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

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Despite a large number of qualitative studies on green militarization and green violence, little is known about whether national parks are hotspots for communal violence during climate shocks. 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. Moreover, we argue that the effect on communal violence in regions with a conservancy can be amplified by rainfall anomalies. We contend that the spatial convergence between conservancies and rainfall variability can spark conflicts over access to resources in times of scarcity and also create strategic opportunities to satisfy secondary goals in times of abundance. This study aims to empirically examine both arguments by using disaggregated data on rainfall anomalies, conservancies, and the incidence of communal violence in Eastern Africa between 1990 and 2018. Our results find little evidence that regions with national parks are more prone to communal violence. However, we find robust evidence in our analysis that positive rainfall anomalies increase the likelihood of violent communal conflicts in regions with a conservancy.

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INTRODUCTION

Communal conflicts, such as farmer-pastoral violence, is a common occurrence in and around conservancies in Africa—or so the argument goes (Bergius et al., 2020; Nelson, 2012; Schmidt-Soltau, 2009; Steinicke & Kabananukye, 2014). The establishment of protected and conservation areas for biodiversity protection (e.g., national parks & game reserves) in sub-Saharan Africa have 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 an 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 (Leff, 2009; O'Brien & Leichenko, 2000). 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, recent evidence suggest the militarization 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 threatens 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 (Kuenzer et al., 2013; Meier et al., 2007). 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, 2018, p. 56). Intercommunal violence gained notoriety after policy makers 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. Seminal research from political science, ecology and geography have advanced our understanding of how rainfall anomalies (on both directions) may increase the likelihood of communal violence (Adano et al., 2012; Detges, 2014; Ember et al., 2012; Fjelde & Uexkull, 2012; Le Billon, 2001; Witsenburg & Adano, 2009). 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 dryer 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 test whether regions with conservancies are more prone to communal violence. Second, to analyze 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 organized 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 they are in direct control or mediate 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 nonexistent (Cederman et al., 2010; Mkutu, 2003). However, the use of violence against other communities to secure livelihood essentials is a more likely scenario that immediately fulfills basic needs left by environmental hardships (Hagmann & Mulugeta, 2008).

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

CONSERVANCIES AND CONFLICT DYNAMICS

East Africa is rich in biological diversity. During the mid-twentieth century many newly independent countries began to develop conservation programs and to designate special protection status to some areas for exclusive wildlife, marine and biodiversity conservation (Elfversson, 2015; Riggio et al., 2019). Most national parks in the region are in savannah regions with moderate population density, with a few exceptions in mild and higher altitude forests in Uganda with densely populated large scale agriculture areas (Burgess et al., 2007). While protected areas are important for biodiversity conservation, they are also significant source of revenue for some governments. For instance, in 2015 wildlife tourism in conservation areas accounted for 10 percent of Kenya's GDP (The World Bank, 2017). In fact, some conservation efforts have been criticized as land grabbing schemes by political elites as well as foreign diplomats and aid actors (Benjaminsen & Bryceson, 2012; Regassa et al., 2019).

A well-established literature on "green violence" and "green militarization" –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; Marijnen et al., 2021; Titeca et al., 2020; Woods & Naimark, 2020). For instance, park ranger violence on "poachers" and indigenous people (Büscher & Ramutsindela, 2016; Butt, 2012), wildlife-human conflicts (Okech, 2011; Weladji & Tchamba, 2003), 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.

Communities living in coexistence in and around conservancies can have positive and negative experiences (Roe, 2008; Schmidt-Soltau, 2009). Recent research using survey data of populations residing on the outskirts of parks shows that among positive outcomes people list employment opportunities, outreach programs for education and good management of environmental conditions (Hartter & Goldman, 2011; Mackenzie & Ahabyona, 2012), while some negative outcomes involve risk to livelihoods from crop and cattle raiding by wildlife and bandits, as well as land tenure security (Hartter et al., 2016).

