CLIMATE SHOCKS AND CONFLICT: EVIDENCE FROM COLONIAL NIGERIA

African economic history working paper series

No. 17/2014

Kostadis J. Papaioannou

Wageningen University

The Netherlands

kostadis.papaioannou@wur.nl

ISBN 978-91-981477-6-6

AEHN working papers are circulated for discussion and comment purposes. The papers have not been peer reviewed, but published at the discretion of the AEHN committee.

The African Economic History Network is funded by Riksbankens Jubileumsfond, Sweden

For submissions, please contact:

Erik Green
Department of Economic History
Lund University
P. O. Box 7083
Sweden
Erik.Green@ekh.lu.se

Climate Shocks and Conflict: Evidence from colonial Nigeria*

Abstract. This paper offers a historical micro-level analysis of the impact of climatic shocks on the incidence of conflict in colonial Nigeria (1912–1945). Primary historical sources on court cases, prisoners and homicides are used to construct an index of socio-political conflict using principal component analysis and measure climatic shocks through deviations from long-term rainfall patterns in a nonlinear (U-shaped) relation, capturing both drought and excessive rainfall. We find a robust and significant relationship between rainfall deviations and conflict intensity, which tends to be stronger in agro-ecological zones that are least resilient to climatic variability (such as Guinean savannah) and where (pre-) colonial political structures were less centralized. We find tentative evidence that the relationship is weaker in areas that specialize in the production of export crops (such as cocoa and palm oil) compared to subsistence farming areas, suggesting that agricultural diversification acts as an insurance mechanism against the whims of nature. Additional historical information on food shortages, crop-price spikes and outbreaks of violence is used to explore the climate–conflict connection in greater detail.

Keywords: Climate Shocks, Conflict, Africa, Colonialism
JEL Codes: N57, Q50, N17

* I am grateful to Kleoniki Alexopoulou, Erwin Bulte, Angus Dalrymple-Smith, Selin Dilli, James Fenske, Ewout Frankema, Kate Frederick, Oscar Gelderblom, Michiel de Haas, Dacil Juif, Alexander Moradi, Elise van Nederveen Meerkerk, Maarten Prak, Anton Schuurman, Gavin Williams, Pieter Woltjer, and the participants of the Tenth Swedish Economic History Meeting at Lund University (October 4–5, 2013), the rural and environmental history group's seminar at the University of Wageningen (November 12, 2013), the GEM seminar at the University of Groningen (December 19, 2013), and the economic history graduate seminar at the University of Utrecht (February 10, 2014) for their valuable comments on previous drafts of this paper. I also thank the Wageningen UR GeoDesk, and in particular Frans Rip for his valuable assistance with ArcGIS. I am grateful for the financial support of the European Research Council under the European Community's Seventh Framework Programme (ERC Grant Agreement no. 313114) as part of the project *Is Poverty Destiny? A New Empirical Foundation for Long-Term African Welfare*. The usual disclaimer applies.

1. Introduction

"*With few stocks in hand, one year's shortfall could easily be translated into a famine*"
–Megan Vaughan (2007: 5)

There is a growing body of literature across multiple scholarly disciplines, including economics, political science and geography, that aims to better understand the impact of climate change on human and social behavior.[1] This literature is inspired by growing public concerns about the potentially distortive effects of climate change on societal cohesion. The literature also raises awareness of global interrelatedness (Johnstone & Mazo, 2011; Sternberg, 2012). For example, the exceptionally dry winter in China in 2010–11 led to global wheat shortages. These shortages had a particularly severe impact on Egypt, the world's largest wheat importer, where, during the period November 2010 to March 2011, bread prices soared to a level that was unaffordable for most low-income households.[2] This is now believed to have planted the seeds that, along with other social, economic and political factors, eventually yielded the Arab Spring in Egypt and beyond. The potential impact of climate-induced resource scarcities is even larger in sub-Saharan Africa. As many as 80 percent of the crops cultivated today are rain-fed, while less than 5 percent of all cultivated land is suitable for irrigation (Bruinsma, 2009). Consequently, extreme rainfall anomalies in the form of either drought or floods can easily destroy harvests, jeopardize food security and increase resource competition over cropland and pastures.

