Climate Change, Conservation, and Conflict: Evidence from Nigeria *

Donald Grasse† Melissa Pavlik‡

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Abstract

Climate change is driving desertification, prompting conservation efforts aiming to protect grasslands by restricting cattle grazing. However, these restrictions occur against the backdrop of simmering tensions between farmers and herders, who compete over land use. Do bans on open grazing impact violent conflict, or mitigate the climate-conflict nexus? We exploit the staggered roll-out of anti-open grazing laws across Nigerian states, which heavily restrict traditional herder practices but strengthen the land claims of farmers. Using a difference-in-differences design, we show anti-grazing laws significantly increased political violence surrounding grazing and land, and exacerbate the effect of climate change on conflict. We find no evidence of purported economic benefits of the laws, which would ostensibly be necessary for a conflict-reducing effect, but some evidence that these laws increase feelings of inequity and decrease trust in government to solve violent conflict. Together, our results suggest conservation laws may have unintended consequences for political violence.

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†Independent Scholar, dgrassephd@gmail.com

‡Yale University, Political Science melissa.pavlik@yale.edu

1 Introduction

Over the past half-century, climate change has turned more than five million square kilometers of arable land into desert. This land degradation has directly impacted more than 213 million people, most of whom live in the Global South (Burrell, Evans and De Kauwe, 2020). Desertification has outsized consequences for how populations interact with the land, and with each other.

Rapid land degradation is occurring against the backdrop of intensifying violence between farmers – sedentary cultivators of the land – and herders – nomadic populations in search of land on which to graze their cattle.[1] As the amount of arable land decreases, so too does the ability of farmers and herders to reconcile their conflicting land use practices, potentially catalyzing conflict. Farmer-herder conflicts have dramatically escalated in recent years, particularly in sub-Saharan Africa, where their death tolls have often far exceeded those of ongoing civil conflicts and insurgencies.[2]

Climate change-spurred desertification and its resulting insecurity pose a complex problem for policymakers, especially in the Global South, who face pressure to respond to the economic and human costs increasingly borne by their populations. In places as diverse as China, Tanzania, Kenya, and Mongolia, lawmakers have responded by restricting a particular land-use practice: free-range cattle grazing. Instead of allowing pastoralists to graze cattle openly, anti-open grazing laws restrict herders to using privately owned or rented lands. These policies are intended not only to slow desertification by preventing over-grazing, but

[1] In what follows, the terms 'herders' and 'pastoralists' and the terms 'farmers' and 'agriculturalists' are used interchangeably.

[2] Experts estimate farmer-herder conflict in Nigeria was "six times" deadlier than Boko Haram. International Crisis Group. "Stopping Nigeriaâs Spiralling Farmer-Herder Violence." 07-26-2018. Accessed 04-01-2023. https://www.crisisgroup.org/africa/west-africa/nigeria/262-stopping-nigerias-spiralling-farmer-herder-violence

to clearly delineate between land available to farmers and to herders and thus avoid conflicts over land. However, a consequence of these policies is that nomadic herders are severely restricted in where they can practice their way of life. Since many pastoralist communities share ethnic or religious identities distinct from agriculturalists, these prohibitions may inflame long-standing tensions between social groups – tensions already exacerbated by climate change.

How do conservation policies such as anti-open grazing laws (AGL) impact violent conflict? And how do these policies affect the relationship between climate change and conflict?

Theoretically, the impact of grazing bans on communal violence is ambiguous. To the extent that desertification spurs violence over scarce resources with multiple claims on use, bans on open grazing can clarify ownership by providing assurance of state involvement if property rights are violated. Such an intervention could reduce conflict by making land less contestable (Bates, Greif and Singh, 2002; Hirshleifer, 1995; Fetzer and Marden, 2017). However, such policies could also fuel communal violence. Conservation policies such as AGL bias property rights protection in favor of sedentary land users, and disadvantage those who rely on seasonal and nomadic use of land resources. This creates strong incentives for disadvantaged populations to raid or engage in violent collective action (Butler and Gates, 2012; Van Leeuwen and Van Der Haar, 2016), and may fuel a sense of discrimination which leads to conflict between groups. While researchers continue to elaborate the possible relationship between climate change and conflict (Burke, Hsiang and Miguel, 2015), it remains unclear how policies oriented towards conservation and environmental protection *themselves* might exacerbate or otherwise alter this relationship.

To address these questions, we focus on the West African country of Nigeria, the sixth most populous country in the world and one where farmer-herder conflict has been expanding in scope and scale in recent years. We study the staggered implementation of AGL across Nigerian states over the last decade to unpack how land use policies shape social conflict over resources in the face of climate change. Nigeria has historically had had a rural-based economy where farmers and headers largely existed in symbiosis: herders would openly graze in cropland during the planting season, providing free fertilization, and migrate to other shrubland during the harvest season. However, Nigeria is one example of a country where climate change has created land scarcity through desertification, limiting available grazing options for headers. As such, conflict over access to land has escalated substantially in the last decade, prompting thousands of violent deaths and widespread public alarm. Over the last five years, clashes between pastoralist herders and settled farmers have resulted in 50% more civilian deaths annually than the more well-known Boko Haram insurgency in the country's Northwest. Individual Nigerian states began passing laws that prohibited open grazing in 2016, and continued to do so into 2021. AGL place a high cost on herders who do not quickly change traditional herding practices in favor of strict adherence to farmers' formal property rights.

Using a difference-in-differences design, we find evidence that anti-open grazing laws increase violent conflicts over grazing and land use. Conflicts increase by nearly 1 additional fatality per 100,000 residents for each category, which represents nearly a .5 standard deviation increase in conflict intensity. We also estimate the degree to which AGL mitigate the relationship between climate change and violent conflict by interacting passage of the ban with a measure of adverse rainfall conditions (McGuirk and Nunn, 2020). We find that AGL passage *exacerbates* the effect of adverse rainfall conditions on farmer-herder conflict in Nigeria, and that the presence of AGL increases violent conflict between farmers and herders even more than a drought alone. Our findings suggest that policies designed to combat climate change and break the climate-conflict nexus, may in fact have the opposite effect.

Our study contributes to three sets of literature. First, we show how the connection between climate change and conflict is shaped by political institutions. A large literature has linked weather shocks to violent conflict (Burke, Hsiang and Miguel, 2015). Climate variability can disrupt access to income, especially in agricultural economies, which can reduce the opportunity cost of conflict (Bai and Kung, 2011; Harari and Ferrara, 2018; Hendrix and Salehyan, 2012; Miguel, Satyanath and Sergenti, 2004). Instead of focusing on weather, our study links conflict to climate change by looking at the *policy response* to climate change – namely, conservation laws. We respond to the call of Koubi (2019), who argues "scholars should continue to investigate how climatic changes interact with and/or are conditioned by socioeconomic, political, and demographic settings to cause conflict." By focusing on the consequences of policies made in response to climate change, rather than variability in temperature or precipitation, we center politics and the policy-making process.

Second, we show how policy responses to scarcity impact resource conflict, beyond a resource's intrinsic value. Conflict over scarce resources is shaped by two factors: (1) contestability, or the conflict actor's ability to potentially capture the resource if they decide to fight for it; and (2) the value of the resource (Fetzer and Marden, 2017). Research on resource conflict largely studies how commodity shocks to resource value impact conflict outcomes (Blair, Christensen and Rudkin, 2021; Dube and Vargas, 2013). By studying how changes in resource value shape conflict incentives, the commodity shocks literature illustrates how shifts in the “size of the prize” influence conflict intensity. While critically important, the focus on resource value is only half the equation. We emphasize how institutional responses to scarce resources can impact violent conflict – namely, how changes that reduce the *contestability* of the prize influence incentives for violence (Couttenier, Grosjean and Sangnier, 2017; Fetzer and Marden, 2017).

Finally, our study highlights the challenges of state-building by showing how strengthening private property rights may backfire. State failure can occur if there is no production, or if there is a surplus of production with no protection (Dal Bó, Hernández-Lagos and Mazzuca, 2022). Conventional wisdom suggests that when property rights are protected – that is, made legible (Scott, 2020) and enforceable with a monopoly on violence (Weber, 1978) – states build strength and achieve better economic outcomes. However, as we see in the case of AGL in Nigeria, land rights for farmers (at the expense of nomadic herders) can prompt increased destruction and extrajudicial violence. Our study speaks to the tightrope states must walk to develop: strengthening land claims under the wrong conditions may in fact exacerbate state fragility by increasing political violence between non-state actors.

2 Theoretical Framework

2.1 Farmer-Herder Conflict and Conservation

Farmer-herder conflicts are characterized by violent competition for finite land between pastoralists (herders) and agriculturalists (farmers). Pastoralists - who constitute 268 million persons across the continent of Africa alone - herd animals such as cows, goats, or camels, and rely on open land for grazing their livestock. Pastoralists cut across private lands for the purpose of grazing, to move animals seasonally for feeding. Meanwhile, agriculturalists are sedentary farmers, who enclose areas of land for crop production.

Violent conflict between pastoralists and farmers due to conflicting demands for land use are as old as agriculture itself – from the story of Cain and Abel, to Mongolian herders led by Genghis Khan, to the contemporary Sahel; groups that rely on free ranging cattle have found themselves locked into competition with farmers, who require the land for different purposes. Conflicts between farmers and pastoralists are also a global phenomenon, encompassing contestation between Bedouin herders and Jewish farmers in Israel, nomadic tribes and agriculturalists in India, and farmers and herders across Sub-Saharan Africa (Penu and Paalo, 2021).

However, farmers' and herders' conflicting needs do not always cause violence: in many places, "alliance farming" models of land use facilitate sharing between these two groups. In Northwest Cameroon, during growing seasons, herders would allow their cattle to graze around farm land, but would not do so during harvest seasons. By allowing grazing during the planting season, herders could feed their livestock while farmers received free fertilizer. During harvest, herders would lead their cattle elsewhere so as to not disrupt crops.[3] Co-operative relations between Mbororo and Gbaya groups – herders and farmers respectively – are maintained through reciprocal gift giving, which builds trust and friendship (Burnham et al., 1980; Bukari, Sow and Scheffran, 2018). In general, informal institutions – such as alternative dispute resolution (Blattman, Hartman and Blair, 2014; Hartman, Blair and Blattman, 2021), norms of reciprocity (Jha, 2013), or reliance on local mediators (Tajima, 2014) – can support communal peace and prevent disagreements from escalating to collective

[3]Thin Lei Win, 9-22-2018. Reuters. "Africa's nomadic herders help, not harm, land and planet - U.N." Accessed 4-1-2023.https://reut.rs/2zort7z

violence. Such institutions sometimes have higher levels of social legitimacy than formal institutions (Lombard, 2016). The informal arrangements encompassing alliance farming have promoted social peace across areas of sub-Saharan Africa (McGuirk and Nunn, 2020).