The negative impacts can particularly threaten the livelihoods of entire communities. For farming communities residing near or inside national parks, crop damage and raiding by wildlife and livestock from herders can damage crop yields used for auto-consumption and as a source of income from selling surplus (Mackenzie & Ahabyona, 2012; Weladji & Tchamba, 2003). 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 in turn provide 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 mean to prevent further loses to recover faster. Moreover, a consequence of settlements from small-scale farmers and pastoral communities on the outskirts of parks leads to a constant level of interaction between communities, which allow 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 neighbors (Bergius et al., 2020; Nelson, 2012; Schmidt-Soltau, 2009; Steinicke & Kabananukye, 2014).

It is therefore no surprise that the most common theoretical tread 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 around some of Guineas 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 than 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 probe to violent conflicts.

Empirical evidence shows that violence spots tend to be strategically chosen or avoided contingent on the spatial distribution of resources, geographical distance and terrain, infrastructure (Ide et al., 2014; Le Billon, 2001). Adaptation as a response is different across social sectors, which in turn, are often dependent on existing inequalities (Adger & Kelly, 1999). Detges (2014) finds in his analysis that pastoral violence is more likely to occur near well sites and in locations with higher rainfall, which suggest that of the use 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 dryer years (Bekele, 2010).

The spatial distribution of rainfall anomalies and communal violence

Since record keeping began, 19 of the 20 warmest years in the planet have occurred since 2000, with the year 2016 tied with 2020 being the warmest since record keeping began (NASA-NOAA, 2021). Climate researchers conclude with high confidence that temperatures will continue to increase during the following decades, largely due to anthropogenic activities. The IPCC envisages that climate change will affect different social and environmental systems as temperature and sea levels continue to rise and erratic rainfall reduces water availability in some parts of the world

(IPCC 2007, 2014, 2019, 2021). Even if warming is limited to 2°C, the goal set by the 2015 Paris Agreement, far-reaching socio-economic and political risks remain over the next few decades due to the carbon already released to the atmosphere (Mauritsen & Pincus, 2017).

Despite a well-established literature on climate and communal conflict in East Africa, empirical results remain divided in 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). Anegdotal evidence from field work suggests that livestock raids during wetter times are are the result of strategically planned behavior tied to self-enrichment opportunism (Meier et al., 2007). For instance, wetter conditions can provide a favorable tactical environment for an ambush. On this matter, Witsenburg and 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 dryer-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 and 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 dryer 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 Normalized Difference Vegetation Index (NDVI) only partially predict conflicts. The discrepancy in results may originate from the notion that pastoralist 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 although 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 to socio-political and economic factors (Ayana et al., 2016; Leff, 2009; O'Loughlin et al., 2012; 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.

To sum, the discussion above suggests two things. First, while a rich number of case studies suggests that conservancies increase the likelihood of violent conflicts, others suggest that the militarization of these conservancies serves as a deterrent for violence (Hartter et al., 2016; Hartter & Goldman, 2011; Weldemichel, 2020). However, neither argument has been examined using a large- *N* study. Second, it suggests two competing findings exist regarding the directionality between positive/negative precipitation anomalies and communal violence, leading to inconclusive results (Salehyan, 2014). The first argument is that negative rainfall anomalies can reduce the availability of grazing land and surface water, which may incentivize for violent attacks between communities to secure access to scare resources (Fjelde & Uexkull 2012; Ember et al., 2014). The second argument is that positive rainfall anomalies increase the likelihood of violence between groups aiming to maximize and guarantee the utilization of abundant resources (Meier et al., 2007; Witsenburg & Adano, 2009).

TEORETICAL FRAMEWORK

We have no expectation for the impacts of regions with conservancies on communal conflict, independently of rainfall patterns. On the one hand, we expect that incursions into conservancies by local neighbors of farmers and/or pastoralists may lead to conflict episodes between local groups of 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 located near or share a border with another country. For instance, the Ilemi Triangle—a disputed zone between Sudan and Kenya—shares a border between Kenya, Sudan and Ethiopia. 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 occurrence, particularly along the Oromo and Sibiloi National Parks (Gebremichael et al., 2005; Leonhardt, 2019; Young & Sing'oei, 2011).

