Transhumant Pastoralism, Climate Change and Conflict in Africa

Eoin F. McGuirk[*†]
Tufts University

Nathan Nunn[*‡]
Harvard University and CIFAR

5 April 2021

Abstract: We consider the effects of climate change on seasonally migrant populations that herd livestock – i.e., transhumant pastoralists – in Africa. Traditionally, transhumant pastoralists benefit from a cooperative relationship with sedentary agriculturalists whereby arable land is used for crop farming in the wet season and animal grazing in the dry season. Droughts can disrupt this arrangement by inducing pastoral groups to migrate to agricultural lands before the harvest, causing conflict to emerge. We examine this hypothesis by combining ethnographic information on the traditional locations of transhumant pastoralists and sedentary agriculturalists with high-resolution data on the location and timing of rainfall and violent conflict events in Africa from 1989–2018. We show that droughts in the territory of transhumant pastoralists lead to conflict in neighboring agricultural areas. Additionally, (i) the conflict is concentrated in the wet season and not the dry season; and (ii) the mechanism operates through rainfall's effect on plant biomass growth. We also find that this effect on conflict is greater in countries where pastoral groups have less political power. The magnitudes of our estimates indicate that nearly all of the reduced-form relationship between adverse rainfall shocks and conflict in Africa is explained by this mechanism.

Key words: Transhumant pastoralism, sedentary agriculture, seasonal migration, conflict, weather.

JEL classification: N10; Q54; Z1.

[*]We thank various seminar audiences at Tufts University, Harvard University, the CEPR Macroeconomics and Growth Programme Meeting, CSAE (Oxford), PacDev (UC San Diego) and the Research Institute for Development, Growth and Economics, Towards Sustainable Growth Workshop, and also Elias Papaioannou. We also thank Mohammad Ahmad, Laura Kincaide and Leo Saenger for excellent RA work.

[†]Tufts University. Address: Tufts University, Department of Economics, 8 Upper Campus Road, Braker Hall, Medford, MA, 02155, USA. (email: eoin.mcguirk@tufts.edu; website: https://eoinmcguirk.com).

[‡]Department of Economics, Harvard University, 1805 Cambridge Street, Cambridge, MA 02138, U.S.A. (e-mail: nnunn@fas.harvard.edu; website: http://www.economics.harvard.edu/faculty/nunn).

1. Introduction

Civil conflict deters private investment, undermines state capacity, and destroys physical and human capital. As of 2020, there were an estimated 79.5 million forcibly displaced people worldwide. In Africa alone, 1.23 million people were killed in civil conflict events during the thirty years from 1989–2018.[1] These events have become more frequent and more severe over time. During the same period, as a consequence of climate change, annual rainfall has been well below average and droughts have become more common. These trends are consistent with a growing literature that links hot and dry weather to violence at both the interpersonal and intergroup levels (Miguel, Satyanath and Sergenti, 2004, Burke, Miguel, Satyanath, Dykema and Lobell, 2009, Hsiang, Burke and Miguel, 2013, Harari and Ferrara, 2018, Fetzer, 2020, Eberle, Rohner and Thoenig, 2020).

Due to a relative dearth of evidence on specific causal mechanisms, questions remain about the future impact of climate change on conflict (Burke, Hsiang and Miguel, 2015, Solow, 2013, Mach, Kraan, Adger, Buhaug, Burke, Fearon, Field, Hendrix, Maystadt, O'Loughlin, Roessler, Scheffran, Schultz and von Uexkull, 2019). In this paper, we test a mechanism linking weather shocks to violent conflict between sedentary agricultural and transhumant pastoral ethnic groups in Africa. Sedentary agricultural groups primarily subsist by cultivating crops on plots of land in fixed settlements. By contrast, pastoral groups obtain a significant proportion of their subsistence through animal husbandry, while *transhumant* pastoral groups additionally engage in transhumance, which is the seasonal movement of grazing animals.

In typical years, neighboring agricultural and transhumant pastoral groups coexist in a symbiotic relationship that is characterized by this seasonal migration (Moritz, 2010). In the wet season, agriculturalists farm on productive lands while transhumant pastoralists exploit more marginal lands that produce sufficient plant biomass (or *phytomass*) for their livestock. After the final harvest, the pastoralists migrate along well-established corridors to arrive at the agricultural farmlands for the dry season, where they benefit from the year-round availability of phytomass while providing organic fertilizer in exchange. These journeys can range from hundreds of meters to hundreds of kilometers (Kitchell, Turner and McPeak, 2014). In low precipitation years, there may not be enough phytomass produced on the marginal grazing lands to sustain pastoralists' livestock. When this happens, they are forced to migrate to agricultural farmlands before the dry season. If the animals arrive before the final harvest, conflict can emerge due to damaged crops and competition for resources such as water and pasture (Brottem, 2016).

This mechanism generates a clear hypothesis: droughts that occur in the territories of transhumant pastoralists lead to conflict in nearby agricultural lands.

We test this hypothesis by examining the incidence of conflict using two sets of geocoded conflict measures, one collected by the Uppsala Conflict Data Program (UCDP) (Sundberg and Melander, 2013) and another by the Armed Conflict Location & Event Data Project (ACLED) (Raleigh, Linke, Hegre and Karlsen, 2010).

[1] Data on displaced people are from the UNHCR's Refugee Population Statistics Database. The figure on conflict fatalities comes from the Uppsala Conflict Data Program version 19.1 (Sundberg and Melander, 2013).

To determine the identity of pastoral groups, we use data from the *Ethnographic Atlas* (Murdock, 1967), which contains information on the economic and cultural practices of pre-colonial ethnic societies worldwide. We construct two ethnicity-level variables that measure transhumant pastoralism. Both variables contain information on the historical importance of animal herding in the society, as used by Becker (2019), combined with information on the mobility of an ethnicity. One variable defines transhumant groups as being those that are traditionally fully- or semi-nomadic. The other broadens the definition to also include groups that are traditionally semi-sedentary or live in impermanent settlements.

To determine the location of these ethnic groups, we turn to George Peter Murdock's map of pre-colonial ethnic societies in Africa (Murdock, 1959). By matching groups in the *Ethnographic Atlas* to territories on this map, we are able to connect the characteristics of ethnic groups to the prevalence of conflict.

We begin the analysis by examining whether or not violence is more prevalent in the neighborhood of transhumant pastoral groups. We first study this relationship at the level of an ethnic group. We find that the incidence of conflict within a group's territory is indeed associated with the extent to which the neighbors of this group are transhumant pastoral. We then study this relationship at the level of a 0.5-degree grid cell. For each grid-cell, we identify its 'nearest neighboring ethnic group,' which is the neighboring ethnic group that is geographically closest to the cell. We find that the same relationship that is present at the ethnicity level is also found at the cell level. Grid-cells that have a nearest neighboring ethnic group that is transhumant pastoral tend to experience more conflict. The relationship is present when using either the UCDP or ACLED data and it appears to be primarily driven by conflicts that involve state actors, such as the police or military. This is consistent with accounts in which state forces represent agricultural landowners and non-state forces represent pastoral groups.

Having documented cross-sectional correlations, we then turn to the question of whether adverse rainfall shocks that occur in the territories of transhumant pastoralists lead to conflict in nearby agricultural lands. We undertake our analysis using a panel that varies by 0.5-degree grid-cells and years (1989–2018 when using the UCDP data and 1997–2020 when using the ACLED data). All specifications include grid-cell fixed effects, which account for time-invariant factors, and country-year fixed effects, which account for common shocks within a country each year.

We test whether the incidence of conflict in a cell is differentially influenced by precipitation in the nearest neighboring ethnic group if they are transhumant pastoral. Thus, the coefficient of interest is for an interaction between the measure of transhumant pastoralism of a grid-cell's nearest neighboring ethnic group and the average amount of rain in that group's territory in a year. We find clear evidence that higher precipitation in the nearest neighboring ethnic group reduces conflict in a given cell, but only if the neighbor is transhumant pastoral.

The estimated effects are sizable and significant. We find that a one standard deviation adverse precipitation shock in a transhumant pastoral society raises the risk of conflict in a nearby grid-cell by around 35%, or 1.21 percentage points (from a mean of 3.5% to 4.71%). For the same shock, a non-transhumant pastoral group is predicted to have a much smaller effect that is not statistically

different from zero (around 2%, or 0.07 percentage points).

The specifications also allow for a direct effect of rainfall that occurs in the grid-cell itself or in the territory of the ethnic group in which the grid-cell lies. We find that these estimated direct effects of precipitation are small and statistically insignificant. Thus, while we estimate sizable spillover effects due to the nearby presence of transhumant pastoralism, we find no evidence that rainfall in a cell directly affects conflict in the same cell.

Consistent with our hypothesis, we find that the estimated spillover effects are primarily driven by conflict in agricultural territories. That is, adverse rainfall shocks in transhumant pastoral territories only affect conflict in a neighboring cell if it is agricultural.[2] Overall, the findings indicate that periods of low precipitation induce pastoralists to migrate early to agricultural farmlands, which results in damaged crops, competition for resources, and conflict.

We conduct a series of additional exercises to test for this mechanism with precision. First, we estimate strikingly similar results when we replace data on precipitation with data on phytomass growth, as recorded by the European Union's *Copernicus* satellite program. Since phytomass growth is potentially endogenous to conflict, we also estimate the relationship using precipitation as an instrument, again finding similar results.

Second, we use month-level conflict data to further test the implications of our hypothesis. If adverse shocks induce pastoral groups to migrate before the harvest, and if this movement leads to conflict due to damaged crops and competition for resources, then we should observe these conflict events during the wet (i.e., growing) season, and not during the dry season. We find that this is the case: adverse rainfall shocks in transhumant pastoral societies lead to conflict in nearby cells during the wet season, but not during the dry season. Again, the results are explained entirely by conflict in agricultural cells. We see precisely the same pattern when we study the impact of phytomass growth rather than precipitation. These results are not due to the existence of 'fighting seasons' during which all conflict takes place—indeed the unconditional probability of conflict is slightly higher during the dry season than the wet season. Instead, they bolster the hypothesis that adverse environmental shocks upend the traditional relationship between neighboring farmers and herders by inducing competition for resources before the growing season has ended.

Finally, we show that there is no spillover effect when we replace our data on precipitation with data on temperature. This is informative for two reasons. First, many studies have shown that temperature is linked to conflict through a variety of mechanisms that are orthogonal to our hypothesis (Burke et al., 2015). The absence of any effect indicates that these mechanisms are not at play. Second, this finding is consistent with the fact that temperature is a second-order determinant of phytomass growth, explaining around six times less variation than precipitation, which is the first-order determinant.

As in the cross-sectional exercise, our main estimates appear to be driven by conflicts that involve state actors. This is consistent with accounts in which state forces represent agricultural landowners and non-state forces represent pastoral groups. We probe this further by investigating

[2]We define cells as 'agricultural' if they are located within the territory of an ethnic group that traditionally obtained more than 50% of its subsistence from agriculture according to variable v5 from the *Ethnographic Atlas*.

explicitly whether the representation of transhumant pastoral groups in national government affects our estimates. We use the Ethnic Power Relations dataset to calculate, for each year and country, the extent to which transhumant pastoral groups hold power in national politics. We then allow our estimated effects to vary depending on this measure.

We find that our spillover effect approaches zero as transhumant pastoral groups gain a higher share of national political power. This result indicates that state forces respond with violence to incursions by pastoral groups when the latter are politically excluded. However, when transhumant pastoral groups share more political power, they are likely afforded grazing rights that circumvent violent clashes. This pattern suggests that climate-induced conflict between farmers and herders can be mitigated with the appropriate political representation.

Our findings provide evidence for a specific but important mechanism through which climate change affects conflict: droughts in the territories of transhumant pastoralists lead to conflict in nearby agricultural lands. Since weather events in one area cause conflict in another, estimating this effect requires a spillover design. Failing to correctly model the spillover effects could lead researchers to underestimate the true impact of adverse rainfall shocks on conflict. The extent of such a bias will depend on the level of analysis chosen by the researcher. For example, when using low-resolution (e.g., country-level) data, it is plausible that both the weather event and the conflict event occur within the same unit of analysis. In this case, the spillover effects will be captured. However, when analyzing high-resolution (e.g., cell-level) data, empirical designs that do not explicitly model the spillover effects will fail to capture the potential impact of weather events that are experienced outside of the cell. This logic indicates that the estimated direct effect of adverse rainfall shocks on conflict will depend on the size of the unit of analysis.

We show that this is indeed the case by estimating the effect of rainfall in a cell-year on conflict in the same cell-year for grid-cells ranging in size from 1 degree to 7 degrees (which is roughly the mean country size in Africa). Consistent with the presence of spillover effects, we find that the negative impact of rainfall on conflict gradually increases in magnitude as we enlarge the area of the unit of analysis. This pattern is only present when we focus on the subsample of Africa that is suitable for agriculture and pastoralism, which is around 56% of its landmass. This exercise highlights the pitfalls of ignoring spillover effects in granular data. It also indicates that in the presence of spatial spillovers, simply adjusting the size of the cells being studied is not sufficient. In settings where the spillovers are not universal across space, one needs also to have a minimal understanding of the source of the spillovers. This implies that details of the local cultural context are important for identifying the effects of climate change.

Our findings add to the existing ethnographic literature on the relationship between sedentary farmers and nomadic herders in Africa in the pre- and post-colonial periods (Lewis, 1961, Jacobs, 1965, Konczacki, 1978, Dyson-Hudson and Dyson-Hudson, 1980). We also build upon more recent studies that document how African pastoral groups are affected by climate shocks (Little, Smith, Cellarius, Coppock and Barrett, 2001, McPeak and Barrett, 2001, Maystadt and Ecker, 2004, Bollig, 2006).

We also contribute directly to the literature on climate and conflict (see Burke et al., 2015) and to a broad literature on the determinants of conflict within Africa, including studies that explore

the importance of historical factors (e.g., Besley and Reynal-Querol, 2014, Depetris-Chauvin, 2015, Michalopoulos and Papaioannou, 2016, Moscona, Nunn and Robinson, 2020); ethnic or social factors (Montalvo and Reynal-Querol, 2005, Esteban, Mayoral and Ray, 2012, Rohner, Thoenig and Zilibotti, 2013); and economic factors, especially shocks to the opportunity cost of conflict (McGuirk and Burke, 2020), which can be challenging to distinguish empirically from shocks that affect other drivers of conflict (Blattman and Miguel, 2010, Dube and Vargas, 2013, Dal Bó and Dal Bó, 2011). We overcome this issue with our spillover design, which traces the effect of an adverse economic shock that occurs in one ethnic territory on conflict that occurs in a neighboring ethnic territory.

Our findings also shed light on the nature of cross-ethnicity conflicts. In particular, they pinpoint one mechanism consistent with the recent finding in Depetris-Chauvin and Ömer Özak (2020) that conflict tends to occur near ethnic boundaries, and also with the recent finding in Eberle et al. (2020) that conflict tends to be higher at the boundaries of nomadic and non-nomadic groups when temperature is higher than average. Our analysis supports these findings and provides evidence that an important mechanism underlying the relationship is the disruption of the traditional symbiotic relationship between pastoralists and sedentary farmers.

An important aspect of our mechanism is that the link between rainfall and conflict occurs through spatial spillovers. Our findings thus contribute to other analyses that aim to estimate climate-conflict relationships at a disaggregated level while allowing for the possibility of spatial spillovers (e.g., Harari and Ferrara, 2018). This prior research takes a more empirical approach towards characterizing the nature of spillovers on average within Africa. By contrast, our analysis starts with a particular theoretical mechanism in mind that is motivated by the ethnographic literature. We then build our estimator to capture this precise mechanism while accounting for other, more general forms of spillover. Thus, our strategy is similar to other studies that also specify a particular spillover mechanism ex-ante that is then brought to the data. For example, König, Rohner, Thoenig and Zilibotti (2017) estimate the effects of weather shocks experienced by a military or rebel group's network of allies and enemies during the Second Congo War.

The paper is organized as follows. In Section 2, we provide a description of the traditional symbiotic relationship between nomadic pastoralists and sedentary farmers in Africa. We also discuss recent changes in climate on the continent and how this has affected the nature of the farmer-herder relationship. In Section 3, we describe the data used in the main analysis. In Section 4, we present quantitative cross-sectional evidence on the prevalence of conflict in these areas. In Section 5, we propose and test an econometric model that explicitly addresses the spillover effect of weather shocks at the cell-level. In Section 6, we present a series of analyses that test for causal mechanisms.

We now turn to a description of the background of our setting and an overview of the relationship between sedentary farmers and transhumant pastoralists that is core to our mechanism of interest.

2. Background and Context

A. Traditional Farmer-Herder Relations

Animal husbandry is the primary mode of subsistence for a large number of individuals in rural parts of the African continent. Recent estimates suggest that 268 million people—approximately 22% of the population of Africa—obtain the majority of their income from animals. Approximately 43% of Africa's landmass supports pastoral activities (FAO, 2018, p. 1).

Most pastoral groups in Africa are *transhumant*, which means that they engage in seasonal movements of their animals. This is an important attribute that is central to our analysis. These activities are also commonly referred to as 'nomadic pastoralism,' which the OECD describes as "the livelihood of a group of human beings based on the movement of large herds of herbivores maximizing use of plant and water resources, which are limited, variable and dispersed." (OECD, 2014, p. 142)

A defining feature of transhumant pastoralism is that it results in regular seasonal interactions with sedentary agriculturalists. Farmers and herders have developed a symbiotic relationship that allows for both groups to use land and other resources in an efficient and mutually beneficial manner.

On the continent, naturally-occurring seasons generate a period (or periods) of the year that are wet or dry. Exactly when during the year the wet and dry seasons occur depends on where one is on the continent, and particularly whether one is north or south of the equator. The seasonal variation is shown in Figure 1, which reports rainfall across the continent in two months, August and January. August, which is shown on the left, is a wet season month for most of the continent that lies north of the equator. For the continent south of the equator, the month is part of the dry season. By contrast, in January, which is shown on the right, the north experiences a dry season and the south a wet season.

The transhumant migrations that occur are illustrated in the maps of Figure 2, which provide stylized depictions of hypothetical sedentary agricultural groups (in blue) and transhumant pastoral group (in red) in West Africa. During the wet season, when crops are cultivated, pastoralists keep their livestock on marginal grazing land that is not suitable for agriculture but does support the growth of wild grasses that provide sustenance to animals. During the dry season, this growth no longer occurs. As a result, herds are moved to the more fertile farmlands that are used for agriculture during the wet season but are left fallow during the dry season. This movement is shown by the arrows in the right map. Animal herds are allowed to graze on the land during this period. This arrangement benefits both the pastoralists, who enjoy the dry-season production of animal feed, and the farmers, whose land is improved by the animals' manure, a form of nitrogen-rich organic fertilizer. At the end of the dry season, herds are moved from the agricultural lands and return to the more marginal grazing lands. This is shown by the arrows in the left map.

Thus, due to the seasonal movements of herds, both sedentary farmers and transhumant pastoralists are able to exploit the land efficiently and cooperatively.

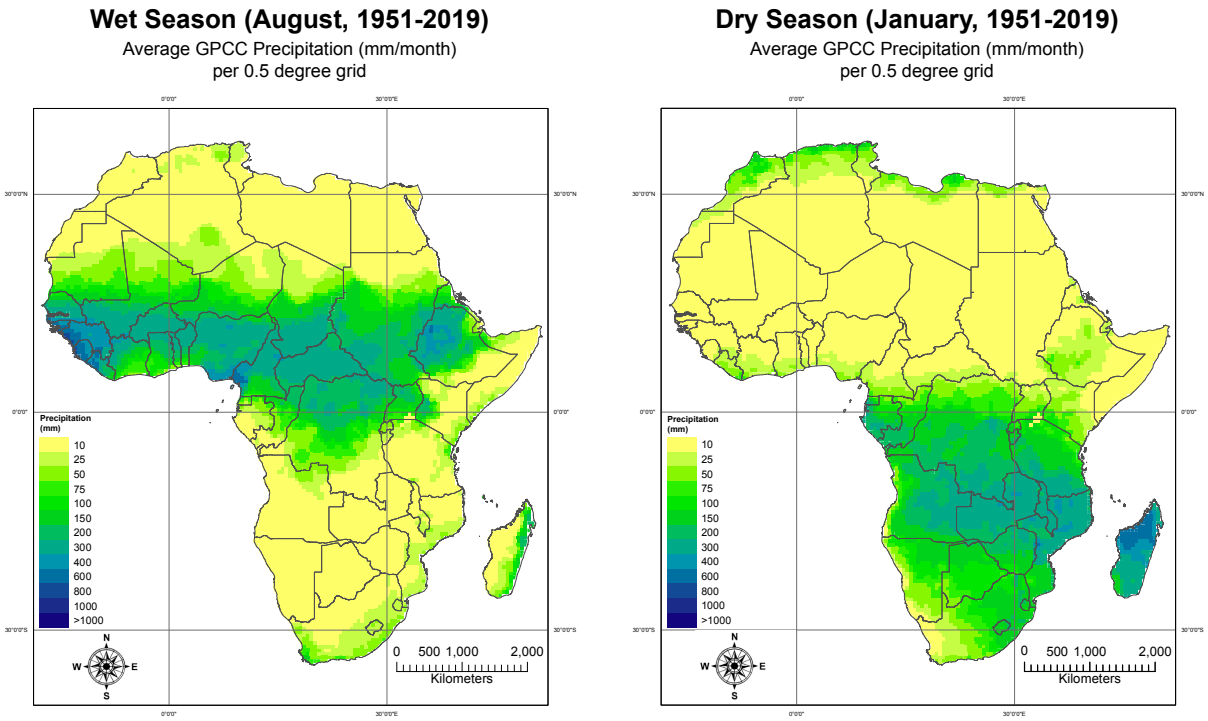


Figure 1: Seasonal rainfall in Africa.

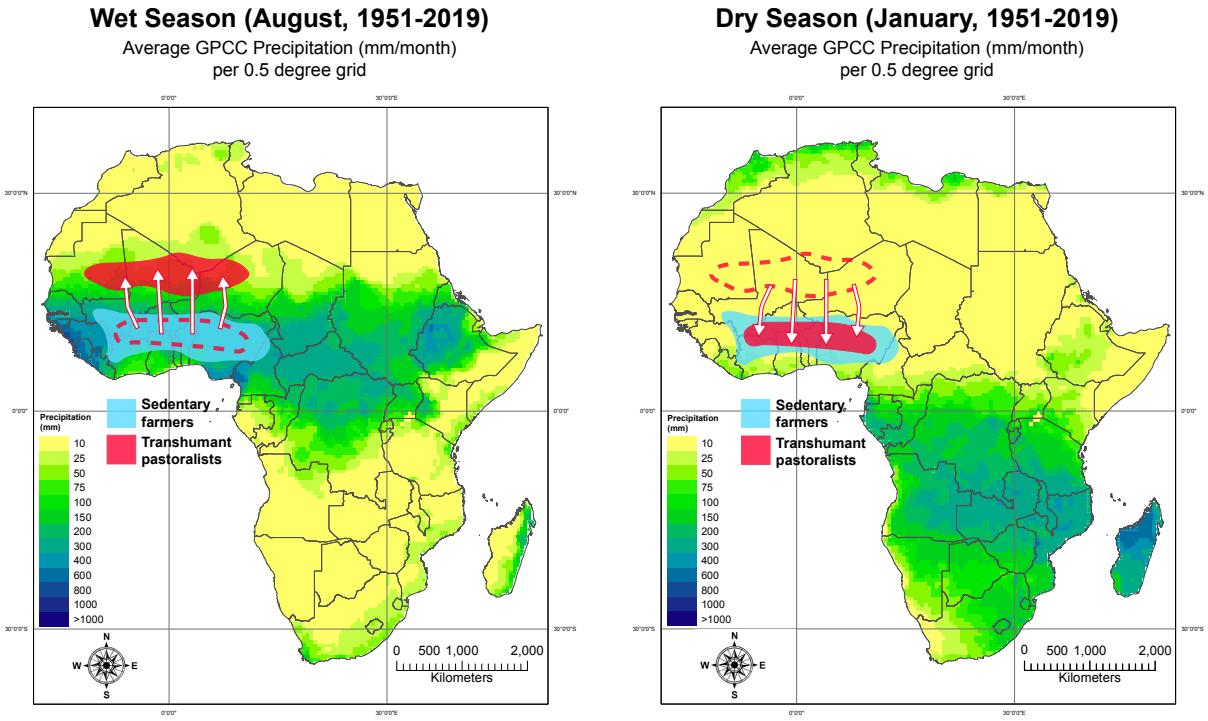


Figure 2: Rainfall and seasonal migration in Africa.

Stenning (1959), in his study of the pastoral Fulani, describes their transhumant relationship with the neighboring agriculturalists of the Uda'en as follows:

> In the dry season herds are dispersed southward in response to shortages of pasture and water and congregate again in the north to avoid tsetse fly in the wet season. A wide variation in the distance and impetus of these movements is found, depending on location variations in savannah habitat, but seasonal movement is a consistent feature of Fulani pastoralism throughout this zone... pastoral life is pursued not in isolation, but in some degree of symbiosis with sedentary agricultural communities. Alongside the continuous exchange of dairy products for grain and other goods, there have existed, possibly for many centuries, arrangements for pasturing cattle on land returning to fallow, and for guaranteeing cattle tracks and the use of water supplies. Pastoral Fulani did not, and do not, merely graze at will, but obtained rights to the facilities they required from the acknowledged owners of the land. (pp. 4, 6)

The details of transhumant pastoralism and of the timing and nature of the symbiotic relationship with farmers varies from region to region. For example, while most of the continent experiences one wet season and one dry season, some locations experience a "dual wet season," meaning a wet season, then a dry season, and then another wet season. Other locations are "bimodal," having one wet season, but within this, two clear peaks during the wet season. However, across the continent, the most common pattern is for one wet season that has a unimodal distribution of rainfall. The second most common, which is present in parts of Kenya, Ethiopia, and Somalia, is for two distinct wet seasons, each of which has a unimodal distribution of rainfall (Herrmann and Mohr, 2012). However, in all cases, the logic of seasonal movements of grazing animals to fallow agricultural lands still holds.

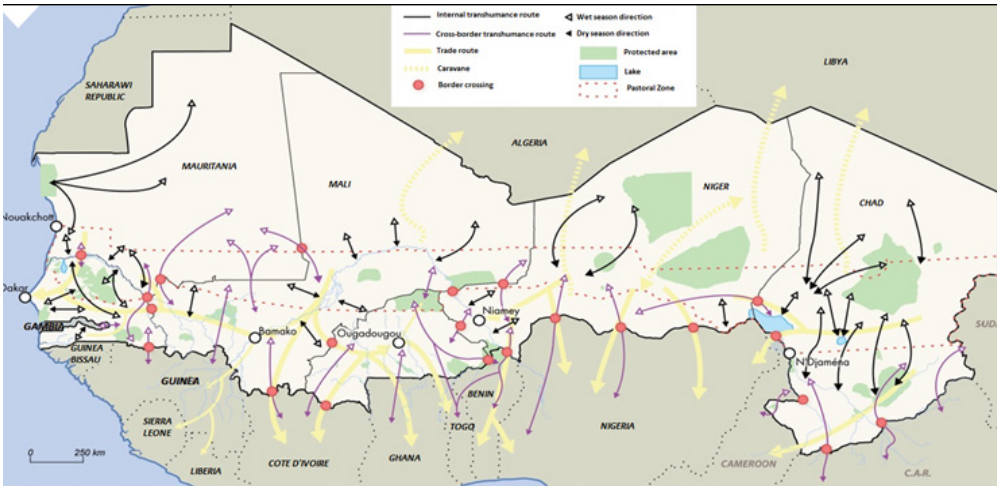
The consequence of these traditional relationships is that there exist extensive transhumance routes in the parts of Africa with ecological zones that have these features, the largest region being the Sahel. These transhumance routes, examples of which are shown in Figures 3a and 3b, can extend over hundreds of kilometers and typically cross ethnic and national boundaries.

