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Conservancies, rainfall anomalies and communal violence: subnational evidence from East Africa

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ABSTRACT

Are conservancies hotspots for communal violence and if so, do rainfall anomalies increase the likelihood of violence? The consensus from a rich number of case studies suggests that conservancies (e.g. national parks, game reserves) increase tensions between communities, which often lead to violent conflicts. Yet, these insights remain to be empirically tested using a large-*N* study. We examine this claim and explore if rainfall anomalies have an amplifying effect on violent conflicts.

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We contend that the spatial convergence between conservancies and rainfall variability can spark conflicts over access to resources in times of scarcity and create strategic opportunities to satisfy secondary goals in times of abundance. To test our expectations, we use sub-national data from East Africa between 1990 and 2018. Our results suggest that regions with conservancies are somewhat more prone to communal violence and find strong evidence that positive rainfall anomalies increase the likelihood of violent communal conflicts in regions with a conservancy.

Keywords – Climate change, conservancies, communal conflict, East Africa.

INTRODUCTION

Communal conflict, such as farmer-pastoral violence, is a common occurrence in and around conservancies in Africa – or so the argument goes (Schmidt-Soltau 2009; Nelson 2012; Steinicke & Kabananukye 2014; Bergius *et al.* 2020). The establishment of protected and conservation areas for biodiversity protection (e.g. national parks and game reserves) in sub-Saharan Africa has spawned numerous socio-political and economic tensions and conflicts over land use, land ownership, cost of conservation, and unequal resource distribution and access to communities (Benjaminsen & Bryceson 2012; Hartter *et al.* 2016). A sizable number of pastoral and farmer groups live in East Africa where conservation areas contribute to their food security, and by extension, intercommunal stability (Hendrix & Brinkman 2013). On the one hand, conservancies create sets of winners and losers that often leads to a surge in the number of incursions from the 'loser' tribe into the territory of the 'winner' tribe, increasing tensions between groups and the propensity for violent conflicts (O'Brien & Leichenko 2000; Leff 2009). In 2016, Ivory Coast's Comoé National Park experienced a three-year long conflict between farmers and herders over access to water and land that resulted in three dozen people losing their lives and about 2,500 people displaced (Agence France-Presse 2019). On the other hand, some evidence suggest the militarisation of conservancies for anti-poaching and the protection of private property can also provide security for communities, deterring incursions and reducing violence between communities (Schetter *et al.* 2022). However, such assumptions surrounding communal violence in and around conservancies have not been empirically tested using a large-*N* study.

To makes matters worse, erratic precipitation patterns from a changing climate further threaten to shrink the resource pie available to groups to sustain their livelihoods and way of life (López-i-Gelats *et al.* 2016). Dubbed the 'climate change canaries', peripheral communities are often thought to be the first casualties of a warmer planet given the decrease in water spots and available fertile soil (Meier *et al.* 2007; Kuenzer *et al.* 2013). The International Panel on Climate Change (IPCC) asserts with *high confidence* that impacts from climate change to 'pastoral systems in Africa include lower pasture and animal productivity, damaged reproductive function, and biodiversity loss' (IPCC 2019: 56). Intercommunal violence gained notoriety after policymakers used the Darfur crisis as an example of the possible adverse effects of climate change (Ki-Moon 2007). This was followed by an increase in academic attention devoted to explain whether climate change in fact played a role in these low-intensity forms of conflict (Kevane & Gray 2008; |Ember *et al.* 2012, 2014; Detges 2017; van Weezel 2020).

In short, the spatial and temporal changes in precipitation and temperature patterns of pastures and water points in and around conservancies could complicate matters further. Research from political science, ecology and geography has advanced our understanding of how rainfall anomalies (in both directions) may increase the likelihood of communal violence (Le Billon 2001; Witsenburg & Adano 2009; Adano *et al.* 2012; Ember *et al.* 2012; Fjelde & Uexkull 2012; Detges 2014). Such research suggests that violent clashes between communities take place in strategic areas where the spatial distribution of resources satisfies a group's objectives. However, objectives and motivations to engage in violence change depending on the group's needs. And therein lies the conundrum. Should we expect a 'neo-Malthusian'-like scenario in regions with conservancies during drier years where conflict emerges between groups fighting for dwindling resources? Or should we expect a 'honey pot'-like effect during wetter years where conflict arises from self-enrichment opportunities?

This article has two main objectives. First, to examine whether regions with conservancies are more prone to communal violence. Second, to analyse whether rainfall anomalies amplify the likelihood of communal violence in areas with conservancies. Communal violence is defined as a fatal violent dispute between non-state groups organised along a shared common identity (Döring 2020). We argue, as have others, that communal conflict is more likely a response to environmental hardship than taking arms against the state in a full-blown conflict (Salehyan & Hendrix 2014). The government becomes an unlikely target after environmental hardships – unless it is in direct control or mediates access to waterholes, farming or grazing land (Hendrix & Salehyan 2012). A precondition that is rare in many peripheral regions of eastern Africa where the government presence is minimal or non-existent (Mkutu 2003; Cederman *et al.* 2010). However, the use of violence against other communities to secure livelihood essentials is a more likely scenario that immediately fulfils basic needs left by environmental hardships (Hagmann & Mulugeta 2008).

We analyse these questions through an examination of 177 communal conflicts in first-order administrative political boundaries for Kenya, Ethiopia, Uganda, Sudan and South Sudan from 1990–2018. Somalia is excluded from the analysis due to the inability to verify the status of conservancies in the country due to political instability. As of 2016 the country did not have any officially protected areas (WDPA 2016). The remainder of this paper is structured as follows. The following section briefly summarises the relevant literature exploring the links between climate variability and communal conflict and conservancies, followed by our theoretical arguments and hypotheses. The next two sections present our research design and results. Our final sections offer a discussion and concluding remarks.