2.2 Climate Change Disrupts Cooperative Norms

However, informal institutions are vulnerable to large external shocks to the system - for instance, a rapidly changing climate. Climate change shocks informal institutions by uprooting long-standing patterns of human behavior, which can lead cooperative behavior to become defection. Nomadic conflicts are inflamed by environmental stressors that place pressure on land use, which may break the informal arrangements that have made cooperation possible. Historically, droughts drove Sino-Nomad conflicts in Ancient China (Bai and Kung, 2011). Today, adverse temperature (Eberle, Rohner and Thoenig, 2020) and precipitation (McGuirk and Nunn, 2020) shocks fuel farmer-herder conflict in the Sahel and elsewhere across sub-Saharan Africa. In particular, land degradation has prompted displacement across the continent (Reuveny, 2007), including forcing shifts in the migration and grazing patterns of nomadic herders. When land that could be used for grazing begins to dry up, pastoralists are forced to graze closer to or even on agricultural lands. As a consequence, crops may be trampled or destroyed by animals, harming farmers' income. Meanwhile, land scarcity can cause farmers to grow crops along livestock migratory corridors and on traditional pasturelands (Bukari and Kuusaana, 2018; Setrana and Kyei, 2021). Climate shocks and their resulting displacement can therefore alter the nature and concentration of existing social institutions, and provoke increased insecurity. (Moser and McIlwaine, 2005).

These pastoralist conflicts are often characterized by one-sided violence against civilians by militia groups. Pastoralism and farming practices across the Sahel are often tied to broader group identities, including ethnicity and religion. In Nigeria, for instance, the Hausa-Fulani[4] are a largely Muslim ethnic group based in the North, many of whom practice pastoralism; while farmers in Southern Nigeria are largely Igbo, Yoruba, or one of many other ethnic and tribal identities; and largely Christian. As such, small conflicts between a few community members can quickly spiral into larger communal conflicts (Fearon and Laitin, 1996). For instance, a farmer may kill the cattle of a pastoralist who was accused of grazing near farmland and destroying crops. Groups of pastoralists in turn may then seek revenge against the farmer, begetting a cycle of reprisals.

2.3 Impacts of Grazing Exclusion on Conflict: Incontestability vs. Inequity

Due to degrading land and the threat of conflict, many African countries have restricted the rights of pastoralists to graze in open areas. Lane (2014) remarked: "[l]egislative instruments have been used by most independent African states to legitimise alienation of pastoral land" (Lane, 2014). Colonial authorities structured much of contemporary African land laws, and invested in creating strong legal protections for farmers rather than pastoralists, as the former was the backbone of the extractive colonial economy (Markakis, 2004). As such, legal rights of pastoralists to roam are on the margins throughout the continent. Pastoralists largely rely on customary access rights, which privatized land law seldom recognizes or accommodates.

[4] Hausa-Fulani refers to an ethnic designation which includes two related but distinct ethnic groups, the Hausa and Fulani. The conjunction is generally used to refer specifically to the population of either of these ethnic groups in Northern Nigeria.

Incontestability

Prior literature suggests two processes by which conservation laws could shape conflict between herders and farmers. A framework emphasizing *incontestability* would suggest that AGL reduce contestation over resources, as the rights of these resources have been clearly assigned. In this view, then, AGL should reduce conflict.[5] A framework emphasizing AGL's protection of property rights and production of *incontestability* would suggest that by banning open grazing, AGL create a clear brightline over land use, clarifying what land can be used for what purpose (Hirshleifer, 1995; Grossman and Kim, 1995; Skaperdas, 1992). A herder in an AGL state clearly knows that they are not permitted to use open land to graze their cattle, and instead need a ranch to keep their animals. By making land less contestable, herders will place less effort into contesting land claims through violence, since such laws clarify that the state is willing to intervene on behalf of farmers. Fetzer and Marden (2017) finds some evidence for this model in the context of the Amazon in Brazil, where land violence decreased after areas became protected forests.

Inequity

An alternative framework emphasizes that AGL produce not incontestibility, but *inequity*, meaning that these laws prioritize the protection of the rights of certain groups over others. By signalling to excluded groups that the state is unwilling to protect their claims, AGL would prompt these groups to rely on self-help and coercion to defend their claims, increasing violence. In this view, herders would not immediately shift to ranching simply because AGL formalize land designations incompatible with their traditional way of life. Instead, since

[5]This perspective is analogous to a Coasian logic, in which widespread and well-defined property rights incentivize cooperation and result in a mutually beneficial bargain.

grazing bans make clear that the state will not support herders, herders will opt to provide security for *themselves*, including by making their militias more organized and equipped for combat. Forsaken by the state, the incentive exists for herders to increase their ability to defend their interests communally. Armed communal militias of herders can protect herders' land use practices by inflicting costs on farmers or the state if they attempt to enforce grazing bans. Butler and Gates (2012) model herder-farmer conflicts and argue that laws biasing farmers may increase conflict in equilibrium for this very reason, which is consistent with literature which argues land use policies can replicate existing structural inequalities (Moser and McIlwaine, 2014), potentially exacerbating conflict (Lombard, 2012).

3 Anti-Grazing Laws in Nigeria

3.1 Farmer-herder conflict in Nigeria

Pastoralist conflict in Nigeria reflects many of the patterns descried above. Nigerian pastoralists – particularly cattle herders – are primarily based in the North and are largely nomadic or semi-nomadic. These herders, while migratory, have traditionally followed fairly regular land-use patterns. Herders typically migrate between the North and the South of Nigeria to access pastures across the country at different times of year (ACAPS, 2017). In the past, this southwards movement took place in the drier first half of the year, as pastoralists and their cattle gravitated away from the Sahara and towards less arid coastal areas in the south. During rainy season from roughly June through October – overlapping with farmer harvesting season – herders headed back north, away from southern flood plains (ACAPS, 2017). However, increasing degradation of pastureland in the North has pushed many herders southwards more frequently and in greater volume. Moreover, herders have traveled to (or remained in) the south and the Middle Belt well later than previously. Herders have begun to graze cattle across the south even in the latter half of the year, while farmers attempt to grow and harvest their crops. The result has been crop destruction, loss of livelihood, and violence.

This farmer-herder violence in Nigeria has reached unprecedented levels in recent years. Its growing severity stems from a complex intersection of environmental, economic, ethnic, and political issues. In particular, differences in ethnic group, region, language, and religion between farmers and herders regularly lead the violence to take on communal dimensions. As mentioned above, many herders in Nigeria are from the majority-Muslim North, often of the Hausa-Fulani ethnic group. On the other hand, populations – and farmers – in southern Nigeria tend to be predominately Christian and identify across a wide variety of ethnic groups (Bamidele, 2020). News reports on the conflict tend to be tinged with inter-ethnic suspicion, often conflating herder banditry with jihadist violence by Boko Haram, also concentrated in the North.

Importantly, climate-related displacement of Hausa-Fulani pastoralists has ignited political conflict over land-use rights between farmers and herders. In many cases, farmers and herders have resorted to violence over land which has been settled and turned to farmland, but which overlaps with traditional migration routes or areas previously reserved for grazing migrating cattle. As a result, both groups have claimed the right to access the land. Farmer-herder violence has increased in complexity even as it has escalated in scope and severity. This includes the introduction and involvement of more professionalized communal and ethnic militias, as well as outbursts of widespread, organized, and brutal banditry.

The Nigerian government has proposed several alternative policy options for addressing the conflict. A variety of attempted federal policies, such as plans by federal government to establish cattle colonies for Herdsmen (such as Rural Grazing Area (RUGA) initiative), have failed to get off the ground, in part due to substantial pushback from states in the South and Middle Belts (Day, 2021). Even prior to this modern conflict, policy approaches adjudicating land claims between farmers and migrating cattle grazers have varied substantially across the North and South. Unsurprisingly, states in the northern region have historically attempted to find ways to accommodate herders, including through the establishment of grazing reserves and migratory routes in the 1950s and 1960s. However in recent years, individual states have again pursued their own approach to combatting desertification and conflict. Increased climate-induced migration southwards has prompted states in southern Nigeria to implement entirely different sorts of laws.

3.2 Anti-open grazing laws in Nigeria

'Anti-open grazing laws' (AGL) is the term we use to collectively refer to a series of land-use policies passed over the past decade by individual states of Nigeria restricting open grazing of cattle in order to combat the destruction of farmlands and stem farmer-herder conflict. 'Open grazing' as defined in one such law is "the act of pasturing livestock to feed on dry grass, growing grass, shrubs, herbage, farm crops etc. in open fields without any form of restriction" (Aondofa Aligba and Gbakighir, 2019/2020). These laws often require that cattle only graze in ranches, which require permits. Legal penalties are associated with grazing cattle in the open, especially if one has a firearm or other weapon while doing so. Fines and penalties may include the impounding of animals, as well as being responsible for damages

(Agwu and Wilson-Okereke, 2019).

The implementation of anti-open grazing laws in Nigeria began in 2016 in the South West state of Ekiti, with Middle Belt states Taraba and Benue passing similar laws in 2017. These laws varied slightly in their details and stated objectives, but had similar implications. For example, the first law passed in Ekiti (The Prohibition of Cattle and other Ruminants Grazing in Ekiti State Law No. 4 of 2016) restricts all grazing of cattle on any land "the Governor has not designated as ranches" (*(The Prohibition of Cattle and other Ruminants Grazing in Ekiti State Law No. 4 of 2016*, 2016). The law explicitly limits any grazing from 6pm - 7am. Under Ekiti's policy, herders in possession of firearms are to be charged with terrorism, have their cattle confiscated, face a mandatory 6 month prison sentence (at minimum), and be forced to compensate for any property destruction. Benue state's anti-grazing law restricts grazing even more broadly, imposing an absolute ban on grazing without possession of a ranch permit obtained by the government. Abia's 2018 policy explicitly lays out its objectives to include (as reported by BBC (2021)):

1. Prevention of destruction of crops, community land, and property by grazing livestock
2. To prevent clashes between farmers and herders
3. To protect environmental degradation and pollution from open grazing and rearing of livestock

Most recently, on May 11, 2021, 17 governors in the Southern States announced their collective intention to ban open grazing in their states, despite opposition from the federal government (Kabir, 2021; Day, 2021). At the governors' meeting, they resolved (as reported by the Premium Times):

"... that open grazing of cattle be banned across Southern Nigeria; noted that development and population growth has put pressure on available land and increased the prospects of conflict between migrating herders and local populations in the South. Given this scenario, it becomes imperative to enforce the ban on open grazing in the South (including cattle movement to the South by foot)" (Kabir, 2021).