B. Effects of Climate Change

Almost certainly, this symbiotic relationship was never free from conflict. However, recent decades appear to have witnessed a rise in conflict between transhumant pastoralists and sedentary farmers, at the very least in terms of media coverage of such conflicts.[3] At this same time, the African continent as a whole, but particularly the Sahel region, has experienced rainfall that is persistently below average. Existing climatological research indicates that there was a noticeable

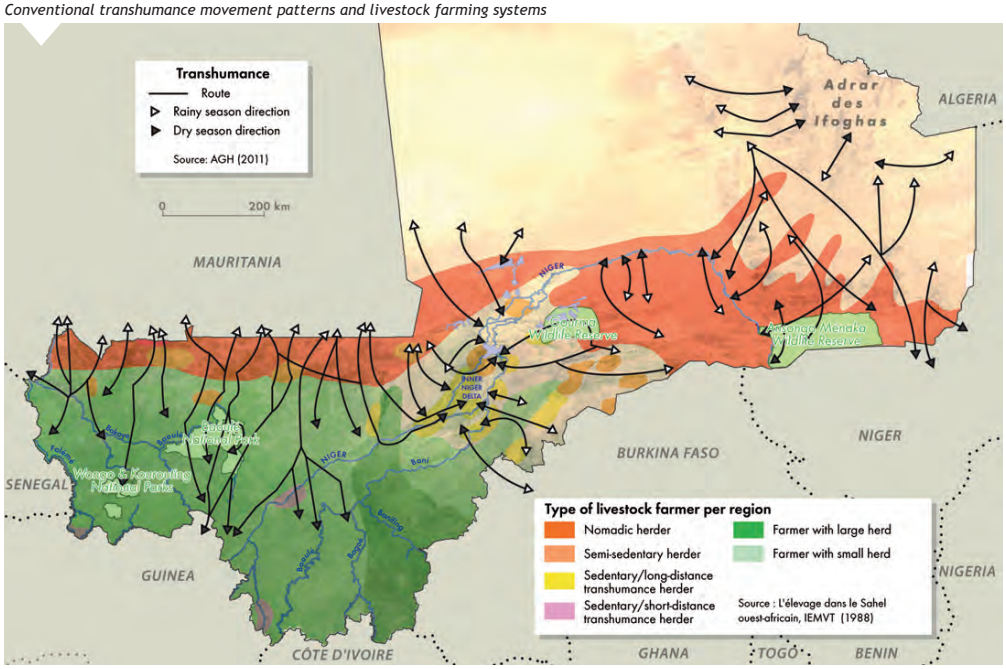
[3]Examples of recent accounts include The Economist ("Fighting in the Sahel has forced 1.7m people from their homes," accessed July 2020 at https://www.economist.com/graphic-detail/2020/06/20/fighting-in-the-sahel-has-forced-17m-people-from-their-homes); Foreign Affairs ("The Deadliest Conflict You've Never Heard of," accessed July 2020 at https://www.foreignaffairs.com/articles/nigeria/2019-01-23/deadliest-conflict-youve-never-heard); and Reuters ("Sahel herders facing harshest dry season in years, aid agency warns," accessed July 2020 at https://www.reuters.com/article/us-africa-herders/sahel-herders-facing-harshest-dry-season-in-years-aid-agency-warns-idUSKBN1CW1ZF).

Figure 13. Cyclic annual transhumance routes in West Africa[11]



Source: FAO and CIRAD, (2012).

(a) Transhumance routes and countries in West Africa. Source: Diop et al. (2012).



(b) Transhumance routes and ethnic groups in Mali. Source: Ham et al. (2012).

Figure 3: Seasonal transhumance routes of nomadic pastoralists in West Africa

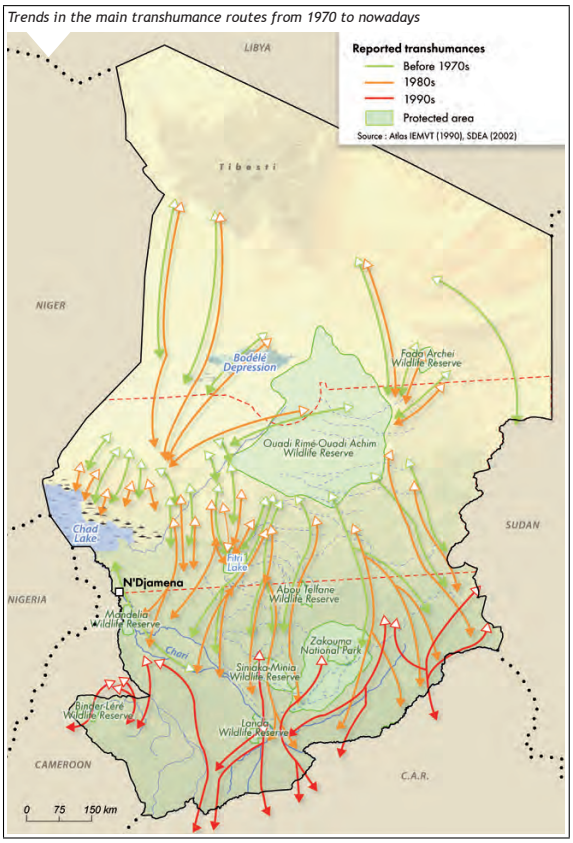


Figure 4: Changing transhumance routes over time, 70s, 80s, and 90s.

change towards a weaker monsoon and drier conditions beginning in the late 1960s (Nicholson, Fink and Funk, 2018). Recent rainfall data show that within the Sahel region, between 1970 and 2017, average rainfall was below the long-run (1900–2017) average in 36 of the 47 years (Schneider, Becker, Finger, Meyer-Christoffer, Rudolf and Ziese, 2015). In recent years, there is some evidence that the rainfall shortage during the past decades is attenuating. However, the evidence also indicates that important characteristics of the rainy season have also permanently changed (Biasutti, 2018, Herrmann and Mohr, 2012).

According to descriptive accounts, this new climate regime has led to changes in transhumance routes. Over time, they tend to extend deeper into agricultural lands and to occur earlier in the season. Although detailed data on the transhumance routes over time are not available, coarse estimates have been put together by various NGOs and government agencies. An example of such information is provided in Figure 4, which is taken from Kamis, Saleh, Ickowicz, Touré, Cesaro and Toutain (2012). It shows the gradual southerly displacement of transhumance routes in Chad from the 1970s to the 1990s.

These trends are plausibly explained by the climatology literature, which has established a strong correlation between rainfall and the amount of living organic plant matter—referred to as *phytomass*—produced in the Sahel. This relationship has been shown to be present regardless of the intensity with which animal grazing takes place (Hein, 2006). While temperature is also a factor, its role is primarily due to the effect that it has on rainfall (Biasutti, 2018). Thus, given

the central importance of rainfall—particularly monsoon rainfall—for phytomass growth, our analysis focuses on this characteristic of climate.

Moreover, because we aim to estimate precise spatial spillovers at a very local level, our analysis requires variability in the determinants of plant growth at a fine geographic resolution. As illustrated by the maps in Appendix Figure A1, this is true for precipitation, but much less so for temperature. The effect that temperature has on rainfall does not vary at a local level: temperature in one macro-level region affects the rainfall patterns in another. For example, Shanahan, Overpeck, Anchukaitis, Beck, Cole, Dettman, Peck, Scholz and King (2009) examine paelohydrological data from the past three millennia and show that persistent drought in West Africa is caused by increased Atlantic sea surface temperatures. Cook and Vizy (2013) document the effects that warming in the Middle East, South Asia, and particularly the Indian Ocean have on precipitation in Eastern Africa.

In short, although temperature changes are important at a macro-level due to their effect on spatial and temporal rainfall patterns, the existing research indicates that, at a local-level, temperature is not the primary determinant of phytomass. As we explain in further detail in the next section, our own calculations are consistent with this conclusion. We find that for a given location, the annual variation in rainfall explains about six times more of the variation in phytomass than temperature does.

3. Data

A. Description, Sources, and Validation

Conflict Our baseline set of geocoded conflict variables is from the Uppsala Conflict Data Program (UCDP). Conflict events are two-sided battles or one-sided attacks that produce at least one fatality. In order to be included, all conflict dyads must have engaged in a large-scale conflict battle in which at least 25 people were killed. We include two mutually exclusive categories of conflict: *State* implies that the state was involved in the event; *Non-State* implies that only non-state actors, such as rebel groups or militias, were involved. UCDP conflict data run from 1989–2018.

We also use an alternative set of geocoded conflict variables taken from the Armed Conflict Location & Event Data project (ACLED), which run from 1997–2020. Because the ACLED data are available for a shorter time period, we use the UCDP data for our baseline estimates and check the robustness of our findings to the use of the ACLED data. We consider only violent conflict events, namely two-sided battles and one-sided attacks. There is no equivalent criteria for inclusion to the ACLED dataset, which is perhaps why the unconditional probability of ACLED conflict incidence is 8% while the figure for UCDP is 3% (see Table 1).

Transhumant Pastoralism To identify transhumant pastoral societies, we use information from the *Ethnographic Atlas*, a database of 1,265 ethnic groups assembled and published by Murdock from 1962–1980. We construct a composite index that captures the two key aspects of transhumant pastoralism.

The first key aspect is that the group moves seasonally; namely, that they are transhumant. There is extensive information in the *Ethnographic Atlas* on the mobility of ethnic groups traditionally. Variable v30 of the database codes groups as falling within one of the following categories that describe the nature of settlement: (1) Nomadic or fully migratory; (2) Seminomadic; (3) Semisedentary; (4) Compact but impermanent settlements; (5) Neighborhoods of dispersed family homes; (6) Separated hamlets; (7) Compact and relatively permanent; and (8) Complex settlements.

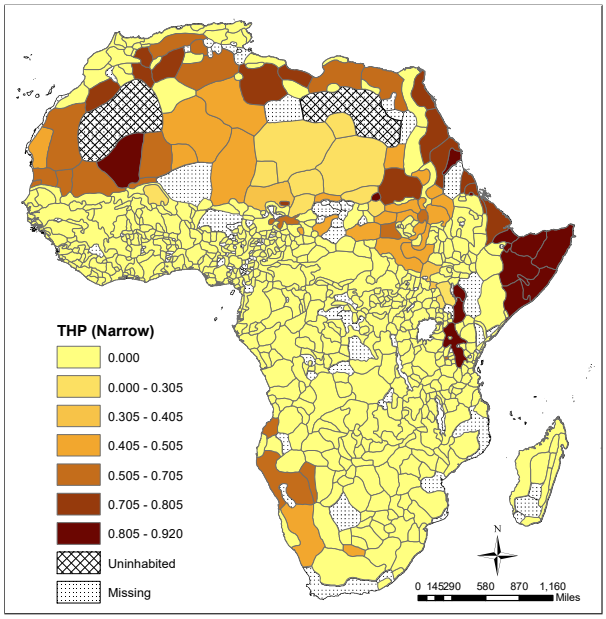
Although transhumance is not measured explicitly, nearly all forms of movement are today seasonal—non transhumant nomadism is now rare. Thus, we take being traditionally nomadic as a proxy for being transhumant. We create two indicator variables that allow for two definitions: our 'narrow' definition of transhumance includes only groups that are 'nomadic or fully migratory' or 'seminomadic'; while our 'broad' definition of transhumance additionally includes groups that are 'semisedentary' or that have 'compact but impermanent settlements.' The variants differ in whether groups that are semi-mobile are coded as being transhumant (second measure) or not (first measure). We denote this variable $Transhumant_e$.

The second key aspect of transhumant pastoralism is the herding of animals. To capture this dimension, we build on a measure developed by Becker (2019). Her variable combines information on the fraction of subsistence that is from animal husbandry (measured on a 0-1 scale, from variable v4 in the *Ethnographic Atlas*) with an indicator variable that equals one if the primary large animal is suitable for herding (from variable v40). Animals that require herding include sheep, goats, equine animals, camels, and bovine animals, but not pigs. Becker's measure is constructed as the interaction between these two measures. Thus, it ranges from 0-1 and is a proxy for the fraction of an ethnic group's subsistence that is from herded animals. We denote this variable $Pastoral_e$.

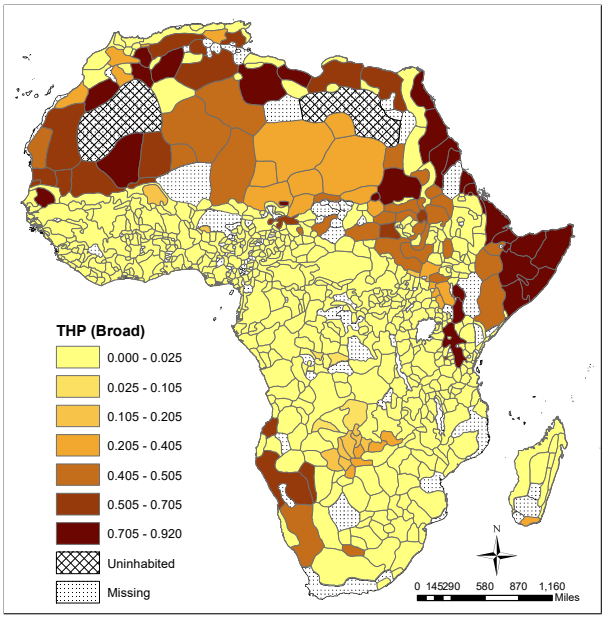
Our measure of 'transhumant pastoralism' is constructed as the interaction between the two components: $Transhumant_e \times Pastoral_e$. The resulting variable, which we denote $TranshumantPastoral_e$, measures the fraction of a transhumant group's subsistence that is from pastoralism.

To assign these variables to spacial units, we match each society from the *Ethnographic Atlas* to ethnic territories in a digitized version of the map from George Peter Murdock's book, *Africa: Its Peoples and their Culture History*. Using a variety of sources, documented in Kincaide, McGuirk and Nunn (2020), we match around 96% of the ethnic territories in the map to corresponding ethnic groups in the *Ethnographic Atlas*. Figure 5 shows the distribution of the transhumant pastoralism indices across ethnic groups using this map.

The location and intensity of transhumant pastoralism is consistent with expectations and determined primarily by the locations of lands that are most suitable for animal grazing rather than agriculture. To confirm this, in Figure 6, we display the spatial distribution of land suitability for transhumant pastoralism and sedentary agriculture. The measures, which are from Beck and



(a) Narrow definition of transhumant pastoralism



(b) Broad definition of transhumant pastoralism

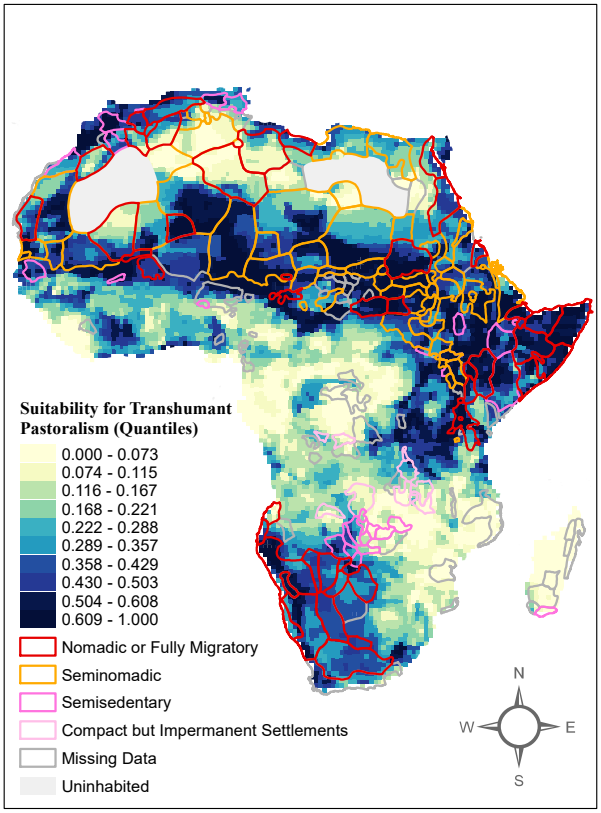
Figure 5: Cross-ethnicity measures of transhumant pastoralism.

Sieber (2010), are displayed with a darker shade indicating greater suitability.[4] Also shown in Figure 6 are the boundaries of ethnic groups from the Murdock map that exhibit some degree of traditional mobility and so are defined as transhumant by our narrow and/or broad definition. From the figure, it is clear that the ecological environment, as captured by the underlying suitability data from Beck and Sieber (2010), is an important determinant of the degree of mobility reported in the *Ethnographic Atlas* and of our measure of transhumant pastoralism.

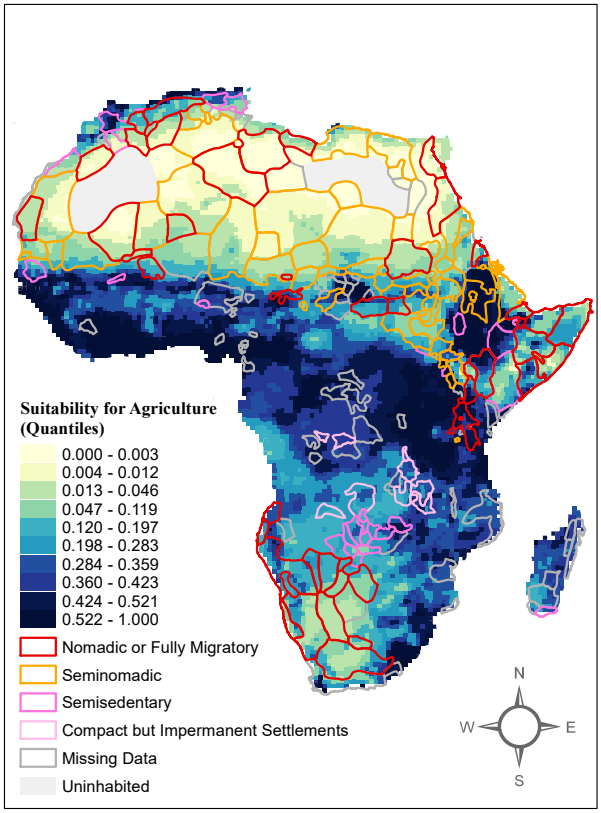
Rainfall Pastoral groups rely on precipitation to produce the phytomass needed to sustain their livestock. Our main weather shock variable is a 0.5 degree cell-year measure of precipitation calculated by the Global Precipitation Climatology Centre (Schneider et al., 2015). It measures land-surface precipitation from rain gauges built on Global Telecommunications System (GTS)-based data, which is an international system for the dissemination of meteorological data from weather stations, satellites and numerical weather prediction centers. This variable covers the full duration of our conflict series (1989–2018). It is measured in centimeters per month.

We verify the importance of rainfall for plant growth using satellite data on dry matter vegetation (i.e., phytomass). The data are at the level of a 1km pixel weekly from 1999–2018 and are taken from *Copernicus*, the European Union's Earth observation program. We aggregate the data to the 0.5 degree cell-year level and measure the final variable in average kilograms per hectare per month.

[4]Beck and Sieber (2010) use ecological niche modeling to derive spatial predictions of land use types based on climactic and soil input data. The database covers all of the African mainland at a 2.5 arc-minute (approx. 5km) resolution. In the database, transhumant pastoralism is called 'nomadic pastoralism.' Since nearly all nomadic activity today (i.e., movement of populations) is transhumant (i.e., seasonal), we refer to the measure as 'transhumant pastoralism.'



(a) Suitability for transhumant pastoralism



(b) Suitability for sedentary agriculture

Figure 6: Ecological Conditions and Transhumant Pastoralism

We estimate the determinants of phytomass at the cell-year level. We model phytomass as a function of average annual precipitation and temperature, while conditioning on cell fixed effects and country-by-year fixed effects.[5] The estimates, which are reported in Appendix Table A1, confirm the importance of precipitation for vegetation growth. We report estimates that include only rainfall, only temperature, and both together. Consistent with the environmental science literature, we find that rainfall is a significant determinant of phytomass growth. In addition, by various metrics, we find rainfall to be a much more important determinant than temperature. First, after partialling out the fixed effects, rainfall explains 3.6% of the residual variation while temperature explains 0.6%; second, the F-statistic for rainfall is 136 while for temperature it is 31; third, we estimate that a within-cell standard deviation rise in rainfall increases phytomass by 1.61% of the mean, while the equivalent rise in temperature decreases phytomass by 0.53%.

Given that rainfall is the main driver of phytomass growth, we proceed using rainfall as our primary climate shock variable. In sensitivity checks, we also report estimates using phytomass directly as a summary measure of the climate shocks experienced in a cell and year.[6]

B. Summary of the Data

The descriptive statistics for our main variables (conflict, transhumant pastoralism, and rainfall), as well as all other covariates used in the analysis, are reported in Table 1. We present in separate panels variables that vary at the cell-year, cell, ethnic-group-year and ethnic group levels. At the cell-year level, the incidence of conflict is 3% when using the UCDP data and 8% when using the ACLED data. The average precipitation is 5.65 centimeters per month and the average temperature is 24.5 degree Celsius. Looking at ethnicity characteristics, one can see that the average measure of transhumant pastoralism is 0.08 when the narrow measure is used and 0.10 when the broad measure is used.

In Table 2, we present summary statistics separately for groups that are transhumant pastoral and groups that are not. In column (1), we report averages for groups with a measure of transhumant pastoralism that is greater than zero; in column (2), we report averages for groups with a measure of transhumant pastoralism that is equal to zero; and in column (3), we estimate the difference in means. We find that transhumant pastoralism is associated with less conflict (for both UCDP and ACLED), less precipitation, less phytomass, higher temperatures, less land suitable for agriculture, and more land suitable for transhumant pastoralism. It is also associated with lower population, fewer nighttime lights, and less national political power. Looking at historical ethnographic traits, we see that transhumant pastoral groups, not surprisingly, practice less agriculture and were more developed politically (as measured by levels of political authority beyond the local community).

These comparisons make clear that transhumant pastoralism is not randomly allocated across the continent. The practice is determined by agricultural conditions. In addition, it is clear that transhumant pastoralism is associated with other factors, namely historical state development

[5]This specification includes the same fixed effects as in our baseline estimating equations.

[6]We use rainfall as our baseline measure since it is available for a much longer time series than phytomass.

Table 1: Descriptive Statistics

	Mean	SD	Count	Min	Median	Max
	Cell-Year Level Variables, 1989-2018					
UCDP: I(Any Conflict), 0/1	0.03	0.18	290730	0.00	0.00	1.00
ACLED: I(Any Conflict), 0/1	0.08	0.27	213202	0.00	0.00	1.00
Precipitation, cm/month	5.65	5.14	290730	0.00	4.38	49.28
Phytomass, kg/ha	30.69	30.35	193820	0.01	23.44	141.11
Temperature, $^{\circ}C$	24.50	3.95	251922	7.51	24.75	39.53
Nighttime Lights, 0-1	0.04	0.03	203511	0.00	0.03	0.96
	Cell Level Variables					
Nearest Neighbor Transhumant Pastoralism (Narrow Definition), 0-1	0.19	0.30	8487	0.00	0.00	0.92
Nearest Neighbor Transhumant Pastoralism (Broad Definition), 0-1	0.21	0.30	8487	0.00	0.00	0.92
B-S: Land Suitability for Transhumant Pastoralism, 0-1	0.32	0.20	9421	0.00	0.29	0.90
B-S: Land Suitability for Agriculture, 0-1	0.24	0.20	9421	0.00	0.22	0.88
ln(Population)	9.55	2.16	9691	0.00	9.88	16.19
	Ethnic-Group-Year Level Variables, 1989-2018					
EPR: Political Power, 0-5	2.12	1.16	11165	0.00	2.00	5.00
	Ethnic Group Level Variables					
Transhumant Pastoralism (Narrow Definition), 0-1	0.08	0.23	591	0.00	0.00	0.92
Transhumant Pastoralism (Broad Definition), 0-1	0.10	0.23	591	0.00	0.00	0.92
Avg. Neighbor Transhumant Pastoralism (Narrow Definition), 0-1	0.10	0.18	649	0.00	0.00	0.92
Avg. Neighbor Transhumant Pastoralism (Broad Definition), 0-1	0.12	0.19	649	0.00	0.00	0.92
EA: Agriculture, 0-1	0.55	0.18	618	0.03	0.61	0.92
EA: Jurisdictional Hierarchy, 0-4	1.28	0.97	571	0.00	1.00	4.00

Note: This table presents basic descriptive statistics. The first panel presents variables that vary at the level of a cell-year. *UCDP: I(Any Conflict)* and *ACLED: I(Any Conflict)* measure conflict incidence. *Precipitation* is measured in average cm per month. *Phytomass* is the average monthly growth of dry vegetation measured in kg/ha. This is computed using the 'Dry Matter Productivity' variable from the *Copernicus* remote sensing program. *Temperature* is from Fan and van den Dool (2008). *Nighttime Lights* is based on data collected by US Air Force Weather Agency and processed by NOAA's National Geophysical Data Center. The second panel presents cross-sectional variables that vary at the level of a cell. *Nearest Neighbor Transhumant Pastoralism* measures, for each cell, the transhumant pastoralism index score of the nearest ethnic group that is contiguous to the ethnic group in which the cell lies. The narrow measure includes only groups that are classified in the *Ethnographic Atlas* as 'nomadic or fully migratory' or as 'seminomadic.' The broad measure additionally includes groups that are 'semisedentary' or that have 'compact but impermanent settlements.' The *Land Suitability* variables are based on data from Beck and Sieber (2010). *Population* is measured in persons and is taken from CIESIN and CIAT (2005). The third panel presents variables that vary at the level of an ethnic-group-year. *EPR: Political Power* is the score assigned to each ethnic group in the *Ethnic Power Relations* dataset, where 0 indicates that the group is either discriminated against or completely excluded from national politics, while a score of 5 indicates that the group has a monopoly on national political power. In cases where an ethnic group shares power in multiple countries, we compute the average score. The fourth panel presents cross-sectional variables that vary at the level of an ethnic group. *Transhumant Pastoralism* is described in the main text. *Avg. Neighbor Transhumant Pastoralism* measures the average transhumant pastoralism index score across an ethnic group's contiguous neighbors. The variable *EA: Agriculture* measures an ethnic group's historical dependence on agriculture for subsistence; the variable *EA: Jurisdictional Hierarchy* measures the number of jurisdictional layers beyond the local community within an ethnic group; both of these variables are from the *Ethnographic Atlas*. The variables *Temperature*, *Nighttime Lights* and *Population* are available in the PRIO-GRID v.2.0 dataset (Tollefsen, Strand and Buhaug, 2012).

Table 2: Balance Table, Sub-Samples by THP Classification

Variable	(1) THP > 0	(2) THP = 0	(3) Difference
	Cell-Year Level, 1989-2018		
UCDP: I(Any Conflict), 0/1	0.024	0.042	-0.018***
	(0.152)	(0.200)	(0.002)
ACLED: I(Any Conflict), 0/1	0.051	0.098	-0.047***
	(0.221)	(0.297)	(0.003)
Precipitation, cm/month	2.066	8.513	-6.447***
	(2.715)	(4.857)	(0.078)
Phytomass, kg/ha	9.214	47.835	-38.621***
	(17.333)	(27.446)	(0.475)
Temperature, $^{\circ}C$	25.323	23.859	1.465***
	(4.115)	(3.688)	(0.083)
Nighttime Lights, 0-1	0.037	0.042	-0.006***
	(0.021)	(0.043)	(0.001)
Observations	115,650	148,740	290,730
	Cell Level		
Nearest Neighbor Transhumant Pastoralism (Narrow Definition), 0-1	0.357	0.070	0.287***
	(0.333)	(0.204)	(0.006)
Nearest Neighbor Transhumant Pastoralism (Broad Definition), 0-1	0.378	0.085	0.294***
	(0.323)	(0.214)	(0.006)
B-S: Land Suitability for Transhumant Pastoralism, 0-1	0.390	0.266	0.124***
	(0.196)	(0.186)	(0.004)
B-S: Land Suitability for Agriculture, 0-1	0.099	0.354	-0.255***
	(0.132)	(0.182)	(0.004)
ln(Population)	8.844	10.840	-1.996***
	(1.626)	(1.446)	(0.033)
Observations	3,855	4,958	9,691
	Ethnic-Group-Year Level, 1989-2018		
EPR: Political Power, 0-5	1.845	2.162	-0.317**
	(1.166)	(1.107)	(0.136)
Observations	3,750	17,610	23,400
	Ethnic Group Level		
Avg. Neighbor Transhumant Pastoralism (Narrow Definition), 0-1	0.275	0.049	0.226***
	(0.233)	(0.128)	(0.015)
Avg. Neighbor Transhumant Pastoralism (Broad Definition), 0-1	0.310	0.060	0.250***
	(0.226)	(0.137)	(0.015)
EA: Agriculture, 0-1	0.338	0.593	-0.255***
	(0.208)	(0.133)	(0.015)
EA: Jurisdictional Hierarchy, 0-4	1.555	1.240	0.315***
	(0.852)	(0.980)	(0.100)
Observations	125	587	780

Note: This tables presents balance tests at the level of an ethnic-group-year. Column (1) shows averages across groups where our measure of *Transhumant Pastoralism* (THP) is greater than zero. Column (2) shows averages across groups where this measure is equal to zero. We use the broader definition of THP that includes all pastoral groups without fully permanent settlements. Standard errors are clustered by ethnic group. See Table 1 for variable descriptions.

and political power today. These facts highlight the importance of our auxiliary analyses which look for evidence of our specific mechanism of interest, test for the importance of other traits, like pre-colonial state centralization, and examine the importance of contemporary political power.