CONSERVANCIES AND CONFLICT DYNAMICS

A well-established literature on green violence and green militarisation –the use of paramilitary, techniques, actors and technologies in the pursuit of conservation – submits that violence in and around conservation areas is common and diverse (Constantinou *et al.* 2020; Dutta 2020; Lombard & Tubiana 2020; Titeca *et al.* 2020; Woods & Naimark 2020; Marijnen *et al.* 2021). For instance, park ranger violence on 'poachers' and indigenous people (Butt 2012; Büscher & Ramutsindela 2016), wildlife-human conflicts (Weladji & Tchamba 2003; Okech 2011), and counterinsurgency and conservation practices are all common events (Verweijen & Marijnen 2016). To date, however, the literature largely neglects the possibility of violence between communities that reside within or in the peripheries of conservation areas.

Mechanisms of multilevel governance can benefit or hinder the lives of peripheral communities. Communities living peacefully in and around conservancies can have positive impacts from such arrangements such as employment opportunities, outreach programmes for education and good management of environmental conditions (Hartter & Goldman 2011; MacKenzie & Ahabyona 2012) and negative experiences (Roe 2008; Schmidt-Soltau 2009; Hartter *et al.* 2016) such as risk to livelihoods from crop and cattle raiding by wildlife and bandits, as well as land tenure security. The negative impacts from mechanisms for multilevel governance can particularly threaten the livelihoods of entire communities, particularly in less-democratic countries (Inguazo 2022). Often the creation of conservancies by central governments leads to the widespread displacement of native peoples and restricts access to their ancestral grazing and farming lands (Mkutu 2018). From one year to the next, native groups go from being locals to trespassers (Neumann 2001). To this day, governments often claim that pastoralists and their livestock threaten wildlife-based tourism by overgrazing and putting off foreign tourism by being 'unnatural' within the wilderness setting (Butt 2014). As a result, governments often employ military and military-like intimidation and violence to deter communities from grazing and farming near conservancies in the name of wildlife conservation practices (Duffy 2014; Duffy *et al.* 2019). For instance, park rangers on the north-eastern border of the Serengeti National Park (SENAPA) burned down 100 huts of local Maasai pastoralists living in the park's boundary in one day (BBC 2017; Weldemichel 2020). Moreover, farming communities residing near or inside national parks, often suffer crop damage and raiding by wildlife and livestock from herders, which can limit crop yields used for auto-consumption and as a source of income from selling surplus yield (Weladji & Tchamba 2003; MacKenzie & Ahabyona 2012). For pastoral communities, wildlife often eat livestock and some carry diseases (e.g. catarrh fever) that diminish herd numbers (Okech 2011). Moreover, the loss of grazing routes to conservancies and farmers further reduces grazing land to sustain livestock, which provides milk and meat for nutrition as well as an essential source of income for pastoral groups. And while it is accepted that in most circumstances, these communities can recover from their losses over several years, the bulk of them lack the capacity to rebuild in the short term, leaving the use of violence as a possible means to prevent further losses and to recover faster. Furthermore, a consequence of settlements from small-scale farmers and pastoral communities on the outskirts of parks is a constant level of interaction between communities, which allows for old grievances over losing access to ancestral lands and the exclusion from the natural resources that peasant communities directly rely on for their livelihoods to constantly surface between neighbours (Schmidt-Soltau 2009; Nelson 2012; Steinicke & Kabananukye 2014; Bergius *et al.* 2020).

It is therefore no surprise that the most common theoretical thread within the literature concerning communal violence in and around conservancies pertains to the indirect impacts that resource scarcity, or access to them, can have on the livelihoods of these communities. For instance, Leonhardt (2019) contends that some of Guinea's national parks, which are rich in pastures and water, attract pastoralists that often lead to conflicts with other pastoral and farmer groups over access to these resources. However, Steinicke & Kabananukye (2014) claim that conflicts over land and resources result from population pressures by different ethnic groups residing around national parks. In sum, these findings suggest that areas in and around national parks should be more prone to violent conflicts.

Empirical evidence shows that violence spots tend to be strategically chosen or avoided contingent on the spatial distribution of resources, geographic distance and terrain, and infrastructure (Le Billon 2001; Ide *et al.* 2014). Adaptation as a response is different across social sectors, which in turn, are often dependent on existing inequalities (Adger & Kelly 1999). Detges (2014) finds that pastoral violence is more likely to occur near well sites and in locations with higher rainfall, which suggests that the use of violence by pastoral groups has more to do with dowry, wealth accumulation and other opportunistic and secondary motives. However, other authors point out that conflicts over fixed water points and grazing areas are more likely to occur during drier years (Bekele 2010).

We expect a positive association between regions with conservancies and communal conflict. Incursions into conservancies by local neighbours of farmers and/or pastoralists may lead to conflict episodes between local groups who reside in and near the conservancies. However, conflicts may also arise between local and outside groups from nearby regions within the same country, or cross-border groups when conservancies are located near or share a border with another country (e.g. the Ilemi Triangle). While farmer and pastoral groups on all three sides of the border engage in cross-border trade, conflicts over sharing natural resources to cattle rustling – for young men to pay dowry, revenge attacks or cultural practices – are common occurrences, particularly along the Oromo and Sibiloi National Parks (Gebremichael *et al.* 2005; Young & Sing'oei 2011; Leonhardt 2019). Thus, we hypothesise that:

H_1 Communal violence should be more likely in regions with conservancies.

THE SPATIAL DISTRIBUTION OF RAINFALL ANOMALIES AND COMMUNAL VIOLENCE

Despite a well-established literature on climate and communal conflict in East Africa, empirical results have divided scholars into three camps. A first cohort of scholars focuses on resource *abundance* and its impact on communal violence via two causal mechanisms. The first of these proposes that the risk of communal violence increases during wetter years (Witsenburg & Adano 2009; Raleigh & Kniveton 2012; Döring 2020), unusually long wet intervals (Nordkvelle *et al.* 2017), or close to well sites and in areas with more rainfall (Detges 2014). Anecdotal evidence from fieldwork suggests that livestock raids during wetter times are the result of strategically planned behaviour tied to self-enrichment opportunism (Meier *et al.* 2007). For instance, wetter conditions can provide a favourable tactical environment for an ambush. On this matter, Witsenburg & Adano (2009) find that 'twice as many people are killed in wet years than in drought years given the high grass and dense bush cover which makes it easier to track and ambush other communities' (Witsenburg & Adano 2009: 520). Nonetheless, there is a scenario where the probability of conflict *decreases* following wetter years as resources are abundant and groups are self-sufficient, making them less likely to take part in conflict.