The contribution of this study to existing empirical analyses is fivefold. First, it measures climatic shocks through deviations from long-term rainfall patterns in a nonlinear (U-shaped) relation, capturing both drought and excessive rainfall, instead of focusing on droughts only. Second, it introduces a new set of conflict variables. The standard conflict measure usually takes the form of a dummy variable (0,1) on the basis of an arbitrary threshold of 25 deaths in order to fit econometric specifications (Buhaug, 2010; Hendrix & Glaser, 2007; Hendrix & Salehyan, 2012; Koubi *et al.*, 2012; Raleigh *et al.*, 2010). However, such dichotomous variables neglect a great deal of additional information on the severity of conflict, since the incidence of more than 25 battle deaths are set equal to, for instance, 125 battle deaths. This study adopts four different continuous dependent variables to capture varying magnitudes of conflict. Third, the literature is dominated by large cross-country regressions that use rather short time frames; these fail to shed light on more localized effects of climatic variability in the long-run. Such research designs are mainly invoked by data availability problems. Although the present historical study is also constrained by data limitations, using colonial Nigeria as the case allows us to conduct a panel analysis on a provincial level for a period of over 30 years (1912–1945). Fourth, almost all studies in this field are solely based on econometric correlations, and make no attempt to contextualize their findings using qualitative evidence. This study uses primary historical sources (newspapers, government reports) to track food shortages, crop-price spikes and outbreaks of violence, in order to back up the findings of the regression analysis.

Last but not least, this study aims to expand existing research agendas to historical periods by merging the theoretical and empirical insights of two strands of literature: the *environmental security*

[1] A special issue of the *Journal of Peace Research* (2012) was created to assess potential linkages.
[2] From $157/metric ton in June 2010 to $326/metric ton in February 2011 (Sternberg, 2012).

literature, which seeks to investigate whether climate-induced scarcities lead to conflict;[3] and the *economic historical* literature, which assesses the welfare effects of different colonial institutional arrangements and modes of economic specialization (such as the cash-crop revolution). The *environmental security* literature has not reached consensus on the linkage between climate and conflict. Hsiang *et al.* (2013) claim that climate change may be partly responsible for occasional outbreaks of violence, and, more generally, greater economic and political instability (see also (Burke *et al.*, 2009; Koubi *et al.*, 2012). Previous studies have blamed climatic variability for increasing the likelihood of civil wars (Burke *et al.*, 2009; Miguel *et al.*, 2004), or even for directly causing them (Davis, 2010; Faris, 2009). These findings have been criticized by other researchers, who have pointed to weaknesses in the construction of the climatological variables (Ciccone, 2011), and the level of aggregation of the conflict variables used (Fjelde & von Uexkull, 2012; Klomp & Bulte, 2012). In line with Fjelde and von Uexkull (2012), this paper will not argue that climatic shocks lead to widespread civil conflict, but rather that the enhanced competition over scarce resources leads to disputes and clashes on a smaller intercommunal scale. In spite of their calamitous impact on civilian life and property, non-state intercommunal conflicts have received limited attention in the literature.[4]

The *economic historical literature* largely agrees that African economies have expanded, to varying degrees, in response to increasing colonial trade and agricultural commercialization, but it remains unclear as to the extent to which ordinary Africans have benefitted from such developments (Bowden *et al.*, 2008; Fieldhouse, 1999; Frankema & Waijenburg, 2012; Moradi, 2009; Rodney, 1978). This debate has led to two rather opposing views. The "neo-Marxists" or "dependency theorists" hold that the introduction of new cash crops (such as cocoa) or the expansion of existing cash crops (including palm oil, rubber, coffee and cotton) in Africa has destroyed farmers' traditional insurance mechanisms by inhibiting food production, without replacing them with any new form of security (Vaughan, 2007; Watts, 1983). The alternative view maintains that crop commercialization has provided the means to increase farmers' incomes through the increased benefits reaped from international and inter-regional trade. This diversified farmers' production and therefore limited the vulnerability of cash-crop farmers to the vagaries of climate (Berry, 1975; Galletti *et al.*, 1956). Therefore, this paper uses closely documented historical sources to answer the underlying question stemming from the aforementioned debate: "Were the cash-crop provinces more – or less – susceptible to climate-induced conflict? Did the introduction of cash crops benefit the local societies, or did it make them more vulnerable to erratic weather fluctuations?"

Colonial Nigeria offers an interesting case for several reasons. As West Africa's largest and most populous nation, it contains within its borders a wide range of geographical (such as agro-ecological

[3] Henceforth, the term "conflict" will be used in its broadest definition in order to encompass a wide range of violent incidents, such as land disputes between resource users (individuals and/or groups); violent and non-violent actions to evict certain resource users; theft; raiding of livestock; beatings; killing of humans or livestock; large-scale destruction of villages; and general armed violence.