A follow-up meeting in Lagos in July confirmed this agenda, giving a deadline of September 1 for region-wide implementation. Despite a declared commitment on the part of southern states, the resolution was unevenly enacted. Not all involved states successfully passed anti-open grazing laws, and less than half were immediately compliant. Only five met the September 1 deadline. The staggered passage of these land-use laws gives us leverage in assessing their effect on the conflict and violence they were designed to prevent.

4 Data and Design

4.1 Data

Our conflict data covers years $t \in \{2007, 2008, ...2023\}$ and states $i \in \{1, 2, ...37\}$. AGL first passed in 2016, and continued to be passed up to 2021. Therefore, we focus on the period of 2007 to present for our main analysis. Since states are the unit where the laws are enacted, we construct a panel of all states from the 2007-2023 period.

AGL in Nigerian States

We construct a dataset of anti-open grazing laws (AGL) in Nigeria from newspaper and official state sources which announce the passage and year of implementation of anti-open grazing laws. These laws began in 2016 and reached their zenith in 2021 when 17 southern states agreed to implement policies which prohibited open grazing, with 7 immediately complying. Our data include c treatment cohorts with $c \in \{2016, 2017, 2018, 2019, 2021, 0(\text{never})\}$. We map the spatial distribution of laws and their timing in Figure 1.

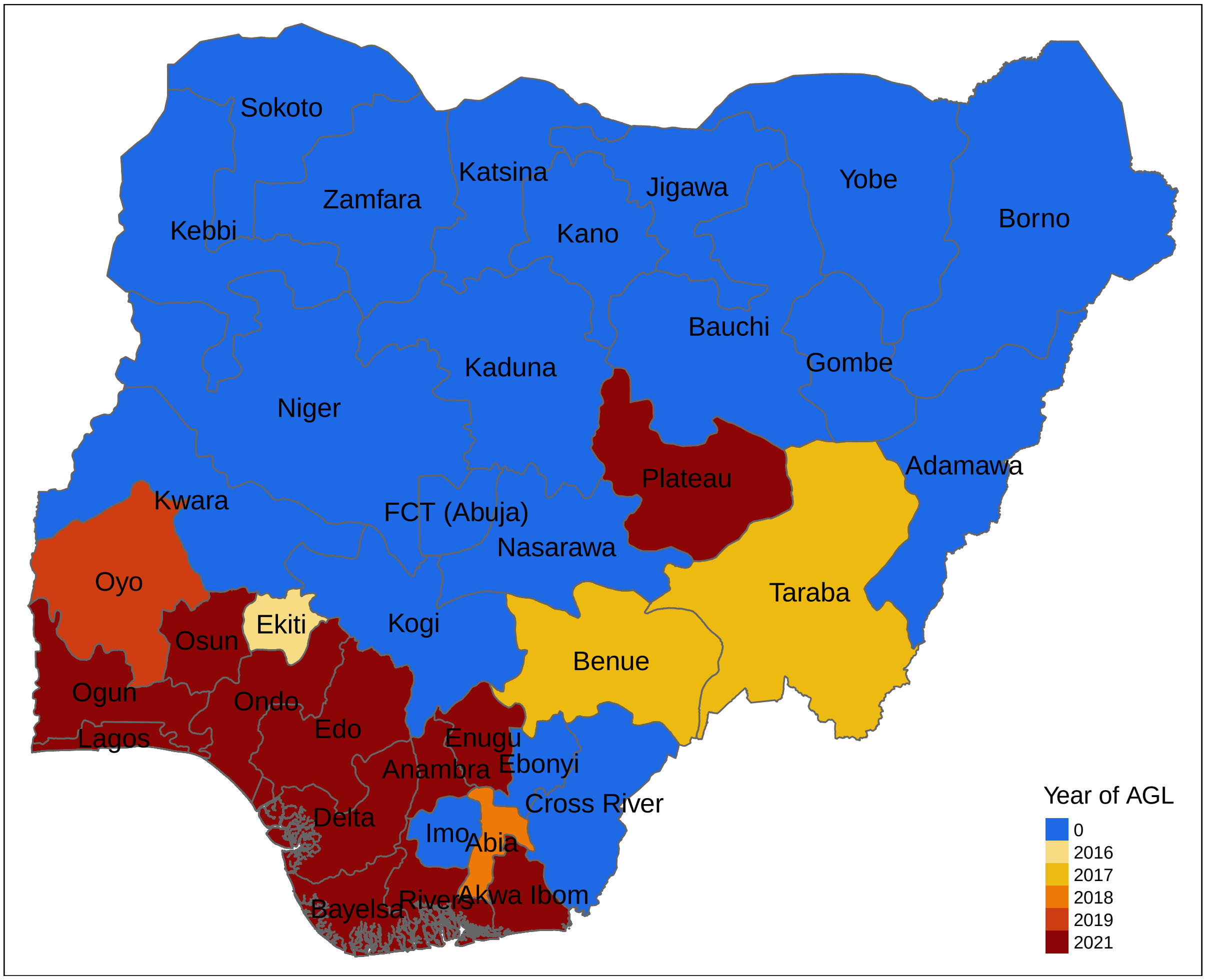
We consider states as treated after states pass AGL. We focus on passage over implementation because the signal that the law will come into force is salient for conflict dynamics. We expect herders and farmers to to begin to adjust their behavior in light of these policies once hearing news of them, since the adjustments required are major.[6] Further, the implementation of laws have a known start date, meaning agents could anticipate their treatment status, threatening inference by making the AGL group non-comparable to the non-AGL group in the lead up to enforcement. As such, passage is our key intervention of interest, for both theoretical and identification-based reasons.

Conflict Data: Nigeria Watch

We use fatality data from violent events gathered by Nigeria Watch. Nigeria Watch is a research project hosted by French Institute for Research in Africa. The group collects information on homicide events from 10 daily and weekly newspapers as well as human rights organizations, to measure violent conflict fatalities across the country. Unlike other conflict event databases, such as the Armed Conflict Location Event Dataset (ACLED) (Raleigh et al., 2010), Nigeria Watch focuses on violent events that are smaller in scale, especially land related conflict and small-scale violence over cattle grazing, which are two

[6] As mentioned, some states agreed in principle to consider passage such laws, but failed to do so in the stated timeframe. Despite the widespread announcement of this intention, plausible uncertainty as to whether a given state would follow through with the agreement means that a law's *passage*, not *announcement*, is the relevant date of interest.

Figure 1: Map of States that Passed Anti-Grazing Laws and the Year of Passage



key categories of conflict for our study.[7] The coverage from Nigeria Watch is therefore more extensive: whereas ACLED records 22,483 conflict events from 1998-2022, Nigeria Watch records nearly 40,000 from 2006-2022.

The newspapers are Nigerian with national coverage. Nigerian press is among the most well established in Africa, however, as Nigeria Watch notes, coverage may be denser in the southern parts of Nigeria near Lagos and sparser further north. Since our identification approach leverages changes in events overtime within regions, we directly account for this source of bias and measurement error. Nigeria Watch includes conflict event causes based on news reporting, two of which are of interest for our purposes: land and cattle grazing. We use these conflict categories as the basis for our analysis.[8]

Survey Data: General Household Survey

We use four waves of the General Household Survey (GHS) in Nigeria, spanning from 2010-2019. Waves were collected in 2010, 2012, 2015, and 2018. The survey is done in concert with World Bank Living Standards Measurement Study (LIMS). The survey is nationally representative, sampling from states and enumeration areas within them. Approximately 5,000 households are selected for a questionnaire during the planting season, and are then revisited during the harvest season, and asked a variety of questions about labor, employment, and consumption.[9] We use these data to measure whether farmers receive positive economic benefits from AGL. Doing so is important for assessing either theoretical mechanism. If property rights are effectively secured by AGL, one would observe farmers increasing their

[7]We perform robustness tests with ACLED data, which can be found in Appendix E and largely support our primary conclusions.

[8]More about data collection and the organization can be found on the Nigeria Watch website `https://www.nigeriawatch.org`

[9]Data can be accessed by registering with the World Bank. `https://microdata.worldbank.org/`

investments in their land, because security increases their time horizon. Further, lawmakers have argued that by helping farmers protect their crops, food security and consumption should increase.

Survey Data: Afrobarometer

Finally, we use three waves of the Afrobarometer in Nigeria, spanning from 2017 to 2022. Waves were collected in 2017, 2020, and 2022. The survey is a nationally representative sample across states, with about 1,600 respondents per wave, and asks a series of questions about general perceptions of governance, democracy, and economic conditions; as well as some more specific questions about country-specific issues.[10] We use these data to measure whether AGL impact treated populations' opinions regarding the state's ability to handle violent conflict, as well as whether groups are treated unequally under law. If AGL fail to properly secure property rights, and instead forment distrust and self-help instincts among herders, we would expect AGL passage to reduce confidence in the state, and in the standard of equal treatment under law.

4.2 Empirical Strategy

We use a difference-in-differences strategy to identify the effect of AGL passage on farmer-herder conflict, taking advantage of the differential timing of the passage of these laws in some states relative to others. While in some cases laws were first proposed as a response to a particularly high-profile case of farmer-herder violence, there is no significant difference between conflict trends in never-treated and treated areas before ban enactment, as we

[10]Data can be accessed at Afrobarometer's website, `https://www.afrobarometer.org/`

demonstrate in the following section. This ensures that treatment timing is not endogenous to conflict levels themselves. We thus estimate the interaction-weighted difference-in-differences estimator to account for the staggered introduction of AGL over time (Sun and Abraham, 2021).

$$y_{it} = \alpha_i + \lambda_t + \sum_{c \neq 0} \sum_{\ell \neq -1} \beta_{c\ell} (\mathbf{1}\{\text{AGL}_i = c\} \cdot D_{it}^{\ell}) + \varepsilon_{it} \tag{1}$$

The outcome y_{it} is the count of fatalities per capita in a state i during year t. Our measure captures the intensive margin of violent conflict; since we measure violence at a highly aggregate level (the state) the extensive margin of violence shows considerably less variability. Theoretically, our argument is concerned with intensity, which makes the measure appropriate.