A second group of scholars shift the focus from abundance to 'scarcity' and find conflict to be more likely during drier years (Bekele 2010; Fjelde & Uexkull 2012). Two broad arguments within the literature deal with scarcity. The first mechanism is a 'zero-sum' scenario, which proposes that the probability of conflict *increases* during drier-than-average years, because social groups will compete for scarce resources imposed by climate change and/or population growth (Homer-Dixon 1995; Kahl 2006). Using primary and secondary data, Bekele (2010) finds that deterioration in resources is a prime motivator for violent clashes between Karrayyo-Oromo and Afar pastoralists in Ethiopia as groups become less tolerant of territorial intrusions, particularly during a drought. Similarly, using first-order administrative boundaries as their unit of analysis, Fjelde & Uexkull (2012) find that large negative rainfall deviations are associated with the likelihood of communal violence across sub-Saharan Africa. Conversely, the other argument suggests that the likelihood of conflict *decreases* during drier years. Evaluating the impact of drought-related violence, Detges (2016) finds that the risk of communal violence in sub-Saharan Africa is not impacted by extremely dry conditions. Likewise, Ayana *et al.* (2016) examine the relationship between environmental factors and pastoral conflict in East Africa and find that data on precipitation and Normalised Difference Vegetation Index (NDVI) only partially predict conflicts. The discrepancy in results may originate from the notion that pastoralists behave differently during years when rainfall is below average than they do during extreme droughts – which are rare. Others point to the role of official and unofficial norms as resolution and peace-building mechanisms that mitigate against violent conflict during harsh climatic conditions (Adano *et al.* 2012; Linke *et al.* 2017), or that in some instances water scarcity-related violence can also be mitigated by a temporary reconciliation of disputes that allows cooperation and the sharing of scarce resources (Mohammed *et al.* 2017).

A third group suggests that climate conditions have a limited predictive power when compared with socio-political and economic factors (Leff 2009; O'Loughlin *et al.* 2012; Ayana *et al.* 2016; van Weezel 2019). Yet, some of these arguments remain largely speculative within the communal violence literature. Others, such as Ember *et al.* (2014) suggest that different ethnic groups have different patterns and cultural differences that may explain why and how different groups engage in violence, independently of rainfall patterns. Given the divergent findings within the literature, we have no expectations on the effect of rainfall deviations on communal violence in the region. Therefore, we hypothesise that:

H_2 Communal violence is more likely during drier than average years.

H_3 Communal violence is more likely during wetter than average years.

THE ROLE OF CONSERVANCIES ON THE RELATIONSHIP BETWEEN RAINFALL PATTERNS AND COMMUNAL VIOLENCE

Although conservancies are non-climatic threats for the viability of fringe communities, climate change is expected to multiply the number of environmental stressors making such areas highly valued commodities during times of climate shocks. We argue that administrative regions with conservancies, whose locations are well known and coveted by groups, are more likely to experience communal violence; however, the motivations for the use of violence may be contingent on rainfall variability. In socio-ecological systems climate shocks frequently create resource asymmetries that increase tensions between the haves and have-less communities. For instance, conducting interviews with herders in Kenya's West Potok and Turkana regions in 2011, Schilling *et al.* (2012) find that 78% of Turkana raiders list hunger as their primary motivation for raiding, while 50% of Potok raiders listed dowry and accumulation of wealth as their primary motive for raiding. Interestingly, that same year seasonal rains failed to materialise in Turkana, while West Potok enjoyed above average rainfall. Therefore, we contend that the spatial convergence between conservancies and rainfall variability can spark conflicts over access to resources in times of scarcity *and* can also create strategic opportunities to satisfy secondary ambitions in times of abundance (Homer-Dixon & Blitt 1998; Collier 2000).

First, we contend that under drier conditions, violence is used based on the justified *need* to cover basic needs for groups to sustain their livelihoods. In times of drought farmers often exhaust all their grain in failed plantings for auto consumption or as currency for trading goods. For herders, the priority is to sell whatever they can salvage for little income. It has been documented that 'at the onset of drought, herders sell off livestock (usually the weakest first) to avoid incurring costs of a severe slow onset disaster that kills a high proportion of the herd' (Linke *et al.* 2017: 4). A common perception by local groups is that rainfall is more abundant in and around conservancies (|Hartter *et al.* 2015, 2016). Thus, we argue that the juxtaposition of such perceptions during drier times can lead to a 'neo-Malthusian'-like effect where groups brawl over dwindling resources. While drier conditions can also give rise to cooperation and resource-sharing arrangements between local groups, the lack of government or non-profit involvement to guarantee compliance with such agreements may leave the use of violence to be perceived as a pragmatic way to secure the group´s livelihood until rains resume. Moreover, drier conditions often motivate desperate external groups seeking alternative water sources, fodder, wood for fire or refuge to make incursions to areas in and near conservancies, despite the threat of park rangers and local groups (Hartter & Goldman 2011; Hartter *et al.* 2016). During a 2015 drought in Kenya, there were reports of pastoralists travelling over 10 kilometres to the nearest dam because it was the last water source in the area (Langat 2015). In 2016, the Tanzanian vice president ordered drought-affected herders in search of water and pasture to remove their cattle from all national parks after reports emerged of violent clashes between farmers and pastoralists (Makoye 2016).

Second, during times of rainfall abundance, areas in and around conservancies may produce a 'honey pot'-like effect that attracts groups to benefit from the resource bounty in the area (Collier 2000; Soysa 2002). During wetter periods groups are self-sufficient due to an increase in vegetative cover for livestock grazing and for crops to thrive. One the one hand, this should decrease the likelihood of conflict given that the livelihood of groups is not being threatened. On the other hand, resource abundance can free up time to pursue secondary-order objectives such as territory expansion, dowry, build wealth, increase social status and prestige or even settle old scores (Omosa 2005; Schilling *et al.* 2012).