On the other hand, the creation of conservancies led to the widespread displacement of native peoples and restrict access to their ancestral grazing and farming lands (Mkutu, 2020). From one year to the next native groups went 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 off-putting foreign tourism by being "unnatural" within the wilderness setting (Butt, 2014). As a result, governments often employ military and military-like intimidation and violence techniques 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 pastoralist living in the park´s boundary in one day (BBC, 2017; Weldemichel, 2020). In other instances, park rangers have been accused of using "excessive force, torture, and even extra judicial killings of suspects" by labeling locals as poachers (Duffy et al., 2019, p. 68). We argue that this militarization of conservancies may deter local groups from farming or grazing in and near conservancies, decreasing the interaction and disputes between groups, and therefore, the likelihood of communal violence. Thus, we hypothesize that:

H_1 Communal violence should be more likely in regions with conservancies

H_2 Communal violence should be less likely in regions with conservancies

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 high valued commodities during times of climate shocks. We argue that administrative regions with conservancies, whose location 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 of 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 materialize 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* also create strategic opportunities to satisfy secondary ambitions in times of abundance (Homer-Dixon & Blitt, 1998; Collier, 2000). In other words, a *río revuelto ganancia de pescadores*, meaning that while the motivation for the use of violence differs, some groups will seek to take advantage of the circumstances created by such convergence.

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, p. 4). A common perception by local groups, is that rainfall is more abundant in and around conservancies (Hartter et al., 2016, 2015). Thus, we argue the 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 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, violence may be the only perceived way to secure the group´s livelihood until the 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 et al., 2016; Hartter & Goldman, 2011). During a 2015 drought in Kenya, there were reports of pastoralists traveling over 10 kilometers 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). This leads to our third hypothesis:

H_3 The effect of negative rainfall anomalies on the likelihood of communal violence is stronger in regions with a conservancy.

Second, that during times of rainfall abundance areas in and around conservancies may create are produce a “honey pot”-like effect that attracts groups to benefit from the resource bounty (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).

in and around conservancies are often for small party raiders to target farms, *kraals*

We argue that the willingness and opportunity of groups to use violence as means to achieve their objectives is amplified by rainfall abundance. First, 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 idyllic for an ambush, hide or evade pursuers after raiding. This opportunity reduces the risk of being captured or killed and increases the likelihood of success. Second, rainfall abundance increases the willingness of groups to act violently to gain a big 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. For instance, during the current (Nov. 2021) drought facing Kenya, “the price of one cow has dropped from about 40,000 Kenyan shillings ($357) to 5,000 KSH ($45)” (Pietromarchi, 2021). Healthier livestock means fewer financial troubles. In short, the combination of willingness and opportunity created by rainfall abundance should make communal violence more likely during wetter years:

H_4 The effect of positive rainfall anomalies on the likelihood of communal violence is stronger in regions with a conservancy

RESEARCH DESIGN

Area of Study

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 is 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 suggest that precipitation patters for the region remains uncertain (Osima et al., 2018).

Methods

This article examines the relationship between rainfall anomalies, conservancies and communal violence from 1990 to 2018. We estimate an exponential mean model by Logistic QMLE with robust clustered errors, given the dichotomous nature of our independent variable. While we first examine the relationship between rainfall anomalies and communal violence, we are also interested on 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 spatial disaggregated approach that allows is to better account for within-country rainfall spatial distribution and the incidence of violence. Out unit of analysis are first-level administrative boundaries retrieved from GADM v.3.6 database of global 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 et al., 20021). UCDP defines a non-state actor conflict as "the use of armed force between two or more formally organized 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 organized 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 on a given year and 0 if otherwise. A summary of main sample statistics is available in Table 1.

-insert Table 1 about here-main 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° x 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° x 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 and Uexkull (2012) and intersect our rainfall deviations data over 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 disregard 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 create 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 than recent concerns have been raised 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 from the Standardized 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, p. 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 annualize 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 utilized to operationalize dryness using the opposite side of the scale. We follow the coding scheme used by Fjelde & Uexkull (2012, p. 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.