$D_{it}^{\ell} := \mathbf{1}\{t - c_i = \ell\}$ where $\ell \in \{-14, -13, ...6\}$ captures the time after laws are passed; positive values indicate laws have passed state legislatures, negative values represent years until laws are passed. D_{it}^{ℓ} is equal to 1 when state i is ℓ periods from passing AGL. We follow convention and exclude the year prior to AGL $\ell = -1$ as a reference. $\mathbf{1}\{\text{AGL}_i = c\}$ is a binary indicator for which treatment cohort $c \in \{2016, 2017, 2018, 2019, 2021, 0(\text{never})\}$ state i belongs to, with 0 set as the reference.

The parameter(s) of interest are $\beta_{c\ell}$, which capture the effect of AGL post-implementation among states in cohort c at event time ℓ relative to states that never implemented AGL. $\beta_{c\ell}$ is a difference-in-differences estimator between states that implemented AGL in time ℓ relative to time $\ell = -1$. We report our main results by plotting $\beta_{c\ell}$ to show dynamic effects and tests for pre-trends in conflict, but also report the average effect of AGL. The average effect of AGL is a weighted average of cohort average treatment effects, where the weights are the share of all treated states that are in each cohort (Sun and Abraham, 2021). In short, our set-up compares the shift in farmer-herder violence after an AGL is passed in those states that passed it, relative to this shift in states in which an AGL is never passed. Each cohort-year has an effect, which are averaged with this weighting strategy.

Throughout, we cluster standard errors on the state, as that is the level where the treatment is assigned. Since there are over 30 states in our panel (37), there are a sufficient number of groups for standard clustering of errors to account for serial correlation (Cameron, Gelbach and Miller, 2008).

Our core identification assumption is parallel trends, that is, the potential outcomes of states that passed AGL would have evolved along a path that is comparable to the states that never passed AGL. This requires those states that passed AGL to have similar conflict trends to those which never passed AGL. Should this assumption hold, we ought to observe no difference-in-differences at times before the laws were passed. The flexible specification provided by Sun and Abraham (2021) is robust to heterogeneous treatment effects, meaning we need not assume that each state responds identically to treatment.

We adjust for different levels in conflict driven by common shocks and state-specific factors. α_i are state fixed effects which account or time-invariant confounders. These include attributes of the state that change little or not at all from year to year, such as geography or historical institutions. λ_t are year fixed effects which account for common shocks across states in a given year, such as the COVID-19 pandemic and national elections.

We include time-invariant covariates interacted with year fixed effects to account for different conflict cycles that may be experienced by states with distinct baseline traits. We spatially merge tribal boundaries from Murdock (1967) to compute the fractionalization of states by different tribes.[11] Next, we use satellite data to compute the area of the state that is cropland,[12] the volume of land that is desertified, as well as total area. Throughout, we use fixed effects for the terciles of these covariates to account for nonlinearlity.

5 Results

5.1 What is the effect of AGL passage on farmer-herder conflict?

We report our baseline results in two ways. First, we present the event study estimates, which show the dynamic effects of AGL. Dynamic effects include placebo treatment times, which measure the difference-in-differences at a sequence of years prior to AGL being implemented versus the year prior to the laws. If the parallel trends assumption holds, it would unlikely that we find sizeable jumps prior to the laws being implemented. Likewise, if parallel trends are violated, it would be unsurprising to find diverging trends between states prior to the laws. After we report our event study estimates, we report the average dynamic effects by cohort in a tabular format with covariates.

Figure 2 shows our event study results. We fail to detect a strong pre-trend in conflict, with coefficients tightly estimated closed to zero. However, right of the vertical dashed line, we report a sharp increase in conflicts in both panels. After AGL, conflicts initially surge after decaying nearly a half decade after the laws.

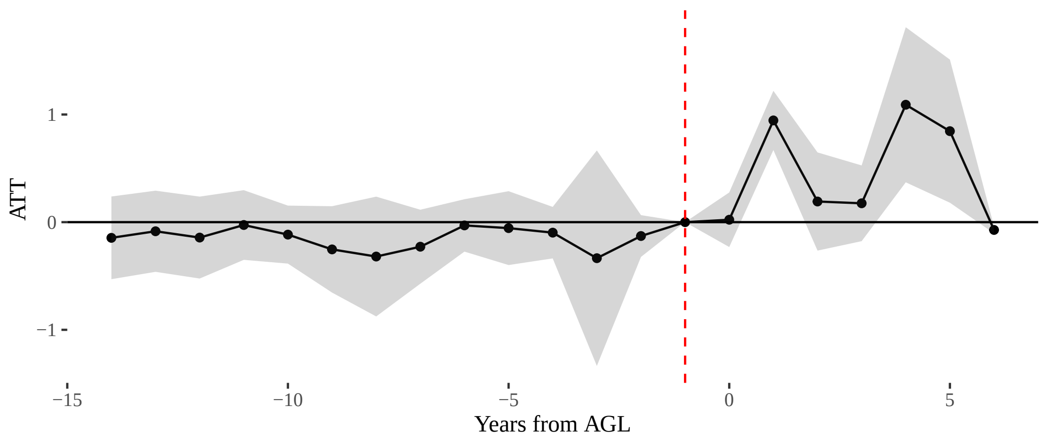
For a sense of what overall conflict levels looked like before and after treatment across cohorts, we plot per-capita farmer-herder conflict trends in Figure 3. The graph shows

[11] Specifically we compute the Herfindahl index: the sum of squared shares.

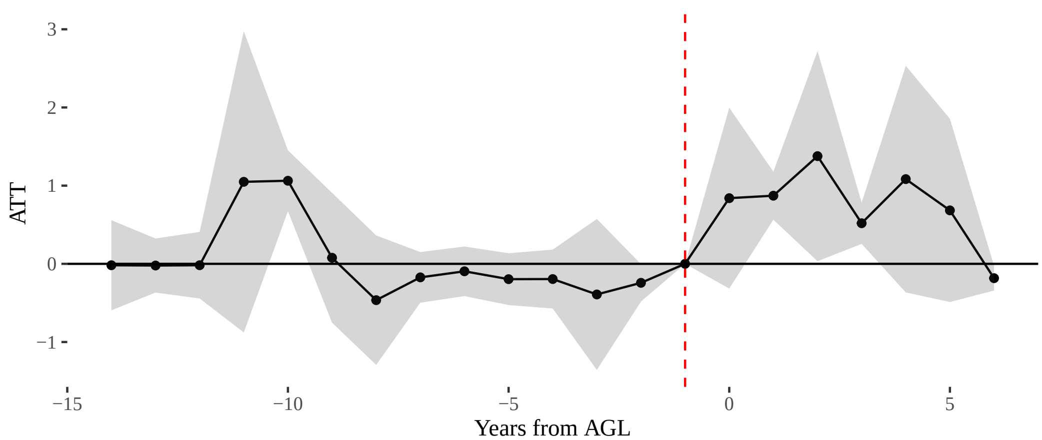
[12] Data obtained from Goodman et al. (2019).

Figure 2: Conflicts Per Capita

(a) Grazing



(b) Land



Note: Outcome is fatalities per capita. Each point estimate represents the difference-in-differences relative to the year before AGL are implemented. Estimates to the left of the vertical dashed line are placebo pre-trend estimates, estimates to the right are treatment effects. Panel A is grazing conflicts, Panel B is land conflicts. Shaded regions are confidence intervals, constructed from standard errors clustered by state. Note that not all cohorts have five periods past treatment general increases in conflict, with larger increases across treated areas after treatment.

Table 1 shows AGL increase grazing and land conflicts significantly after passage on average. Columns 1-2 refer to grazing conflicts and 3-4 refer to land conflicts. Odd numbered columns only include year and state fixed effects, and even columns include tercile x year fixed effects for area, crop area, desertification, and ethnic fractionalization. Grazing conflicts increase by around 0.5 per 100,000 residents, whereas land conflicts increase by nearly 0.9 per 100,000. To put things in perspective, the standard deviation of grazing conflict is 0.90, while the standard deviation of land conflict is 1.47. Our most conservative estimates represent a 0.53 and 0.58 standard deviation increases, respectively. Our estimates in Columns 2 and 4 show that the inclusion of covariates do not meaningfully change the results.

Robustness

Modeling the Counterfactual

Our core identifying assumption is that the trend of the untreated (non or yet to have AGL states) provides a valid counterfactual for what the evolution of conflict would have looked in AGL states had they not been implemented. We fail to find evidence of diverging pretrends in our event study results, however, we probe the robustness of our main result with three different modeling strategies.

Regional trends: We include results for specifications that include region-by-year linear time trends in Appendix B. Nigerian states are grouped into six broader regions or 'geopolitical zones', namely North Central, North East, North West, South West, South East and South South. While state fixed effects account for time-invariant idiosyncrasies of each state, and year-fixed effects account for yearly shocks which affect all states, region-by-year fixed