We argue that the willingness and opportunity of groups to use violence as a means to achieve their objectives is amplified by rainfall abundance. First, rainfall abundance increases the willingness of groups to act violently to gain loot. Livestock are stronger and fatter during wetter periods. Stronger animals can travel longer distances and fatter animals sell for higher prices in meat markets. Healthier livestock means fewer financial troubles. Moreover, selling livestock at higher prices translates to more disposable income for communities to purchase firearms. For instance, in South Sudan's black market an AK-47 is available for the price of two cows and PKM-type machine guns for as little as 10

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cows (Leff 2012). Cattle rustling during times of abundance can increase the community´s herd size, cover bride prices for young males or gain favour with local county leaders for sharing the loot. Second, rainfall abundance creates opportunity. Specifically, wetter periods provide better tactical conditions on the ground. Meier *et al.* (2007) suggest that wetter periods provide thicker vegetation, which makes areas in and around conservancies ideal for an ambush, or to hide or evade pursuers after raiding. This opportunity reduces the risk of being captured or killed and increases the likelihood of success. In short, the combination of willingness and opportunity created by rainfall abundance should make communal violence more likely during wetter years. Given the above presented theoretical arguments we postulate that:

H_4 The relationship between negative rainfall patterns and communal violence is higher in regions with conservancies.

H_5 The relationship between positive rainfall patterns and communal violence is higher in regions with conservancies.

RESEARCH DESIGN

Area of study and methods

We focus our research in Kenya, Ethiopia, Sudan, South Sudan and Uganda for the following reasons. First, these countries hold the largest concentration of agro-pastoralists activity in the continent (Omosa 2005). This suggests that the livelihoods of a large number of groups are dependent on access to grazing areas and surface water, making resource-induced violence more likely. Second, erratic rainfall patterns driven mainly by north-south movement of the Intertropical Convergence Zone (ITCZ) and El Niño Southern Oscillation (ENSO), are the main constraint on vegetation and water availability in the region (Nash & Endfield 2008; Nicholson 2015). Finally, recent research suggests that the region is drying and will continue to dry (Platts *et al.* 2015). However, this last point remains contentious within the literature as recent research suggests that precipitation patterns for the region remain uncertain (Osima *et al.* 2018).

This article examines the relationship between rainfall anomalies, conservancies and communal violence from 1990–2018. We estimate an exponential means model by Logistic QMLE with robust clustered errors given the dichotomous nature of our dependent variable. While we first examine the relationship between rainfall anomalies and communal violence, we are also interested in whether the effect of rainfall variability amplifies the incidence of communal violence in administrative regions with a conservancy. As is now common in climate-conflict studies, we employ a spatially disaggregated approach that allows us to better account for within-country rainfall spatial distribution and the incidence of violence. Our unit of analysis is first-level administrative boundaries retrieved from the GADM v.3.6 database of global

TABLE I
Summary of main sample statistics

	mean	sd	min	max
Communal violence	0.05	0.23	0	1
Pos. Inter-annual rainfall anomalies	0.38	0.54	0	3.00
Neg. Inter-annual rainfall anomalies	0.38	0.60	0	3.88
Pos.SPEI-6	0.44	0.72	0	2.5
Neg. SPEI-6	0.62	0.85	0	2.5
Conservancies	0.37	0.48	0	1
log total population	13.40	1.21	8.72	17.45
log GDP per capita $_{(t-1)}$	15.93	1.49	10.61	20.86
Spatial lag civil war $_{(t-1)}$	0.31	0.46	0	1
Spatial lag communal violence $_{(t-1)}$	0.14	0.34	0	1

administrative areas. Fourteen different models were conducted to test our theoretical expectations and their robustness under different specifications.

Data

Dependent variable

For our dependent variable, we rely on data from the UCDP Georeferenced Event Dataset which is combined with the UCPD Non-State Conflict Database to offer specific information about each warring party (Sundberg *et al.* 2012; Pettersson 2021). UCDP defines a non-state actor conflict as the use of armed force between two or more formally organised groups, neither of which is the government of a state, which results in at least 25-battle related deaths in a year (Sundberg *et al.* 2012; Pettersson 2021). We only consider conflicts between informally organised groups that share a common identification along ethnic, religions, national or tribal lines (Pettersson 2021). Our coding includes farmer-herder conflicts, herder-herder conflicts and conflicts by communal militias that often carry out violence over larger tensions between ethnic groups (Döring 2020). Using spatial overlay operations using MATLAB software we assign a communal violence event to the geo-referenced location representing a first-level administrative region each year. Because we are interested in the incidence of communal violence our binary variable takes a value of 1 if there is a communal violence event within an administrative unit in a given year and 0 if not. A summary of the main sample statistics is available in Table I.

Independent variables

For rainfall variability we include different specifications of rainfall deviations from normal rainfall patterns (e.g. rainfall anomalies). Data for our variables are drawn from Climate Research Unit (CRU) Time Series (TS) version 4.04 of high-resolution 0.5° × 0.5° latitude/longitude gridded data of month-by-month variation from the University of East Anglia (Harris *et al.* 2020). To create our rainfall anomalies, for each 0.5° × 0.5° grid cell we calculate the deviations from the long-term mean (1960–1989) and divide it by the panel's standard deviation (Hendrix & Salehyan 2012). We follow the approach of Fjelde & Uexkull (2012) and intersect our rainfall deviations data with the first-level administrative units layer, and assign to each region the maximum value on the rainfall deviations measure recorded within the region that year. Assigning the maximum value rather than the mean value within each region guarantees that we avoid the influence of large – positive and negative – deviations within a region. Given the fact that deviations on both extremes have been associated with communal conflict in the literature, we divide our *Inter-Annual Rainfall Deviations* into positive and negative deviation measures. Positive deviations are measured as the absolute value for all observations with positive deviations, with all negative values set to zero. Negative deviations are measured as the absolute value for all observations with negative deviations, with all positive values set to zero (Fjelde & Uexkull 2012; Landis 2014).