4. Cross-Sectional Relationships

We begin our analysis by presenting cross-sectional evidence on the relationship between being near transhumant pastoral groups and conflict. Motivated by our mechanism of interest, our empirical setup allows transhumant pastoralism to affect conflict in nearby territories. We begin by first estimating variation across ethnic groups before undertaking a finer analysis at the grid-cell level.

A. Ethnicity-level analysis

Looking across ethnic groups, we test whether an ethnic group e experiences more conflict within their territory if they are adjacent to ethnic groups that are transhumant pastoral. We examine this with the following estimating equation:

$$y_{et} = \delta_1 TranshumantPastoral_e^{Neighbor} + \delta_2 TranshumantPastoral_e^{OwnGroup} + \delta_3 \ln(pop_e) + \alpha_t + \varepsilon_{et}, \quad (1)$$

where e indexes ethnic groups and t years (1989–2018); y_{et} is an indicator for the presence of conflict within the traditional territory of ethnicity e during year t; $TranshumantPastoral_e^{Neighbor}$ is the average value of our measure of transhumant pastoralism among all ethnic groups that are a neighbor to (i.e., contiguous to) ethnicity e. We also allow for the possibility that transhumant pastoralism affects the amount of conflict in their own territory by including $TranshumantPastoral_e^{OwnGroup}$, which is the measure of transhumant pastoralism of ethnicity e. Lastly, $\ln(pop_e)$ is the natural log of the population of ethnicity e, averaged over 1990, 1995, 2000, 2005, and 2010, and α_t denote year fixed effects. The parameter of interest, δ_1, describes the effect of having transhumant pastoral neighbors. Standard errors are two-way clustered at the level of an ethnic group (to account for serial correlation with ethnic groups) and climate zone-year (to account for spatial correlation within 14 climate zones).

Estimates of equation (1) are reported in Table 3. Panel A reports estimates using the more restrictive definition of transhumance that includes two categories, while panel B reports estimates for the broader measure that includes four categories. Each column reports estimates using a different dependent variable. Columns 1–3 report estimates for the incidence of any conflict, state-involved conflicts, and conflicts not involving the state, each measured using the UCDP data. Column 4 reports estimate for the incidence of any conflict using the ACLED data.

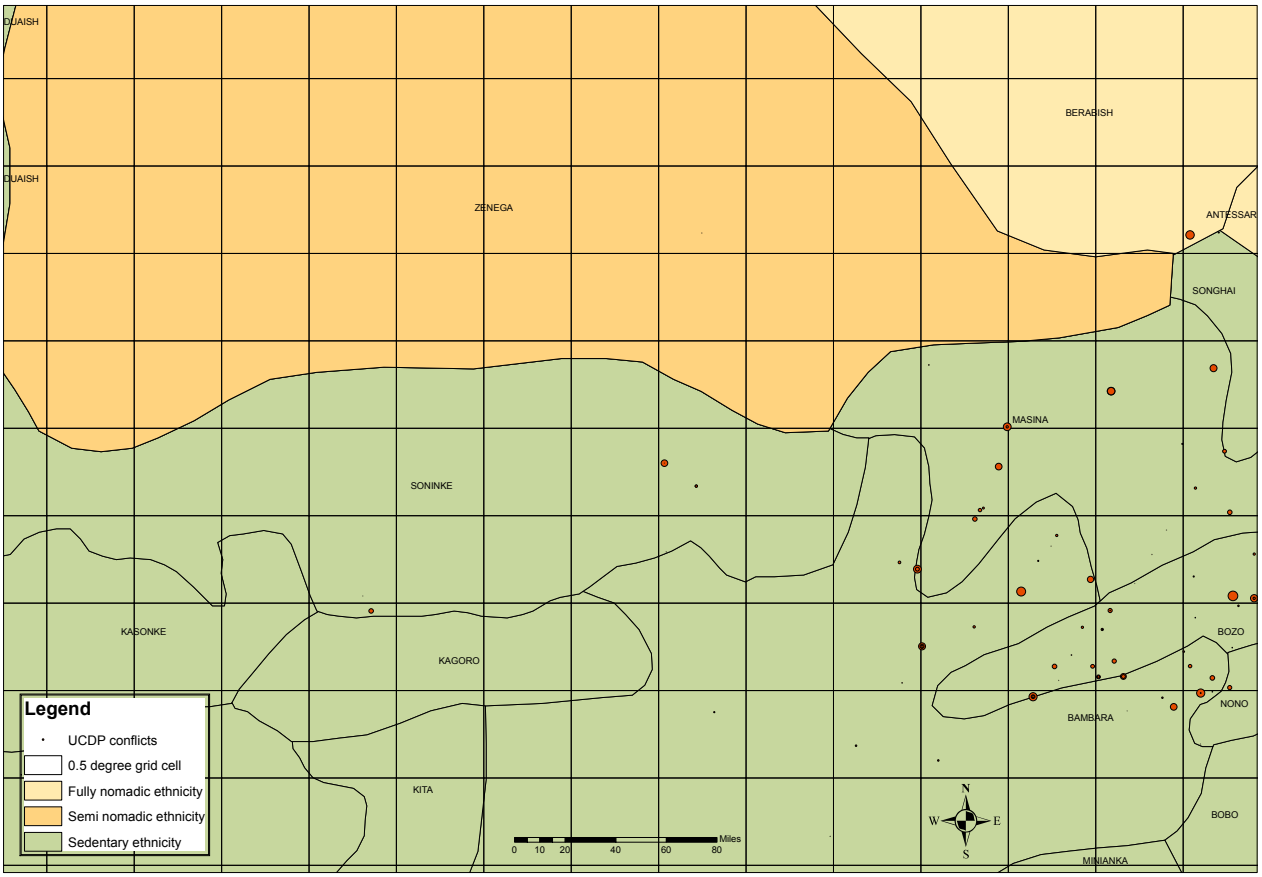
In all specifications, we find that an ethnic group is more likely to experience conflict if its neighbors are transhumant pastoralist. While this relationship is present for all conflict measures, it is much smaller – about one-third the magnitude – for conflicts that do not involve the state. Thus, the aggregate conflict results appear to be primarily driven by conflicts that involve state forces, such as the police or military.

Table 3: Transhumance-Related Conflict in the Cross-Section: Ethnicity-Level Spillover Analysis

	Indicator for the presence of conflict			
	(1) UCDP I(Any)	(2) UCDP I(State)	(3) UCDP I(Non-State)	(4) ACLED I(Any)
Panel A: Transhumant definition includes only groups that are migratory or nomadic				
Avg. Neighbor Transhumant Pastoral [δ_1]	0.3089***	0.2862***	0.0995**	0.3258***
	(0.0671)	(0.0597)	(0.0442)	(0.0805)
Transhumant Pastoral [δ_2]	0.1269**	0.0707	0.1049**	0.1476**
	(0.0559)	(0.0490)	(0.0419)	(0.0643)
ln(population) [δ_3]	0.0355***	0.0258***	0.0253***	0.0862***
	(0.0063)	(0.0056)	(0.0046)	(0.0083)
Panel B: Transhumant definition includes all groups without fully permanent settlements				
Avg. Neighbor Transhumant Pastoral [δ_1]	0.2928***	0.2768***	0.0884**	0.3316***
	(0.0616)	(0.0549)	(0.0415)	(0.0760)
Transhumant Pastoral [δ_2]	0.1383***	0.0813*	0.1066***	0.1409**
	(0.0522)	(0.0456)	(0.0384)	(0.0616)
ln(population) [δ_3]	0.0363***	0.0267***	0.0253***	0.0871***
	(0.0064)	(0.0057)	(0.0046)	(0.0083)
Dep. Var. Mean	0.174	0.131	0.096	0.374
Year FE	Yes	Yes	Yes	Yes
Climate-Zone-Years	393	393	393	316
Ethnic Groups	711	711	711	711
Observations	21,330	21,330	21,330	17,064

Note: All outcome variables measure conflict incidence at the level of an ethnic group-year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in the territory of an ethnic group in a year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in the territory of an ethnic group in a year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in the territory of an ethnic group in a year. ln(Population) is the natural log of average cell-level population measured in 1990, 1995, 2000, 2005, and 2010. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of an ethnic group and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Figure 7: **Structure of Data and Analysis**



Note: The figure displays the data used in our cell-level analysis. The 0.5-degree cells are shown, along with the boundaries of the ethnic groups, their names of ethnic groups, and the extent to which they are transhumant or sedentary (from variable v30 of the *Ethnographic Atlas*).

B. Cell-level analysis

We next examine variation at the level of a 0.5 degree grid cell (approx. 55km $\times$ 55km at the equator). The sample comprises 9,691 cells nested in approximately 700 ethnic territories located across Africa. These are shown for a region in Western Africa in Figure 7 that was traditionally inhabited by the Zenega, Soninke, Masina and others. The maps also shows the location of conflicts in the UCDP data from 1989–2018.

As in the ethnicity-level analysis, our aim is to study the effect of nearby transhumant pastoralism on conflict in a cell. To do this, we exploit variation in the identity of a cell's nearest neighbor, which we define as the nearest ethnic group that is contiguous to the ethnicity to which the cell belongs. We refer to this as the cell's *Neighbor*. In Figure 7, for the cells in the northern portion of the Soninke ethnic territory, the *Neighbor* is Zenega. For those that are in the southern portion, the *Neighbor* is either Kasonke, Kagoro, or Bambara depending on the east-west location of the cell.

With this data structure, we then estimate the following equation:

$$y_{iet} = \gamma_1 \, TranshumantPastoral_i^{Neighbor} + \gamma_2 \, TranshumantPastoral_e^{OwnGroup} + \gamma_3 \ln(pop_i) + \alpha_t + \eta_{iet}, \quad (2)$$

where i indexes 0.5-degree grid-cells, e ethnic groups, and t years (1989–2018). The dependent variable, y_{iet}, is conflict incidence in cell i, which lies within the traditional territory of ethnicity e, and in year t. The variable $\textit{TranshumantPastoral}_i^{\textit{Neighbor}}$ is the measure of transhumant pastoralism for the nearest neighboring ethnic group to cell i. The variable $\textit{TranshumantPastoral}_e^{\textit{OwnGroup}}$ is the same measure of transhumant pastoralism, but for the ethnicity in which the cell is located. Lastly, $\ln(pop_i)$ is the natural log of the population of cell i, averaged over 1990, 1995, 2000, 2005, and 2010. The parameter of interest is γ_1, which represents the effect of the nearest neighboring ethnic group's transhumant pastoralism on conflict in a cell. Standard errors are adjusted for two-way clustering at the level of a cell and a climate zone-year.

Estimates of equation (2) are reported in Table 4, which reports estimates for the same dependent variables as in Table 3 (columns 1–4) and using both transhumant pastoralism measures (panels A and B). The estimates show the same finding: having a nearest neighbor that is transhumant pastoral is associated with significantly more conflict. This is primarily driven by conflicts that involve the state.

5. Spillover Precipitation Shocks and Agro-Pastoral Conflict

We now turn to our baseline estimating equation which studies whether adverse climate events in transhumant pastoral territories result in conflict in neighboring agricultural lands.

Estimating Equation Using rainfall as our primary measure of climate shocks, we estimate a variant of equation (2) that traces the differential effects of rainfall in neighboring transhumant pastoral territories on conflict. Specifically, we continue to exploit cell-level variation in the identity of the nearest neighboring ethnic group to each cell's centroid, and estimate the following equation:

$$\begin{aligned} y_{iet} \;=\; & \gamma_0^s \, \textit{Rain}_{it}^{\textit{Neighbor}} \;\; + \gamma_1^s \, \textit{Rain}_{it}^{\textit{Neighbor}} \;\; \times \textit{TranshumantPastoral}_i^{\textit{Neighbor}} \\ & + \gamma_2^s \, \textit{Rain}_{et}^{\textit{OwnGroup}} + \gamma_3^s \, \textit{Rain}_{et}^{\textit{OwnGroup}} \times \textit{TranshumantPastoral}_e^{\textit{OwnGroup}} \\ & + \gamma_4^s \, \textit{Rain}_{it}^{\textit{OwnCell}} \;\; + \gamma_5^s \, \textit{Rain}_{it}^{\textit{OwnCell}} \;\; \times \textit{TranshumantPastoral}_e^{\textit{OwnGroup}} \\ & + X_{iet}' \Gamma + \alpha_i^s + \alpha_{c(i)t}^s + \eta_{iet}^s, \end{aligned} \tag{3}$$

where y_{iet} is an indicator for the incidence of conflict in cell i in ethnic group e and year t; $\textit{Rain}_{it}^{\textit{Neighbor}}$ measures average precipitation in the nearest neighboring ethnic group to cell i in year t; $\textit{TranshumantPastoral}_i^{\textit{Neighbor}}$ is the transhumant pastoral index measure for that neighboring ethnic group; $\textit{Rain}_{et}^{\textit{OwnGroup}}$ measures precipitation in group e in year t; $\textit{TranshumantPastoral}_e^{\textit{OwnGroup}}$ is the transhumant pastoralism index for ethnicity e; and $\textit{Rain}_{it}^{\textit{OwnCell}}$ measures precipitation in cell i in year t. The vector X_{iet}' captures additional covariates that we include in auxiliary robustness and sensitivity checks.

The parameter α_i denotes cell fixed effects, which absorb $\ln(pop_i)$ and also account for time-invariant differences between cells, such as geographic characteristics; $\alpha_{c(i)t}$ denotes country-year fixed effects, which capture any determinant of conflict that varies by country and year, such

Table 4: Agro-Pastoral Conflict in the Cross-Section: Cell-Level Spillover Analysis

	Indicator for the presence of conflict			
	(1)	(2)	(3)	(4)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Panel A: Transhumant definition includes only groups that are migratory or nomadic				
Neighbor Transhumant Pastoral [γ_1]	0.0310***	0.0278***	0.0077***	0.0636***
	(0.0053)	(0.0047)	(0.0026)	(0.0097)
Transhumant Pastoral [γ_2]	0.0075	0.0059	0.0013	0.0256***
	(0.0059)	(0.0048)	(0.0029)	(0.0099)
ln(Population) [γ_3]	0.0143***	0.0109***	0.0064***	0.0364***
	(0.0011)	(0.0009)	(0.0006)	(0.0025)
Panel B: Transhumant definition includes all groups without fully permanent settlements				
Neighbor Transhumant Pastoral [γ_1]	0.0335***	0.0311***	0.0069***	0.0603***
	(0.0052)	(0.0047)	(0.0024)	(0.0091)
Transhumant Pastoral [γ_2]	0.0069	0.0053	0.0007	0.0239**
	(0.0056)	(0.0046)	(0.0027)	(0.0094)
ln(Population) [γ_3]	0.0143***	0.0110***	0.0063***	0.0359***
	(0.0011)	(0.0009)	(0.0006)	(0.0025)
Dep. Var. Mean	0.036	0.026	0.016	0.085
Year FE	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	336
Cells	7,722	7,722	7,722	7,722
Observations	231,660	231,660	231,660	185,328

Note: All outcome variables measure conflict incidence at the level of a cell-year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. ln(Population) is the natural log of average cell-level population measured in 1990, 1995, 2000, 2005, and 2010. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

as nationwide political factors and macroeconomic shocks. To account for spatial and temporal dependence, our standard errors are two-way clustered at the level of cell and at the level of a climate zone-year.

The parameter γ_1^s represents the differential effect of rainfall in a neighboring ethnic territory on conflict in cell i when the neighboring ethnicity is transhumant pastoral relative to when it is not transhumant pastoral. A negative estimate of γ_1^s indicates that, consistent with our hypothesis, dry weather in pastoral territories causes additional conflict in neighboring cells.

It is important to note that this specification accounts flexibly for many factors that have been studied in the conflict literature. The cell fixed effects α_i^s capture all time-invariant determinants of conflict that have been studied in the literature, such as artificial borders, historical conflicts, and ethnic traits (e.g., Besley and Reynal-Querol, 2014, Michalopoulos and Papaioannou, 2016, Moscona et al., 2020). Also included are country-year fixed effects $\alpha_{c(i)t}^s$, which capture time-varying national-level factors such as changes in country GDP, domestic institutions, ethnic polarization, resource endowments, and international geo-political characteristics, all of which have been prominent in the cross-country literature on conflict (e.g., Collier and Hoeffler, 1998, 2004, Fearon and Laitin, 2003, Ross, 2004, Esteban et al., 2012). Lastly, equation (3) also includes controls for the direct effects of rainfall in a cell, $\gamma_4^s Rain_{it}^{OwnCell}$ and in the territory of a cell's ethnic group $\gamma_2^s Rain_{et}^{OwnGroup}$. Thus, the estimates account for the direct effect of rainfall on conflict (Miguel et al., 2004, Hsiang et al., 2013, Burke et al., 2015, Harari and Ferrara, 2018).

Results Estimates of the parameters in equation (3) are reported in columns 1–4 of Tables 5 and 6. Table 5 reports estimates using our narrow definition of transhumance (first two categories), while Table 6 report estimates using the broader definition (first four categories). In column 1, the outcome variable is an indicator that is equal to 1 if UCDP records any violent event as occurring in a grid cell and year. The first set of coefficients, reported under the heading 'Nearest Neighboring Ethnic Group,' are for the effect of rainfall in the nearest neighboring ethnic group, γ_0^s, and the effect of the variable interacted with the ethnic group's transhumant pastoralism index measure, γ_1^s.

We find that less rainfall in a cell's nearest neighboring ethnic group leads to more conflict in a cell, but only if the nearest neighboring ethnic group is transhumant pastoral. The estimated effect for non-transhumant pastoral groups, $\hat{\gamma_0^s}$, is -0.0006 (in both tables), which is not statistically different from zero. The differential effects for transhumant pastoral neighbors, $\hat{\gamma_1^s}$, is -0.110 and -0.0082, which are both significant at the 1% level. To assess the magnitude of these effects, we calculate the impact of a one standard deviation decrease in rainfall. This adverse shock would cause an increase in conflict that is equal to 39.4% and 29.8% of the mean respectively, which are sizable effects. (These calculations are reported in the second panel of the tables.)

Table 5: Effect of Neighbor's Rainfall when Neighbor is Transhumant Pastoral: Using the Narrower Two-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain [γ_0^s]	-0.0006	0.0001	-0.0004	-0.0006	-0.0007	0.0001	-0.0006	-0.0001	-0.0000	-0.0001	0.0007	-0.0105***
	(0.0006)	(0.0006)	(0.0005)	(0.0011)	(0.0007)	(0.0006)	(0.0005)	(0.0011)	(0.0026)	(0.0024)	(0.0019)	(0.0036)
Rain × Transhumant Pastoral [γ_1^s]	-0.0110***	-0.0121***	-0.0012	-0.0096**	-0.0122***	-0.0124***	-0.0030	-0.0172***	-0.0053	-0.0062	-0.0001	0.0052
	(0.0033)	(0.0031)	(0.0021)	(0.0038)	(0.0047)	(0.0038)	(0.0028)	(0.0056)	(0.0056)	(0.0051)	(0.0034)	(0.0064)
Own Ethnic Group												
Rain [γ_2^s]	-0.0000	0.0013	-0.0003	0.0009	-0.0001	0.0012	-0.0002	0.0002	-0.0057	-0.0028	-0.0014	-0.0022
	(0.0010)	(0.0009)	(0.0007)	(0.0014)	(0.0011)	(0.0009)	(0.0007)	(0.0014)	(0.0046)	(0.0038)	(0.0033)	(0.0067)
Rain × Transhumant Pastoral [γ_3^s]	-0.0015	-0.0046	0.0016	-0.0013	0.0089	0.0057	0.0091	-0.0186	0.0043	-0.0013	0.0021	0.0079
	(0.0047)	(0.0047)	(0.0038)	(0.0065)	(0.0134)	(0.0078)	(0.0118)	(0.0175)	(0.0084)	(0.0084)	(0.0060)	(0.0115)
Own Cell												
Rain [γ_4^s]	-0.0002	-0.0004	-0.0001	-0.0004	-0.0002	-0.0004	-0.0001	-0.0006	0.0012	-0.0023	0.0028	-0.0001
	(0.0007)	(0.0006)	(0.0005)	(0.0010)	(0.0007)	(0.0006)	(0.0005)	(0.0010)	(0.0031)	(0.0019)	(0.0026)	(0.0048)
Rain × Transhumant Pastoral [γ_5^s]	0.0039	0.0055*	-0.0009	0.0046	-0.0072	-0.0063	-0.0054	0.0169	-0.0001	0.0065	-0.0056	0.0054
	(0.0035)	(0.0033)	(0.0024)	(0.0051)	(0.0101)	(0.0077)	(0.0085)	(0.0142)	(0.0060)	(0.0048)	(0.0044)	(0.0087)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-2.02	0.25	-3.31	-0.79	-1.98	0.60	-3.78	-0.13	-0.14	-0.73	8.88	-22.95
p-value	[0.36]	[0.92]	[0.38]	[0.60]	[0.32]	[0.80]	[0.25]	[0.93]	[0.99]	[0.96]	[0.71]	[0.00]
Rain × Transhumant Pastoral	-37.42	-56.94	-9.22	-13.82	-37.27	-52.82	-19.38	-21.65	-25.72	-39.97	-0.97	11.27
p-value	[0.00]	[0.00]	[0.55]	[0.01]	[0.01]	[0.00]	[0.28]	[0.00]	[0.34]	[0.22]	[0.98]	[0.42]
Rain + Rain × Transhumant Pastoral	-39.44	-56.69	-12.53	-14.62	-39.25	-52.22	-23.16	-21.78	-25.86	-40.70	7.91	-11.69
p-value	[0.00]	[0.00]	[0.41]	[0.01]	[0.01]	[0.00]	[0.20]	[0.00]	[0.31]	[0.19]	[0.84]	[0.33]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	322	390	390	390	299	390	390	390	299
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 6: Effect of Neighbor's Rainfall when Neighbor is Transhumant Pastoral: Using the Broader Four-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain [γ_0^s]	-0.0006	0.0001	-0.0005	-0.0004	-0.0006	0.0002	-0.0007	-0.0000	0.0002	0.0005	0.0005	-0.0107***
	(0.0006)	(0.0006)	(0.0005)	(0.0011)	(0.0007)	(0.0006)	(0.0005)	(0.0011)	(0.0027)	(0.0025)	(0.0019)	(0.0035)
Rain × Transhumant Pastoral [γ_1^s]	-0.0082***	-0.0105***	0.0007	-0.0093**	-0.0067*	-0.0087***	0.0004	-0.0125**	-0.0053	-0.0074	0.0007	0.0051
	(0.0031)	(0.0028)	(0.0019)	(0.0037)	(0.0038)	(0.0033)	(0.0023)	(0.0056)	(0.0054)	(0.0049)	(0.0035)	(0.0063)
Own Ethnic Group												
Rain [γ_2^s]	0.0002	0.0015*	-0.0002	0.0010	0.0002	0.0014	-0.0001	0.0006	-0.0042	-0.0021	-0.0008	-0.0055
	(0.0011)	(0.0009)	(0.0007)	(0.0014)	(0.0011)	(0.0009)	(0.0007)	(0.0014)	(0.0044)	(0.0041)	(0.0028)	(0.0070)
Rain × Transhumant Pastoral [γ_3^s]	-0.0050	-0.0065	-0.0010	-0.0028	-0.0063	-0.0040	-0.0020	-0.0258**	0.0017	-0.0025	0.0010	0.0133
	(0.0042)	(0.0042)	(0.0035)	(0.0062)	(0.0082)	(0.0063)	(0.0063)	(0.0117)	(0.0080)	(0.0088)	(0.0054)	(0.0119)
Own Cell												
Rain [γ_4^s]	-0.0003	-0.0005	-0.0001	-0.0005	-0.0002	-0.0004	-0.0001	-0.0008	-0.0008	-0.0038*	0.0019	0.0026
	(0.0007)	(0.0006)	(0.0005)	(0.0010)	(0.0007)	(0.0006)	(0.0005)	(0.0010)	(0.0026)	(0.0019)	(0.0019)	(0.0048)
Rain × Transhumant Pastoral [γ_5^s]	0.0048	0.0061**	-0.0000	0.0054	-0.0023	-0.0028	0.0002	0.0183*	0.0034	0.0088*	-0.0039	0.0005
	(0.0033)	(0.0030)	(0.0024)	(0.0048)	(0.0067)	(0.0056)	(0.0051)	(0.0102)	(0.0053)	(0.0048)	(0.0036)	(0.0088)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-1.97	0.71	-3.93	-0.62	-1.98	0.81	-4.16	-0.01	0.81	2.94	6.37	-23.37
p-value	[0.37]	[0.79]	[0.30]	[0.69]	[0.32]	[0.73]	[0.21]	[0.99]	[0.95]	[0.85]	[0.80]	[0.00]
Rain × Transhumant Pastoral	-27.83	-49.58	5.59	-13.38	-20.30	-36.90	2.65	-15.69	-25.72	-47.62	8.84	11.04
p-value	[0.01]	[0.00]	[0.70]	[0.01]	[0.08]	[0.01]	[0.86]	[0.03]	[0.33]	[0.13]	[0.85]	[0.42]
Rain + Rain × Transhumant Pastoral	-29.80	-48.87	1.66	-14.00	-22.28	-36.09	-1.51	-15.71	-24.90	-44.69	15.21	-12.33
p-value	[0.00]	[0.00]	[0.91]	[0.01]	[0.06]	[0.01]	[0.92]	[0.02]	[0.30]	[0.12]	[0.71]	[0.30]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	322	390	390	390	299	390	390	390	299
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Tables 5 and 6 also report the estimated coefficients for γ_2^s–γ_5^s, which are the estimated effects of rainfall in the own ethnic group and own cell of an observation, as well as the differential effects of the rainfall measures when the own ethnic group is transhumant pastoral. These are reported under the headings 'Own Ethnic Group' and 'Own Cell' in the tables. All of the estimated coefficients are small in magnitude and not statistically different from zero. Thus, while we find that less rainfall in the territory of the nearest neighboring transhumant pastoral groups leads to greater conflict, there is no evidence of effects of own-cell or own-group precipitation shocks.

In columns 2 and 3, we examine the effects on conflicts that involve the state and those that do not. We find that the effects of rainfall in the territory of transhumant pastoral nearest neighbors are largest for conflicts that involve the state. A one-standard-deviation decrease in rainfall in the territory of transhumant pastoral nearest neighbors increases state-involved conflicts by 56.7% and 48.9% relative to the mean. The same figures for conflicts that do not involve the state are much smaller at an increase of 12.5% and a decrease of 1.7% relative to the mean. Thus, the spillover effects estimated for aggregate conflicts (column 1) appear to be driven by conflicts that involve state actors. This is consistent with the fact that herder-farmer conflicts regularly involve state entities such as police, conservation officers, or even the military.

In column 4, we report estimates using ACLED data. Despite the shorter panel available with these data, we obtain qualitatively similar estimates. The estimated effects suggest that a one-standard-deviation decrease in rainfall in the territory of transhumant pastoral nearest neighbors increases the average incidence of any conflict by 14.6% and 14.0% relative to the mean.

In the remaining columns (5–12) of the tables, we present the same estimation on sub-samples of cells that are agricultural versus those that are not. This is motivated by the mechanism of interest, which is the early movement of herds to agricultural farmlands when adverse rainfall shocks occur. Therefore, we expect the effects of adverse rainfall shocks in a neighboring transhumant pastoral territory to be observed in grid-cells that are located in an agricultural territory but not in grid-cells that are not. Using data from the *Ethnographic Atlas*, we split the sample between cells that are located within the territory of ethnic groups whose traditional reliance on agriculture for subsistence exceeded 50% and those whose reliance was less than 50%.[7]

Columns 5–8 report results from the same specifications as in columns 1–4, but restricting the sample to grid-cells that are nested in majority-agricultural territories, according to our measure. We obtain estimates that are qualitatively identical and quantitively very similar. Columns 9–12 report the same specifications, but restricting the sample to grid-cells that are not located in majority-agricultural territories. We no longer estimate effects that are statistically significant. Thus, consistent with expectations, the estimates show clearly that it is primarily agricultural grid-cells that are responsible for the aggregate effects estimated in columns 1–4.

