016; Döring 2020). While groundwater levels are relatively homogenous within Karamoja, deep boreholes are less evenly distributed across districts (Avery 2014). Thus, it might be relevant for future research to investigate how such point water sources affect levels of pastoralist violence in this region.

While the QCA results show that drought does have an impact on the intensity level of pastoralist conflicts, it only does so in combination with the explanatory conditions remoteness and water resource or cattle asymmetry. Resource asymmetry means that the distribution of natural resources such as water and pasture is uneven between the warring pastoralist groups, which has been argued to be a contributing factor to violent cattle raiding (Butler and Gates 2012). In combination with drought, this indicates that violence between pastoralist groups may intensify when one group is more adversely affected by a drought than a neighboring group. This is supported by Ayana et al. (2016) who found that pastoralist conflict events in East Africa tend to occur at locations with relative abundance of water and grazing. A landscape-based sub-analysis of Karamoja also showed that relative resource abundance in the mountainous highlands sometimes attracts pastoralists from the neighboring lowlands in Kenya, which are often harder hit by droughts (Ayana et al. 2016). Indeed, several of the conflict episodes covered by the QCA solution are cattle raids involving the Turkana from the Kenyan lowlands and different pastoralist groups from the mountainous Karamoja region. For example, in July 2000, the Turkana allied with the Matheniko to raid the Bokora, whose territory had been much less affected by a drought, and this conflict resulted in at least 60 deaths (Lokwang 2000). Earlier that year, thousands of heavily armed Turkana herders had migrated into northern Karamoja in search for water and pasture due to the severe drought. This mass movement heightened fears of violence between the groups, but the government did not intervene and months later, tensions escalated as the Dodoth attacked the Turkana, reportedly fueled by resentment towards their presence, and this conflict eventually claimed the lives of more than 70 people (BBC 2000). These empirical examples are in line with the explanation by Ayana et al. (2016) and they support the theorized pathway that resource asymmetries between pastoralist groups during droughts

may lead to high-intensity conflict in remote areas where the state is less likely to intervene.

Remoteness, cattle asymmetry, and other armed conflicts

The third configuration covers five conflict episodes and although the conditions remoteness and cattle asymmetry recur in this pathway, an important difference is that drought is replaced by other armed conflicts. This combination of conditions represents a scenario where cattle raiding is incentivized by an uneven wealth distribution and opportunities for raiding are conducive due to remoteness and nearby armed conflicts. While restocking and retaliatory raids have traditionally been conducted by young men with permission from community elders, a new type of commercialized cattle raiding has become widespread in Karamoja since the 1980s, which operates outside of the customary institutional system and is driven by individual short-term economic profit (Agade 2010). This commercialization of cattle raiding has been possible because of the limited reach of the state and the incapacity of the police to monitor markets for stolen cattle (Agade 2010; Eaton 2010). The fact that remoteness is strongly associated with high-intensity pastoralist conflict could therefore indicate opportunistic behaviors of cattle raiders who take policing into account when planning their attacks, and/or that the state has not intervened, which has enabled conflict escalation.

In remote areas characterized by an uneven distribution of cattle among groups, nearby armed conflicts add another ingredient to a potent recipe for violent pastoralist conflict. Karamoja was particularly affected by warfare involving the Lord's Resistance Army (LRA) between the years 2000 and 2004 (UCDP 2023). Violence at the state level may affect micro-level dynamics, for instance by exacerbating and deepening local cleavages (Kalyvas 2006) and by increasing the availability of small arms, which is an important source of violence in pastoralist areas (Gray 2000; Gray et al. 2003; Leff 2009). The proliferation of weapons from conflicts has created a spiral of intensified violence among pastoralist groups in previously peaceful areas of Uganda (Agade 2008).

Armed conflicts may also exacerbate state absence locally by shifting the government's priorities. For example, after a half-completed disarmament exercise in Karamoja in 2001–2002, the army was suddenly redeployed to deal with the LRA in Northern Uganda, which left some pastoralist groups unarmed. This made them easy targets for neighboring groups, who had not been disarmed, and started violent spirals of revenge raids between different groups (Akabwai and Ateyo 2007; Government of Uganda 2007). Notably, six of the nine high-intensity conflict episodes that were not covered by the QCA solution occurred during 2002–2003, a period when the power balance between pastoralist groups was significantly disturbed by the disarmament failure (Akabwai and Ateyo 2007). This disruption offers a plausible explanation for the high-intensity violence in these episodes, even in the absence of other known risk factors. For example, in one of the uncovered cases (Bo-Ma03), the chief of a raided village expressed that the attack on them was a direct result of the disarmament, which had made the Bokora vulnerable and easy targets for the Matheniko (Wamboka 2003). While the shifting power dynamics could not be factored in as an explanatory condition in the QCA due to a lack of comprehensive data regarding which groups were disarmed, I conducted two robustness tests to assess its impact, detailed in the Supplementary Materials (Table S1). This yielded a solution where high-intensity violence was more closely associated with wet weather conditions, rather than drought. Not only does this underscore the ambiguity of the "dryness" condition, but it also indicates that conflicts during these years were likely driven by strategic advantages, rather than resource scarcity.