[4] Statistics relating to intercommunal conflicts over scarce resources in recent post-colonial Nigeria reveal their importance, severity and frequency: these resource conflicts claimed more than 7000 lives between 1991 and 2006 (Fjelde, 2009; Sundberg *et al.*, 2012) and have been responsible for over 51 percent of all clashes in the whole country for the same time period (Fasona & Omojola, 2005).

zones) and institutional (such as political entities) features; consequently, meaningful comparisons can be derived. Additionally, the timeframe of this study guarantees a rather uniform institutional framework under British colonial rule; 1912 marked the end of effective resistance to British rule and the establishment of the borders of the Nigerian colonial state, while 1945 saw the start of serious internal resistance to colonial policies before the independence movement gained any real power. The Nigerian *Colonial Annual Reports* provide substantial information on both the background and frequency of conflict, as well as on climate-related data, which allowed us to create balanced panel data of all the administrative provinces in colonial Nigeria.[5] These sources also made it possible to isolate instances of conflict caused by resistance against colonial rule from those related to climatic shocks.

Overall, the results suggest a strong relationship between rainfall deviations and conflict intensity, which tends to be stronger in agro-ecological zones that are least resilient to climatic variability (such as Guinean savannah) and where (pre-) colonial political structures were less centralized. We also find tentative evidence that the relationship is weaker in areas that specialize in the production of export crops. This is a topic of considerable urgency today as the process of global climate change accelerates, generating more severe and unpredictable weather events, as well as more erratic rainfall patterns.

The paper proceeds as follows. Section 2 reviews the theoretical and empirical environmental security literature, and discusses the Nigerian colonial context in terms of geographical characteristics, political structures and economic activity. Section 3 describes the baseline model, the data and the estimation methodology. Section 4 reports the empirical results of the various measures. Section 5 provides detailed evidence from a number of historical cases in colonial Nigeria, and identifies the mechanisms through which climate-induced scarcities led to conflict. Section 6 concludes the paper.

2. Climate shocks and conflict in colonial Nigeria

2.1 Theory

The primary theoretical relationship between climate shocks and conflict runs via the increased *scarcity* of vital resources such as food and fresh water. A harvest failure leading to food shortages, or unexpected declines in freshwater supplies intensifies the competition over access to water and land, and increases the possibility of conflict (Baechler, 1999; Homer-Dixon, 1999; Tietenberg & Lewis, 2000). The principal criticism of this simple theoretical argument is that it neglects socio-political and economic contextual factors that play a role in mediating or aggravating the effects of climate-induced scarcities (Barnett, 2003; Dalby, 2002; Gleditsch, 1998; Hagmann, 2005). This criticism has led to the development of more

[5] The sources used are the annual reports filed by the colonial administration. These reports were filed by political departments, and give information and explanations on all incidences of resistance and conflict considered worthy of mention, along with their likely causes. This information will be supplemented and supported by the reports of the police, prisons and military departments. Clearly, a serious weakness is that these reports present only one side of the story (that of the colonizers). However, African accounts are unfortunately scarce. Therefore, when possible, secondary accounts and research by later Nigerian academics are used to corroborate the primary sources. In addition, the reports are reliable enough to provide clear general patterns that differentiate the regions chosen in terms of how often (armed) conflict broke out during the period studied.

specific, context-dependent, theoretical mechanisms to explain the causal pathways between climate, demography, environment and conflict (Homer-Dixon, 2010; Kahl, 2006).

The literature covers different time horizons. Studies of *long-term* climate change look mainly into the causes of desertification of previously arable lands (Benjaminsen *et al.*, 2012; Homer-Dixon, 1999). Studies analyzing the *short-term* effects climatic shocks[6] look into the effects of an extreme deviation from an expected historical mean, which can lead to an immediate scarcity of water or food (Dercon, 2004; Dercon & Krishnan, 2000; Fjelde & von Uexkull, 2012). However, in both time horizons the outcome can be the same; that is, increasing competition over *scarce* resources, which may yield a higher incidence of violence and disorder if political institutions fail to mitigate distributional conflicts.