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 the year of their designation and afterwards—unless the designation is withdrawn. Using spatial overlay operations using 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 two or more administrative areas, all administrative areas are assigned a value of 1. Data on is from the World Database on Protected Areas (WDPA), a joint project of IUCN and UNEP version 1.6 (UNEP-WCMC, 2019). WMDPA designates conservancies after reviewed submissions from governments, international secretariats, NGOs, regional entities, or individual actors who manage such areas (UNEP-WCMC, 2019). The database categorizes 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 squared kilometers.

Control variables

The inclusion of control variables remains controversial among climate-conflict researchers. One side advocate that when included, control variables may be influenced by climatic factors, which in turn can lead to biased results (Buhaug et al., 2014; Hsiang et al., 2013; Hsiang & Meng, 2014). They argue that researchers should instead use panel fixed effects and/or time trends to identify the causal impact of contemporaneous climatic variations. The other side argues that the inclusion of variables previously identified in the literature is necessary to balance the causal weight of climatic factors (Buhaug, 2010; Salehyan & Hendrix, 2014). To make the results comparable to the existing collective mobilization 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 in (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 is obtained from the Gridded Population of the Word, Version 4 (CIESIN 2018). We interpolate the trend between data points and extrapolated the values from 1990 to 1999 and from 2016 to 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 is 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 et al. (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 requites the inclusion of variables controlling for the proximity of conflict within nearby areas for possible influence on the risk of future conflict events (Gleditsch & Weidmann, 2012; Raleigh et al., 2010). Thus, we include two controls for spatial dependence for the occurrence of armed conflict taking place within 150km of our communal conflict events, and a second one to account for other communal conflicts taking place within 50km 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; Therese et al., 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 2). 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 statically significant association to the incidence of violent communal conflict ($p < 0.05$). This finding suggests that opposite to some arguments in the literature, drier conditions *decrease,* rather than increase the incidence of communal violence (Ember et al., 2014b; Fjelde & Uexkull, 2012). However, the coefficient does not reach statistical significance under our second measurement using intra-annual negative rainfall anomalies (SPEI-6) in Model 4.

We next estimate a possible association between positive rainfall anomalies and communal conflict. We find robust evidence under different model specifications that wetter conditions are positive and statistically significant associated to the incidence of communal violence. Model 2 includes our inter-annual positive rainfall anomalies measurement, and the coefficient effect is statistically significant ($p < 0.01$) 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 ($p <0.01$), 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 (p <0.1) association between wetter years and the incidence of communal violence. These results hold with the inclusion of fixed effects in Model 7. 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 vales, moderately wet years are associated with a 2.8% increase 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.

-insert Table 2 about here—

We know present our results evaluating our first two hypotheses: that communal violence should be more (or less) 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 to 8. While our results are in line with the prevalent arguments within qualitative literature that find evidence of administrative regions with a conservancies being more likely to experience communal violence (Butt, 2012; Greiner, 2012; Homewood et al., 2012; Toutain et al., 2004), our results should be interpreted with some skepticism. We find limited support for our first hypothesis and no support for our second one. Figure 1 displays the spatial distribution of protected areas and communal conflicts in Eastern Africa. The results (from Table 2 and the in Figure 1) suggest two things. First, communal violence is somewhat more likely in areas with a conservancy. The motivation for the use of violence can vary from disputes of over one group accusing another of reserving too much pasture for dry times, using too much water during wet seasons from a disputed water source in or near the conservancies, or revenge attacks from cuttle restring for a myriad of reasons (Schetter et al., 2022; Turner & Schlecht, 2019). Second, we find no evidence that communal violence is less likely in areas with conservancies. This suggest that the militarization of conservancies does not deter groups from using violence to satisfy their specific needs and objectives. In fact, a recent report of experts claims that park rangers often help escalate violence between communities to tilt the balance of community power-relations in favor of one group (Waso Professional Forum, 2019; Mkutu, 2020).

-insert Figure 1 about here—

Table 3 present 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 (Models 9 & 10), while on the other hand we find a robust statistically significant relationship (*p.* <0.01) between positive rainfall anomalies and conservancies with the likelihood of communal violence under different model specifications. 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 zero (Ai & Norton, 2003; Berry et al., 2010; Brambor et al., 2006). To account for this we recode our conservancies variable by subtracting 1 on all values (Fjelde & Uexkull, 2012, p. 451).