Given recent concerns regarding accuracy of inter-annual rainfall measurements not accounting for rainfall coming in the wrong season, we also include another measurement of positive and negative anomalies using the Standardised Precipitation-Evapotranspiration Index (SPEI). The SPEI combines the 'the sensitivity of the PDSI to changes in evaporation demand (caused by temperature fluctuations and trends) with the multitemporal nature of the SPI' (Vicente-Serrano *et al.* 2010: 1034). The SPEI-6 monthly index shows the deviations from long-term normal rainfall patterns during the six previous months for each month and is divided into moderate, severe, and extreme dry and wet conditions. We annualise the SPEI-6 index following the PRIO-GRID dataset coding scheme, where 0 takes a value of near normal conditions in each grid cell during any given year; 1 if at least three consecutive months fall within the moderately wet category; 1.5 if there are at least two consecutive months that fall under the category of very wet; and a value of 2.5 are coded as extreme wet if both of the previous criteria are met (Tollefsen *et al.* 2012). The same coding scheme is utilised to operationalise dryness using the opposite side of the scale. We follow the coding scheme used by Fjelde & Uexkull (2012: 449) to construct our positive and negative and *Intra-Annual Rainfall Anomaly* through spatial overlay operations between the SPEI-6 and the first-level administrative regions, and assign to each region the maximum positive or negative values of the SPI-6 index recorded within the region that year.

Conditioning variable: conservancies

Conservancies is a binary variable that takes a value of 1 if there is at least one conservancy within a first-level administrative unit; 0 if otherwise. Conservancies are included in the dataset for the year of their designation and afterwards – unless the designation is withdrawn. Using spatial overlay operations with MATLAB software we assign a conservancy to the geo-referenced location representing a first-level administrative region each year. When a conservancy crosses boundaries between administrative areas, all administrative areas are assigned a value of 1. Data are from the World Database on Protected Areas (WDPA), a joint project of IUCN and UNEP version 1.6 (UNEP-WCMC 2019). WDPA designates conservancies after reviewed submissions from governments, international secretariats, NGOs, regional entities, or individual actors who manage such areas (UNEP-WCMC 2019). The database categorises Protected Areas into six different categories: strict nature reserves, wilderness area, national parks, natural monuments, habitat management area, protected landscape/seascape, and protected area with sustainable use of natural resources. We exclusively focus on national parks and habitat/species management areas because they encompass about 88% of conservancies in East Africa and are often the largest areas in km^2.

Control variables

To make the results comparable to the existing collective mobilisation literature, several commonly used controls are included in the analysis. Total population is used to account for the neo-Malthusian premise that populous areas will experience stronger degradation and scarcity of natural resources (Renner 1996; Gleditsch & Urdal 2002), particularly in the outskirts of national parks (Steinicke & Kabananukye 2014). Data on first-order administrative units for 2000, 2005, 2010 and 2015 are obtained from the Gridded Population of the World, Version 4 (CIESIN 2018). We interpolate the trend between data points and extrapolated the values from 1990–1999 and from 2016–2018.

Sabates-Wheeler *et al.* (2008) suggest that during periods of environmental hardship, economic adversity among vulnerable groups is often exacerbated. That is, abrupt short-term declines in economic performance are likely to be perceived as increased deprivation for many people (Hendrix & Haggard 2015). Given the primary emphasis placed on the temporal changes in the welfare of indigenous communities, we include GDP per capita chained at 2011 US dollars purchasing power parity for each first-order administrative unit. Data are from the Gridded global datasets for Gross Domestic Product and human Development Index over 1990–2015 (Kummu *et al.* 2018). The dataset has global extent at 5 arc-min resolution for the 26-year period. We extrapolate to obtain the data for the remaining three years in our sample.

Collier (2003) claim that the spatial and temporal occurrence of conflict can lead to repeating cycles of political violence. From a theoretical perspective the occurrence of civil war is included in the analysis to avoid the inter-dependencies that arise from the 'conflict trap', as well as the increased access to small arms and light weapons by peripheral communities in times of armed conflict (Sharamo 2014). From a methodological perspective such inter-dependence requires the inclusion of variables controlling for the proximity of conflict

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within nearby areas for possible influence on the risk of future conflict events (Raleigh *et al.* 2010; Gleditsch & Weidmann 2012). Thus, we include two controls for spatial dependence for the occurrence of armed conflict taking place within 150 km of our communal conflict events, and a second one to account for other communal conflicts taking place within 50 km of our observations. Both variables take a value of 1 for all administrative units that fall within their respective radius, 0 if otherwise. Data on armed conflicts are from the UCDP Georeferenced Event Dataset v.20.1 and the UCPD Non-State Conflict Database (Sundberg *et al.* 2012; Pettersson 2021). In the UCDP-GED dataset, armed conflicts are defined as the use of armed force between two armed groups resulting in at least 25 battle-related deaths in at least one year (Croicu & Sundberg 2016).

RESULTS

In this section we describe our empirical results from the logistic regression analysis on the influence of rainfall and conservancies on communal violence in East Africa (Table II). We first present our results for the effects between inter-annual negative rainfall anomalies and the incidence of communal violence (Model 1) and find a negative and statistically significant association with the incidence of violent communal conflict at 5%. This finding suggests that contrary to some arguments in the literature, drier conditions *decrease*, rather than increase the incidence of communal violence (Fjelde & Uexkull 2012; Ember *et al.* 2014). However, the coefficient does not reach statistical significance under our second measurement using intra-annual negative rainfall anomalies (SPEI-6) in Model 4. Therefore, we find no support for H_2.