Robustness and Sensitivity Checks We now turn to an examination of the sensitivity of our estimates.

We check the sensitivity of our findings by accounting for other characteristics of neighboring ethnic groups: including their traditional political complexity, the presence of segmentary lineage

[7]This information is obtained from variable v5.

organization, and a traditional belief in a religion with a moralizing high god, such as Islam. Pre-colonial political centralization has been shown to be an important determinant of public goods provision and economic development (Gennaioli and Rainer, 2007, Michalopoulos and Papaioannou, 2013), both of which are relevant for conflict. Segmentary lineage organization has been shown to be associated with conflict (Moscona et al., 2020). The presence of a moralizing high gods is believed to be an important factor for cooperation, conflict, and long-term economic growth (Norenzayan, 2013) and, as noted, many of the conflicts in the Sahel region of Africa have a religious dimension to them.

To ensure that our estimates of interest are not biased by these characteristics, we additionally control for the interaction between these characteristics of the nearest neighboring ethnic group interacted with the rainfall of the group. The estimates, which we report in Tables 7 and 10, show that our findings remain robust to the inclusion of these additional controls. The estimated effects are very similar in magnitude and remain highly significant.

Table 7: Robustness to Additional Controls for Ethnicity-Level Characteristics: Using the Narrower Two-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain [γ_0^s]	-0.0026*	-0.0011	-0.0015	-0.0025	-0.0032**	-0.0015	-0.0017	-0.0029	0.0078	0.0059	0.0016	-0.0032
	(0.0015)	(0.0013)	(0.0012)	(0.0023)	(0.0016)	(0.0013)	(0.0012)	(0.0024)	(0.0053)	(0.0054)	(0.0033)	(0.0052)
Rain × Transhumant Pastoral [γ_1^s]	-0.0117***	-0.0123***	-0.0026	-0.0094**	-0.0124**	-0.0117***	-0.0045	-0.0151***	-0.0070	-0.0097*	0.0005	0.0028
	(0.0036)	(0.0031)	(0.0023)	(0.0038)	(0.0052)	(0.0039)	(0.0032)	(0.0053)	(0.0059)	(0.0051)	(0.0039)	(0.0065)
Rain × Jurisdictional Hierarchy	0.0005	0.0000	0.0001	-0.0002	0.0007	0.0002	0.0001	-0.0003	-0.0025	-0.0023	-0.0007	-0.0002
	(0.0006)	(0.0005)	(0.0005)	(0.0008)	(0.0007)	(0.0005)	(0.0005)	(0.0009)	(0.0020)	(0.0019)	(0.0012)	(0.0026)
Rain × Segmentary Lineage	0.0025	0.0020	0.0012	0.0032	0.0030	0.0024	0.0010	0.0049	-0.0087	-0.0074	-0.0000	-0.0168**
	(0.0019)	(0.0016)	(0.0014)	(0.0029)	(0.0019)	(0.0016)	(0.0014)	(0.0031)	(0.0053)	(0.0050)	(0.0040)	(0.0080)
Rain × High Gods: Active, Not Supportive	0.0021	0.0014	0.0033	0.0030	0.0024	0.0015	0.0038	0.0044	-0.0043	-0.0013	-0.0034	0.0023
	(0.0021)	(0.0016)	(0.0022)	(0.0036)	(0.0024)	(0.0018)	(0.0025)	(0.0038)	(0.0045)	(0.0039)	(0.0031)	(0.0097)
Rain × High Gods: Active, Supportive	0.0014	0.0018*	0.0012	-0.0009	0.0010	0.0013	0.0010	-0.0028	0.0011	0.0041	-0.0011	0.0052
	(0.0013)	(0.0010)	(0.0011)	(0.0022)	(0.0015)	(0.0011)	(0.0012)	(0.0025)	(0.0040)	(0.0035)	(0.0030)	(0.0065)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-8.71	-5.28	-10.63	-3.41	-10.01	-6.66	-10.15	-3.61	33.02	33.26	19.05	-6.12
p-value	[0.10]	[0.39]	[0.19]	[0.28]	[0.04]	[0.25]	[0.18]	[0.24]	[0.14]	[0.27]	[0.62]	[0.54]
Rain × Transhumant Pastoral	-39.23	-58.80	-18.29	-13.08	-38.66	-53.06	-27.60	-19.06	-29.73	-54.57	5.54	5.44
p-value	[0.00]	[0.00]	[0.26]	[0.01]	[0.02]	[0.00]	[0.16]	[0.01]	[0.23]	[0.06]	[0.90]	[0.66]
Rain + Rain × Transhumant Pastoral	-47.94	-64.07	-28.93	-16.49	-48.67	-59.73	-37.75	-22.67	3.29	-21.31	24.59	-0.68
p-value	[0.00]	[0.00]	[0.10]	[0.01]	[0.01]	[0.00]	[0.08]	[0.00]	[0.91]	[0.53]	[0.66]	[0.96]
Dep. Var. Mean	0.0357	0.0251	0.0172	0.0865	0.0384	0.0264	0.0197	0.0952	0.0282	0.0214	0.0104	0.0624
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	322	390	390	390	299	360	360	360	276
Cells	6,554	6,554	6,554	6,554	4,812	4,812	4,812	4,812	1,742	1,742	1,742	1,742
Observations	196,620	196,620	196,620	150,742	144,360	144,360	144,360	110,676	52,260	52,260	52,260	40,066

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 8: Robustness to Additional Controls for Ethnicity-Level Characteristics: Using the Broader Four-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain [γ_0^s]	-0.0025	-0.0009	-0.0015	-0.0023	-0.0031**	-0.0013	-0.0017	-0.0027	0.0079	0.0063	0.0014	-0.0030
	(0.0016)	(0.0013)	(0.0012)	(0.0023)	(0.0016)	(0.0013)	(0.0012)	(0.0024)	(0.0052)	(0.0054)	(0.0033)	(0.0051)
Rain × Transhumant Pastoral [γ_1^s]	-0.0075**	-0.0098***	-0.0003	-0.0081**	-0.0045	-0.0065**	-0.0003	-0.0081	-0.0072	-0.0116**	0.0015	0.0020
	(0.0031)	(0.0029)	(0.0020)	(0.0040)	(0.0040)	(0.0032)	(0.0025)	(0.0057)	(0.0054)	(0.0046)	(0.0038)	(0.0069)
Rain × Jurisdictional Hierarchy	0.0006	0.0001	0.0001	-0.0002	0.0007	0.0002	0.0001	-0.0002	-0.0023	-0.0021	-0.0006	-0.0005
	(0.0006)	(0.0005)	(0.0004)	(0.0008)	(0.0006)	(0.0005)	(0.0005)	(0.0009)	(0.0019)	(0.0018)	(0.0012)	(0.0026)
Rain × Segmentary Lineage	0.0023	0.0018	0.0011	0.0030	0.0027	0.0021	0.0009	0.0046	-0.0084	-0.0066	-0.0003	-0.0167**
	(0.0018)	(0.0015)	(0.0014)	(0.0029)	(0.0019)	(0.0016)	(0.0014)	(0.0031)	(0.0053)	(0.0050)	(0.0039)	(0.0081)
Rain × High Gods: Active, Not Supportive	0.0020	0.0012	0.0033	0.0028	0.0024	0.0014	0.0038	0.0043	-0.0042	-0.0015	-0.0032	0.0020
	(0.0022)	(0.0016)	(0.0022)	(0.0036)	(0.0025)	(0.0018)	(0.0025)	(0.0038)	(0.0045)	(0.0038)	(0.0031)	(0.0096)
Rain × High Gods: Active, Supportive	0.0006	0.0011	0.0009	-0.0015	0.0005	0.0009	0.0008	-0.0034	0.0005	0.0036	-0.0014	0.0057
	(0.0013)	(0.0011)	(0.0010)	(0.0022)	(0.0015)	(0.0011)	(0.0012)	(0.0025)	(0.0041)	(0.0038)	(0.0029)	(0.0069)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-8.37	-4.54	-10.66	-3.23	-9.76	-6.14	-10.17	-3.44	33.45	35.49	16.46	-5.68
p-value	[0.11]	[0.46]	[0.19]	[0.31]	[0.05]	[0.29]	[0.18]	[0.27]	[0.14]	[0.24]	[0.67]	[0.57]
Rain × Transhumant Pastoral	-25.32	-47.05	-1.99	-11.26	-14.13	-29.60	-1.96	-10.21	-30.54	-65.20	17.12	3.92
p-value	[0.02]	[0.00]	[0.89]	[0.04]	[0.26]	[0.04]	[0.90]	[0.16]	[0.18]	[0.01]	[0.70]	[0.77]
Rain + Rain × Transhumant Pastoral	-33.69	-51.60	-12.65	-14.49	-23.89	-35.74	-12.12	-13.64	2.91	-29.71	33.59	-1.76
p-value	[0.00]	[0.00]	[0.40]	[0.02]	[0.07]	[0.02]	[0.47]	[0.07]	[0.91]	[0.37]	[0.50]	[0.91]
Dep. Var. Mean	0.0357	0.0251	0.0172	0.0865	0.0384	0.0264	0.0197	0.0952	0.0282	0.0214	0.0104	0.0624
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	322	390	390	390	299	360	360	360	276
Cells	6,554	6,554	6,554	6,554	4,812	4,812	4,812	4,812	1,742	1,742	1,742	1,742
Observations	196,620	196,620	196,620	150,742	144,360	144,360	144,360	110,676	52,260	52,260	52,260	40,066

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

The second sensitivity check that we perform is motivated by the potential concern is that our measure of rainfall happens to be correlated with other aggregate factors that differentially affect the amount of conflict that is adjacent to transhumant pastoral groups. Given the general increase in the effects of climate change over the period of analysis, a concern is that the rainfall measure could be capturing the effects of any other factor that is also trending over time, such as the availability of firearms, population density, and so forth. To account for this, we include a control for a linear time trend interacted with each cell's nearest neighbor's measure of transhumant pastoralism, which captures any differential effect that trending determinants have on conflict adjacent to transhumant pastoral groups.

Although this captures aggregate time-varying factors that are trending over time, many other factors have more irregular movements. Motivated by this, we also interact the measure of a cell's nearest neighbor's transhumant pastoralism with numerous aggregate price indices that may affect conflict differently across space. These include price indices for energy, for metals and minerals, and for precious metals (Berman, Couttenier, Rohner and Thoenig, 2017), as well as a price index for agricultural products (McGuirk and Burke, 2020).[8] Estimates of equation (3) with these additional covariates are reported in Tables 9 and 10. Again, we find that the estimates are robust to the inclusion of these variables. The point estimates are similar in magnitude and they remain highly significant.

[8]The data are from the World Bank's "Pink Sheet" commodity price index dataset. The energy commodities include coal, crude oil, and natural gas; the metals and minerals include aluminum, copper, iron ore, lead, nickel, steel, tin and zinc; the precious metals include gold, platinum and silver; and the agricultural products include oils and meals, grains, and other food such as bananas, meat and sugar. All indices are based on real prices.

Table 9: Robustness to Additional Controls for Time-Varying Characteristics: Using the Narrower Two-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain [γ_0^s]	-0.0006	0.0001	-0.0004	-0.0006	-0.0006	0.0002	-0.0006	-0.0001	0.0002	-0.0000	0.0008	-0.0100***
	(0.0006)	(0.0006)	(0.0005)	(0.0011)	(0.0007)	(0.0006)	(0.0005)	(0.0011)	(0.0027)	(0.0025)	(0.0019)	(0.0036)
Rain × Transhumant Pastoral [γ_1^s]	-0.0114***	-0.0126***	-0.0013	-0.0096***	-0.0125***	-0.0135***	-0.0028	-0.0176***	-0.0066	-0.0072	-0.0005	0.0031
	(0.0033)	(0.0031)	(0.0020)	(0.0036)	(0.0048)	(0.0040)	(0.0029)	(0.0054)	(0.0057)	(0.0052)	(0.0034)	(0.0059)
Year × Transhumant Pastoral	-0.0002	0.0001	-0.0003	-0.0064***	-0.0000	0.0002	0.0000	-0.0055**	-0.0017**	-0.0013*	-0.0008*	-0.0075***
	(0.0006)	(0.0006)	(0.0003)	(0.0018)	(0.0011)	(0.0011)	(0.0005)	(0.0026)	(0.0008)	(0.0007)	(0.0004)	(0.0022)
Price Index: Energy × Transhumant Pastoral	0.0004**	0.0002	0.0001	0.0005**	0.0002	-0.0002	0.0001	0.0002	0.0004	0.0003	0.0000	0.0004
	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0005)	(0.0003)	(0.0002)	(0.0001)	(0.0003)
Price Index: Metals and Minerals × Transhumant Pastoral	0.0001	0.0003	-0.0001	-0.0003	0.0002	0.0006**	-0.0002	-0.0002	0.0003	0.0003	0.0002	0.0002
	(0.0002)	(0.0002)	(0.0001)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0005)	(0.0004)	(0.0003)	(0.0002)	(0.0003)
Price Index: Precious Metals × Transhumant Pastoral	-0.0006*	-0.0006**	0.0001	0.0005	0.0006	0.0005	0.0007***	0.0007	-0.0006*	-0.0006**	-0.0000	0.0006
	(0.0003)	(0.0003)	(0.0002)	(0.0005)	(0.0005)	(0.0005)	(0.0002)	(0.0007)	(0.0003)	(0.0003)	(0.0002)	(0.0007)
Price Index: Agriculture × Transhumant Pastoral	0.0004	0.0006	-0.0001	0.0006	-0.0018**	-0.0013*	-0.0011**	-0.0000	0.0006	0.0006	0.0000	-0.0001
	(0.0005)	(0.0005)	(0.0003)	(0.0007)	(0.0008)	(0.0007)	(0.0005)	(0.0012)	(0.0005)	(0.0005)	(0.0003)	(0.0009)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-2.02	0.31	-3.27	-0.88	-1.96	0.75	-3.79	-0.17	0.92	-0.12	11.00	-21.75
p-value	[0.36]	[0.91]	[0.39]	[0.56]	[0.33]	[0.75]	[0.25]	[0.90]	[0.94]	[0.99]	[0.65]	[0.01]
Rain × Transhumant Pastoral	-38.88	-59.31	-9.74	-13.71	-38.04	-57.51	-17.89	-22.10	-31.68	-46.42	-6.30	6.65
p-value	[0.00]	[0.00]	[0.52]	[0.01]	[0.01]	[0.00]	[0.34]	[0.00]	[0.25]	[0.17]	[0.89]	[0.61]
Rain + Rain × Transhumant Pastoral	-40.90	-59.01	-13.01	-14.60	-40.00	-56.75	-21.67	-22.27	-30.76	-46.54	4.70	-15.10
p-value	[0.00]	[0.00]	[0.39]	[0.00]	[0.01]	[0.00]	[0.25]	[0.00]	[0.23]	[0.14]	[0.91]	[0.18]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	322	390	390	390	299	390	390	390	299
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 10: Robustness to Additional Controls for Time-Varying Characteristics: Using the Broader Four-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain [γ_0^s]	-0.0006	0.0002	-0.0005	-0.0006	-0.0007	0.0002	-0.0006	-0.0001	0.0005	0.0008	0.0006	-0.0100***
	(0.0006)	(0.0006)	(0.0005)	(0.0011)	(0.0007)	(0.0006)	(0.0005)	(0.0011)	(0.0027)	(0.0025)	(0.0019)	(0.0036)
Rain × Transhumant Pastoral [γ_1^s]	-0.0086***	-0.0110***	0.0007	-0.0092**	-0.0072*	-0.0096***	0.0003	-0.0122**	-0.0066	-0.0086*	0.0004	0.0031
	(0.0031)	(0.0028)	(0.0019)	(0.0036)	(0.0040)	(0.0034)	(0.0024)	(0.0054)	(0.0055)	(0.0050)	(0.0035)	(0.0061)
Year × Transhumant Pastoral	0.0003	0.0004	-0.0001	-0.0055***	0.0003	0.0004	0.0004	-0.0037	-0.0013**	-0.0010**	-0.0007*	-0.0071***
	(0.0006)	(0.0005)	(0.0003)	(0.0017)	(0.0010)	(0.0010)	(0.0005)	(0.0024)	(0.0006)	(0.0005)	(0.0004)	(0.0022)
Price Index: Energy × Transhumant Pastoral	0.0005***	0.0003*	0.0001	0.0006***	0.0002	-0.0001	0.0001	0.0004	0.0005**	0.0004**	0.0001	0.0004*
	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0004)	(0.0002)	(0.0002)	(0.0001)	(0.0003)
Price Index: Metals and Minerals × Transhumant Pastoral	0.0000	0.0002	-0.0001	-0.0004*	0.0002	0.0005*	-0.0001	-0.0003	0.0003	0.0002	0.0001	0.0001
	(0.0002)	(0.0002)	(0.0001)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0004)	(0.0003)	(0.0003)	(0.0001)	(0.0003)
Price Index: Precious Metals × Transhumant Pastoral	-0.0007**	-0.0007**	0.0000	0.0003	0.0005	0.0003	0.0005**	0.0002	-0.0006*	-0.0006**	-0.0001	0.0005
	(0.0003)	(0.0003)	(0.0001)	(0.0005)	(0.0004)	(0.0004)	(0.0002)	(0.0007)	(0.0003)	(0.0003)	(0.0002)	(0.0007)
Price Index: Agriculture × Transhumant Pastoral	0.0005	0.0007	0.0000	0.0009	-0.0017**	-0.0011*	-0.0009**	0.0006	0.0007	0.0005	0.0001	-0.0002
	(0.0006)	(0.0005)	(0.0003)	(0.0007)	(0.0007)	(0.0006)	(0.0004)	(0.0010)	(0.0005)	(0.0005)	(0.0003)	(0.0009)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-1.96	0.75	-3.87	-0.83	-1.99	0.90	-4.12	-0.16	2.54	4.81	8.06	-21.76
p-value	[0.38]	[0.78]	[0.31]	[0.59]	[0.32]	[0.70]	[0.22]	[0.91]	[0.85]	[0.77]	[0.75]	[0.01]
Rain × Transhumant Pastoral	-29.51	-52.09	4.93	-13.25	-21.83	-41.06	2.12	-15.31	-31.94	-55.31	5.48	6.82
p-value	[0.00]	[0.00]	[0.73]	[0.01]	[0.07]	[0.01]	[0.89]	[0.02]	[0.23]	[0.08]	[0.90]	[0.61]
Rain + Rain × Transhumant Pastoral	-31.47	-51.34	1.06	-14.08	-23.81	-40.16	-2.00	-15.46	-29.40	-50.50	13.54	-14.94
p-value	[0.00]	[0.00]	[0.94]	[0.01]	[0.05]	[0.01]	[0.90]	[0.02]	[0.22]	[0.08]	[0.73]	[0.20]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	322	390	390	390	299	390	390	390	299
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

The next check that we perform builds on the fact that our ethnic characteristic of interest, transhumant pastoralism, can be viewed as an interaction between a measure of transhumance and a measure of pastoralism. Our mechanism of interest suggests that both aspects are important; namely, that the groups moves seasonally and that they engage in animal herding. If an ethnic group is characterized by only one of the two, we do not expect to observe the same effects.

Motivated by this, we estimate a version of equation (3) that also includes each of the components of the measure of transhumant pastoralism interacted with rainfall. This is particularly important given the recent findings of Eberle et al. (2020) that documents the importance of mobility for mediating the effects of temperature on conflict. By accounting for the effect of transhumance of neighboring groups, we are accounting for any effect that mobility alone has in our setting. The exercise also addresses the concerned about the role of other factors that are associated with pastoralism, such as the presence of a "culture of honor" and revenge-taking, which tends to be present in pastoral groups (Nisbett and Cohen, 1996, Grosjean, 2014, Cao, Enke, Falk, Giuliano and Nunn, 2021). Such effects are captured by inclusion of the pastoralism measure directly (along with relevant interactions) in the equation directly.

The estimates with the components and their interactions included in the equation are reported in Tables 11 and 12. We find that our estimates of interest are robust to controlling for the components of transhumant pastoralism. This suggests that it is the seasonal movement of migrating herd animals that is important for our findings and not either mobility or the presence of herd animals alone. In addition, both components of the interaction tend to be insignificant, suggesting that these aspects are not important determinants of the effect of rainfall on conflict in neighboring cells. We note that this is not evidence that mobility or pastoralism on their own are unimportant, but that they do not matter differentially through the particular spatial spillover mechanism that we analyze.

Table 11: Decomposing the Effect of Transhumant Pastoralism: Using the Narrower Two-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain [γ_0^s]	-0.0015	0.0003	-0.0019**	-0.0019	-0.0018*	0.0000	-0.0021**	-0.0022	0.0024	0.0032	0.0017	-0.0101
	(0.0011)	(0.0008)	(0.0009)	(0.0015)	(0.0011)	(0.0008)	(0.0009)	(0.0016)	(0.0049)	(0.0049)	(0.0036)	(0.0087)
Rain × Pastoral	0.0046	-0.0016	0.0078**	0.0068	0.0063	0.0003	0.0084**	0.0117*	-0.0095	-0.0131	-0.0038	-0.0032
	(0.0044)	(0.0035)	(0.0035)	(0.0062)	(0.0047)	(0.0036)	(0.0038)	(0.0065)	(0.0130)	(0.0141)	(0.0106)	(0.0290)
Rain × Transhumant	0.0041	0.0022	0.0038**	0.0029	0.0029	0.0007	0.0038	0.0026	0.0011	0.0015	-0.0007	0.0060
	(0.0025)	(0.0018)	(0.0019)	(0.0039)	(0.0028)	(0.0020)	(0.0024)	(0.0060)	(0.0055)	(0.0056)	(0.0038)	(0.0096)
Rain × Transhumant Pastoral [γ_1^s]	-0.0195***	-0.0135**	-0.0119**	-0.0186**	-0.0208***	-0.0131**	-0.0146**	-0.0298**	-0.0008	0.0002	0.0034	-0.0006
	(0.0069)	(0.0056)	(0.0049)	(0.0088)	(0.0078)	(0.0064)	(0.0057)	(0.0119)	(0.0156)	(0.0167)	(0.0116)	(0.0305)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-5.13	1.30	-14.13	-2.67	-5.51	0.13	-13.12	-2.79	11.76	20.38	21.85	-22.08
p-value	[0.16]	[0.74]	[0.03]	[0.22]	[0.10]	[0.97]	[0.02]	[0.16]	[0.62]	[0.52]	[0.65]	[0.25]
Rain × Transhumant Pastoral	-66.47	-63.64	-88.73	-26.64	-63.23	-55.83	-93.08	-37.46	-3.96	1.21	44.41	-1.23
p-value	[0.00]	[0.02]	[0.02]	[0.04]	[0.01]	[0.04]	[0.01]	[0.01]	[0.96]	[0.99]	[0.77]	[0.99]
Rain + Rain × Transhumant Pastoral	-71.60	-62.35	-102.86	-29.31	-68.74	-55.70	-106.20	-40.26	7.80	21.60	66.26	-23.31
p-value	[0.01]	[0.03]	[0.01]	[0.04]	[0.01]	[0.06]	[0.01]	[0.01]	[0.93]	[0.87]	[0.73]	[0.78]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	322	390	390	390	299	390	390	390	299
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* and *Own Cell* variables are controlled for but not reported. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 12: Decomposing the Effect of Transhumant Pastoralism: Using the Broader Four-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain [γ_0^s]	-0.0016	0.0002	-0.0017*	-0.0020	-0.0018	0.0001	-0.0019**	-0.0020	0.0042	0.0029	0.0031	-0.0081
	(0.0011)	(0.0009)	(0.0009)	(0.0015)	(0.0011)	(0.0008)	(0.0009)	(0.0016)	(0.0053)	(0.0048)	(0.0038)	(0.0080)
Rain × Pastoral	0.0045	-0.0010	0.0063	0.0084	0.0057	0.0000	0.0071*	0.0113*	-0.0168	-0.0108	-0.0111	-0.0109
	(0.0047)	(0.0037)	(0.0038)	(0.0059)	(0.0048)	(0.0038)	(0.0041)	(0.0066)	(0.0149)	(0.0127)	(0.0108)	(0.0246)
Rain × Transhumant	0.0053***	0.0030**	0.0034**	0.0013	0.0044**	0.0021	0.0029**	0.0025	-0.0006	0.0009	-0.0011	0.0006
	(0.0018)	(0.0014)	(0.0013)	(0.0030)	(0.0017)	(0.0013)	(0.0013)	(0.0036)	(0.0063)	(0.0061)	(0.0045)	(0.0105)
Rain × Transhumant Pastoral [γ_1^s]	-0.0191***	-0.0141***	-0.0088*	-0.0171**	-0.0179***	-0.0119**	-0.0094*	-0.0246**	0.0062	-0.0016	0.0097	0.0113
	(0.0063)	(0.0053)	(0.0046)	(0.0084)	(0.0066)	(0.0055)	(0.0050)	(0.0104)	(0.0175)	(0.0152)	(0.0126)	(0.0282)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-5.37	0.73	-12.91	-2.81	-5.38	0.27	-12.14	-2.54	20.15	18.63	40.20	-17.68
p-value	[0.16]	[0.86]	[0.06]	[0.19]	[0.12]	[0.94]	[0.04]	[0.20]	[0.43]	[0.55]	[0.41]	[0.31]
Rain × Transhumant Pastoral	-65.34	-66.62	-65.54	-24.51	-54.35	-50.90	-60.12	-30.94	30.04	-10.37	126.97	24.56
p-value	[0.00]	[0.01]	[0.06]	[0.04]	[0.01]	[0.03]	[0.06]	[0.02]	[0.72]	[0.92]	[0.44]	[0.69]
Rain + Rain × Transhumant Pastoral	-70.71	-65.89	-78.45	-27.32	-59.73	-50.64	-72.26	-33.48	50.19	8.26	167.17	6.88
p-value	[0.00]	[0.02]	[0.04]	[0.04]	[0.01]	[0.05]	[0.05]	[0.02]	[0.63]	[0.95]	[0.41]	[0.93]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	322	390	390	390	299	390	390	390	299
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* and *Own Cell* variables are controlled for but not reported. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

The final check that we perform is about inference. We examine the robustness of our main results to various methods of calculating standard errors. We verify the validity of our conclusions to calculating standard errors that are clustered by country, by country and climate-zone-year, and by country and climate-zone. We also check that our standard errors are similar when we allowing for arbitrary spatial correlation within 1,000 kilometers of a cell and for serial correlation throughout the 30-year sample. In addition, we compute standard errors by randomization inference, whereby rainfall in a cell's nearest neighboring territory is randomly permuted 500 times. As we report in Appendix Section B, significance is very similar and our conclusions are identical for each of the alternative methods of estimating standard errors.

6. Testing for Mechanisms

The estimates provided to this point are consistent with adverse rainfall shocks inducing transhumant pastoral groups to migrate to nearby agricultural lands before the harvest, which results in conflict. In this section, we undertake a number of tests for this specific causal mechanism.

Phytomass We begin by re-estimating equation (3) using the measure of phytomass in place of rainfall. Our interpretation is that lack of rainfall in the territory of transhumant pastoral groups leads to conflict because it reduces the amount of vegetation available for herded animals, which are moved to more fertile agricultural lands as a consequence. If this is the case, we should find that less phytomass in the territory of neighboring transhumant pastoral groups should be associated with increased conflict in precisely the same manner as rainfall.

The estimates, which are reported in Tables 13 and 14, show that we obtain qualitatively identical estimates when we use phytomass rather than rainfall. The estimates are also very similar quantitatively. For example, when we study all cells, and examine any conflict from the UCDP database (column 1), we find that the predicted effect of a one standard deviation decrease in phytomass in the territory of a transhumant pastoral group is to increase conflict by 37% of the mean incidence when the narrow measure transhumance is used and by and 29% when the broad measure is used. The equivalent effects using rainfall are 39% and 30%

Unlike rainfall, one might be concerned that our satellite measure of phytomass growth is itself endogenous to conflict and indeed to the location of grazing animals. To address this concern, we instrument the six phytomass variables—i.e., phytomass and phytomass interacted with transhumant pastoralism at the level of the cell's nearest neighbor, the cell's own group, and the cell itself—with their analogous rainfall variables. We present the results of this exercise in Appendix Tables A10 and A11. In these specifications, the results are more precisely estimated in the agricultural subsample, and especially for UCDP conflict involving the state and for any ACLED conflict.