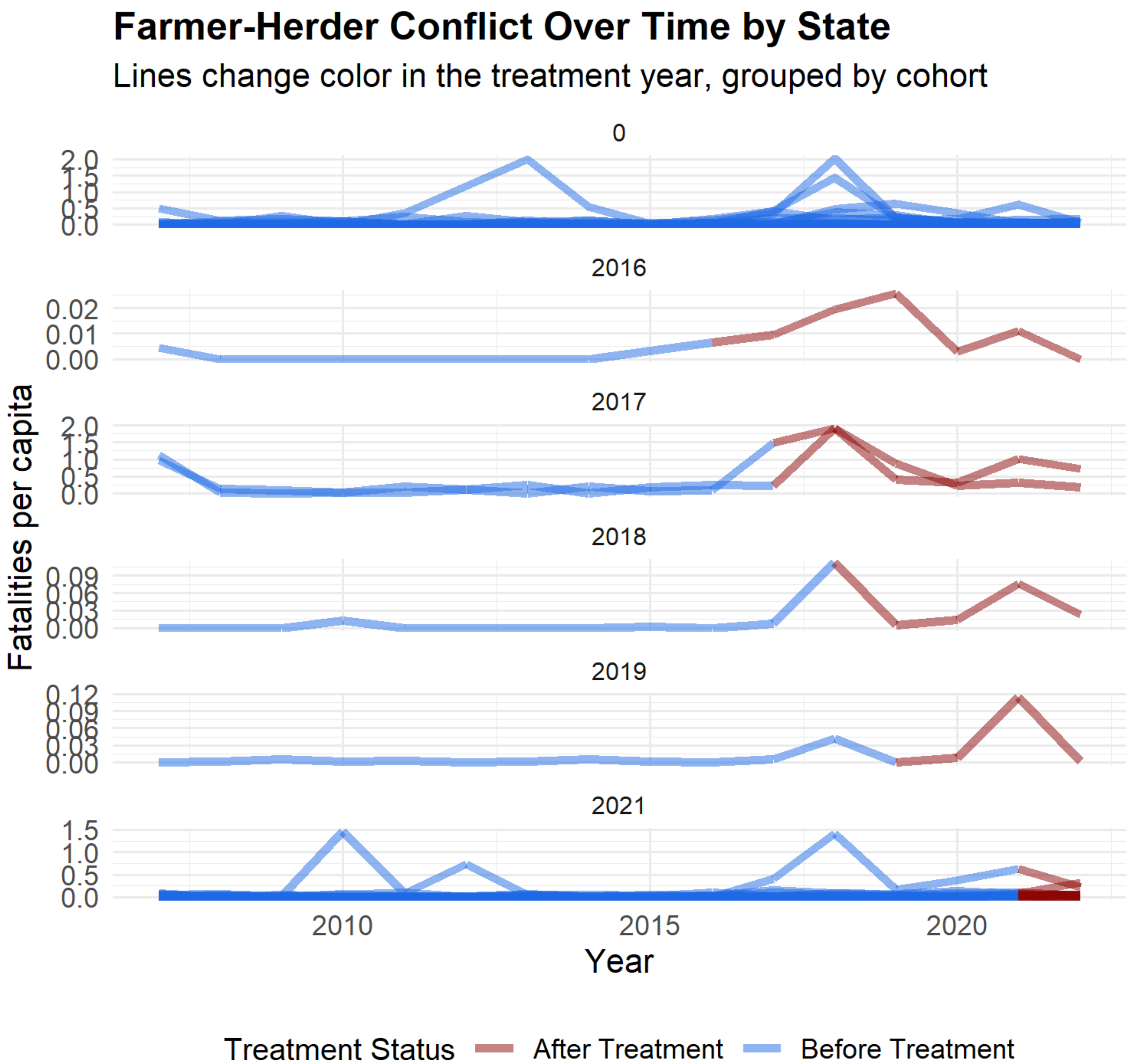


Figure 3: Number of grazing or land-related fatalities per 10,000 individuals by state. Each state is a line, faceted by cohort. Each state's line becomes red when treated.

Table 1: AGL Increase Grazing and Land Conflicts Per Capita

Dependent Variables:	Grazing Conflict		Land Conflict	
Model:	(1)	(2)	(3)	(4)
Variables				
ATT	0.4830***	0.5185***	0.8611***	0.8878***
	(0.0653)	(0.1565)	(0.1774)	(0.2585)
Fixed-effects				
State	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Crop Tercile x Year		Yes		Yes
Area Tercile x Year		Yes		Yes
Desertification Tercile x Year		Yes		Yes
Ethnic Fractionalization Tercile x Year		Yes		Yes
Fit statistics				
Observations	592	592	592	592
N State	37	37	37	37
N Year	16	16	16	16

Clustered (state) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

effects control for linear changes over time which effect each region differently, accounting for concerns that diverging potential outcome trends are driven by region-wide shifts over time. While estimates mechanically lose precision, the general trends of the main results hold.

Generalized Syntehtic Control: Since we have a long pretreatment history of conflict, we can better approcimate the counterfactual trend by using data on conflict dynamics overtime across states before AGL. We use the generalized synthetic control method (Xu, 2017) to construct a control group. We select a set of weights such that the average outcome of the weighted control group is equal to the average outcome of the treated group, and then use these weights to interpolate the counterfactual trend of what the treated group would have looked like absent AGL. We obtain very similar point estimates with this approach (Appendix A), further strengthening confidence in our estimation strategy.

Synthetic Difference-in-Differences: We combine the difference-in-differences strategy with the synthetic control method and apply the synthetic difference-in-differences (SDID) approach form Arkhangelsky et al. (2021). Intuitively, the estimator combines difference-in-differences with the synthetic control method by computing weights to construct a counterfactual and then comparing the change in the treated versus the control group after the policy. SDID competes with (or dominate) both the synthetic control method and difference-in-differences (Arkhangelsky et al., 2021). Our point estimates are similar using this strategy, which is consistent with difference-in-differences and generalized synethic control also obtaining similar results.

Measurement Error

Our data is from a newspaper based dataset. One concern is reporting coverage could drive our results instead of facts on the ground. As mentioned in the data section, our identification strategy is based on changes in trends, meaning regional biases in coverage (such as increased media density in the south of the country) ought to be accounted for state fixed effects. Since many problems that plague media reporting are systematic and structural rather than sharply varying across time and space, we believe state fixed effects are a strong control. Next, since we focus on fatal events, it is difficult for data that we observe to be concealed since there is clear evidence of violence.

Nevertheless, we take two steps to address the possibility that our results are driven by the data generating process from the media rather than the impact of AGL.

Weighted regression: To further safeguard our results against measurement error, we build on the insight of Weidmann (2016) that cell phone coverage predicts accuracy of event dataset reporting and weigh our regressions based on pre-treatment mobile phone density across states. The intuition for this approach is that a state with more mobile phone users will have more accurate reporting than a state with fewer mobile phone users, since the penetration of information communication technology into the market eases the access of reporting and reduces the cost of the flow of information. Our estimates (reported in Appendix D) attenuate in size, but remain positive and precise after implementing this exercise.

Survey Data Afrobarometer inquires about farmer herder conflicts in the 2017 and 2020 rounds. We leverage three questions about the conflict to create a peace index (higher values corresponding to a perception of peace and lower ones to violence) and estimate a triple differences specification based on the timing of the AGL in some states and whether the individual respondent was employed in the agricultural sector. The triple difference strategy relies on a weaker parallel trends assumption, which is useful for our purposes since we cannot test for pretrends in our data based on the limited times the question was asked in previous rounds. We find a differential reduction in perceptions of peace among individuals employed in agriculture after AGL, which suggests that individuals most exposed to the conflict - farmers - perceive more conflict after AGL in implementing states. The survey result corroborates the primary finding from the newspaper database (Appendix F).

5.2 Did AGL exacerbate the climate-conflict nexus?

Thus far, evidence suggests that farmer-herder violence is exacerbated by conversation laws such as AGL, in contrast to *incontestability* theories of property rights and in support of frameworks emphasizing these laws' exacerbation of *inequity*. But farmer-herder conflict existed prior to AGL passage, and has been shown to be reactive to changes in the environment (McGuirk and Nunn, 2020). Given that the purpose of AGL was in part to mitigate the effect of climate change on conflict, we now turn to the question: What role do AGL play in moderating the relationship that exists between weather shocks and violent conflict?

To answer, we evaluate if AGL intensify or mollify drought-induced conflicts. If the argument we posit is correct, conflicts will be more intense after AGL under drought conditions, because there are fewer resources for both pastoralists and herders to draw from. Since AGL make land use less secure for herders, greater scarcity under conditions of insecurity ought to breed more violence.

We test this argument by collecting information on rainfall at the local government area (LGA) level, the lowest administrative unit for which our data is available. We use this unit of analysis to measure to leverage more fine-grained climate variation. We compute the standardized perception index (SPI) for each LGA l in each state s per year t, which is the sum of rainfall levels per year minus the long-run average divided by the standard deviation. We reverse the scale so higher levels reflect a more severe drought - e.g. 1 means 1 standard deviation *less* rainfall than average.

We then estimate the following triple difference specification.

$$\text{Conflict}_{lst} = \delta_1 \text{Post AGL}_{st} + \delta_2 \text{SPI}_{lst} + \delta_3 \big(\text{Post AGL}_{st} \times \text{SPI}_{lst}\big) + \mu_s \tau_t + \lambda_t + \varepsilon_{lst} \quad (2)$$

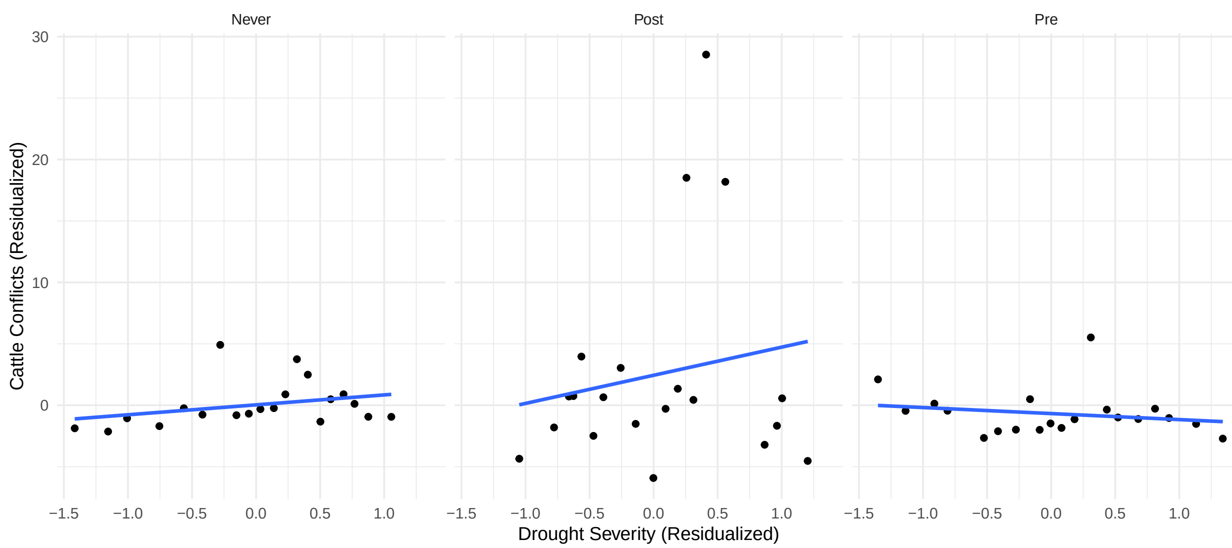
Our outcome of interest remains grazing and land conflicts per capita. We adjust for for either LGA or state fixed effects with unit specific trends ($\mu_s \tau_t$) to account for cross-sectional heterogeneity and variation in trends across places. The parameter of interest is δ_3, which is the differential effect of a drought shock after AGL has been implemented in a state. The ratio of $\frac{\delta_3}{\delta_1}$ captures the percentage difference of the effect of droughts after the implementation of AGL, which can be interpreted as the difference in intensity of droughts on conflict post-AGL.