We next estimate a possible association between positive rainfall anomalies and communal conflict. We find robust evidence under different model specifications that we tested that wetter conditions are positively and statistically significantly associated with the incidence of communal violence. Model 2 includes our inter-annual positive rainfall anomalies measurement, and the coefficient effect is statistically significant and in the expected direction. Model 3 includes both the linear and the squared term of rainfall anomalies to account for a possible curvilinear relationship between rainfall and conflict. Only our linear term is statistically significant, while our squared term is not. We therefore find no curvilinear effect between positive rainfall anomalies and the incidence of conflict as have previous studies that focus on low-intensity forms of social unrest (Hendrix & Salehyan 2012). Model 5 includes our intra-annual positive rainfall anomalies measurement (SPEI-6). The coefficient estimates show a positive and statistically significant association between wetter years and the incidence of communal violence. These results hold with the inclusion of fixed effects in Model 7 and provide further support for H_3. Having said that, to evaluate the substantive effects of our findings we calculate the marginal effects of positive rainfall anomalies on communal violence. Holding all variables to their mean values, moderately wet years are associated with a 2.8% increase

TABLE II

Logit models, rainfall anomalies and communal conflict in Eastern Africa, 1990–2018.

						Robustness checks		
	Model-1	Model-2	Model-3	Model-4	Model-5	Model-6	Model-7	Model-8
Inter-annual *neg.* rainfall anomaly	−0.483**							
	(0.188)							
Inter-annual *pos.* rainfall anomaly		0.704***	1.159***			0.822***		
		(0.179)	(0.385)			(0.222)		
Inter-annual *pos.* rainfall anomaly, sq			-0.267					
Intra-annual *neg.* rainfall anomaly, (SPEI-6)				-0.035				−0.01
				(0.113)				(0.154)
Intra-annual *pos.* rainfall anomaly, (SPEI-6)					0.234†		0.304**	
					(0.136)		(0.134)	
Conservancies	0.560**	0.522†	0.539†	0.533†	0.544†	−0.874	−1.107	−1.143
	(0.284)	(0.285)	(0.288)	(0.281)	(0.280)	(0.777)	(0.769)	(0.766)
Population $_{log}$	0.519***	0.522***	0.519***	0.513***	0.512***	−0.081	−0.065	−0.085
	(0.156)	(0.156)	(0.155)	(0.153)	(0.154)	(0.269)	(0.269)	(0.267)
GDP per capita, ppp $_{log\ (t-1)}$	−0.350***	−0.351***	−0.351***	−0.355***	−0.352***	0.051	0.062	0.057
	(0.079)	(0.077)	(0.077)	(0.078)	(0.078)	(0.144)	(0.143)	(0.142)
Spatial lag, civil war $_{(t-1)}$	0.437	0.483	0.495	0.442	0.436	0.195	0.093	0.126
	(0.356)	(0.351)	(0.351)	(0.355)	(0.357)	(0.246)	(0.244)	(0.242)
Spatial lag, communal conflict $_{(t-1)}$	1.668***	1.725***	1.716***	1.705***	1.721***	0.955***	0.965***	0.943***
	(0.293)	(0.295)	(0.295)	(0.290)	(0.292)	(0.222)	(0.220)	(0.219)
Administrative-unit fixed effects?						*Yes*	*Yes*	*Yes*
Period dummies?	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Clustered errors?	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*			
Constant	−5.316**	−5.699***	−5.693***	−5.412**	−5.531**			
	(2.218)	(2.204)	(2.203)	(2.193)	(2.217)			
Observations	2,805	2,806	2,806	2,806	2,806	1,051	1,051	1,051

*** $p < 0.01$, ** $p < 0.05$, † $p < 0.1$.

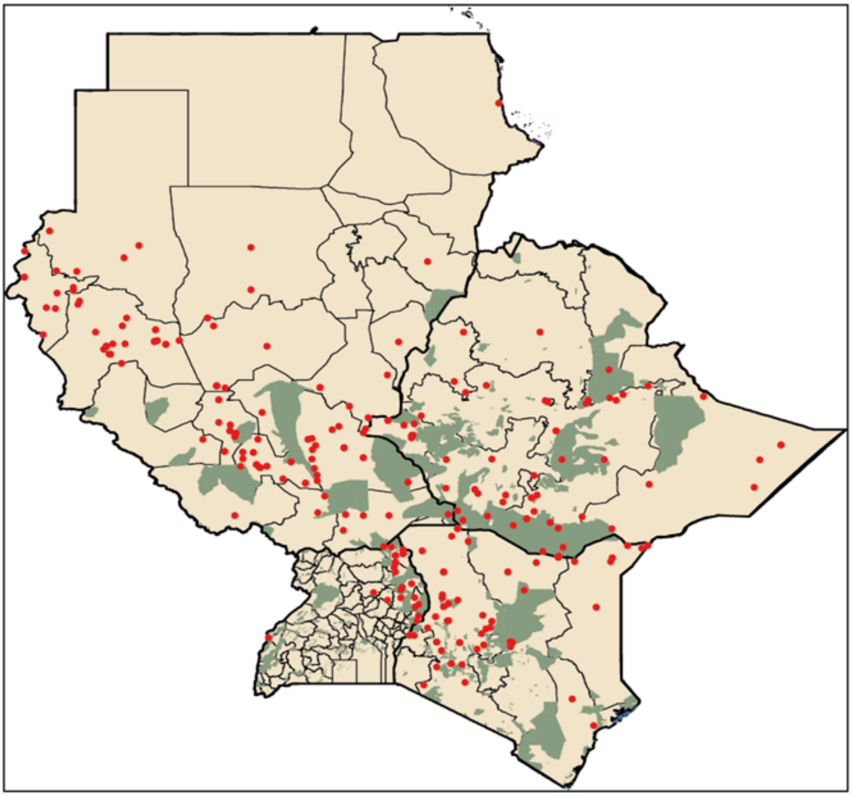

Figure 1 Spatial overlay between conservancies and communal conflict incidence in east|ern Africa, 1990–2018.

in the probability of communal conflict; very wet years increase that probability by 3.1%; and extremely wet annual conditions are associated with a 4.0% increase in the probability of communal violence.