Table 13: Estimates using Phytomass rather than Rainfall: Narrower Two-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP 1(Conflict)	UCDP 1(State)	UCDP 1(Non-State)	ACLED 1(Conflict)	UCDP 1(Conflict)	UCDP 1(State)	UCDP 1(Non-State)	ACLED 1(Conflict)	UCDP 1(Conflict)	UCDP 1(State)	UCDP 1(Non-State)	ACLED 1(Conflict)
Nearest Neighboring Ethnic Group												
Phytomass	0.0001	0.0000	-0.0000	0.0004	0.0003	0.0001	0.0001	0.0004	-0.0016	-0.0008	-0.0010	0.0000
	(0.0005)	(0.0004)	(0.0003)	(0.0006)	(0.0005)	(0.0004)	(0.0003)	(0.0006)	(0.0011)	(0.0009)	(0.0007)	(0.0013)
Phytomass × Transhumant Pastoral	-0.0043**	-0.0041**	-0.0011	-0.0085***	-0.0040*	-0.0025	-0.0026*	-0.0100***	-0.0016	-0.0031	0.0009	-0.0043*
	(0.0018)	(0.0016)	(0.0010)	(0.0018)	(0.0021)	(0.0017)	(0.0014)	(0.0025)	(0.0023)	(0.0022)	(0.0012)	(0.0022)
Own Ethnic Group												
Phytomass	0.0004	0.0005	0.0001	0.0009	0.0004	0.0005	0.0003	0.0013	-0.0022	-0.0018	-0.0009	-0.0057***
	(0.0005)	(0.0005)	(0.0004)	(0.0008)	(0.0005)	(0.0005)	(0.0004)	(0.0008)	(0.0015)	(0.0012)	(0.0013)	(0.0021)
Phytomass × Transhumant Pastoral	-0.0045**	-0.0025	-0.0018	-0.0090***	0.0043	0.0066	0.0038	-0.0317***	-0.0024	0.0003	-0.0019	0.0000
	(0.0022)	(0.0018)	(0.0016)	(0.0033)	(0.0086)	(0.0079)	(0.0065)	(0.0119)	(0.0032)	(0.0032)	(0.0021)	(0.0045)
Own Cell												
Phytomass	-0.0008*	-0.0006	-0.0002	0.0002	-0.0009*	-0.0006	-0.0002	0.0002	-0.0005	0.0005	-0.0004	-0.0003
	(0.0005)	(0.0005)	(0.0003)	(0.0006)	(0.0005)	(0.0005)	(0.0004)	(0.0007)	(0.0010)	(0.0010)	(0.0008)	(0.0014)
Phytomass × Transhumant Pastoral	0.0010	0.0006	0.0005	0.0001	-0.0031	-0.0023	-0.0020	0.0082	0.0016	-0.0005	0.0011	0.0007
	(0.0019)	(0.0016)	(0.0013)	(0.0024)	(0.0079)	(0.0071)	(0.0051)	(0.0090)	(0.0024)	(0.0023)	(0.0017)	(0.0034)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Phytomass Shock as % of Dep. Var. Mean:												
Phytomass	0.59	0.43	-0.94	1.44	2.36	1.13	2.18	1.45	-17.74	-12.01	-28.61	0.26
p-value	[0.89]	[0.93]	[0.88]	[0.51]	[0.57]	[0.82]	[0.70]	[0.49]	[0.14]	[0.34]	[0.19]	[0.97]
Phytomass × Transhumant Pastoral	-37.93	-51.29	-21.18	-32.47	-33.05	-29.33	-43.35	-33.87	-17.83	-45.67	27.15	-24.58
p-value	[0.02]	[0.01]	[0.26]	[0.00]	[0.06]	[0.15]	[0.07]	[0.00]	[0.49]	[0.16]	[0.45]	[0.05]
Phytomass + Phytomass × Transhumant Pastoral	-37.33	-50.86	-22.11	-31.02	-30.69	-28.20	-41.17	-32.42	-35.57	-57.68	-1.46	-24.32
p-value	[0.02]	[0.01]	[0.21]	[0.00]	[0.08]	[0.18]	[0.08]	[0.00]	[0.10]	[0.05]	[0.95]	[0.06]
Dep. Var. Mean	0.0373	0.0265	0.0174	0.0866	0.0404	0.0281	0.0199	0.0983	0.0297	0.0225	0.0114	0.0585
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	280	280	280	294	260	260	260	273	260	260	260	273
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	153,340	153,340	153,340	161,007	108,540	108,540	108,540	113,967	44,800	44,800	44,800	47,040

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 14: Estimates using Phytomass rather than Rainfall: Broader Four-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP 1(Conflict)	UCDP 1(State)	UCDP 1(Non-State)	ACLED 1(Conflict)	UCDP 1(Conflict)	UCDP 1(State)	UCDP 1(Non-State)	ACLED 1(Conflict)	UCDP 1(Conflict)	UCDP 1(State)	UCDP 1(Non-State)	ACLED 1(Conflict)
Nearest Neighboring Ethnic Group												
Phytomass	0.0001	0.0001	-0.0000	0.0006	0.0003	0.0002	0.0002	0.0006	-0.0016	-0.0007	-0.0012*	-0.0001
	(0.0005)	(0.0004)	(0.0003)	(0.0006)	(0.0005)	(0.0004)	(0.0003)	(0.0006)	(0.0010)	(0.0009)	(0.0007)	(0.0013)
Phytomass × Transhumant Pastoral	-0.0034**	-0.0038***	-0.0008	-0.0078***	-0.0028*	-0.0025	-0.0021*	-0.0099***	-0.0014	-0.0032	0.0016	-0.0028
	(0.0014)	(0.0013)	(0.0009)	(0.0017)	(0.0017)	(0.0016)	(0.0011)	(0.0025)	(0.0020)	(0.0020)	(0.0011)	(0.0022)
Own Ethnic Group												
Phytomass	0.0002	0.0003	0.0002	0.0010	0.0002	0.0002	0.0003	0.0012	-0.0023	-0.0018	-0.0009	-0.0055**
	(0.0005)	(0.0005)	(0.0004)	(0.0008)	(0.0005)	(0.0006)	(0.0004)	(0.0009)	(0.0016)	(0.0013)	(0.0011)	(0.0021)
Phytomass × Transhumant Pastoral	-0.0025	-0.0002	-0.0019	-0.0069**	0.0047	0.0075	-0.0001	-0.0100	-0.0022	0.0004	-0.0018	-0.0000
	(0.0022)	(0.0019)	(0.0016)	(0.0028)	(0.0049)	(0.0049)	(0.0033)	(0.0065)	(0.0032)	(0.0032)	(0.0019)	(0.0045)
Own Cell												
Phytomass	-0.0006	-0.0004	-0.0001	0.0002	-0.0006	-0.0004	-0.0002	0.0001	-0.0002	0.0004	-0.0003	-0.0008
	(0.0005)	(0.0005)	(0.0003)	(0.0007)	(0.0005)	(0.0005)	(0.0004)	(0.0007)	(0.0010)	(0.0009)	(0.0006)	(0.0013)
Phytomass × Transhumant Pastoral	-0.0008	-0.0009	0.0002	0.0007	-0.0064	-0.0058	-0.0002	0.0058	0.0009	-0.0004	0.0009	0.0014
	(0.0018)	(0.0017)	(0.0012)	(0.0023)	(0.0045)	(0.0044)	(0.0026)	(0.0057)	(0.0025)	(0.0023)	(0.0015)	(0.0034)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Phytomass Shock as % of Dep. Var. Mean:												
Phytomass	1.00	1.67	-0.95	2.22	2.84	2.30	3.13	2.11	-17.60	-9.76	-34.28	-0.52
p-value	[0.81]	[0.73]	[0.88]	[0.31]	[0.50]	[0.64]	[0.59]	[0.30]	[0.13]	[0.44]	[0.09]	[0.94]
Phytomass × Transhumant Pastoral	-30.17	-47.11	-15.15	-29.77	-23.32	-29.60	-34.43	-33.50	-15.64	-47.26	47.28	-16.02
p-value	[0.02]	[0.01]	[0.35]	[0.00]	[0.10]	[0.12]	[0.06]	[0.00]	[0.49]	[0.12]	[0.13]	[0.20]
Phytomass + Phytomass × Transhumant Pastoral	-29.18	-45.44	-16.10	-27.55	-20.48	-27.29	-31.30	-31.39	-33.24	-57.02	13.00	-16.54
p-value	[0.01]	[0.01]	[0.30]	[0.00]	[0.15]	[0.15]	[0.09]	[0.00]	[0.09]	[0.04]	[0.62]	[0.20]
Dep. Var. Mean	0.0373	0.0265	0.0174	0.0866	0.0404	0.0281	0.0199	0.0983	0.0297	0.0225	0.0114	0.0585
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	280	280	280	294	260	260	260	273	260	260	260	273
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	153,340	153,340	153,340	161,007	108,540	108,540	108,540	113,967	44,800	44,800	44,800	47,040

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Conflict by Season The second test focuses on the timing of conflict. According to the mechanism, the movement of transhumant pastoral groups in response to adverse rainfall shocks leads to conflict if this occurs during the wet season, when the agricultural lands are used for cultivation. During the dry season, when land is fallow, there is no tension as animal grazing is beneficial for both groups.

We perform this test by estimating equation (3) separately for conflict in each of the two seasons. Because the length of each season differs across locations, we measure the dependent variable as a monthly average. We use two measures: (i) the fraction of months during the season for which there is at least one conflict incident, and (ii) the average number of conflict incidents per month.

To separate wet-season conflict from dry-season conflict, we turn to data on cropping periods around the year 2000 from the MIRCA2000 global dataset (Portmann, Siebert and Döll, 2010). The dataset provides estimates for the beginning and end of the growing season at a high resolution using information from a wide variety of sources. Specifically, we use the starting and final months of the growing season for the 'main crop' in a cell, itself defined as crop with the greatest harvested area in the cell. Our sample is therefore restricted to cells that contain some harvested cropland and that experience both growing seasons and dry seasons within a year. Among these cells, the average duration of the main crop's growing season is 5.75 months.

To ensure that we are capturing all conflict events due to the joint use of resources, we define wet-season conflict as conflict events that begin during either the main crop's growing season or the first month after it ends. This allows for conflict events that coincide with the harvesting period, which may extend beyond the estimated final month of the main crop's growing season according to the MIRCA2000 data. We define dry season conflict as conflict events that begin at any point during the rest of the year.[9]

Using these definitions, the average per-month incidence of wet-season conflict is 0.75% and the average per-month incidence of dry-season conflict is 0.79%. Similarly, the average per-month number of conflict events is 0.0139 in the wet season and 0.0142 in the dry season. Dry season conflict is therefore marginally more prevalent than wet-season conflict. Despite this, we expect to find that our main results are explained primarily by wet-season conflict.

The estimates are reported in Tables 15 and 16. In Table 15 we use rainfall and in Table 16 we use phytomass. Columns 1 and 2 report estimates examining all conflict types during the wet season (for the two monthly measures), while columns 3 and 4 report the same estimates but for the dry season. Whether we use rainfall or phytomass, we find that cells with a transhumant pastoral nearest neighbor that experiences an adverse shock have more conflict. However, this effect is much larger in magnitude, much more precise, and statistically significant only during the wet season. In columns 5–8, we repeat the same exercise but restricting the sample to cells in majority-agricultural territories. We find the same pattern. Lastly, in columns 9–12, we restrict the sample to the remaining cells, finding no significant effect in either the wet or dry seasons.

[9]In generating these variables, we make use of the fine-grained UCDP data on the timing of events. This allows us to make the distinction between the first incident within a conflict event—which is our object of interest—and other incidents that are more likely to be a continuation of previous clashes.

Table 15: Effects of Neighbor's Rainfall on Conflict during the Wet and Dry Seasons

	UCDP Conflict per Month: All Grid Cells				Agricultural Cells				Non-Agricultural Cells			
	Wet Season		Dry Season		Wet Season		Dry Season		Wet Season		Dry Season	
	(1) Incidence	(2) Number	(3) Incidence	(4) Number	(5) Incidence	(6) Number	(7) Incidence	(8) Number	(9) Incidence	(10) Number	(11) Incidence	(12) Number
	Panel A: Transhumant definition includes only groups that are migratory or nomadic											
Nearest Neighboring Ethnic Group												
Rain	0.0001	0.0003	-0.0001	-0.0002	0.0000	0.0003	-0.0002	-0.0003	0.0005	0.0007	0.0004	0.0021
	(0.0002)	(0.0004)	(0.0003)	(0.0010)	(0.0002)	(0.0004)	(0.0003)	(0.0010)	(0.0010)	(0.0017)	(0.0011)	(0.0016)
Rain × Transhumant Pastoral	-0.0030***	-0.0107**	-0.0014	-0.0057	-0.0032**	-0.0077*	-0.0005	-0.0025	-0.0016	-0.0168	-0.0012	-0.0120
	(0.0011)	(0.0051)	(0.0010)	(0.0037)	(0.0015)	(0.0039)	(0.0013)	(0.0041)	(0.0016)	(0.0144)	(0.0013)	(0.0107)
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	0.83	2.39	-2.12	-1.34	0.36	2.73	-2.56	-2.72	6.44	4.09	5.36	13.74
p-value	[0.79]	[0.48]	[0.59]	[0.86]	[0.91]	[0.48]	[0.54]	[0.76]	[0.64]	[0.69]	[0.73]	[0.19]
Rain × Transhumant Pastoral	-47.12	-92.61	-20.73	-45.57	-52.62	-72.09	-7.40	-20.61	-22.88	-102.23	-16.92	-78.14
p-value	[0.01]	[0.04]	[0.15]	[0.13]	[0.03]	[0.05]	[0.71]	[0.55]	[0.30]	[0.24]	[0.37]	[0.27]
Rain + Rain × Transhumant Pastoral	-46.29	-90.22	-22.86	-46.91	-52.26	-69.36	-9.95	-23.32	-16.44	-98.15	-11.57	-64.40
p-value	[0.01]	[0.04]	[0.12]	[0.11]	[0.03]	[0.06]	[0.62]	[0.50]	[0.45]	[0.26]	[0.57]	[0.33]
	Panel B: Transhumant definition includes all groups without fully permanent settlements											
Nearest Neighboring Ethnic Group												
Rain	0.0001	0.0004	-0.0001	-0.0002	0.0000	0.0003	-0.0002	-0.0003	0.0005	0.0011	0.0004	0.0020
	(0.0002)	(0.0004)	(0.0003)	(0.0010)	(0.0002)	(0.0004)	(0.0003)	(0.0011)	(0.0010)	(0.0017)	(0.0011)	(0.0018)
Rain × Transhumant Pastoral	-0.0022**	-0.0082**	-0.0011	-0.0034	-0.0018	-0.0049	-0.0003	-0.0010	-0.0016	-0.0149	-0.0009	-0.0089
	(0.0009)	(0.0038)	(0.0009)	(0.0028)	(0.0011)	(0.0030)	(0.0011)	(0.0033)	(0.0017)	(0.0122)	(0.0014)	(0.0087)
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	1.13	3.07	-1.92	-1.33	0.49	3.06	-2.48	-2.70	7.26	6.44	5.44	13.29
p-value	[0.72]	[0.38]	[0.63]	[0.87]	[0.88]	[0.44]	[0.56]	[0.76]	[0.61]	[0.54]	[0.73]	[0.27]
Rain × Transhumant Pastoral	-35.18	-70.43	-16.58	-27.32	-30.07	-45.99	-3.76	-8.41	-22.18	-90.35	-13.49	-57.88
p-value	[0.01]	[0.03]	[0.21]	[0.22]	[0.11]	[0.10]	[0.82]	[0.76]	[0.34]	[0.22]	[0.52]	[0.31]
Rain + Rain × Transhumant Pastoral	-34.05	-67.37	-18.51	-28.65	-29.58	-42.93	-6.25	-11.11	-14.92	-83.91	-8.05	-44.59
p-value	[0.02]	[0.04]	[0.15]	[0.17]	[0.12]	[0.12]	[0.68]	[0.67]	[0.49]	[0.25]	[0.70]	[0.40]
Dep. Var. Mean	0.008	0.014	0.008	0.015	0.007	0.013	0.008	0.014	0.009	0.020	0.008	0.018
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	420	390	390	390	390	390	390	390	390
Cells	4,592	4,592	4,592	4,592	3,857	3,857	3,857	3,857	735	735	735	735
Observations	137,760	137,760	137,760	137,760	115,710	115,710	115,710	115,710	22,050	22,050	22,050	22,050

Note: The unit of observation is a 0.5-degree grid-cell and year. "Incidence" is per-month UCDP conflict incidence in either the wet season or the dry season as defined in the main text. "Number" is per-month number of UCDP conflict events. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* and *Own Cell* variables are controlled for but not reported. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 16: Effects of Neighbor's Phytomass on Conflict during the Wet and Dry Seasons

	UCDP Conflict per Month: All Grid Cells				Agricultural Cells				Non-Agricultural Cells			
	Wet Season		Dry Season		Wet Season		Dry Season		Wet Season		Dry Season	
	(1) Incidence	(2) Number	(3) Incidence	(4) Number	(5) Incidence	(6) Number	(7) Incidence	(8) Number	(9) Incidence	(10) Number	(11) Incidence	(12) Number
	Panel A: Transhumant definition includes only groups that are migratory or nomadic											
Nearest Neighboring Ethnic Group												
Phytomass	0.0001	0.0004	0.0000	0.0003	0.0001	0.0004	0.0000	0.0003	0.0002	-0.0003	-0.0003	-0.0004
	(0.0001)	(0.0003)	(0.0001)	(0.0003)	(0.0001)	(0.0003)	(0.0002)	(0.0003)	(0.0002)	(0.0008)	(0.0002)	(0.0006)
Phytomass × Transhumant Pastoral	-0.0008**	-0.0032*	-0.0001	-0.0014	-0.0008*	-0.0017***	0.0003	0.0006	-0.0005	-0.0047	-0.0003	-0.0034
	(0.0003)	(0.0018)	(0.0004)	(0.0015)	(0.0005)	(0.0006)	(0.0005)	(0.0008)	(0.0005)	(0.0040)	(0.0005)	(0.0032)
Effect of 1 Std. Dev. Phytomass Shock as % of Dep. Var. Mean:												
Phytomass	4.72	7.82	1.80	5.21	2.57	10.25	0.89	5.64	4.75	-3.23	-8.54	-6.13
p-value	[0.37]	[0.22]	[0.72]	[0.37]	[0.68]	[0.19]	[0.88]	[0.45]	[0.52]	[0.76]	[0.23]	[0.46]
Phytomass × Transhumant Pastoral	-32.17	-70.35	-3.47	-27.50	-37.88	-42.09	11.89	13.52	-15.62	-59.07	-9.01	-48.60
p-value	[0.02]	[0.08]	[0.81]	[0.35]	[0.06]	[0.00]	[0.55]	[0.42]	[0.28]	[0.24]	[0.59]	[0.28]
Phytomass + Phytomass × Transhumant Pastoral	-27.45	-62.53	-1.67	-22.30	-35.31	-31.84	12.78	19.17	-10.87	-62.30	-17.55	-54.73
p-value	[0.05]	[0.13]	[0.90]	[0.46]	[0.09]	[0.03]	[0.51]	[0.23]	[0.44]	[0.29]	[0.27]	[0.28]
	Panel B: Transhumant definition includes all groups without fully permanent settlements											
Nearest Neighboring Ethnic Group												
Phytomass	0.0001	0.0004	0.0000	0.0003	0.0001	0.0005	0.0000	0.0003	0.0001	-0.0001	-0.0003	-0.0004
	(0.0001)	(0.0003)	(0.0001)	(0.0003)	(0.0001)	(0.0003)	(0.0002)	(0.0003)	(0.0002)	(0.0006)	(0.0002)	(0.0004)
Phytomass × Transhumant Pastoral	-0.0006**	-0.0026*	0.0000	-0.0009	-0.0008**	-0.0016***	0.0001	0.0003	-0.0002	-0.0043	0.0001	-0.0030
	(0.0003)	(0.0015)	(0.0003)	(0.0013)	(0.0004)	(0.0006)	(0.0005)	(0.0011)	(0.0005)	(0.0043)	(0.0005)	(0.0035)
Effect of 1 Std. Dev. Phytomass Shock as % of Dep. Var. Mean:												
Phytomass	5.29	9.41	1.58	5.61	4.10	11.85	1.53	6.19	3.30	-1.80	-11.02	-5.43
p-value	[0.31]	[0.13]	[0.77]	[0.35]	[0.50]	[0.14]	[0.81]	[0.41]	[0.66]	[0.83]	[0.12]	[0.39]
Phytomass × Transhumant Pastoral	-26.26	-57.54	0.92	-18.01	-34.86	-39.49	5.72	7.68	-5.14	-54.15	4.48	-42.01
p-value	[0.03]	[0.08]	[0.94]	[0.49]	[0.04]	[0.01]	[0.76]	[0.74]	[0.73]	[0.31]	[0.77]	[0.40]
Phytomass + Phytomass × Transhumant Pastoral	-20.97	-48.13	2.50	-12.40	-30.76	-27.64	7.25	13.87	-1.84	-55.94	-6.54	-47.44
p-value	[0.09]	[0.15]	[0.83]	[0.63]	[0.08]	[0.04]	[0.68]	[0.53]	[0.90]	[0.34]	[0.65]	[0.37]
Dep. Var. Mean	0.008	0.015	0.009	0.016	0.007	0.013	0.008	0.015	0.011	0.026	0.010	0.024
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	280	280	280	280	260	260	260	260	260	260	260	260
Cells	4,592	4,592	4,592	4,592	3,857	3,857	3,857	3,857	735	735	735	735
Observations	91,840	91,840	91,840	91,840	77,140	77,140	77,140	77,140	14,700	14,700	14,700	14,700

Note: The unit of observation is a 0.5-degree grid-cell and year. "Incidence" is per-month UCDP conflict incidence in either the wet season or the dry season as defined in the main text. "Number" is per-month number of UCDP conflict events. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* and *Own Cell* variables are controlled for but not reported. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Temperature The last check that we perform examines the role of temperature. While it is well documented that temperature is linked to conflict through many potential channels (e.g., Burke et al., 2015, Eberle et al., 2020), these underlying mechanisms are orthogonal to our mechanism of interest. Since temperature is a relatively unimportant determinant of phytomass, we should not expect to observe the same spillover effects when we replace the rainfall variables with the equivalent temperature variables in our main specification.

The estimates are reported in Tables 17 and 18. Again, each table reports estimates using a different measure of transhumance. We estimate a fairly precise zero coefficient for the interaction between the temperature of a cell's nearest neighbor and the neighbor's measure of transhumant pastoralism. Thus, we do not observe the same patterns in the data when we use temperature rather than rainfall. This is consistent with our observation that, unlike rainfall, temperature is not a first-order determinant of phytomass growth. This exercise also indicates that the established mechanisms linking temperature to conflict in the literature cannot account for our main spillover effect of interest. Interestingly, we do find evidence of a direct relationship between temperature and conflict, as in the existing literature. Specifically, we estimate that, in general, higher temperatures experienced by the ethnic group of a cell result in more conflict in that cell.

In Tables 19 and 20, we report estimates from regressions in which the rainfall and temperature variables are included together. Our estimated rainfall spillover effects from transhumant pastoral neighbors remain large and statistically significant, while again we observe no equivalent spillover effect from temperature shocks.

Table 17: Estimates using Temperature rather than Rainfall: Narrower Two-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Temperature	0.0029*	0.0033**	0.0013	0.0029	0.0029	0.0030*	0.0014	0.0038	0.0029	0.0038	0.0011	0.0031
	(0.0016)	(0.0014)	(0.0011)	(0.0028)	(0.0020)	(0.0017)	(0.0013)	(0.0032)	(0.0029)	(0.0025)	(0.0021)	(0.0046)
Temperature × Transhumant Pastoral	0.0005	0.0033	0.0000	0.0027	0.0007	0.0015	-0.0005	-0.0060	0.0003	0.0041	0.0005	0.0051
	(0.0036)	(0.0035)	(0.0023)	(0.0046)	(0.0062)	(0.0062)	(0.0032)	(0.0080)	(0.0045)	(0.0040)	(0.0032)	(0.0060)
Own Ethnic Group												
Temperature	0.0063**	0.0047**	0.0044***	0.0114***	0.0065***	0.0041*	0.0049***	0.0090**	0.0030	0.0031	0.0009	0.0217**
	(0.0025)	(0.0023)	(0.0016)	(0.0034)	(0.0025)	(0.0023)	(0.0017)	(0.0039)	(0.0061)	(0.0044)	(0.0047)	(0.0093)
Temperature × Transhumant Pastoral	0.0054	0.0047	-0.0024	-0.0118	0.0027	0.0062	-0.0021	-0.0003	0.0077	0.0053	0.0021	-0.0279*
	(0.0058)	(0.0052)	(0.0039)	(0.0085)	(0.0131)	(0.0135)	(0.0077)	(0.0183)	(0.0111)	(0.0085)	(0.0080)	(0.0161)
Own Cell												
Temperature	-0.0022	-0.0025	-0.0015	-0.0029	-0.0020	-0.0021	-0.0013	-0.0017	-0.0017	-0.0012	-0.0025	-0.0096
	(0.0019)	(0.0018)	(0.0011)	(0.0024)	(0.0020)	(0.0019)	(0.0012)	(0.0026)	(0.0037)	(0.0034)	(0.0028)	(0.0067)
Temperature × Transhumant Pastoral	0.0026	0.0031	0.0032	0.0028	0.0040	0.0026	0.0015	-0.0069	0.0012	0.0005	0.0044	0.0107
	(0.0041)	(0.0036)	(0.0032)	(0.0065)	(0.0086)	(0.0081)	(0.0073)	(0.0126)	(0.0077)	(0.0063)	(0.0061)	(0.0137)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Temp. Shock as % of Dep. Var. Mean:												
Temperature	7.04	11.30	7.15	3.42	6.43	9.04	6.38	3.93	10.36	18.43	11.25	5.72
p-value	[0.07]	[0.02]	[0.22]	[0.30]	[0.15]	[0.07]	[0.30]	[0.23]	[0.33]	[0.12]	[0.58]	[0.50]
Temp. × Transhumant Pastoral	1.33	11.01	0.02	3.16	1.43	4.46	-2.47	-6.18	1.27	20.11	4.77	9.39
p-value	[0.88]	[0.36]	[1.00]	[0.56]	[0.92]	[0.81]	[0.87]	[0.46]	[0.94]	[0.30]	[0.88]	[0.40]
Temp. + Temp. × Transhumant Pastoral	8.37	22.31	7.17	6.57	7.86	13.50	3.91	-2.25	11.63	38.55	16.03	15.11
p-value	[0.35]	[0.07]	[0.55]	[0.16]	[0.54]	[0.44]	[0.77]	[0.76]	[0.49]	[0.08]	[0.56]	[0.09]
Dep. Var. Mean	0.032	0.024	0.015	0.068	0.037	0.027	0.017	0.078	0.022	0.017	0.008	0.043
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	364	364	364	252	338	338	338	234	338	338	338	234
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	199,298	199,298	199,298	137,978	141,080	141,080	141,080	97,672	58,218	58,218	58,218	40,306