One of the nine conflicts covered by the third configuration is a deviant case, which means that it shares all explanatory conditions, but not the outcome. This conflict case is a Jie attack on the Turkana, who had entered Jie territory in search for water and grazing during a severe drought (Mukoo et al. 2004). Subsequently, a peace dialogue involving the parties was organized by chiefs, elders, and civil society groups, focusing on compensation and resource sharing. Although previous dialogues had only yielded temporary solutions (Mukoo et al. 2004), this particular meeting might have been effective in preventing a violent escalation, despite the presence of risk factors. Although peace meetings in Karamoja during this time have been described as firefighting exercises that do not address the root causes of conflict (Agade 2008), there are examples of successful resource sharing agreements between pastoralist groups (Abrahams 2020). Such local resource management institutions could be key in preventing future escalation of pastoralist conflicts.

Conclusion

More than a decade of research has unveiled a complex relationship between climate variability and conflict (Buhaug et al. 2023). Pastoralists are often mentioned in the climate-conflict literature, but it leaves unaddressed how causal conditions interact towards high-intensity pastoralist violence (Adams et al. 2023). I address this gap through a QCA of pastoralist conflict episodes in Karamoja, which identified three pathways to high-intensity conflict involving both conditions related to incentive and opportunity structures. Specifically, I find that an asymmetrical distribution of resources between pastoralist groups during a drought incentivizes conflict, particularly in remote areas with nearby armed conflicts. This study contributes towards

an improved understanding of the multifaceted nature of pastoralist conflicts, moving beyond simplistic narratives of resource scarcity. Additionally, it highlights the need for policy approaches that consider both environmental variability and political contexts in addressing pastoralist violence.

While previous research has been ambiguous regarding the impact of rainfall on pastoralist conflict, this study reinforces earlier evidence suggesting that periods of high-intensity violence are more closely linked to drought conditions than to wet weather. This is especially true when there is an uneven distribution of resources between groups. The distribution of resources, both water and cattle, between conflicting groups is a factor that has been largely overlooked in the literature, yet it emerged as a significant explanatory condition in all three pathways of the QCA solution. Remoteness is also part of all three identified pathways to high-intensity pastoralist conflict, indicating the crucial role that politics play in this type of "non-state" conflict. Although prior studies have found pastoralist violence to be more likely with increasing distance to road infrastructure (Detges 2014), my results add that they also tend to become more violent at such locations. A likely explanation to this is that opportunistic cattle raiders prefer to attack in remote areas where state reach is limited (Eaton 2010; Le Billon 2001). These results echo De Juan's (2015) conclusion that any relationship between climate variability and violence is always contingent on local and national institutions. Preventing pastoralist conflicts from escalating in the African drylands, where climate extremes are expected to increase and the population is rapidly growing (Trisos et al. 2022), will therefore require improved accessibility and institutional capacity.

Future research should delve into the causal processes behind intense pastoralist conflicts and pay particular attention to non-quantifiable elements like intergroup power dynamics. Factors for which systematic data are scarce, like access to artificial water sources, also require more attention. Improving groundwater access in pastoralist areas is a potentially important future adaptation measure since both drought and asymmetrical resource distribution were found to be associated with high-intensity conflict. The QCA approach of this study proved useful for identifying combinations of conditions that increase risk for high-intensity pastoralist conflict, but its reliance on secondary sources limited the depth of the qualitative analysis. The results hint at the significant impact that a failed disarmament campaign had on power dynamics in Karamoja and the potential positive effect of peace meetings for preventing conflict escalation. However, further research is needed to confirm and build upon these findings. Preventing future escalation of pastoralist conflicts is important and urgent as violence is intensifying in Karamoja at an alarming rate (Arasio and Stites 2022) and remains pervasive across the African continent (African Union 2022).

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Declarations

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