-insert Table 3 about here—

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 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 communal violence. Thus, we find robust evidence that the incidence of communal *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 et al., 2003). The spatial lag for communal conflict is positive and significant (1% level), validating the notion of a spatial influence on other communal conflicts taking place within a 50km radius, particularly recent conflicts. By contrast, we find no statistical association between the spatial lag of armed conflict within 150km radius of our communal violence observations.

In sum, our empirical results lend suggest three key findings. First, they lend support to a growing number of studies who focus on Eastern Africa, which find that communal conflicts are more likely during wetter 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 dryer years (Nordkvelle et al., 2017; Raleigh & Kniveton, 2012; Witsenburg & Adano, 2009). 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 lines of 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 methodological explanation for the discrepant findings was recently proposed by (Salehyan, 2014), who argued that results can be biased when different geographical areas are included in a study. 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 ought to explore the long-held inference by case-specific qualitative literature that administrative regions with conservancies are hotspots for communal violence. We find some, albeit not robust evidence, to agree with this conclusion. Our findings suggest communal conflicts occur in areas with conservancies despite the growing militarization of “green areas” (Duffy et al., 2019; Lewis, 1996; Marijnen et al., 2021; Massé & Lunstrum, 2016; Rechciński et al., 2019). A possible explanation is that most conflicts occur in the peripheries of conservancies, outside the reach of so called “ecoguards” who limit their enforcement activities within the conservancy’s boundaries, and the motivation for violent conflicts in and around parks can have different motivations: from disputes over natural resources or cultural practices (Gebremichael et al., 2005; Leonhardt, 2019; Mkutu, 2003; Young & Sing’oei, 2011).

Based on our main theoretical argument we expected that violent conflicts around conservancies should be amplified by climate shocks. Indeed, we find strong evidence of a “honey pot”-like effect: positive rainfall anomalies amplify violent conflicts in administrative regions with a conservancy. Therefore, 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 favorable tactical conditions on the ground and the favorable conditions for livestock. This suggest that during wetter periods the basic needs of groups are met, which in turn, allow them to peruse violence as 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, 2020). Thus, conflicts are more likely to be between neighboring local groups in or near conservancies who are aware of the favorable tactical conditions on the ground and of that livestock are fatter, which in turn, provides increases the purchasing power of the group. Interestingly, such conflicts take place despite the militarization of conservancies. 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 conditions do not amplify the incidence of violent events in areas with a conservancy. As we just discussed, a possible explanation is that the motivations for groups on making decisions to use violence is conditioned by rainfall patterns. During dryer 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 (Salehyan & Hendrix, 2014; Schilling et al., 2012). Another possible explanation is than during dryer years, governments and non-governmental groups tend to launch large-scale humanitarian aid programs 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 an 3.5% probability of violent communal conflicts, while the same regions under wetter conditions substantially increase this likelihood—up to 17%. This is against one of our original assumptions that during drier than average years conservancies attract neighboring 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 traveled from other regions to feed their stock in the park (AWF-EWCA, 2015). Further research that explores whether neighboring groups migrate to national parks in times of rainfall scarcity using recording GPS movements of herds could help clarify this assumption (see Butt et al., 2009).

CONCLUDING REMARKS

Considering the discussion above, we now turn to our original research questions: are national parks hotspots for communal violence? Are regions with national parks more prone to incidence of communal violence during periods of rainfall shocks—or is violent conflict mitigated under such conditions? 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 national parks are hotspots for communal violence. However, we find strong support that rainfall abundance amplifies communal violence in administrative areas with a national park.

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 more sensible 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.

To sum, we find strong evidence that during wetter than average years the likelihood of communal conflict increases in first-level administrative areas with a conservancy. 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 programs and development needs to reduce the some of the motivations for engaging in violence. Such programs ought to incorporate consultation with local groups to create conflict mitigation strategies without solely adding to the militarization of conservations areas in the region.

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