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 18: Estimates using Temperature rather than Rainfall: Broader Four-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Temperature	0.0026	0.0030**	0.0014	0.0033	0.0031	0.0031*	0.0018	0.0045	0.0014	0.0024	0.0004	0.0024
	(0.0016)	(0.0014)	(0.0011)	(0.0028)	(0.0021)	(0.0017)	(0.0014)	(0.0033)	(0.0026)	(0.0021)	(0.0018)	(0.0043)
Temperature × Transhumant Pastoral	0.0017	0.0045	-0.0002	0.0011	-0.0006	0.0009	-0.0030	-0.0102	0.0029	0.0065	0.0019	0.0054
	(0.0037)	(0.0036)	(0.0023)	(0.0047)	(0.0061)	(0.0061)	(0.0030)	(0.0076)	(0.0045)	(0.0041)	(0.0030)	(0.0060)
Own Ethnic Group												
Temperature	0.0049**	0.0032	0.0041**	0.0121***	0.0049*	0.0026	0.0044**	0.0093**	0.0041	0.0038	0.0014	0.0338***
	(0.0024)	(0.0022)	(0.0016)	(0.0035)	(0.0026)	(0.0023)	(0.0018)	(0.0041)	(0.0071)	(0.0051)	(0.0052)	(0.0103)
Temperature × Transhumant Pastoral	0.0098*	0.0093*	-0.0011	-0.0132	0.0205	0.0224	0.0044	-0.0039	0.0060	0.0044	0.0013	-0.0444***
	(0.0059)	(0.0051)	(0.0040)	(0.0087)	(0.0172)	(0.0154)	(0.0085)	(0.0182)	(0.0123)	(0.0095)	(0.0087)	(0.0158)
Own Cell												
Temperature	-0.0015	-0.0016	-0.0013	-0.0033	-0.0012	-0.0010	-0.0011	-0.0025	-0.0008	-0.0004	-0.0020	-0.0092
	(0.0018)	(0.0017)	(0.0011)	(0.0023)	(0.0019)	(0.0017)	(0.0012)	(0.0025)	(0.0040)	(0.0036)	(0.0031)	(0.0068)
Temperature × Transhumant Pastoral	-0.0001	-0.0000	0.0025	0.0039	-0.0070	-0.0112	-0.0009	0.0057	-0.0000	-0.0007	0.0038	0.0104
	(0.0043)	(0.0036)	(0.0034)	(0.0066)	(0.0126)	(0.0120)	(0.0079)	(0.0126)	(0.0080)	(0.0066)	(0.0065)	(0.0141)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Temp. Shock as % of Dep. Var. Mean:												
Temperature	6.46	10.25	7.80	3.86	6.78	9.19	8.17	4.69	5.14	11.87	3.54	4.37
p-value	[0.11]	[0.03]	[0.18]	[0.24]	[0.15]	[0.08]	[0.21]	[0.17]	[0.58]	[0.26]	[0.84]	[0.59]
Temp. × Transhumant Pastoral	4.30	15.17	-1.30	1.30	-1.37	2.72	-13.94	-10.50	10.58	31.55	18.37	10.02
p-value	[0.63]	[0.21]	[0.92]	[0.81]	[0.92]	[0.88]	[0.32]	[0.18]	[0.51]	[0.11]	[0.53]	[0.36]
Temp. + Temp. × Transhumant Pastoral	10.76	25.42	6.51	5.16	5.41	11.91	-5.77	-5.81	15.72	43.42	21.91	14.39
p-value	[0.22]	[0.03]	[0.57]	[0.28]	[0.65]	[0.48]	[0.63]	[0.38]	[0.36]	[0.06]	[0.44]	[0.11]
Dep. Var. Mean	0.032	0.024	0.015	0.068	0.037	0.027	0.017	0.078	0.022	0.017	0.008	0.043
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	364	364	364	252	338	338	338	234	338	338	338	234
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	199,298	199,298	199,298	137,978	141,080	141,080	141,080	97,672	58,218	58,218	58,218	40,306

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 19: Estimates including Temperature in addition to Rainfall: Narrower Two-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain [γ_0^s]	-0.0005	0.0002	-0.0007	-0.0001	-0.0006	0.0002	-0.0008	0.0006	0.0001	-0.0003	0.0002	-0.0110***
	(0.0007)	(0.0006)	(0.0005)	(0.0012)	(0.0007)	(0.0006)	(0.0005)	(0.0012)	(0.0026)	(0.0025)	(0.0019)	(0.0040)
Rain × Transhumant Pastoral [γ_1^s]	-0.0117***	-0.0127***	-0.0005	-0.0073**	-0.0151***	-0.0158***	-0.0028	-0.0138**	-0.0045	-0.0044	0.0008	0.0069
	(0.0035)	(0.0033)	(0.0022)	(0.0036)	(0.0047)	(0.0041)	(0.0030)	(0.0054)	(0.0062)	(0.0057)	(0.0037)	(0.0068)
Temperature	0.0029*	0.0035**	0.0012	0.0030	0.0029	0.0031*	0.0013	0.0039	0.0029	0.0038	0.0011	0.0026
	(0.0016)	(0.0014)	(0.0011)	(0.0027)	(0.0021)	(0.0017)	(0.0013)	(0.0032)	(0.0029)	(0.0025)	(0.0020)	(0.0045)
Temperature × Transhumant Pastoral	-0.0000	0.0026	0.0000	0.0023	-0.0004	0.0003	-0.0006	-0.0071	0.0001	0.0040	0.0005	0.0058
	(0.0036)	(0.0035)	(0.0023)	(0.0045)	(0.0061)	(0.0062)	(0.0032)	(0.0080)	(0.0044)	(0.0040)	(0.0032)	(0.0059)
Own Ethnic Group												
Rain [γ_2^s]	0.0000	0.0011	-0.0004	0.0013	0.0002	0.0011	-0.0001	0.0010	-0.0107*	-0.0052	-0.0051	-0.0025
	(0.0011)	(0.0010)	(0.0007)	(0.0016)	(0.0011)	(0.0010)	(0.0007)	(0.0016)	(0.0056)	(0.0043)	(0.0039)	(0.0083)
Rain × Transhumant Pastoral [γ_3^s]	0.0022	-0.0016	0.0028	0.0061	0.0184	0.0162*	0.0114	0.0038	0.0137	0.0039	0.0080	0.0142
	(0.0050)	(0.0050)	(0.0042)	(0.0062)	(0.0139)	(0.0083)	(0.0125)	(0.0169)	(0.0092)	(0.0083)	(0.0067)	(0.0128)
Temperature	0.0061**	0.0046**	0.0043***	0.0114***	0.0063**	0.0041*	0.0048***	0.0089**	0.0018	0.0021	0.0006	0.0214**
	(0.0025)	(0.0023)	(0.0016)	(0.0034)	(0.0025)	(0.0023)	(0.0017)	(0.0039)	(0.0061)	(0.0044)	(0.0047)	(0.0093)
Temperature × Transhumant Pastoral	0.0055	0.0046	-0.0023	-0.0115	0.0034	0.0067	-0.0017	0.0007	0.0091	0.0062	0.0025	-0.0272*
	(0.0058)	(0.0052)	(0.0039)	(0.0086)	(0.0132)	(0.0134)	(0.0077)	(0.0184)	(0.0111)	(0.0085)	(0.0080)	(0.0162)
Own Cell												
Rain [γ_4^s]	-0.0003	-0.0004	-0.0002	-0.0008	-0.0003	-0.0003	-0.0002	-0.0010	0.0012	-0.0028	0.0035	-0.0009
	(0.0008)	(0.0006)	(0.0006)	(0.0011)	(0.0008)	(0.0006)	(0.0006)	(0.0012)	(0.0033)	(0.0019)	(0.0028)	(0.0053)
Rain × Transhumant Pastoral [γ_5^s]	0.0023	0.0046	-0.0018	0.0002	-0.0079	-0.0064	-0.0059	0.0115	-0.0016	0.0065	-0.0071	0.0036
	(0.0040)	(0.0037)	(0.0026)	(0.0054)	(0.0098)	(0.0077)	(0.0089)	(0.0122)	(0.0066)	(0.0052)	(0.0047)	(0.0095)
Temperature	-0.0023	-0.0025	-0.0015	-0.0029	-0.0020	-0.0021	-0.0012	-0.0017	-0.0018	-0.0015	-0.0023	-0.0099
	(0.0019)	(0.0018)	(0.0011)	(0.0024)	(0.0020)	(0.0019)	(0.0012)	(0.0026)	(0.0037)	(0.0034)	(0.0028)	(0.0067)
Temperature × Transhumant Pastoral	0.0029	0.0034	0.0032	0.0030	0.0040	0.0027	0.0015	-0.0070	0.0015	0.0010	0.0042	0.0113
	(0.0041)	(0.0036)	(0.0032)	(0.0065)	(0.0085)	(0.0080)	(0.0073)	(0.0124)	(0.0077)	(0.0063)	(0.0061)	(0.0137)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-1.75	0.92	-5.58	-0.26	-1.84	0.99	-5.45	0.89	0.36	-2.52	2.34	-30.55
p-value	[0.47]	[0.75]	[0.18]	[0.90]	[0.40]	[0.70]	[0.14]	[0.63]	[0.98]	[0.89]	[0.93]	[0.01]
Rain × Transhumant Pastoral	-43.34	-63.90	-4.46	-12.99	-49.48	-71.06	-19.42	-21.35	-24.63	-32.12	11.59	19.06
p-value	[0.00]	[0.00]	[0.80]	[0.04]	[0.00]	[0.00]	[0.35]	[0.01]	[0.46]	[0.44]	[0.83]	[0.31]
Rain + Rain × Transhumant Pastoral	-45.10	-62.98	-10.03	-13.24	-51.32	-70.07	-24.87	-20.45	-24.27	-34.64	13.93	-11.49
p-value	[0.00]	[0.00]	[0.57]	[0.03]	[0.00]	[0.00]	[0.23]	[0.01]	[0.43]	[0.37]	[0.78]	[0.49]
Dep. Var. Mean	0.032	0.024	0.015	0.068	0.037	0.027	0.017	0.078	0.022	0.017	0.008	0.043
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	364	364	364	252	338	338	338	234	338	338	338	234
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	199,298	199,298	199,298	137,978	141,080	141,080	141,080	97,672	58,218	58,218	58,218	40,306

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 20: Estimates including Temperature in addition to Rainfal: Broader Four-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain [γ_0^s]	-0.0005	0.0003	-0.0008	-0.0001	-0.0005	0.0003	-0.0008	0.0006	0.0002	0.0002	-0.0000	-0.0112***
	(0.0007)	(0.0006)	(0.0005)	(0.0012)	(0.0007)	(0.0006)	(0.0005)	(0.0012)	(0.0028)	(0.0026)	(0.0020)	(0.0040)
Rain × Transhumant Pastoral [γ_1^s]	-0.0085***	-0.0105***	0.0011	-0.0068*	-0.0084**	-0.0101***	0.0005	-0.0089*	-0.0049	-0.0062	0.0011	0.0060
	(0.0032)	(0.0030)	(0.0020)	(0.0036)	(0.0040)	(0.0036)	(0.0024)	(0.0051)	(0.0057)	(0.0052)	(0.0038)	(0.0069)
Temperature	0.0026	0.0032**	0.0013	0.0033	0.0030	0.0032*	0.0016	0.0046	0.0015	0.0025	0.0003	0.0019
	(0.0016)	(0.0014)	(0.0011)	(0.0028)	(0.0022)	(0.0017)	(0.0014)	(0.0033)	(0.0026)	(0.0022)	(0.0018)	(0.0043)
Temperature × Transhumant Pastoral	0.0013	0.0039	-0.0001	0.0007	-0.0013	-0.0000	-0.0029	-0.0109	0.0027	0.0063	0.0019	0.0062
	(0.0037)	(0.0036)	(0.0023)	(0.0046)	(0.0061)	(0.0062)	(0.0030)	(0.0075)	(0.0044)	(0.0041)	(0.0030)	(0.0060)
Own Ethnic Group												
Rain [γ_2^s]	0.0002	0.0013	-0.0002	0.0014	0.0005	0.0013	0.0000	0.0012	-0.0088	-0.0047	-0.0039	-0.0026
	(0.0011)	(0.0010)	(0.0007)	(0.0016)	(0.0011)	(0.0010)	(0.0007)	(0.0016)	(0.0055)	(0.0048)	(0.0034)	(0.0089)
Rain × Transhumant Pastoral [γ_3^s]	-0.0023	-0.0041	-0.0001	0.0035	-0.0036	-0.0008	-0.0022	-0.0094	0.0098	0.0029	0.0057	0.0154
	(0.0046)	(0.0044)	(0.0038)	(0.0059)	(0.0084)	(0.0070)	(0.0065)	(0.0112)	(0.0090)	(0.0088)	(0.0062)	(0.0134)
Temperature	0.0048*	0.0032	0.0040**	0.0121***	0.0049*	0.0026	0.0044**	0.0092**	0.0023	0.0022	0.0010	0.0330***
	(0.0024)	(0.0022)	(0.0016)	(0.0035)	(0.0026)	(0.0023)	(0.0018)	(0.0041)	(0.0072)	(0.0052)	(0.0053)	(0.0106)
Temperature × Transhumant Pastoral	0.0096	0.0089*	-0.0011	-0.0132	0.0199	0.0220	0.0042	-0.0036	0.0082	0.0061	0.0018	-0.0432***
	(0.0060)	(0.0052)	(0.0040)	(0.0087)	(0.0172)	(0.0154)	(0.0085)	(0.0183)	(0.0124)	(0.0096)	(0.0087)	(0.0161)
Own Cell												
Rain [γ_4^s]	-0.0004	-0.0005	-0.0002	-0.0008	-0.0003	-0.0004	-0.0003	-0.0012	-0.0010	-0.0042**	0.0023	0.0021
	(0.0008)	(0.0006)	(0.0006)	(0.0012)	(0.0008)	(0.0006)	(0.0006)	(0.0012)	(0.0027)	(0.0020)	(0.0020)	(0.0052)
Rain × Transhumant Pastoral [γ_5^s]	0.0032	0.0050	-0.0007	0.0006	-0.0014	-0.0016	0.0005	0.0123	0.0025	0.0088*	-0.0047	-0.0015
	(0.0037)	(0.0034)	(0.0026)	(0.0050)	(0.0064)	(0.0056)	(0.0052)	(0.0090)	(0.0059)	(0.0052)	(0.0039)	(0.0098)
Temperature	-0.0015	-0.0016	-0.0013	-0.0033	-0.0012	-0.0010	-0.0011	-0.0025	-0.0010	-0.0008	-0.0019	-0.0095
	(0.0018)	(0.0017)	(0.0011)	(0.0023)	(0.0019)	(0.0017)	(0.0012)	(0.0025)	(0.0040)	(0.0036)	(0.0031)	(0.0068)
Temperature × Transhumant Pastoral	0.0002	0.0003	0.0025	0.0041	-0.0068	-0.0110	-0.0009	0.0057	0.0004	-0.0001	0.0036	0.0109
	(0.0043)	(0.0036)	(0.0034)	(0.0066)	(0.0126)	(0.0120)	(0.0079)	(0.0126)	(0.0080)	(0.0066)	(0.0065)	(0.0141)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-1.74	1.28	-6.21	-0.11	-1.78	1.23	-5.81	0.99	1.17	1.55	-0.19	-30.90
p-value	[0.47]	[0.65]	[0.14]	[0.96]	[0.42]	[0.63]	[0.12]	[0.60]	[0.94]	[0.94]	[0.99]	[0.01]
Rain × Transhumant Pastoral	-31.60	-52.92	9.07	-12.09	-27.41	-45.26	3.24	-13.82	-26.62	-44.66	16.47	16.54
p-value	[0.01]	[0.00]	[0.58]	[0.06]	[0.04]	[0.00]	[0.85]	[0.08]	[0.39]	[0.24]	[0.77]	[0.39]
Rain + Rain × Transhumant Pastoral	-33.33	-51.64	2.86	-12.20	-29.20	-44.04	-2.56	-12.83	-25.45	-43.10	16.27	-14.36
p-value	[0.00]	[0.00]	[0.86]	[0.05]	[0.03]	[0.01]	[0.88]	[0.09]	[0.35]	[0.20]	[0.73]	[0.40]
Dep. Var. Mean	0.032	0.024	0.015	0.068	0.037	0.027	0.017	0.078	0.022	0.017	0.008	0.043
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	364	364	364	252	338	338	338	234	338	338	338	234
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	199,298	199,298	199,298	137,978	141,080	141,080	141,080	97,672	58,218	58,218	58,218	40,306

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* refers to the ethnic territory that contains cell i. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

7. Implications

A. Estimating Direct Effects of Rainfall on Conflict at Varying Cell Sizes

While our findings inform a deeper understanding of one particular conflict mechanism in Africa, they also provide a lesson on estimating the effects of weather events on conflict more generally. In our setting, we find that there are substantial spillover (or *indirect*) effects but there do not appear to be large own-cell (or *direct*) effects.

An important implication of this finding is that estimates of the direct effect of rainfall in a location on conflict in the same location may be sensitive to the unit of analysis chosen by the researcher. If one uses smaller units, then the spillover effects are less likely to be captured since the rainfall shock and the conflict event may occur in different cells. If one uses larger units, then spillover effects are more likely to be captured. Thus, the unit of analysis is crucial in a setting with spillover effects.

Our study examines the spillover effects by relying on a particular structure that is motivated by contextual knowledge. The question remains as to whether one could also obtain fairly accurate estimates without the detailed knowledge and resulting structure, but by conducting the analysis with larger units of analysis. This is particular important for estimates in other settings where the nature of the spatial spillovers are different and potentially unknown.

To make progress on this question, we estimate the direct effect of rainfall on conflict at different levels of analysis, ranging in size from cells that are 1-degree by 1-degree to 7-degree by 7-degree cells, which is just larger than the average size of countries in Africa. For each of the seven different-sized grid-cells, we estimate the following equation:

$$y_{it} = \alpha_i + \alpha_t + \gamma_0 Rain_{it} + \epsilon_{it}. \tag{4}$$

where i indexes a grid-cell and t a year. The dependent variable, y_{it}, measures the average incidence of UCDP conflict events in each 0.5-degree cell within cell i. We measure the outcome in this way so that it is not mechanically affected by the size of the unit of analysis. The variable $Rain_{it}$ is average precipitation in cell i in year t. The parameter γ_0 captures the effect of rainfall on conflict. We cluster standard errors at the grid-cell level to allow for serial correlation within cells and at the level of a year to allow for spatial correlation across cells.

There are multiple ways that one can create cells of each size. In turn, since the creation of cells affects the estimate of γ_0, the number of potential estimates of γ_0 also varies by cell size. Our interest is in how the average estimated effect of rainfall on conflict varies by cell size. Thus, we plot the mean estimate of γ_0 against the corresponding unit of analysis i in Figure 8a. The mean coefficient estimate at each cell size is close to zero and does not appear to vary appreciably with cell size. Thus, producing estimates that capture the effect of rainfall on conflict that we document in this paper does not appear to be possible by simply varying the size of the units of analysis.

This may be surprising at first. However, an obvious explanation for the absence of a relationship is that the analysis estimates average effects across the whole continent of Africa. By contrast, the spillover effects that we identify are due to conflict in areas that are used by both

agriculturalists and transhumant pastoralists. Thus, for much of the continent, these spillovers are not present.

To improve upon this test, we consider whether one can provide estimates of the effects we identify in the paper, but without the use of ethnographic data or the structure our analysis imposes. We presume the researcher only has access to geo-climatic data on locations that are suitable for both agriculture and transhumant pastoralism. We define a 0.5-degree grid-cell as being a cell that has dual use by sedentary agriculturalists and transhumant pastoralists if the cell has suitability that is above the 25th percentile for both agriculture and pastoralism as constructed by Beck and Sieber (2010). By this measure, 56% of the 0.5-degree cells in Africa are suitable for dual use. We then calculate the fraction of 0.5-degree cells within our unit of analysis that are suitable for dual-use. We denote this measure $\textit{Dual Suitability}_i$. We then allow the effect of rainfall on conflict to differ by this measure. Specifically, we estimate:

$$y_{it} = \alpha_i + \alpha_t + \beta_0 \textit{Rain}_{it} + \beta_1 \textit{Rain}_{it} \times \textit{Dual Suitability}_i + \varepsilon_{it}. \tag{5}$$

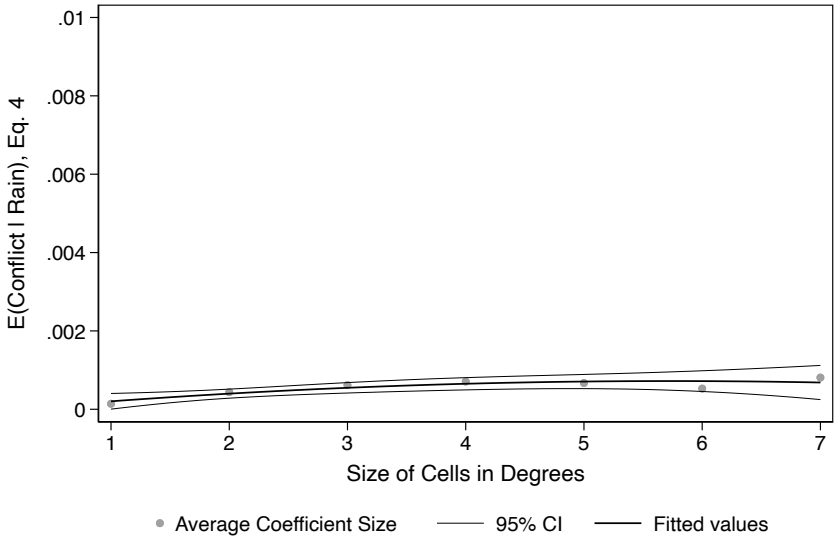
where, as before, i indexes 1–7 degree grid-cells and t years, y_{it}, measures the average incidence of UCDP conflict events in each 0.5-degree cell within cell i, $\textit{Rain}_{it}$ is average precipitation in cell i in year t, and $\textit{Dual Suitability}_i$ is the share of 0.5-degree cells that are suitable for both agriculture and transhumant pastoralism. We continue to cluster standard errors at the level of an i degree cell and year.

We plot the mean estimates of β_1, along with confidence intervals and fitted values, for each cell size in Figure 8b. (For comparability, the scale of the y-axis is the same as in Figure 8a.) A very different picture now emerges. The effect of rainfall on conflict within a grid-cell is negative and significant for cells that are suitable for both agriculture and transhumant pastoralism. Importantly, we now find that cell size matters. The magnitude of the estimated effect for dual-use cells tends to be greater the larger the cells, which we expect will better capture spatial spillovers. The magnitude of the average estimated effect monotonically increases up to about four degrees, after which it stays fairly flat. Thus, the spillovers appear to be well captured by four-degree grid cells and there is little gain to increasing cells beyond this.[10]

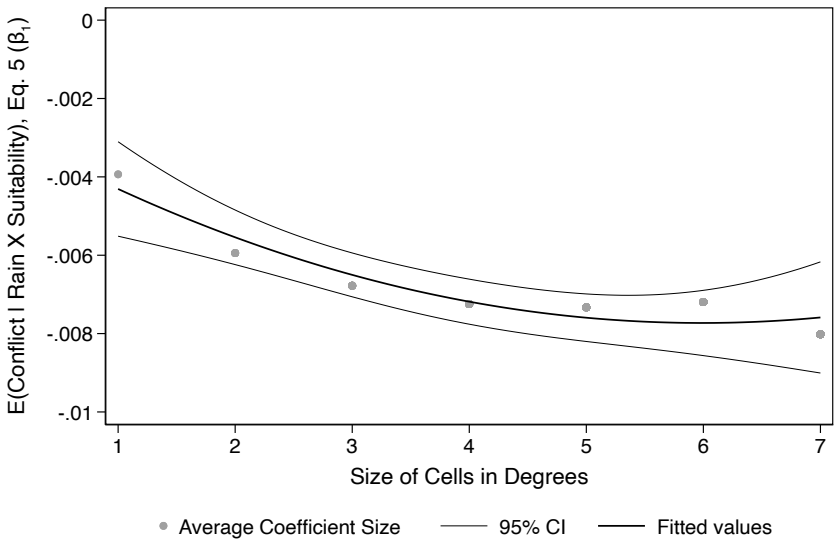
The magnitudes of our estimated effects are sizeable. At the 1-degree level, the estimate of β_1 is around -0.0039. This implies that for a grid-cell that is fully dual-use (relative to no dual-use), a one-standard-deviation increase in rainfall lowers the incidence of conflict by 13.3%. At the 7-degree level, the average estimate is -0.008. This implies that a one-standard-deviation increase in rainfall in a fully dual-use cell (relative to a no dual-use cell) lowers the incidence of conflict by 27.3%. Thus, the estimated effect more than doubles in magnitude as we increase the unit of analysis in size from 1 degree to 7 degrees.

Taken together, the results are consistent with our main finding that adverse rainfall shocks lead to more conflict in Africa due to a spillover mechanism rather than a direct mechanism. Beyond this, the exercise highlights the pitfalls of ignoring spillover effects in granular data. It also indicates that in the presence of spatial spillovers, simply adjusting the size of the cells being

[10] In fact, if we increase cell sizes beyond 7 degrees the estimates begin to attenuate slightly towards zero, which is consistent with an increase in the amount of measurement error relative to real variation as cell sizes are enlarged.



(a) Estimated effect of rainfall: β_0 from equation (4)



(b) Estimated differential effect of rainfall in dual-use cells: β_1 from equation (5)

Figure 8: Effects of Rainfall on Conflict at Various Levels of Analysis

studied is not sufficient to obtain accurate estimates. In settings, where the spillover effects are not universal across space, one needs also to have a minimal understanding of the source of the spillovers themselves.

B. Representation in Government, Climate Change, and Conflict

Thus far, we have established that much, if not all, of the conflict induced by droughts in transhumant pastoral territories involves the state. This suggests that national political economy forces may play an important role in either moderating or amplifying this relationship. In this section, we test whether the same spillover effects are present or not when pastoral groups have more political power.

The logic behind the test if that pastoral groups are less likely to be afforded grazing rights when they are excluded from national politics. In this scenario, state forces will serve to protect the property rights of landowning farmers only. On the other hand, if pastoral groups occupy a greater share of national political power, then property rights are more likely to be balanced between the interests of both farmers and herders.

We measure the extent to which political power in a country is held by transhumant pastoral groups using information from the Ethnic Power Relations (EPR) Database, which documents the nature of political power held by ethnic groups. We use this information to construct a measure of the total amount of political power held by an ethnic group e in country c in year t, which we denote by $Power_{ect}$. The categories and values of the variable are given by:

0. Fully excluded from politics (self exclusion or discrimination)
1. Powerless
2. Junior partner in government
3. Senior partner in government
4. Dominant power
5. Monopoly power

Our interest is in the share of political power in a country that is held by groups that are transhumant pastoral. We measure the total amount of political power in a country by aggregating the power of all ethnic group: $\sum_e Power_{ec(i)t}$. We measure the amount of power held by transhumant pastoral groups by: $\sum_e TranshumantPastoral_e \times Power_{ec(i)t}$. Our measure of the share of power held by transhumant pastoral groups is then:

$$Power^{THP}_{c(i)t} = \frac{\sum_e TranshumantPastoral_e \times Power_{ec(i)t}}{\sum_e Power_{ec(i)t}}.$$

In our sample, a third of the countries have a measure of $Power^{THP}_{c(i)t}$ that is equal to zero, indicating that there are no transhumant pastoral groups in the country who hold political power. The highest value of the measure is 0.61, which is for Mauritania from 1989–2017, when the

Delim, Trarza, Regeibat, Zenega, Tajakant, and Berabish pastoral groups were represented by junior partners in government.

Using the transhumant political power measure, we estimate a variant of equation (3) that allows our effect of interest to differ depending on the extent to which transhumant pastoral groups hold political power in that country and year, $Power^{THP}_{c(i)t}$. The estimating equation is:

$$\begin{aligned} y_{iet} \;=\; & \phi^s_0 \, Rain^{Neighbor}_{it} + \phi^s_1 \, Rain^{Neighbor}_{it} \times TranshumantPastoral^{Neighbor}_{i} \\ & + \phi^s_2 \, Rain^{Neighbor}_{it} \times TranshumantPastoral^{Neighbor}_{i} \times Power^{THP}_{c(i)t-1} \\ & + \phi^s_3 Rain^{Neighbor}_{it} \times Power^{THP}_{c(i)t-1} + \phi^s_4 TranshumantPastoral^{Neighbor}_{i} \times Power^{THP}_{c(i)t-1} \\ & + \phi^s_5 \, Rain^{OwnGroup}_{et} + \phi^s_6 \, Rain^{OwnGroup}_{et} \times TranshumantPastoral^{OwnGroup}_{e} \\ & + \phi^s_7 \, Rain^{OwnCell}_{it} + \phi^s_8 \, Rain^{OwnCell}_{it} \times TranshumantPastoral^{OwnGroup}_{e} \\ & + \alpha^s_i + \alpha^s_{c(i)t} + \xi^s_{iet}, \end{aligned} \tag{6}$$

where all indices and variables are as in equation (3). The estimates of interest are ϕ^s_1, which is our main spillover effect when transhumant pastoral groups have no political power, and ϕ^s_2, which determines how much the main spillover effect changes as transhumant pastoral groups gain more political power.