We now present our results evaluating our third hypothesis: that communal violence should be more likely in regions with a conservancy. While the coefficient for conservancies is positive in 7 of our 14 models, the coefficients fail to reach statistical significance when administrative fixed effects are introduced in Models 6–8. While our results are in line with the prevalent arguments within qualitative literature that find evidence of administrative regions with conservancies being more likely to experience communal violence (Toutain *et al.* 2004; Butt 2012; Greiner 2012; Homewood *et al.* 2012), our results find limited support for H_1 and suggest that our findings should be taken with some scepticism. Figure 1 displays the spatial distribution of protected areas and communal conflicts in eastern Africa. The results (from Table II and Figure 1) suggest two things. First, communal violence is somewhat more

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likely in areas with a conservancy. The motivation for the use of violence can vary from disputes over one group accusing another of reserving too much pasture for dry times, to using too much water during wet seasons from a disputed water source in or near the conservancies, or revenge attacks for livestock rustling (Turner & Schlecht 2019; Schetter *et al.* 2022). Second, we find no evidence that communal violence is less likely in areas with conservancies. A possible explanation is that the militarisation of conservancies does not deter groups from using violence to satisfy their specific needs and objectives. In fact, a recent expert report claims that park rangers often help escalate violence between communities to tilt the balance of community power relations in favour of one group (Mkutu 2018; Waso Professional Forum 2019).

Table III presents the implications for our remaining two hypotheses, which hold that the effect of negative (or positive) rainfall anomalies on the likelihood of communal violence is stronger in regions with a conservancy. We introduce interaction terms to our models to assess whether communal conflict is solely the consequence of an environmental dimension (e.g. having a conservancy), or rather the interaction between the environment and pressures brought on from climate variability. Overall, we find no statistical association between negative rainfall anomalies and conservancies on communal violence (H_4 – Models 9 and 10), while on the other hand we find a robust statistically significant relationship between positive rainfall anomalies and conservancies with the likelihood of communal violence under different model specifications (H_5). However, interaction terms are a nuisance. In non-linear models the coefficient sign of the interaction term can misrepresent the 'direction' of the interaction and the statistical significance does not denote marginal effects, but rather conditional effects if the other component is equal to 0 (Ai & Norton 2003; Brambor *et al.* 2006; Berry *et al.* 2010). To account for this we recode our conservancies variable by subtracting 1 on all values (Fjelde & Uexkull 2012: 451).

Therefore, we present the *conditional marginal effects* of our interaction variable by comparing the effect of inter-annual rainfall anomalies on administrative regions with a conservancy (Model 11). A one standard deviation increase in positive precipitation anomalies in regions with a conservancy is associated with a 3.0% increase in the probability communal violence, while a two standard deviation increase in positive precipitation anomalies in regions with a conservancy is associated with an 8.2% increase in the probability of communal violence. A three standard deviation increase in positive precipitation anomalies in regions with a conservancy is associated with a 17.4% increase in the probability of communal violence. Thus, we find robust evidence that the incidence of communal violence *is* strongly conditional on abundant rainfall in regions with conservancies.

Our control variables mostly behave as expected. More populous and poor regions are more conflict prone (Homer-Dixon 1995; Collier 2003). The spatial lag for communal conflict is positive and significant, validating the notion of a spatial influence on other communal conflicts taking place within a 50 km radius, particularly recent conflicts. By contrast, we find no statistical

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TABLE III

Interaction terms: conservancies, rainfall anomalies and communal conflict.

					Robustness check	
	Model-9	Model-10	Model-11	Model-12	Model-13	Model-14
Inter-annual *neg.* rainfall anomaly	−0.536**					
	(0.270)					
Intra-annual *neg.* rainfall anomaly, (SPEI-6)		0.024				
		(0.149)				
Conservancies	0.601**	0.454	0.192	0.782**	−1.265	−0.916
	(0.292)	(0.317)	(0.335)	(0.321)	(0.805)	(0.776)
Inter-annual *neg.* rainfall anomaly* Conser.	−0.145					
	(0.416)					
Negative deviations, SPEI-06* Conser.		0.169				
		(0.249)				
Inter-annual *pos.* rainfall anomaly			0.952***		1.037***	
			(0.196)		(0.246)	
Intra-annual *pos.* rainfall anomaly, (SPEI-6)				0.029		0.026
				(0.182)		(0.183)
Inter-annual *pos.* rainfall anomaly* Conser.			0.841***		0.907**	
			(0.312)		(0.448)	
Positive deviations, SPEI-06* Conser.				−0.459†		−0.609**
				(0.256)		(0.263)
Population $_{\log}$	0.520***	0.510***	0.523***	0.514***	−0.085	−0.076
	(0.157)	(0.153)	(0.157)	(0.153)	(0.267)	(0.271)
GDP per capita, ppp $_{\log\ (t-1)}$	−0.349***	−0.352***	−0.352***	−0.350***	0.063	0.081
	(0.079)	(0.078)	(0.077)	(0.079)	(0.144)	(0.145)
Spatial lag, civil war $_{(t-1)}$	0.440	0.443	0.483	0.457	0.185	0.142
	(0.357)	(0.355)	(0.353)	(0.360)	(0.248)	(0.247)
Spatial lag, communal conflict $_{(t-1)}$	1.669***	1.694***	1.727***	1.726***	0.942***	0.966***
	(0.293)	(0.294)	(0.295)	(0.290)	(0.224)	(0.221)

TABLE III (*Cont.*)

	Model-9	Model-10	Model-11	Model-12	Robustness check	
					Model-13	Model-14
Administrative-unit fixed effects?					*Yes*	*Yes*
Period dummies?	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Clustered errors?	*Yes*	*Yes*	*Yes*	*Yes*		
Constant	−4.765**	−4.908**	−5.320**	−4.954**		
	(2.292)	(2.262)	(2.305)	(2.262)		
Observations	2,805	2,806	2,806	2,806	1,051	1,051

*** $p < 0.01$, ** $p < 0.05$, † $p < 0.1$.

association between the spatial lag of armed conflict within a 150 km radius of our communal violence observations.