First, we plot the relationship between drought and conflict in states without AGL, in states that had AGL before the laws came into effect, and AGL states after the laws. We show a binned scatterplot of the relationship in Figure 4. Increasingly severe droughts appear to be more sharply related to conflict in states after they pass AGL rather than before.

Table 2 shows droughts intensify the effect of AGL at the LGA level. A one-standard deviation increase in drought corresponds to approximately two more fatalities per capita from land/grazing conflict after states pass AGL. Given the baseline impact of a standard deviation increase in drought is nearly 1 fatality per capita, our estimates suggest the impact of drought on conflict *doubles* as a result of AGL. A standard deviation increase in drought further corresponds with a 16% increase in conflict post-AGL. The result is consistent with the inequality framework: when scarcity becomes more severe, herders incentive to use violence to protect their cattle grazing practices becomes stronger.

Our continuous triple difference approach with staggered treatment timing is a complicated departure from the standard approach. For robustness, we report in appendix the results from more tractable 2x2x2 triple differences by cohort (Appendix G).

Figure 4: Relationship Between Drought and Conflict Before, After, and Without AGL



Note: Binned scatter plot of drought and conflict in states without AGL (never), after AGL (post), and before AGL (pre). The never group is states that have no AGL (cohort 0). Pre are states that passed AGL before the laws came into effect, and post are states with AGL after AGL.

Table 2: AGL Intensify the Effect of Drought on Conflict

Dependent Variables:	Grazing	Land	Grazing	Land
Model:	(1)	(2)	(3)	(4)
Drought	0.6998*	1.120*	0.7820*	1.470**
	(0.3778)	(0.6066)	(0.4189)	(0.7026)
Post AGL	5.363*	12.28*	5.370*	12.38*
	(2.862)	(6.477)	(2.935)	(6.674)
Drought × Post AGL	2.825	2.120**	3.498	2.959**
	(1.755)	(0.9146)	(2.561)	(1.455)
Fixed-effects				
Year	Yes	Yes	Yes	Yes
State	Yes	Yes		
LGA			Yes	Yes
Varying Slopes				
State	Yes	Yes		
LGA			Yes	Yes
Observations	13,073	13,073	13,073	13,073

Clustered (State) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

6 Mechanisms

Our evidence suggests that not only does AGL passage increase farmer-herder conflict-related fatalities per capita, but that they exacerbate the positive effect of adverse weather conditions on violent conflict. Why do AGL – designed to prevent further environmental degradation and in fact *break* the climate-conflict nexus – seem to do precisely the opposite of what they are intended to achieve? Below, we examine possible mechanisms through which AGL affects behavior related to conflict outcomes.

6.1 Incontenstibility: Did AGL Increase Investment?

The argument which suggests that AGL reduces conflict through making land less contestable (*incontestability*) would maintain that my making property rights secure, AGL would make farmers want to invest more in productive assets on their farm. When land is contestable, farmers may be reluctant to plant all crops they can, since they may be destroyed by herders. As a consequence, food security, consumption, and planted area would all decline. On the flip side, should AGL provide farmers with confidence that their claims are secure, they would invest more in their farms.

We leverage GHS household survey data on household economic welfare to test whether household economic benefits were felt for farmers using the following two period difference-in-differences specification.

$$y_{hst} = \alpha_s + \beta_t + \delta A_{hst} + \epsilon_{hst} \tag{3}$$

Table 3: AGL Do Not Economically Benefit Farmers

	lncons (1)	lnfood (2)	log(planted area) (3)
Post AGL	-0.0094	0.0459	0.0452
	(0.0495)	(0.3608)	(0.7788)
Observations	18,935	19,054	11,933
N States	37	37	37
N Years	4	4	4
State fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓

The outcome y_{hst} is either consumption, food security, or area planted for household h in state s at time t. The parameter of interest is δ which captures the pre/post difference between households in AGL states versus the pre/post difference in non AGL states. α_s and β_t are state and year fixed effects respectively. Since the survey waves are grouped every two years and our data does not extend into 2021, we only have two treatment groups (AGL and control) so the difference-in-differences is not staggered.

Table 3 shows no change in economic benefits for households. Neither consumption, food security, nor land area dedicated to planting shift in response to AGL. This evidence suggests that the economic effects of the law cannot explain the change in violence observed in the main results, which strikes against the 'incontestability' argument.

6.2 Grazing rights and grievances: Is there backlash from AGL?

Meanwhile, an *inequity*-focused argument would suggest that, far from maintaining peace by securing property rights, AGL will increase feelings of inequality and distrust in the state's ability fairly adjudicate disputes. In order to evaluate these implications, we turn to Afrobarometer survey data across three rounds

Afrobarometer has many advantages, but also several qualities which limit our ability to make inferences. Afrobarometer selects interviewees based on households, meaning nomadic and semi-nomadic populations are extremely underrepresented, or even absent. While an ideal analysis would unpack heterogeneous treatment effects between farmers and herders, limited diversity of within-state sampling prevents such analyses. Afrobarometer also investigates a variety of questions across rounds; but not all questions are asked in every round.[13]

Our analysis focuses on two relevant questions which appear on three rounds of the Afrobarometer survey, encompassing the periods before and after passage of AGL across almost all cohorts: Rounds 7 (2017), 8 (2020) and 9 (2022).[14] We first examine respondents' opinion about how the state handles violent conflict (*1: Very badly - 4: Very well*); and second, whether they feel people are treated unequally under the law (*0: Never - 3: Always*). An inequity-focused argument would suggest that individuals after AGL passage would decrease trust in the government's ability to handle violent conflicts, as well as increase feelings of inequality among citizens of these states. Results for these outcomes are shown in Table 4.

After the passage of AGL in a given state, respondents show much lower rates of confidence in the ability of states to handle violent conflict. This difference represents a significant and substantively large effect, and indicates that AGL passage is followed by a decrease in treated citizens' opinion of the state's handling of violent conflict. Meanwhile, AGL has the

[13] Of particular relevance to this issue, Rounds 7 (2017) and 8 (2020) of Afrobarometer ask specific questions about farmer-herder conflict. Because of the limited number of states treated between these years, our ability to draw firm inferences from these questions is limited – nevertheless, we analyze and discuss these results in Appendix F.

[14] Only one state (Ekiti, in 2016) passed AGL before Round 7 questions were asked; passage of the law for the 2017 cohort occurred a month or more after Afrobarometer conducted its Found 7 survey.

Table 4: AGL effects on opinions regarding state handling of violent conflict and perceptions of unequal treatment under law

	State handling conflict (1)	Treated unequally under law (2)
Post AGL	-0.170382 **	0.3276 ***
	(0.080619)	(0.0939)
Observations	4,682	4,724
N States	37	37
N Years	3	3
State fixed effects	✓	✓
Year fixed effects	✓	✓

Clustered (State) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

opposite relationship with citizens' perception of whether individuals are treated unequally under law, suggesting there may be some concern over the law's differential impacts on different groups. While these results should be interpreted cautiously, they are nevertheless suggestive that passage of these laws correlates with increasing distrust and feelings of inequity.

7 Conclusion

Do conservation policies that seek to protect land have a peace dividend? We find evidence in Nigeria that anti-grazing laws prompt a significant increase in land and grazing conflict. Although land is less contestable legally as a result of AGL, the bans leave herders with two options: abandon their traditional grazing routes without a clear alternative, or fight farmers to undermine the implementation of the laws. We find that violent conflict over land and cattle grazing intensifies in response to AGL, and that the impact is worse in drought years when resources are more scarce. The laws do not benefit farmers economically on average, and individuals report feeling that laws are more unfair after the laws are passed. Together, these results suggest that inequality dominates incontestability.

These findings complicate our understanding of policies intended to fight environmental degradation and land conflict in an age of increasingly scarce land. Our findings highlight the adverse consequences of crafting conservation and land-use laws with distributional consequences that fall along societal fault-lines.

In Western industrialized economies, a transition to green energy has forced some populations – such as coal workers – to struggle to maintain their way of life. And as political science research increasingly concerns itself with how states compensate these climate change 'losers,' (Gaikwad, Genovese and Tingley, 2022; Bolet, Green and Gonzàlez-Eguino, 2023), our findings elaborate on how climate-related conservation policies in the Global South can similarly create, and indeed marginalize, populations already suffering from the worst effects of a warming globe.

Indeed, in the case of Nigeria, our findings suggest that the rapidly growing scope and severity of farmer-herder violence may only be exacerbated by recent laws intending to quell it. Moreover, such laws may also exacerbate the relationship between climate change and conflict. In short, our results indicate that conservation laws do not serve to produce *incontestability*, or a Coasian-like peace based on property rights, but *inequity*, prompting herders' increasing isolation from the state and motivation to engage in self-help strategies to protect their way of life. Beyond Nigeria, these results offer a cautionary tale of how political institutions can interact with environmental degradation to produce violence.

Climate change is far from a future problem; but one which has already had devastating impacts around the globe. As institutions evolve to mitigate its consequences, it has become increasingly important to evaluate how these solutions to climate change – not just climate change itself – affect human security and stability.