Estimates of equation (6) are reported in Tables 21 and 22. We find that the estimated coefficient for the interaction between a nearest neighbor's rainfall and that neighbor's measure of transhumant pastoralism, $\hat{\phi^s_1}$, is negative and significant for state-involved UCDP conflict and all types of ACLED conflict. This is the estimated effect for a country where the share of power held by transhumant pastoral groups is zero. The estimated coefficient for the triple interaction, $\hat{\phi^s_2}$, is positive and generally significant using the narrower definition of transhumance, indicating that the effect of rainfall in the territory of neighboring transhumant pastoral groups on conflict is lower when transhumant pastoral groups have more national political power. In some specifications, the interaction terms lack statistical power, but in all the estimated effect is positive and meaningful.

To assess the importance of the estimated heterogeneity, in the bottom panel of each table we calculate the predicted effect and statistical significance of $Rain^{Neighbor}_{it} \times TranshumantPastoral^{Neighbor}_{i}$ at different values of $Power^{THP}_{c(i)t-1}$. The first predicted effect that we report is for a value of $Power^{THP}_{c(i)t-1}$ that is equal to the 25th percentile of its distribution, which is zero. Below this, we report the same statistic calculated at the 50th percentile (0.094) and the 75th percentile (0.284).

We find that for country-years in which no transhumant pastoral groups share political power, the spillover effect is very large. For example, a one-standard-deviation decrease in rainfall is associated with an increase of conflict of 30–56% for all conflicts using the UCDP measure and 67–82% for all conflicts using the ACLED measure (depending on the definition of transhumance used). When a country is at the 75th percentile of transhumant pastoral political power, these effects are not statistically different from zero. In addition, they are very small: 13–14% for UCDP

Table 21: Heterogeneity by Share of Political Power Held by Transhumant Pastoral Groups: Using Narrower Two-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group								
Rain	-0.0007	0.0006	-0.0011*	-0.0046***	-0.0008	0.0004	-0.0011*	-0.0032**
	(0.0008)	(0.0007)	(0.0006)	(0.0014)	(0.0008)	(0.0007)	(0.0007)	(0.0015)
Rain × Transhumant Pastoral	-0.0153**	-0.0146***	-0.0031	-0.0510***	-0.0188**	-0.0214***	-0.0006	-0.0607***
	(0.0061)	(0.0054)	(0.0035)	(0.0091)	(0.0086)	(0.0074)	(0.0051)	(0.0114)
Rain × Transhumant Pastoral × THP Power Share	0.0412*	0.0332	0.0097	0.1790***	0.0459	0.0573*	-0.0131	0.2247***
	(0.0227)	(0.0206)	(0.0130)	(0.0391)	(0.0348)	(0.0333)	(0.0209)	(0.0511)
Rain × THP Power Share	-0.0008	-0.0057	0.0076*	0.0533***	0.0002	-0.0017	0.0055	0.0495***
	(0.0075)	(0.0072)	(0.0040)	(0.0140)	(0.0088)	(0.0082)	(0.0048)	(0.0164)
Transhumant Pastoral × THP Power Share	-0.2409**	-0.2234**	-0.0149	-1.0375***	-0.4192**	-0.4306***	0.0212	-1.3999***
	(0.1050)	(0.1023)	(0.0377)	(0.1657)	(0.1692)	(0.1618)	(0.0592)	(0.2243)
Nearest Neighboring Ethnic Group: Additional Calculations								
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:								
Rain × Transhumant Pastoral when THP Power at 25 pctile	-56.1	-71.6	-26.5	-82.1	-59.6	-91.5	-4.4	-80.3
p-value	[0.01]	[0.01]	[0.38]	[0.00]	[0.03]	[0.00]	[0.90]	[0.00]
Rain × Transhumant Pastoral when THP Power at 50 pctile	-41.9	-56.3	-18.7	-55.0	-45.9	-68.5	-13.1	-52.4
p-value	[0.01]	[0.00]	[0.40]	[0.00]	[0.02]	[0.00]	[0.62]	[0.00]
Rain × Transhumant Pastoral when THP Power at 75 pctile	-13.2	-25.5	-2.8	-0.1	-18.3	-22.0	-30.8	4.1
p-value	[0.34]	[0.16]	[0.88]	[0.99]	[0.34]	[0.37]	[0.21]	[0.73]
Dep. Var. Mean	0.033	0.025	0.014	0.074	0.038	0.028	0.017	0.091
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	406	406	406	308	377	377	377	286
Cells	6,965	6,965	6,965	6,962	5,089	5,089	5,089	5,086
Observations	194,442	194,442	194,442	148,128	140,923	140,923	140,923	107,000

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* and *Own Cell* variables are controlled for but not reported. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

and 0–1% for ACLED.[11]

Overall, these results suggest that political power plays in an important role in explaining our main results. When transhumant pastoral groups have a higher share of political power, droughts in their home territories cease to induce the same outbreak of conflict in neighboring areas.

[11] Although the estimates for the double interactions involving transhumant pastoral political power are not directly of interest, it is noteworthy that the estimated effect of $TranshumantPastoral_i^{Neighbor} \times Power_{ct-1}^{THP}$ is negative and generally significant. Thus, there is less conflict in the neighborhood of transhumant pastoral groups when transhumant pastoral groups hold political power.

Table 22: Heterogeneity by Share of Political Power Held by Transhumant Pastoral Groups: Using Broader Four-Category Definition of Transhumance

	Conflict in All Grid Cells				Conflict in Agricultural Cells			
	(1) UCDP I(Any)	(2) UCDP I(State)	(3) UCDP I(Non-State)	(4) ACLED I(Any)	(5) UCDP I(Any)	(6) UCDP I(State)	(7) UCDP I(Non-State)	(8) ACLED I(Any)
Nearest Neighboring Ethnic Group								
Rain	-0.0008	0.0006	-0.0012*	-0.0044***	-0.0009	0.0003	-0.0011*	-0.0031**
	(0.0008)	(0.0007)	(0.0007)	(0.0015)	(0.0008)	(0.0007)	(0.0007)	(0.0015)
Rain × Transhumant Pastoral	-0.0081	-0.0097**	-0.0002	-0.0417***	-0.0075	-0.0120**	0.0020	-0.0408***
	(0.0052)	(0.0045)	(0.0028)	(0.0080)	(0.0067)	(0.0058)	(0.0037)	(0.0097)
Rain × Transhumant Pastoral × THP Power Share	0.0151	0.0146	0.0060	0.1452***	0.0084	0.0221	-0.0074	0.1603***
	(0.0202)	(0.0185)	(0.0106)	(0.0359)	(0.0293)	(0.0276)	(0.0152)	(0.0470)
Rain × THP Power Share	0.0020	-0.0034	0.0070*	0.0565***	0.0037	0.0012	0.0047	0.0535***
	(0.0074)	(0.0070)	(0.0038)	(0.0144)	(0.0086)	(0.0080)	(0.0047)	(0.0170)
Transhumant Pastoral × THP Power Share	-0.1598	-0.1633	-0.0156	-0.9318***	-0.2773	-0.3107*	0.0066	-1.2088***
	(0.1074)	(0.1045)	(0.0323)	(0.1581)	(0.1740)	(0.1681)	(0.0477)	(0.2144)
Nearest Neighboring Ethnic Group: Additional Calculations								
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:								
Rain × Transhumant Pastoral when THP Power at 25 pctile	-29.7	-47.5	-1.6	-67.2	-23.8	-51.3	14.2	-53.9
p-value	[0.12]	[0.03]	[0.95]	[0.00]	[0.26]	[0.04]	[0.59]	[0.00]
Rain × Transhumant Pastoral when THP Power at 50 pctile	-24.5	-40.8	3.2	-45.2	-21.3	-42.4	9.3	-34.0
p-value	[0.09]	[0.02]	[0.86]	[0.00]	[0.17]	[0.02]	[0.64]	[0.00]
Rain × Transhumant Pastoral when THP Power at 75 pctile	-13.9	-27.2	13.1	-0.7	-16.2	-24.4	-0.6	6.3
p-value	[0.31]	[0.13]	[0.44]	[0.94]	[0.35]	[0.27]	[0.98]	[0.58]
Dep. Var. Mean	0.033	0.025	0.014	0.074	0.038	0.028	0.017	0.091
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	406	406	406	308	377	377	377	286
Cells	6,965	6,965	6,965	6,962	5,089	5,089	5,089	5,086
Observations	194,442	194,442	194,442	148,128	140,923	140,923	140,923	107,000

Note: The unit of observation is a 0.5-degree grid-cell and year. "UCDP I(Any)" is an indicator variable that equals one if at least one violent conflict occurs in a cell and year as coded in the UCDP data. "UCDP I(State)" is an indicator variable that equals one if at least one conflict event involving the state occurs in a cell and year; " UCDP I(Non-State)" is an indicator variable that equals one if at least one conflict event not involving the state occurs in a cell and year. *Nearest Neighboring Ethnic Group* refers to the nearest neighboring ethnic territory to cell i. *Own Ethnic Group* and *Own Cell* variables are controlled for but not reported. Standard errors, which are reported in parentheses, are adjusted for clustering at the level of a grid-cell and climate zone-year. * p < 0.1, ** p < 0.05, *** p < 0.01.

8. Conclusions

In this paper, we examined the hypothesis that climate change is disrupting the longstanding cooperative relationship between transhumant pastoral ethnic groups and neighboring agricultural ethnic groups in Africa. Specifically, we found that adverse rainfall shocks in transhumant pastoral territories force groups to migrate to neighboring agricultural territories before the harvest, causing conflict to emerge.

To pinpoint this mechanism, we show that the effects are due to insufficient phytomass growth, which animals require for sustenance. These shocks lead to conflict during the wet season in neighboring agricultural territories, when land is still used to cultivate crops, and not during the dry season, when land is available for grazing. This spillover mechanism appears to explain most of the overall association between precipitation and conflict in Africa. Moreover, our estimated effects approach zero as pastoral groups gain more national political power.

Our findings point to the significant efficiency costs of incomplete property rights for both farmers and herders in Africa. Institutions that enforce the right balance of grazing and cultivating rights will play an important role in mitigating the costs of climate change in agro-pastoral zones.

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For Online Publication: Appendix

Appendix A. Figures

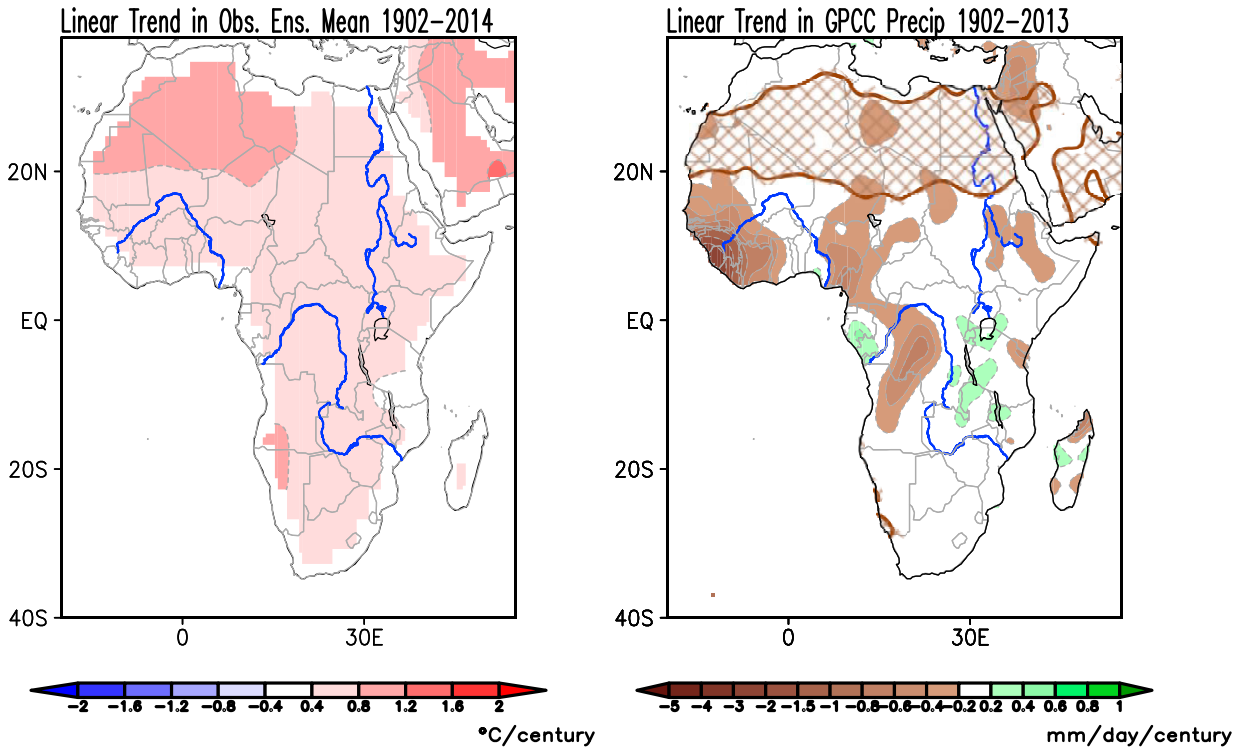

FIG. C1. Linear trend in annual-mean (left) SAT (°C century^{-1}) and (right) precipitation (mm day^{-1} century^{-1}) over the 1902–2014

Figure A1: Comparing spatial variation in temperature and rainfall anomalies. Variation for rainfall is much greater at a finer spatial scale than for temperature. Source: Thomas and Nigam (2018).

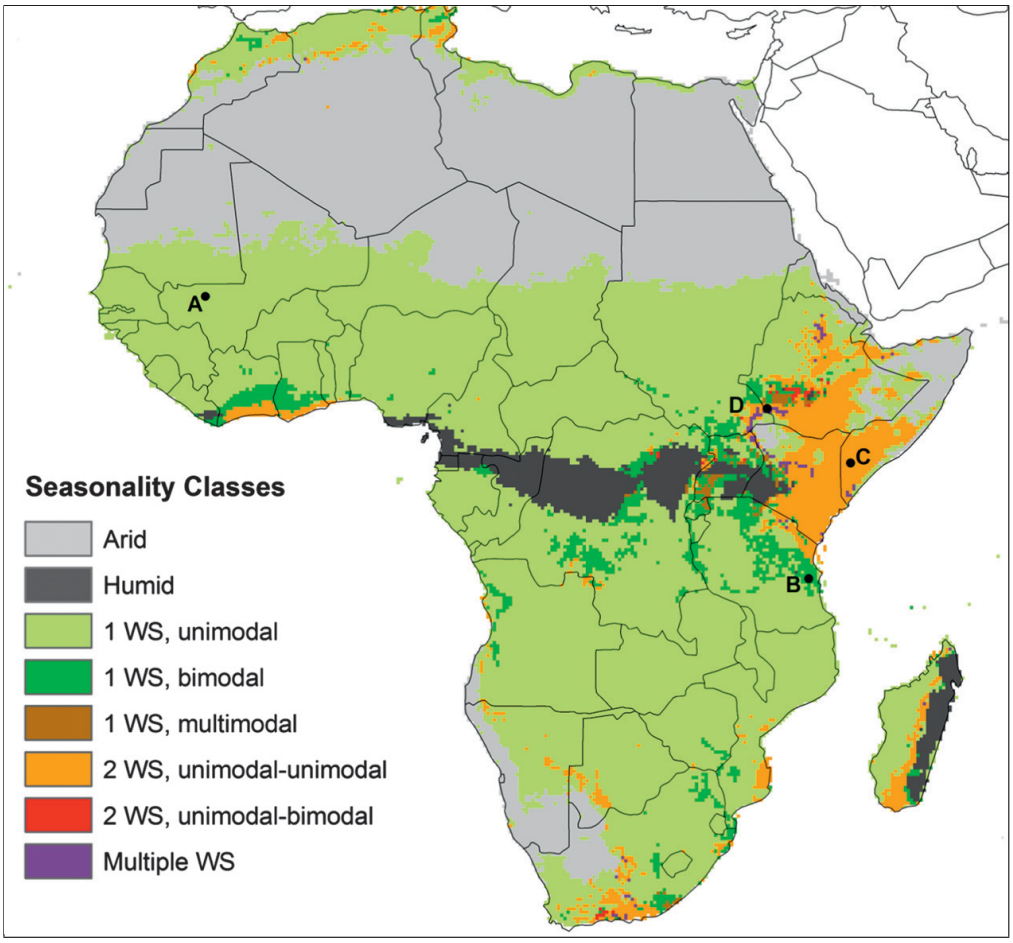

Figure A2: Distribution of types of rainy seasons across the African Continent. Source: Herrmann and Mohr (2012).

Appendix B. Tables

A. Estimating Phytomass as a Function of Rain and Temperature

Table A1: Phytomass

	Phytomass		
	(1)	(2)	(3)
Rain	0.4151***		0.4092***
	(0.0357)		(0.0350)
Temp		-0.2223***	-0.2018***
		(0.0400)	(0.0383)
Share of RSS explained by weather variable(s) (in %)	3.63	0.61	4.13
F statistic	135.55	30.84	75.07
Effect of 1 Std. Dev. Shock as % of Dep. Var. Mean:			
Rain	1.63		1.61
p-value	[0.00]		[0.00]
Temp		-0.58	-0.53
p-value		[0.00]	[0.00]
Dep. Var. Mean	30.571	30.571	30.571
Cell FE	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes
Climate-Zone-Years	224	224	224
Cells	9,691	9,691	9,691
Observations	155,032	155,032	155,032

Note: This table presents phytomass (in kg/ha) as a function of rainfall (in cm/month) and temperature (in °C), conditional on cell fixed effects and country-by-year fixed effects. *RSS* refers to the residual sum of squares after partialling out the cell fixed effects and country-by-year fixed effects. Standard errors (in parentheses) are adjusted for serial correlation at the level of a cell and spatial correlation at the level of a climate zone. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

B. Re-Estimating the Main Specification with Standard Errors Clustered at Various Levels

a. Clustering by country

Table A2: Clustering by Country using Narrow Definition of Transhumant Pastoralism

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain	-0.0006	0.0001	-0.0004	-0.0006	-0.0007	0.0001	-0.0006	-0.0001	-0.0000	-0.0001	0.0007	-0.0105**
	(0.0006)	(0.0005)	(0.0006)	(0.0011)	(0.0007)	(0.0005)	(0.0007)	(0.0012)	(0.0025)	(0.0012)	(0.0025)	(0.0042)
Rain × Transhumant Pastoral	-0.0110**	-0.0121***	-0.0012	-0.0096***	-0.0122**	-0.0124**	-0.0030	-0.0172***	-0.0053	-0.0062	-0.0001	0.0052
	(0.0044)	(0.0039)	(0.0022)	(0.0022)	(0.0052)	(0.0051)	(0.0019)	(0.0041)	(0.0064)	(0.0049)	(0.0036)	(0.0052)
Own Ethnic Group												
Rain	-0.0000	0.0013	-0.0003	0.0009	-0.0001	0.0012	-0.0002	0.0002	-0.0057	-0.0028	-0.0014	-0.0022
	(0.0009)	(0.0011)	(0.0006)	(0.0012)	(0.0010)	(0.0012)	(0.0006)	(0.0012)	(0.0049)	(0.0042)	(0.0040)	(0.0049)
Rain × Transhumant Pastoral	-0.0015	-0.0046	0.0016	-0.0013	0.0089	0.0057	0.0091	-0.0186	0.0043	-0.0013	0.0021	0.0079
	(0.0051)	(0.0036)	(0.0035)	(0.0035)	(0.0085)	(0.0070)	(0.0070)	(0.0153)	(0.0096)	(0.0059)	(0.0063)	(0.0081)
Own Cell												
Rain	-0.0002	-0.0004	-0.0001	-0.0004	-0.0002	-0.0004	-0.0001	-0.0006	0.0012	-0.0023	0.0028	-0.0001
	(0.0006)	(0.0005)	(0.0005)	(0.0010)	(0.0006)	(0.0004)	(0.0006)	(0.0010)	(0.0033)	(0.0023)	(0.0031)	(0.0040)
Rain × Transhumant Pastoral	0.0039	0.0055	-0.0009	0.0046	-0.0072	-0.0063*	-0.0054	0.0169	-0.0001	0.0065	-0.0056	0.0054
	(0.0051)	(0.0043)	(0.0031)	(0.0046)	(0.0091)	(0.0037)	(0.0092)	(0.0128)	(0.0087)	(0.0062)	(0.0058)	(0.0095)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-2.02	0.25	-3.31	-0.79	-1.98	0.60	-3.78	-0.13	-0.14	-0.73	8.88	-22.95
p-value	[0.35]	[0.92]	[0.44]	[0.61]	[0.35]	[0.77]	[0.37]	[0.93]	[0.99]	[0.92]	[0.79]	[0.02]
Rain × Transhumant Pastoral	-37.42	-56.94	-9.22	-13.82	-37.27	-52.82	-19.38	-21.65	-25.72	-39.97	-0.97	11.27
p-value	[0.02]	[0.00]	[0.58]	[0.00]	[0.02]	[0.02]	[0.12]	[0.00]	[0.42]	[0.21]	[0.98]	[0.33]
Rain + Rain × Transhumant Pastoral	-39.44	-56.69	-12.53	-14.62	-39.25	-52.22	-23.16	-21.78	-25.86	-40.70	7.91	-11.69
p-value	[0.01]	[0.00]	[0.45]	[0.00]	[0.02]	[0.02]	[0.08]	[0.00]	[0.37]	[0.22]	[0.82]	[0.26]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries	49	49	49	49	48	48	48	48	26	26	26	26
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

Table A3: Clustering by Country using Broad Definition of Transhumant Pastoralism

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain	-0.0006	0.0001	-0.0005	-0.0004	-0.0006	0.0002	-0.0007	-0.0000	0.0002	0.0005	0.0005	-0.0107**
	(0.0006)	(0.0005)	(0.0006)	(0.0011)	(0.0007)	(0.0005)	(0.0007)	(0.0012)	(0.0027)	(0.0014)	(0.0027)	(0.0046)
Rain × Transhumant Pastoral	-0.0082*	-0.0105***	0.0007	-0.0093***	-0.0067	-0.0087**	0.0004	-0.0125***	-0.0053	-0.0074	0.0007	0.0051
	(0.0041)	(0.0037)	(0.0020)	(0.0022)	(0.0045)	(0.0041)	(0.0018)	(0.0045)	(0.0063)	(0.0054)	(0.0037)	(0.0057)
Own Ethnic Group												
Rain	0.0002	0.0015	-0.0002	0.0010	0.0002	0.0014	-0.0001	0.0006	-0.0042	-0.0021	-0.0008	-0.0055
	(0.0009)	(0.0011)	(0.0006)	(0.0013)	(0.0010)	(0.0012)	(0.0006)	(0.0013)	(0.0051)	(0.0044)	(0.0037)	(0.0051)
Rain × Transhumant Pastoral	-0.0050	-0.0065*	-0.0010	-0.0028	-0.0063	-0.0040	-0.0020	-0.0258**	0.0017	-0.0025	0.0010	0.0133
	(0.0051)	(0.0038)	(0.0031)	(0.0032)	(0.0080)	(0.0075)	(0.0037)	(0.0106)	(0.0102)	(0.0066)	(0.0061)	(0.0079)
Own Cell												
Rain	-0.0003	-0.0005	-0.0001	-0.0005	-0.0002	-0.0004	-0.0001	-0.0008	-0.0008	-0.0038	0.0019	0.0026
	(0.0006)	(0.0005)	(0.0006)	(0.0010)	(0.0006)	(0.0004)	(0.0006)	(0.0010)	(0.0031)	(0.0027)	(0.0025)	(0.0036)
Rain × Transhumant Pastoral	0.0048	0.0061	-0.0000	0.0054	-0.0023	-0.0028	0.0002	0.0183*	0.0034	0.0088	-0.0039	0.0005
	(0.0047)	(0.0039)	(0.0030)	(0.0044)	(0.0030)	(0.0036)	(0.0030)	(0.0100)	(0.0083)	(0.0064)	(0.0053)	(0.0093)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-1.97	0.71	-3.93	-0.62	-1.98	0.81	-4.16	-0.01	0.81	2.94	6.37	-23.37
p-value	[0.36]	[0.78]	[0.36]	[0.70]	[0.35]	[0.71]	[0.33]	[0.99]	[0.95]	[0.74]	[0.86]	[0.03]
Rain × Transhumant Pastoral	-27.83	-49.58	5.59	-13.38	-20.30	-36.90	2.65	-15.69	-25.72	-47.62	8.84	11.04
p-value	[0.05]	[0.01]	[0.71]	[0.00]	[0.14]	[0.04]	[0.82]	[0.01]	[0.40]	[0.18]	[0.86]	[0.38]
Rain + Rain × Transhumant Pastoral	-29.80	-48.87	1.66	-14.00	-22.28	-36.09	-1.51	-15.71	-24.90	-44.69	15.21	-12.33
p-value	[0.04]	[0.01]	[0.91]	[0.00]	[0.11]	[0.03]	[0.90]	[0.01]	[0.34]	[0.18]	[0.64]	[0.22]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries	49	49	49	49	48	48	48	48	26	26	26	26
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

b. Clustering by Country and Climate-Zone-Year

Table A4: Clustering by Country and Climate-Zone-Year using Narrow Definition of Transhumant Pastoralism

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain	-0.0006	0.0001	-0.0004	-0.0006	-0.0007	0.0001	-0.0006	-0.0001	-0.0000	-0.0001	0.0007	-0.0105**
	(0.0006)	(0.0005)	(0.0005)	(0.0011)	(0.0007)	(0.0005)	(0.0006)	(0.0012)	(0.0025)	(0.0013)	(0.0025)	(0.0043)
Rain × Transhumant Pastoral	-0.0110**	-0.0121***	-0.0012	-0.0096***	-0.0122**	-0.0124**	-0.0030	-0.0172***	-0.0053	-0.0062	-0.0001	0.0052
	(0.0043)	(0.0037)	(0.0021)	(0.0018)	(0.0054)	(0.0051)	(0.0020)	(0.0028)	(0.0065)	(0.0050)	(0.0036)	(0.0052)
Own Ethnic Group												
Rain	-0.0000	0.0013	-0.0003	0.0009	-0.0001	0.0012	-0.0002	0.0002	-0.0057	-0.0028	-0.0014	-0.0022
	(0.0010)	(0.0012)	(0.0006)	(0.0012)	(0.0011)	(0.0013)	(0.0006)	(0.0012)	(0.0047)	(0.0041)	(0.0039)	(0.0053)
Rain × Transhumant Pastoral	-0.0015	-0.0046	0.0016	-0.0013	0.0089	0.0057	0.0091	-0.0186	0.0043	-0.0013	0.0021	0.0079
	(0.0049)	(0.0040)	(0.0039)	(0.0038)	(0.0094)	(0.0071)	(0.0075)	(0.0159)	(0.0092)	(0.0062)	(0.0063)	(0.0089)
Own Cell												
Rain	-0.0002	-0.0004	-0.0001	-0.0004	-0.0002	-0.0004	-0.0001	-0.0006	0.0012	-0.0023	0.0028	-0.0001
	(0.0006)	(0.0005)	(0.0005)	(0.0009)	(0.0006)	(0.0005)	(0.0006)	(0.0010)	(0.0034)	(0.0023)	(0.0031)	(0.0042)
Rain × Transhumant Pastoral	0.0039	0.0055	-0.0009	0.0046	-0.0072	-0.0063	-0.0054	0.0169	-0.0001	0.0065	-0.0056	0.0054
	(0.0050)	(0.0040)	(0.0031)	(0.0047)	(0.0090)	(0.0041)	(0.0092)	(0.0130)	(0.0087)	(0.0060)	(0.0058)	(0.0102)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-2.02	0.25	-3.31	-0.79	-1.98	0.60	-3.78	-0.13	-0.14	-0.73	8.88	-22.95
p-value	[0.32]	[0.92]	[0.39]	[0.62]	[0.33]	[0.78]	[0.32]	[0.93]	[0.99]	[0.93]	[0.79]	[0.02]
Rain × Transhumant Pastoral	-37.42	-56.94	-9.22	-13.82	-37.27	-52.82	-19.38	-21.65	-25.72	-39.97	-0.97	11.27
p-value	[0.01]	[0.00]	[0.56]	[0.00]	[0.03]	[0.02]	[0.13]	[0.00]	[0.42]	[0.23]	[0.98]	[0.33]
Rain + Rain × Transhumant Pastoral	-39.44	-56.69	-12.53	-14.62	-39.25	-52.22	-23.16	-21.78	-25.86	-40.70	7.91	-11.69
p-value	[0.01]	[0.00]	[0.43]	[0.00]	[0.02]	[0.02]	[0.10]	[0.00]	[0.38]	[0.23]	[0.82]	[0.26]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	322	390	390	390	299	390	390	390	299
Countries	49	49	49	49	48	48	48	48	26	26	26	26
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