In sum, our empirical results suggest three key findings. First, they lend support to a growing number of studies that focus on East Africa and find that communal conflicts are more likely during wetter rather than drier years. Second, our results show little support for qualitative studies that suggest that conservancies are hotspots for communal violence. Finally, our results indicate that communal conflicts in regions with conservancies are amplified when there is an excess in precipitation.

DISCUSSION

When it comes to rainfall there appears to be an emerging consensus that communal violence in East Africa is more likely during wetter years, rather than drier years (Witsenburg & Adano 2009; Raleigh & Kniveton 2012; Nordkvelle *et al.* 2017). In line with this growing number of studies, we find that wetter years increase the incidence of communal violent events in the region. However, other scholars using similar evidence conclude the opposite: that the incidence of communal violence is more likely during drier periods. A possible theoretical explanation for these discrepant findings is that communities have different priorities that are contingent on rainfall conditions, which in turn change their motivations and predisposition for the use of violence. An alternative explanation for the discrepant findings can be attributed to the different statistical models utilised and the different geographic areas included in a study (Salehyan 2014). For instance, the eastern African drylands host the largest concentration of agropastoral groups in the continent, which are directly dependent on rainfall for their livelihoods. Therefore, most communal conflicts in the region are farmer-herder, while other regions may experience more conflicts by communal militias over larger tensions between ethnic groups, leading to apple-to-orange comparisons when larger areas of studies are used.

In this article we also set out to explore the long-held inference by case-specific qualitative literature that administrative regions with conservancies are hotspots for communal violence. We find some, though not robust evidence, to agree with this conclusion. Our findings suggest communal conflicts occur in areas with conservancies in spite of the growing militarisation of 'green areas' (Lewis 1996; Massé & Lunstrum 2016; Duffy *et al.* 2019; Rechciński *et al.* 2019; Marijnen *et al.* 2020). A possible explanation is that most conflicts occur in the peripheries of conservancies, outside the reach of so-called 'eco-guards' who limit their enforcement activities within the conservancy's boundaries (Mkutu 2003; Gebremichael *et al.* 2005; Young & Sing'oei 2011; Leonhardt 2019).

Based on our main theoretical argument we expected rainfall anomalies (in either direction) to amplify communal violence events in regions with a conservancy. Indeed, we find strong evidence of a 'honey pot'-like effect: positive rainfall anomalies amplify violent conflicts in administrative regions with a

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conservancy. Abundant rainfall may serve as a conflict-amplifying factor that results from the combination of willingness and opportunities exploited by groups attempting to self-enrich themselves given the favourable tactical conditions on the ground and the favourable conditions for livestock. This suggests that during wetter periods the basic needs of groups are met, which in turn allows them to pursue violence as a means to satisfy secondary needs such as accumulation of wealth, territorial expansion, dowry, or engage in revenge attacks against rival communities. This is in line with the previous findings that show that conflicts tend to be more intense and deadly during wetter periods (Ember *et al.* 2012). Pastoral groups tend to move longer distances during the dry seasons (Mkutu 2018). Thus, conflicts are more likely to be between neighbouring local groups in or near conservancies who are aware of the favourable tactical conditions on the ground and that livestock are fatter, which provides opportunities to increase the purchasing power of the group. Interestingly, such conflicts take place despite the militarisation of some conservancies by national governments. Due to time and data limitations this paradox is not examined here. However, it could serve as a starting point for future research.

By contrast, we find no evidence of a 'neo-Malthusian'-like effect. In other words, drier than average conditions do not amplify the incidence of violent events in areas with a conservancy. As previously mentioned, a possible explanation is that the motivations for groups on making decisions to use violence are conditioned by rainfall patterns. During drier years groups are more likely to 'hunker-down' and their main concern is to secure income and resources needed to sustain their livelihoods and survival (Schilling *et al.* 2012; Salehyan & Hendrix 2014). Another possible explanation is that during drier years, governments and non-governmental groups tend to launch large-scale humanitarian aid programmes to aid peripheral communities in need (Hagmann & Mulugeta 2008).

It is worth noting that our stronger results come from our interaction terms. Regions with conservancies have a 3.5% probability of violent communal conflicts, while the same regions under wetter conditions substantially increase this likelihood – up to 17%. This contradicts one of our original assumptions that during drier than average years conservancies attract neighbouring outside groups in times of environmental stress. For example, along the borders of Ethiopia's Simien Mountains National Park more than 130,000 livestock could be found in 2015, some of which were from herders who had travelled from other regions to feed their stock in the park (AWF-EWCA 2015). Further research that explores whether neighbouring groups migrate to national parks in times of rainfall scarcity using recording GPS movements of herds could help to clarify this assumption (see Butt *et al.* 2009).

CONCLUSION

Are conservancies hotspots for communal violence and if so, do rainfall anomalies increase the likelihood for violence? To the best of our knowledge this is the first large-*N* study to examine these questions. We find some evidence, albeit not a strong one, to support the claim that areas with conservancies are hotspots for communal violence. However, we find strong support that rainfall abundance amplifies communal violence in administrative areas with a conservancy.

What do our findings contribute to the conservation and climate-conflict literatures? First, to the conflict-climate literature we add to the growing number of studies that find positive rainfall anomalies increase the probability of communal conflicts in East Africa. Second, our findings uphold the rich qualitative literature on the complexities of conservation practices and green violence. Finally, we show that regions with national parks areas are more susceptible to violent conflicts during wetter years. Arguably, this influences the motivations behind the use of violence by groups as rainfall abundance allows them to pursue secondary goals and dense vegetation can provide a superior tactical advantage for surprise attacks and self-enrichment opportunities. Policymakers are more prone to devote humanitarian assistance and deploy conflict mitigation strategies to areas stricken by drought. However, our findings suggest that equal attention should be devoted to conservancies in times of rainfall abundance. It would be appropriate to also focus conflict prevention programmes and development needs to reduce some of the motivations for engaging in violence. Such programmes ought to incorporate consultation with local groups to create conflict mitigation strategies without adding to the militarisation of conservation areas in the region.

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