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Online Appendix

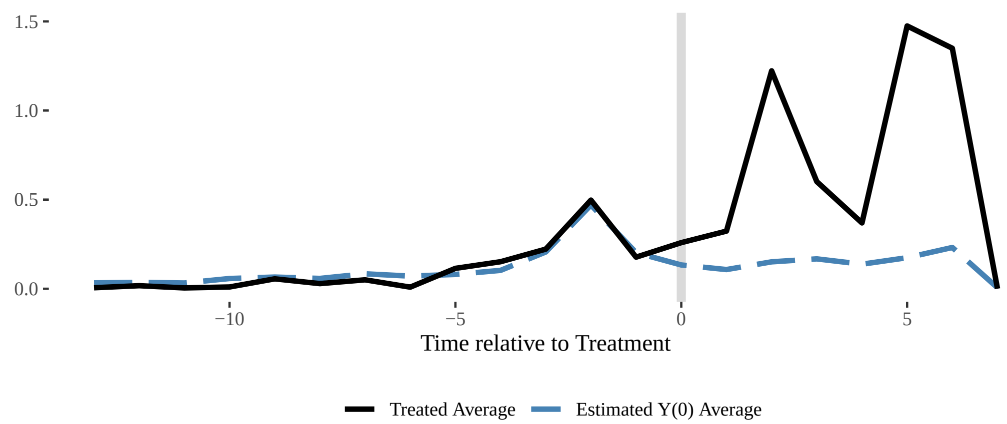
A Synthetic Control

Table A.1: Generalized Synthetic Control Results: Periodwise Treatment Effects for Grazing Conflict Per Capita

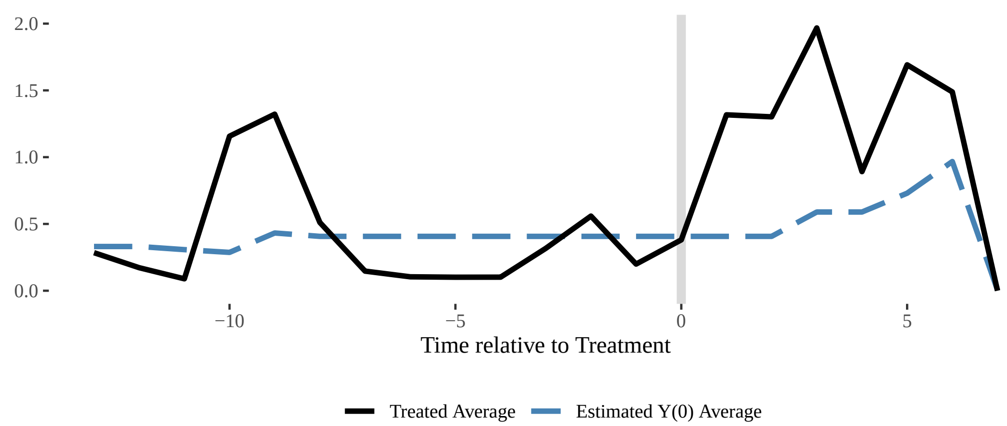
Relative Time	ATT	S.E.	CI.lower	CI.upper	P-value	Number Treated
Pre-treatment						
-8	0.10	0.21	-0.31	0.51	0.62	0.00
-7	-0.26	0.36	-0.97	0.45	0.47	0.00
-6	-0.30	0.10	-0.50	-0.10	0.00	0.00
-5	-0.31	0.17	-0.65	0.04	0.08	0.00
-4	-0.31	0.17	-0.63	0.02	0.07	0.00
-3	-0.09	0.19	-0.47	0.29	0.65	0.00
-2	0.15	0.39	-0.60	0.91	0.69	0.00
-1	-0.21	0.14	-0.49	0.07	0.15	0.00
Post-treatment						
0	-0.03	0.16	-0.35	0.29	0.87	0.00
1	0.91	0.21	0.51	1.31	0.00	17.00
2	0.89	0.19	0.52	1.27	0.00	17.00
3	1.38	0.49	0.42	2.33	0.00	5.00
4	0.30	0.28	-0.25	0.85	0.28	5.00
5	0.96	0.31	0.35	1.58	0.00	4.00
6	0.52	0.33	-0.13	1.17	0.12	3.00
7	-0.00	0.38	-0.75	0.74	0.99	1.00
Average						
Average	0.65	1.43	-2.17	3.45	0.65	17

Figure A.1: Generalized Synthetic Control: Counterfactual Fit

(a) Grazing



(b) Land



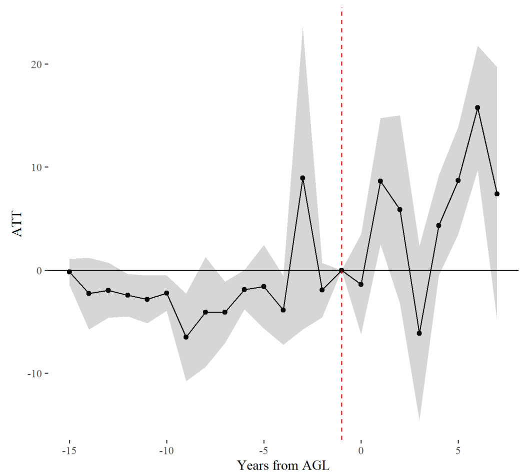
Note: Outcome is fatalities per capita. Panel A is grazing conflicts, Panel B is land conflicts. Dashed line is the counterfactual average and the solid line is the average for the treated cohorts.

Table A.2: Generalized Synthetic Control Results: Periodwise Treatment Effects for Land Conflict Per Capita

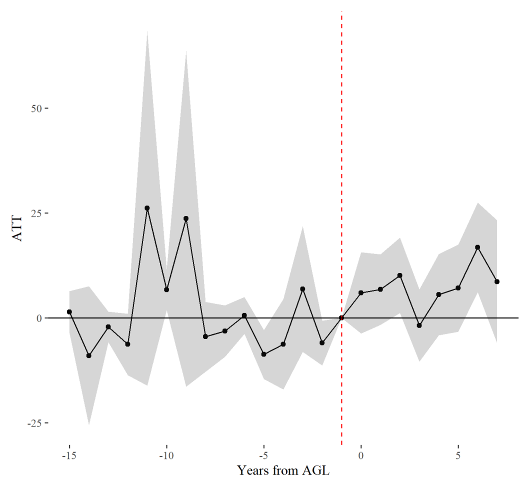
Relative Time	ATT	S.E.	CI.lower	CI.upper	P-value	Number Treated
Pre-treatment						
-8	-0.03	0.11	-0.25	0.19	0.80	0.00
-7	-0.03	0.17	-0.36	0.29	0.84	0.00
-6	-0.06	0.06	-0.19	0.06	0.32	0.00
-5	0.03	0.05	-0.07	0.14	0.52	0.00
-4	0.05	0.04	-0.03	0.13	0.22	0.00
-3	0.02	0.10	-0.17	0.21	0.87	0.00
-2	0.03	0.11	-0.18	0.24	0.80	0.00
-1	-0.03	0.14	-0.31	0.26	0.86	0.00
0	0.13	0.11	-0.09	0.34	0.25	0.00
Post-treatment						
1	0.22	2.99	-5.64	6.07	0.94	17.00
2	1.07	0.44	0.21	1.94	0.02	17.00
3	0.43	4.95	-9.28	10.14	0.93	5.00
4	0.23	4.21	-8.02	8.48	0.96	5.00
5	1.30	7.92	-14.23	16.83	0.87	4.00
6	1.12	10.24	-18.95	21.18	0.91	3.00
7	-0.01	0.20	-0.39	0.38	0.98	1.00
Average						
Average	0.86	0.12	0.60	1.11	3.21e-11	17

B Results with Region-by-Year Linear Trends

(a) Grazing



(b) Land



Note: Outcome is fatalities per capita. Each point estimate represents the difference-in-differences relative to the year before AGL are implemented, from specifications which include region by year linear time trends. Estimates to the left of the vertical dashed line are placebo pre-trend estimates, estimates to the right are treatment effects. Panel A is grazing conflicts, Panel B is land conflicts. Shaded regions are confidence intervals, constructed from standard errors clustered by state.

C Synthetic Difference-in-Differences

We present the results from synthetic difference in differences by cohort first, and then in aggregate. We obtain standard errors from 1,000 bootstrap replications.

Table C.1: Synthetic DID Estimates: Land Conflict Outcome

Cohort	τ	*weight*	*weighted* τ
2016	-0.16	7.00	-0.02
2017	3.93	12.00	0.91
2018	0.17	5.00	0.02
2019	-0.01	4.00	-0.00
2021	0.21	24.00	0.10
Overall effects			
Aggregate ATT	0.9996		
Bootstrap SE	0.5470		
P-value	0.076		

Table C.2: Synthetic DID Estimates: Grazing Conflict Outcome

Cohort	τ	*weight*	*weighted* τ
2016	-0.12	7.00	-0.02
2017	2.24	12.00	0.52
2018	-0.10	5.00	-0.01
2019	0.05	4.00	0.00
2021	0.17	24.00	0.08
Overall effects			
Aggregate ATT	0.5738		
Bootstrap SE	0.3179		
P-value	0.079		

D Measurement Error

Table D.1: Conflict Results with Weighted Regression (Cell Phone Density Weights)

Dependent Variables:	Grazing Conflict		Land Conflict	
Model:	(1)	(2)	(3)	(4)
Variables				
ATT	0.3150***	0.3151**	0.4909***	0.5189***
	(0.0658)	(0.1480)	(0.1136)	(0.1806)
Fixed-effects				
State	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Crop Tercile x Year		Yes		Yes
Area Tercile x Year		Yes		Yes
Desertification Tercile x Year		Yes		Yes
Ethnic Fractionalization Tercile x Year		Yes		Yes
Fit statistics				
Observations	592	592	592	592

Clustered (State) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

E Alternative Conflict Data: Armed Conflict Location Event Dataset (ACLED)

Our preferred specification and main results rely on the Nigeria Watch dataset, produced by a political violence observatory which focuses on smaller-scale land and cattle-related killings, among other forms of violence. We believe these data give us the clearest indication of ground-level conditions of farmer-herder conflict in Nigeria. However, in order to probe the robustness of our findings, we run alternative specifications with geo-referenced conflict data from the Armed Conflict Location Event Dataset (ACLED) (Raleigh et al., 2010). ACLED collects political violence and protest events worldwide, at highly disaggregated levels (by day and latitutde/longitude). Unlike Nigeria Watch, ACLED also collects information about events that do not have fatalities. However, ACLED does not code causes for violence: as such, information about whether the event fits within the relevant 'farmer-herder' violence category is deduced from secondary information on actors involved. Moreover, ACLED focuses on political violence: smaller-scale incidents such as land disputes may not fall within their coding parameters. We therefore parse ACLED data to include only those events which feature Farmers, Herders, and Pastoralists as actors or associate actors (or are noted in the event description). Figure E.1 shows a comparison between this subsection of ACLED data compared to Nigeria Watch data on aggregate, showing similar trends reported at the country-level over time.

We replicate our primary specifications with ACLED event count at the state level. We do not use ACLED fatality estimates in this analyses. According to ACLED documentation, fatality counts are low-confidence and to be taken as best guesses only. Many event fatality counts represent low-confidence estimates that draw from diverging reports. Moreover, when the number of fatalities is unknown, ACLED codes a '10' – skewing fatality counts substantially. Especially for remote and less organized conflicts like the ones we review in this paper, such noisy fatality data is inappropriate. Therefore, we use per-capita event counts as our primary measurement.