Table A5: Clustering by Country and Climate-Zone-Year using Broad Definition of Transhumant Pastoralism

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain	-0.0006	0.0001	-0.0005	-0.0004	-0.0006	0.0002	-0.0007	-0.0000	0.0002	0.0005	0.0005	-0.0107**
	(0.0006)	(0.0005)	(0.0005)	(0.0011)	(0.0007)	(0.0005)	(0.0006)	(0.0013)	(0.0028)	(0.0015)	(0.0027)	(0.0046)
Rain × Transhumant Pastoral	-0.0082**	-0.0105***	0.0007	-0.0093***	-0.0067	-0.0087**	0.0004	-0.0125***	-0.0053	-0.0074	0.0007	0.0051
	(0.0040)	(0.0036)	(0.0019)	(0.0021)	(0.0046)	(0.0040)	(0.0017)	(0.0044)	(0.0062)	(0.0051)	(0.0037)	(0.0059)
Own Ethnic Group												
Rain	0.0002	0.0015	-0.0002	0.0010	0.0002	0.0014	-0.0001	0.0006	-0.0042	-0.0021	-0.0008	-0.0055
	(0.0011)	(0.0012)	(0.0006)	(0.0013)	(0.0011)	(0.0013)	(0.0006)	(0.0013)	(0.0049)	(0.0044)	(0.0036)	(0.0056)
Rain × Transhumant Pastoral	-0.0050	-0.0065	-0.0010	-0.0028	-0.0063	-0.0040	-0.0020	-0.0258**	0.0017	-0.0025	0.0010	0.0133
	(0.0048)	(0.0039)	(0.0034)	(0.0035)	(0.0072)	(0.0070)	(0.0029)	(0.0101)	(0.0097)	(0.0068)	(0.0061)	(0.0090)
Own Cell												
Rain	-0.0003	-0.0005	-0.0001	-0.0005	-0.0002	-0.0004	-0.0001	-0.0008	-0.0008	-0.0038	0.0019	0.0026
	(0.0007)	(0.0005)	(0.0006)	(0.0009)	(0.0006)	(0.0005)	(0.0006)	(0.0009)	(0.0031)	(0.0026)	(0.0025)	(0.0038)
Rain × Transhumant Pastoral	0.0048	0.0061*	-0.0000	0.0054	-0.0023**	-0.0028	0.0002	0.0183*	0.0034	0.0088	-0.0039	0.0005
	(0.0045)	(0.0036)	(0.0030)	(0.0044)	(0.0011)	(0.0031)	(0.0026)	(0.0099)	(0.0084)	(0.0061)	(0.0054)	(0.0100)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-1.97	0.71	-3.93	-0.62	-1.98	0.81	-4.16	-0.01	0.81	2.94	6.37	-23.37
p-value	[0.34]	[0.78]	[0.31]	[0.71]	[0.33]	[0.70]	[0.28]	[0.99]	[0.95]	[0.76]	[0.86]	[0.03]
Rain × Transhumant Pastoral	-27.83	-49.58	5.59	-13.38	-20.30	-36.90	2.65	-15.69	-25.72	-47.62	8.84	11.04
p-value	[0.05]	[0.01]	[0.69]	[0.00]	[0.15]	[0.04]	[0.81]	[0.01]	[0.40]	[0.16]	[0.86]	[0.40]
Rain + Rain × Transhumant Pastoral	-29.80	-48.87	1.66	-14.00	-22.28	-36.09	-1.51	-15.71	-24.90	-44.69	15.21	-12.33
p-value	[0.04]	[0.01]	[0.90]	[0.00]	[0.12]	[0.03]	[0.90]	[0.00]	[0.33]	[0.16]	[0.63]	[0.24]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	420	420	420	322	390	390	390	299	390	390	390	299
Countries	49	49	49	49	48	48	48	48	26	26	26	26
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

c. Clustering by Country and Climate-Zone

Table A6: Clustering by Country and Climate-Zone using Narrow Definition of Transhumant Pastoralism

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain	-0.0006	0.0001	-0.0004	-0.0006	-0.0007	0.0001	-0.0006	-0.0001	-0.0000	-0.0001	0.0007	-0.0105*
	(0.0006)	(0.0005)	(0.0005)	(0.0009)	(0.0006)	(0.0004)	(0.0006)	(0.0012)	(0.0024)	(0.0013)	(0.0025)	(0.0050)
Rain × Transhumant Pastoral	-0.0110***	-0.0121***	-0.0012	-0.0096***	-0.0122**	-0.0124**	-0.0030	-0.0172***	-0.0053	-0.0062	-0.0001	0.0052
	(0.0033)	(0.0029)	(0.0015)	(0.0014)	(0.0048)	(0.0047)	(0.0019)	(0.0035)	(0.0051)	(0.0040)	(0.0037)	(0.0070)
Own Ethnic Group												
Rain	-0.0000	0.0013	-0.0003	0.0009	-0.0001	0.0012	-0.0002	0.0002	-0.0057	-0.0028	-0.0014	-0.0022
	(0.0008)	(0.0010)	(0.0006)	(0.0008)	(0.0008)	(0.0010)	(0.0007)	(0.0008)	(0.0059)	(0.0052)	(0.0035)	(0.0032)
Rain × Transhumant Pastoral	-0.0015	-0.0046	0.0016	-0.0013	0.0089	0.0057	0.0091	-0.0186	0.0043	-0.0013	0.0021	0.0079
	(0.0036)	(0.0039)	(0.0020)	(0.0056)	(0.0082)	(0.0050)	(0.0104)	(0.0140)	(0.0081)	(0.0089)	(0.0023)	(0.0071)
Own Cell												
Rain	-0.0002	-0.0004	-0.0001	-0.0004	-0.0002	-0.0004	-0.0001	-0.0006	0.0012	-0.0023	0.0028	-0.0001
	(0.0006)	(0.0004)	(0.0005)	(0.0009)	(0.0006)	(0.0004)	(0.0005)	(0.0011)	(0.0030)	(0.0020)	(0.0027)	(0.0026)
Rain × Transhumant Pastoral	0.0039	0.0055	-0.0009	0.0046	-0.0072	-0.0063	-0.0054	0.0169	-0.0001	0.0065	-0.0056	0.0054
	(0.0044)	(0.0040)	(0.0024)	(0.0047)	(0.0099)	(0.0057)	(0.0089)	(0.0142)	(0.0072)	(0.0059)	(0.0045)	(0.0074)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-2.02	0.25	-3.31	-0.79	-1.98	0.60	-3.78	-0.13	-0.14	-0.73	8.88	-22.95
p-value	[0.33]	[0.91]	[0.41]	[0.56]	[0.26]	[0.73]	[0.31]	[0.93]	[0.99]	[0.93]	[0.79]	[0.06]
Rain × Transhumant Pastoral	-37.42	-56.94	-9.22	-13.82	-37.27	-52.82	-19.38	-21.65	-25.72	-39.97	-0.97	11.27
p-value	[0.01]	[0.00]	[0.43]	[0.00]	[0.02]	[0.02]	[0.13]	[0.00]	[0.31]	[0.15]	[0.98]	[0.48]
Rain + Rain × Transhumant Pastoral	-39.44	-56.69	-12.53	-14.62	-39.25	-52.22	-23.16	-21.78	-25.86	-40.70	7.91	-11.69
p-value	[0.01]	[0.00]	[0.36]	[0.00]	[0.02]	[0.02]	[0.12]	[0.00]	[0.24]	[0.10]	[0.83]	[0.25]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zones	14	14	14	14	13	13	13	13	13	13	13	13
Countries	49	49	49	49	48	48	48	48	26	26	26	26
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

Table A7: Clustering by Country and Climate-Zone using Broad Definition of Transhumant Pastoralism

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain	-0.0006	0.0001	-0.0005	-0.0004	-0.0006	0.0002	-0.0007	-0.0000	0.0002	0.0005	0.0005	-0.0107*
	(0.0006)	(0.0005)	(0.0005)	(0.0010)	(0.0006)	(0.0004)	(0.0005)	(0.0012)	(0.0027)	(0.0014)	(0.0026)	(0.0055)
Rain × Transhumant Pastoral	-0.0082**	-0.0105***	0.0007	-0.0093***	-0.0067	-0.0087*	0.0004	-0.0125***	-0.0053	-0.0074*	0.0007	0.0051
	(0.0035)	(0.0032)	(0.0014)	(0.0016)	(0.0049)	(0.0046)	(0.0016)	(0.0026)	(0.0054)	(0.0041)	(0.0041)	(0.0088)
Own Ethnic Group												
Rain	0.0002	0.0015	-0.0002	0.0010	0.0002	0.0014	-0.0001	0.0006	-0.0042	-0.0021	-0.0008	-0.0055*
	(0.0009)	(0.0012)	(0.0006)	(0.0010)	(0.0009)	(0.0011)	(0.0007)	(0.0010)	(0.0055)	(0.0054)	(0.0030)	(0.0028)
Rain × Transhumant Pastoral	-0.0050	-0.0065	-0.0010	-0.0028	-0.0063	-0.0040	-0.0020	-0.0258***	0.0017	-0.0025	0.0010	0.0133**
	(0.0034)	(0.0040)	(0.0019)	(0.0064)	(0.0065)	(0.0033)	(0.0025)	(0.0066)	(0.0077)	(0.0094)	(0.0018)	(0.0057)
Own Cell												
Rain	-0.0003	-0.0005	-0.0001	-0.0005	-0.0002	-0.0004	-0.0001	-0.0008	-0.0008	-0.0038*	0.0019	0.0026
	(0.0006)	(0.0005)	(0.0005)	(0.0010)	(0.0006)	(0.0004)	(0.0005)	(0.0012)	(0.0021)	(0.0020)	(0.0017)	(0.0025)
Rain × Transhumant Pastoral	0.0048	0.0061	-0.0000	0.0054	-0.0023	-0.0028	0.0002	0.0183*	0.0034	0.0088	-0.0039	0.0005
	(0.0040)	(0.0035)	(0.0027)	(0.0051)	(0.0026)	(0.0020)	(0.0024)	(0.0096)	(0.0061)	(0.0057)	(0.0034)	(0.0064)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-1.97	0.71	-3.93	-0.62	-1.98	0.81	-4.16	-0.01	0.81	2.94	6.37	-23.37
p-value	[0.35]	[0.76]	[0.31]	[0.67]	[0.28]	[0.67]	[0.24]	[0.99]	[0.95]	[0.75]	[0.86]	[0.08]
Rain × Transhumant Pastoral	-27.83	-49.58	5.59	-13.38	-20.30	-36.90	2.65	-15.69	-25.72	-47.62	8.84	11.04
p-value	[0.04]	[0.01]	[0.61]	[0.00]	[0.20]	[0.09]	[0.79]	[0.00]	[0.34]	[0.10]	[0.87]	[0.57]
Rain + Rain × Transhumant Pastoral	-29.80	-48.87	1.66	-14.00	-22.28	-36.09	-1.51	-15.71	-24.90	-44.69	15.21	-12.33
p-value	[0.03]	[0.01]	[0.89]	[0.00]	[0.15]	[0.07]	[0.90]	[0.00]	[0.24]	[0.07]	[0.69]	[0.33]
Dep. Var. Mean	0.0352	0.0254	0.0160	0.0838	0.0394	0.0282	0.0189	0.0956	0.0249	0.0187	0.0092	0.0551
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zones	14	14	14	14	13	13	13	13	13	13	13	13
Countries	49	49	49	49	48	48	48	48	26	26	26	26
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

d. Allowing for Arbitrary Spatial Correlation within 1000km and Serial Correlation over 30 Years

Table A8: Arbitrary Spatial Correlation within 1000km using Narrow Definition of Transhumant Pastoralism

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain	-0.0006	0.0001	-0.0004	-0.0006	-0.0007	0.0001	-0.0006	-0.0001	-0.0000	-0.0001	0.0007	-0.0105***
	(0.0007)	(0.0006)	(0.0005)	(0.0010)	(0.0007)	(0.0006)	(0.0006)	(0.0010)	(0.0028)	(0.0025)	(0.0018)	(0.0038)
Rain × Transhumant Pastoral	-0.0110***	-0.0121***	-0.0012	-0.0096**	-0.0122**	-0.0124***	-0.0030	-0.0172**	-0.0053	-0.0062	-0.0001	0.0052
	(0.0040)	(0.0035)	(0.0025)	(0.0043)	(0.0053)	(0.0048)	(0.0032)	(0.0071)	(0.0058)	(0.0051)	(0.0037)	(0.0063)
Own Ethnic Group												
Rain	-0.0000	0.0013	-0.0003	0.0009	-0.0001	0.0012	-0.0002	0.0002	-0.0057	-0.0028	-0.0014	-0.0022
	(0.0010)	(0.0008)	(0.0007)	(0.0013)	(0.0010)	(0.0008)	(0.0007)	(0.0013)	(0.0049)	(0.0040)	(0.0034)	(0.0065)
Rain × Transhumant Pastoral	-0.0015	-0.0046	0.0016	-0.0013	0.0089	0.0057	0.0091	-0.0186	0.0043	-0.0013	0.0021	0.0079
	(0.0054)	(0.0059)	(0.0033)	(0.0071)	(0.0124)	(0.0083)	(0.0102)	(0.0169)	(0.0092)	(0.0099)	(0.0056)	(0.0118)
Own Cell												
Rain	-0.0002	-0.0004	-0.0001	-0.0004	-0.0002	-0.0004	-0.0001	-0.0006	0.0012	-0.0023	0.0028	-0.0001
	(0.0007)	(0.0005)	(0.0005)	(0.0010)	(0.0007)	(0.0005)	(0.0005)	(0.0010)	(0.0030)	(0.0020)	(0.0024)	(0.0042)
Rain × Transhumant Pastoral	0.0039	0.0055	-0.0009	0.0046	-0.0072	-0.0063	-0.0054	0.0169	-0.0001	0.0065	-0.0056	0.0054
	(0.0040)	(0.0036)	(0.0022)	(0.0046)	(0.0081)	(0.0068)	(0.0055)	(0.0129)	(0.0061)	(0.0050)	(0.0043)	(0.0082)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Rain Shock as % of Dep. Var. Mean:												
Rain	-2.12	0.27	-3.41	-0.82	-2.02	0.61	-3.83	-0.13	-0.16	-0.81	9.71	-25.46
p-value	[0.39]	[0.93]	[0.41]	[0.58]	[0.36]	[0.82]	[0.29]	[0.92]	[0.99]	[0.96]	[0.70]	[0.01]
Rain × Transhumant Pastoral	-39.18	-60.30	-9.49	-14.34	-37.96	-54.08	-19.63	-21.86	-28.40	-44.47	-1.06	12.50
p-value	[0.01]	[0.00]	[0.62]	[0.02]	[0.02]	[0.01]	[0.34]	[0.02]	[0.36]	[0.22]	[0.98]	[0.41]
Rain + Rain × Transhumant Pastoral	-41.29	-60.03	-12.90	-15.17	-39.98	-53.47	-23.46	-21.99	-28.56	-45.28	8.65	-12.96
p-value	[0.00]	[0.00]	[0.50]	[0.02]	[0.02]	[0.01]	[0.26]	[0.01]	[0.35]	[0.20]	[0.86]	[0.31]
Dep. Var. Mean	0.0336	0.0240	0.0156	0.0807	0.0387	0.0275	0.0186	0.0947	0.0225	0.0168	0.0084	0.0497
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

Table A9: Arbitrary Spatial Correlation within 1000km using Broad Definition of Transhumant Pastoralism

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)	UCDP I(Any)	UCDP I(State)	UCDP I(Non-State)	ACLED I(Any)
Nearest Neighboring Ethnic Group												
Rain	-0.0006	0.0001	-0.0005	-0.0004	-0.0006	0.0002	-0.0007	-0.0000	0.0002	0.0005	0.0005	-0.0107***
	(0.0007)	(0.0006)	(0.0005)	(0.0010)	(0.0007)	(0.0006)	(0.0006)	(0.0011)	(0.0029)	(0.0026)	(0.0018)	(0.0039)
Rain × Transhumant Pastoral	-0.0082**	-0.0105***	0.0007	-0.0093**	-0.0067	-0.0087**	0.0004	-0.0125*	-0.0053	-0.0074	0.0007	0.0051
	(0.0036)	(0.0032)	(0.0022)	(0.0041)	(0.0044)	(0.0039)	(0.0027)	(0.0065)	(0.0059)	(0.0051)	(0.0036)	(0.0061)
Own Ethnic Group												
Rain	0.0002	0.0015*	-0.0002	0.0010	0.0002	0.0014*	-0.0001	0.0006	-0.0042	-0.0021	-0.0008	-0.0055
	(0.0010)	(0.0008)	(0.0007)	(0.0013)	(0.0010)	(0.0008)	(0.0007)	(0.0013)	(0.0048)	(0.0042)	(0.0030)	(0.0067)
Rain × Transhumant Pastoral	-0.0050	-0.0065	-0.0010	-0.0028	-0.0063	-0.0040	-0.0020	-0.0258**	0.0017	-0.0025	0.0010	0.0133
	(0.0047)	(0.0052)	(0.0028)	(0.0066)	(0.0089)	(0.0069)	(0.0062)	(0.0121)	(0.0089)	(0.0103)	(0.0050)	(0.0120)
Own Cell												
Rain	-0.0003	-0.0005	-0.0001	-0.0005	-0.0002	-0.0004	-0.0001	-0.0008	-0.0008	-0.0038*	0.0019	0.0026
	(0.0007)	(0.0005)	(0.0005)	(0.0010)	(0.0007)	(0.0005)	(0.0005)	(0.0010)	(0.0026)	(0.0021)	(0.0019)	(0.0042)
Rain × Transhumant Pastoral	0.0048	0.0061*	-0.0000	0.0054	-0.0023	-0.0028	0.0002	0.0183	0.0034	0.0088*	-0.0039	0.0005
	(0.0036)	(0.0033)	(0.0021)	(0.0045)	(0.0062)	(0.0051)	(0.0040)	(0.0115)	(0.0056)	(0.0050)	(0.0036)	(0.0081)
Dep. Var. Mean												
Observations	230,010	230,010	230,010	176,341	162,810	162,810	162,810	124,821	67,200	67,200	67,200	51,520

C. Instrumental Variables Estimates

Table A10: IV 2SLS Estimates: Instrumenting Phytomass with Rain and using the Narrow Definition of Transhumant Pastoralism

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP 1(Conflict)	*UCDP: State*	*UCDP: Non-State*	ACLED 1(Conflict)	UCDP 1(Conflict)	*UCDP: State*	*UCDP: Non-State*	ACLED 1(Conflict)	UCDP 1(Conflict)	*UCDP: State*	*UCDP: Non-State*	ACLED 1(Conflict)
Nearest Neighboring Ethnic Group												
Phytomass	-0.0036	-0.0013	-0.0007	-0.0048	-0.0029	0.0003	-0.0008	-0.0035	-0.0023	-0.0019	0.0002	-0.0138***
	(0.0026)	(0.0021)	(0.0021)	(0.0036)	(0.0033)	(0.0025)	(0.0027)	(0.0047)	(0.0039)	(0.0034)	(0.0030)	(0.0046)
Phytomass × Transhumant Pastoral	-0.0031	-0.0076**	0.0012	-0.0061	-0.0101*	-0.0134***	-0.0027	-0.0117**	0.0027	-0.0005	0.0028	0.0049
	(0.0038)	(0.0036)	(0.0024)	(0.0039)	(0.0059)	(0.0049)	(0.0038)	(0.0052)	(0.0057)	(0.0054)	(0.0032)	(0.0053)
Own Ethnic Group												
Phytomass	-0.0029	0.0024	-0.0014	0.0030	-0.0034	0.0025	-0.0010	0.0017	-0.0040	0.0019	-0.0051	0.0106
	(0.0051)	(0.0044)	(0.0036)	(0.0068)	(0.0058)	(0.0051)	(0.0040)	(0.0078)	(0.0065)	(0.0048)	(0.0054)	(0.0100)
Phytomass × Transhumant Pastoral	0.0030	-0.0042	0.0025	-0.0117	0.0323	0.0130	0.0347	-0.1370	0.0112	0.0052	0.0064	-0.0107
	(0.0114)	(0.0099)	(0.0086)	(0.0154)	(0.0777)	(0.0608)	(0.0464)	(0.1004)	(0.0139)	(0.0112)	(0.0100)	(0.0192)
Own Cell												
Phytomass	0.0042	0.0001	0.0019	0.0007	0.0027	-0.0021	0.0012	-0.0006	0.0027	-0.0020	0.0045	-0.0039
	(0.0054)	(0.0045)	(0.0044)	(0.0077)	(0.0063)	(0.0053)	(0.0050)	(0.0094)	(0.0060)	(0.0040)	(0.0047)	(0.0089)
Phytomass × Transhumant Pastoral	0.0014	0.0081	-0.0025	0.0153	-0.0240	-0.0153	-0.0242	0.1351	-0.0049	0.0032	-0.0076	0.0200
	(0.0115)	(0.0101)	(0.0083)	(0.0145)	(0.0776)	(0.0648)	(0.0450)	(0.1009)	(0.0136)	(0.0119)	(0.0102)	(0.0185)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Phytomass Shock as % of Dep. Var. Mean:												
Phytomass	-31.74	-16.06	-14.16	-18.31	-23.51	3.96	-12.65	-11.68	-25.11	-27.53	4.94	-78.36
p-value	[0.18]	[0.54]	[0.72]	[0.18]	[0.39]	[0.90]	[0.78]	[0.46]	[0.56]	[0.59]	[0.96]	[0.00]
Phytomass × Transhumant Pastoral	-27.25	-94.67	22.73	-23.42	-82.53	-157.72	-45.06	-39.55	30.00	-7.04	82.75	27.84
p-value	[0.42]	[0.04]	[0.62]	[0.11]	[0.09]	[0.01]	[0.47]	[0.03]	[0.64]	[0.93]	[0.37]	[0.35]
Phytomass + Phytomass × Transhumant Pastoral	-58.99	-110.72	8.57	-41.73	-106.04	-153.76	-57.71	-51.23	4.89	-34.57	87.69	-50.52
p-value	[0.13]	[0.02]	[0.87]	[0.01]	[0.07]	[0.01]	[0.47]	[0.02]	[0.94]	[0.69]	[0.45]	[0.14]
First Stage Kleibergen-Paap LM Test Stat.	35.71	35.71	35.71	33.36	30.34	30.34	30.34	27.40	28.66	28.66	28.66	30.67
p-value	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Dep. Var. Mean	0.04	0.03	0.02	0.09	0.04	0.03	0.02	0.10	0.03	0.02	0.01	0.06
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	280	280	280	294	260	260	260	273	260	260	260	273
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	153,340	153,340	153,340	161,007	108,540	108,540	108,540	113,967	44,800	44,800	44,800	47,040

Table A11: IV 2SLS Estimates: Instrumenting Phytomass with Rain and using the Broad Definition of Transhumant Pastoralism

	Conflict in All Grid Cells				Conflict in Agricultural Cells				Conflict in Non-Agricultural Cells			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UCDP 1(Conflict)	*UCDP: State*	*UCDP: Non-State*	ACLED 1(Conflict)	UCDP 1(Conflict)	*UCDP: State*	*UCDP: Non-State*	ACLED 1(Conflict)	UCDP 1(Conflict)	*UCDP: State*	*UCDP: Non-State*	ACLED 1(Conflict)
Nearest Neighboring Ethnic Group												
Phytomass	-0.0038	-0.0013	-0.0009	-0.0048	-0.0032	0.0002	-0.0011	-0.0036	-0.0029	-0.0023	-0.0000	-0.0144***
	(0.0027)	(0.0021)	(0.0022)	(0.0037)	(0.0033)	(0.0025)	(0.0027)	(0.0047)	(0.0040)	(0.0035)	(0.0031)	(0.0047)
Phytomass × Transhumant Pastoral	0.0000	-0.0052*	0.0021	-0.0051	-0.0037	-0.0091**	-0.0001	-0.0082*	0.0051	0.0018	0.0033	0.0064
	(0.0036)	(0.0032)	(0.0024)	(0.0037)	(0.0048)	(0.0039)	(0.0031)	(0.0049)	(0.0055)	(0.0051)	(0.0032)	(0.0056)
Own Ethnic Group												
Phytomass	-0.0021	0.0033	-0.0007	0.0039	-0.0030	0.0030	-0.0003	0.0043	-0.0023	0.0031	-0.0046	0.0044
	(0.0054)	(0.0047)	(0.0039)	(0.0074)	(0.0061)	(0.0053)	(0.0044)	(0.0085)	(0.0063)	(0.0052)	(0.0054)	(0.0103)
Phytomass × Transhumant Pastoral	-0.0011	-0.0081	-0.0014	-0.0145	-0.0026	-0.0101	-0.0037	-0.0765**	0.0087	0.0037	0.0058	0.0015
	(0.0109)	(0.0095)	(0.0088)	(0.0155)	(0.0240)	(0.0206)	(0.0174)	(0.0300)	(0.0133)	(0.0113)	(0.0099)	(0.0196)
Own Cell												
Phytomass	0.0034	-0.0009	0.0013	-0.0002	0.0027	-0.0022	0.0008	-0.0028	0.0004	-0.0038	0.0036	0.0018
	(0.0057)	(0.0047)	(0.0047)	(0.0081)	(0.0066)	(0.0055)	(0.0054)	(0.0097)	(0.0055)	(0.0040)	(0.0043)	(0.0089)
Phytomass × Transhumant Pastoral	0.0043	0.0112	0.0005	0.0170	0.0008	0.0055	0.0049	0.0726**	-0.0010	0.0057	-0.0058	0.0079
	(0.0110)	(0.0096)	(0.0085)	(0.0145)	(0.0239)	(0.0210)	(0.0171)	(0.0306)	(0.0127)	(0.0116)	(0.0098)	(0.0188)
Nearest Neighboring Ethnic Group: Additional Calculations												
Effect of 1 Std. Dev. Phytomass Shock as % of Dep. Var. Mean:												
Phytomass	-33.69	-16.61	-17.08	-18.43	-26.62	2.06	-18.39	-12.13	-32.10	-34.47	-0.42	-81.38
p-value	[0.16]	[0.53]	[0.68]	[0.19]	[0.32]	[0.94]	[0.68]	[0.44]	[0.47]	[0.51]	[1.00]	[0.00]
Phytomass × Transhumant Pastoral	0.06	-65.25	40.11	-19.32	-30.29	-107.10	-2.08	-27.77	56.54	26.07	95.28	36.28
p-value	[1.00]	[0.10]	[0.38]	[0.18]	[0.44]	[0.02]	[0.97]	[0.10]	[0.36]	[0.73]	[0.30]	[0.25]
Phytomass + Phytomass × Transhumant Pastoral	-33.63	-81.86	23.02	-37.75	-56.91	-105.04	-20.47	-39.90	24.43	-8.39	94.87	-45.10
p-value	[0.33]	[0.06]	[0.64]	[0.01]	[0.21]	[0.04]	[0.74]	[0.04]	[0.72]	[0.92]	[0.42]	[0.20]
First Stage Kleibergen-Paap LM Test Stat.	31.85	31.85	31.85	29.84	25.87	25.87	25.87	23.54	29.82	29.82	29.82	31.89
p-value	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Dep. Var. Mean	0.04	0.03	0.02	0.09	0.04	0.03	0.02	0.10	0.03	0.02	0.01	0.06
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate-Zone-Years	280	280	280	294	260	260	260	273	260	260	260	273
Cells	7,667	7,667	7,667	7,667	5,427	5,427	5,427	5,427	2,240	2,240	2,240	2,240
Observations	153,340	153,340	153,340	161,007	108,540	108,540	108,540	113,967	44,800	44,800	44,800	47,040