Estimates are noisy, but largely replicate the main results. No evidence is detected of pre-trends, and the year after AGL sees a sharp divergence between AGL and non-AGL states in farmer-herder conflict event trends measured by ACLED, adjusted by state population. Using ACLED data, the positive effect on conflict dissipates more quickly.

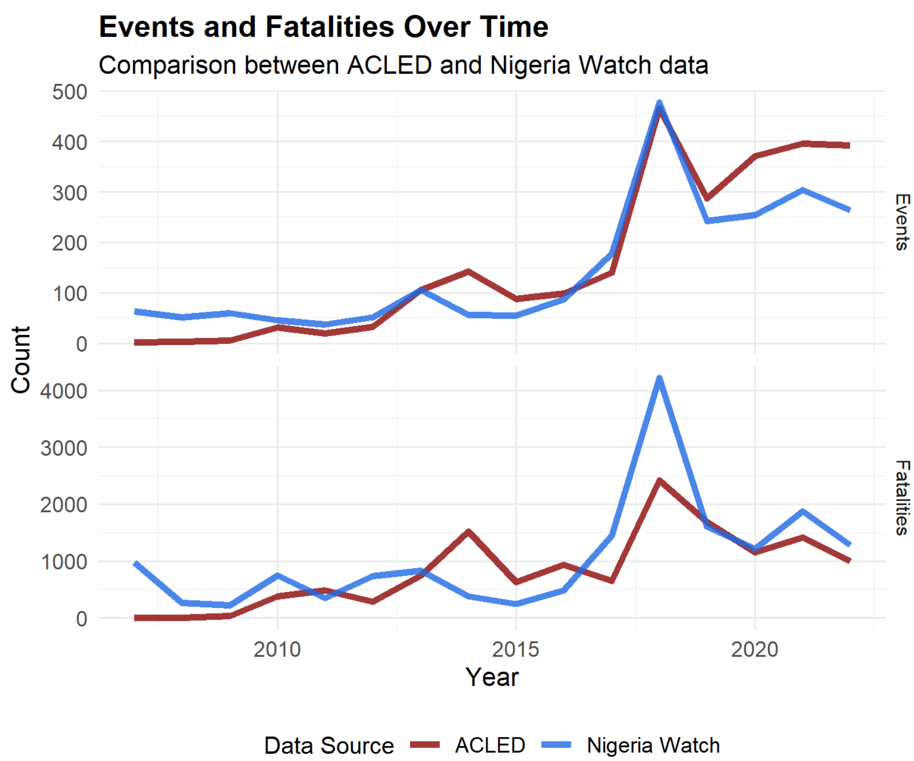


Figure E.1: Conflict events (top) and fatality trends (bottom) over time related to pastoralist conflict in Nigeria, as reported by ACLED (red) and Nigeria Watch (blue). Nigeria Watch event counts for cattle grazing and land conflict were summed.

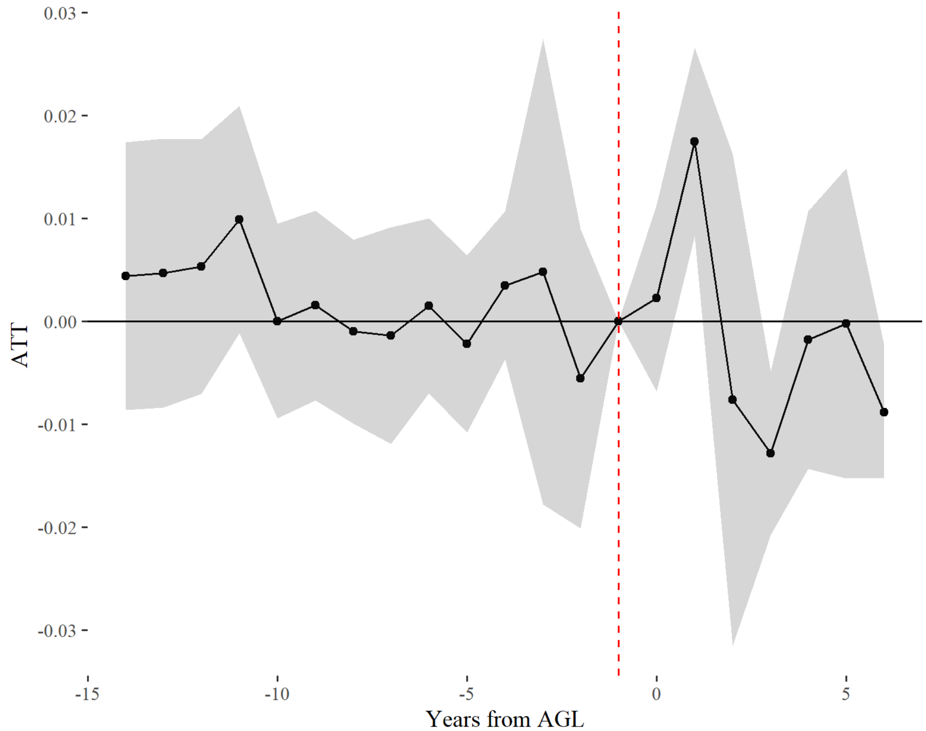


Figure E.2: ACLED event study results

F Further Afrobarometer Analyses

In addition to our main analysis using three rounds of Afrobarometer survey data, Rounds 7 (2017) and 8 (2020) ask three questions directly about farmer-herder conflict, recorded in Table F.1.

Table F.1: Afrobarometer Rounds 7 (2017) and 8 (2020) Survey Questions on Farmer-Herder Conflict

Label	**Question**	**Response**
Heard of conflict	*How much, if at all, have you heard about the conflicts between farmers and herders in this country?*	0 Not at all 1 A little bit 2 Some 3 A lot
Concerned about conflict	*How concerned are you about the conflicts between farmers and herders?*	1 Very concerned 2 Somewhat concerned 3 Not very concerned 4 Not concerned at all
Conflict trend	*In your opinion, would you say the conflict between farmers and herders has increased, decreased, or stayed the same over the past year?*	0 Increased a lot 1 Increased a little 2 Stayed the same 3 Decreased a little 4 Decreased a lot

We use these questions to create a principal component index that captures individuals perceptions of farmer-herder conflict. We reverse the scale of the 'heard of conflict' measure to ensure that high values for all questions suggest less frequent violence. Higher values of the index correspond to the perception of peace, whereas lower ones correspond to more of a perception of conflict. Because these questions appear in only two rounds of Afrobarometer, our data encompasses only two observations for each state (with only 2 states passing treatment in between), limiting the inferences we can draw and the cohorts we draw inferences from. For instance, across these two rounds in the states treated in 2018 and 2019 (the states therefore with baseline and post-treatment results), zero individuals reporting Hausa or Fulani ethnicity were surveyed. With these limitations in mind, we nevertheless regress respondents' responses on whether their state was treated at the time the survey was administered.

Since our data is only two rounds, we cannot test for the parallel trend assumption as we do with our conflict outcome. However, we leverage the fact that farmers ought to be the ones who perceive conflict most acutely, since they are the targets of pastoralist militias.

Table F.2: AGL Reduces Perceptions of Peace Among Farmers

Dependent Variables:	Peace Index	Trend	Concern	Heard Of
Model:	(1)	(2)	(3)	(4)
Variables				
1(Ag Occupation)	-0.3163**	0.0490	-0.0112	-0.2808***
	(0.1280)	(0.1219)	(0.0855)	(0.0778)
AGL State × Post AGL	0.5585	0.6096**	0.2867	-0.0043
	(0.4436)	(0.2435)	(0.1897)	(0.1870)
AGL State × 1(Ag Occupation)	0.5051	0.0564	0.1458	0.2801
	(0.4840)	(0.2539)	(0.2413)	(0.1714)
Post AGL × 1(Ag Occupation)	0.1134	-0.2093	-0.0957	0.2509***
	(0.1546)	(0.1583)	(0.1043)	(0.0917)
AGL State × Post AGL × 1(Ag Occupation)	-0.9145*	0.0022	-0.4221*	-0.5412**
	(0.5288)	(0.2009)	(0.2209)	(0.2023)
Fixed-effects				
State	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Fit statistics				
Observations	2,585	2,585	2,585	2,585

Clustered (State) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Therefore, we estimate the triple difference model. Our approach controls the fact that farmers and non-farmers have baseline differences in the perception of the conflict as well as baseline differences between states.

Results are reported in Table F.2. Our results in column (1) show a .57 standard deviation decrease in perceptions of peace. The result is driven by change in concern about conflict and reports of having heard about conflict (columns 3 and 4).

G Drought By Cohort

Triple difference estimation with staggered treatment timing is relatively unexplored econometrically. In general, staggered treatments may containment treatment effects, meaning it is possible that estimates of δ_3 from equation (2) are biased. As such, we estimate five separate models, one for each treatment cohort, where the data contain only clean control states (ones that never had AGL) and the states in a single treatment cohort. Our approach ensures that each specification has a single treatment time.

Table G.1: Drought and AGL by Cohort

Model:	(1)	(2)	(3)	(4)	(5)
Panel A:Dependent Variable:	Land Conflict				
Variables					
Drought	1.54	1.71	1.44	1.43	0.97
	(0.98)	(1.05)	(0.93)	(0.97)	(0.62)
AGL	-2.43	64.56***	3.75**	3.78	3.14
	(2.22)	(20.98)	(1.66)	(2.64)	(2.81)
Drought × AGL	-0.51	11.47***	3.88**	0.56	2.70
	(1.13)	(3.24)	(1.85)	(1.20)	(2.43)
Panel B: Dependent Variable:	Cattle Conflict				
Drought	0.77	1.13	0.73	0.69	0.50
	(0.68)	(0.69)	(0.65)	(0.69)	(0.38)
AGL	-1.89	24.80***	-2.16	3.74	2.27
	(1.82)	(2.20)	(1.44)	(2.59)	(2.78)
Drought × AGL	-0.34	17.04***	-1.22	0.84	0.10
	(0.89)	(3.03)	(1.83)	(1.04)	(1.74)
Fixed-effects					
Year	Yes	Yes	Yes	Yes	Yes
LGA	Yes	Yes	Yes	Yes	Yes
Varying Slopes					
LGA Trends	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Cohort	2016	2017	2018	2019	2021
Observations	7,412	7,803	7,429	7,684	11,305

Clustered (state) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*