Even though a large volume of recently published studies aim to link climate-induced scarcities to different incidents of conflict, there is no consensus yet on precisely how these mechanisms operate (Buhaug, 2010; Ciccone, 2011; Klomp & Bulte, 2012). The problem is that most of the research so far has focused on large-scale conflict, such as civil wars (Buhaug & Lujala, 2005; Burke *et al.*, 2009; Hendrix & Glaser, 2007; Miguel *et al.*, 2004; Ross, 2004). The use of civil war as the dependent variable has been severely criticized on both methodological grounds (Ciccone, 2011) and those of the proposed causal mechanisms (Buhaug, 2010; Gleditsch, 1998). Kahl (2006) and Homer-Dixon (2010) have pointed out that demographic and environmental pressures are more prone to cause inter-communal mini-scale conflict than to cause widespread civil conflict. Recent research has been gradually moving away from larger cross-national conflict studies to use more disaggregated sub-national measures of conflict (Adano *et al.*, 2012; Fjelde, 2009; Raleigh & Kniveton, 2012; Theisen, 2012). In addition, these studies pay more attention to qualitative evidence in order to contextualize their empirical findings (Benjaminsen *et al.*, 2012; Blakeslee & Fishman, 2013), and provide a more subtle argument about the role of climate shocks in outbreaks of (inter-communal) conflict (Hsiang *et al.*, 2013). The present study can be seen as a contribution to these tendencies.

2.2 Contextual conditions

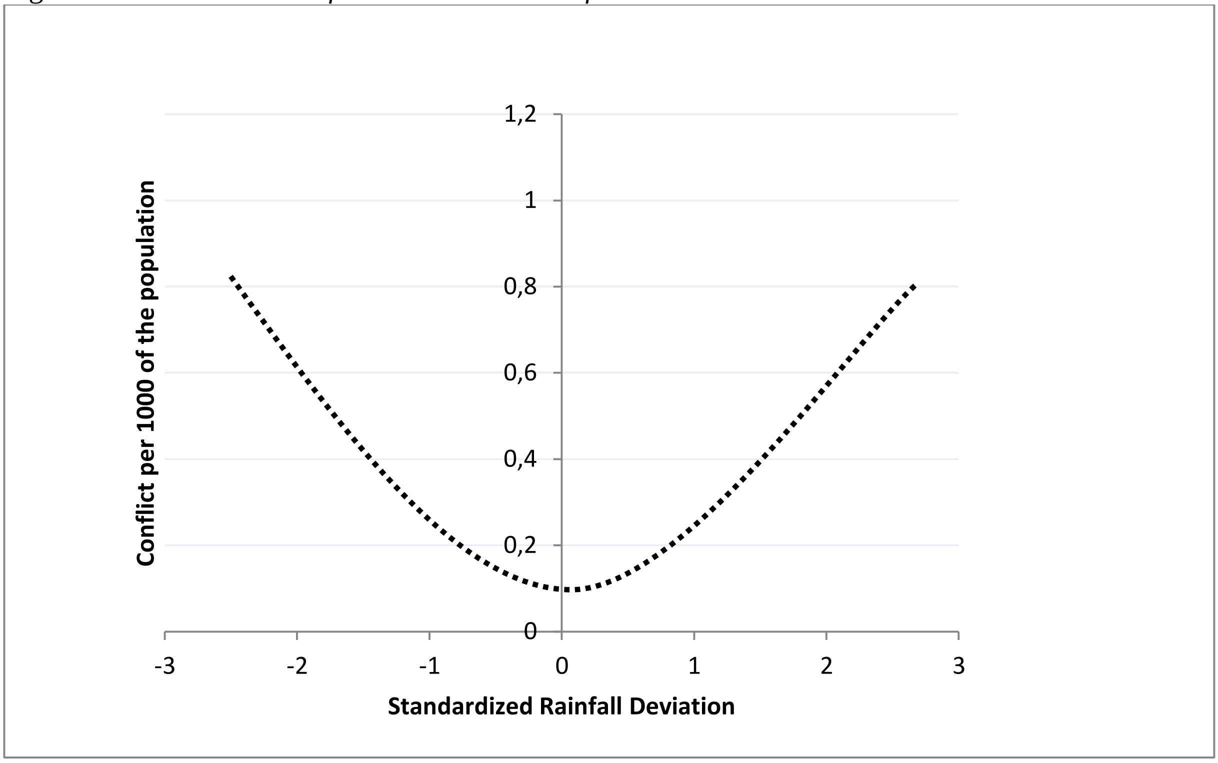
In thinking about the possible mechanisms underpinning the climate–conflict nexus in colonial Nigeria, it is important to consider some of the underlying agro-ecological, economic and political conditions. The first condition is that the great majority of the Nigerian population during colonial times relied on rain-fed agriculture. This implies that rainfall shocks had a potentially dramatic and direct impact on food security. In terms of historical barriers to the internal transport of imported foodstuffs, this potential impact was almost certainly larger than it is today (Nigeria became a major net food importer during the second half of the 20th century, but was largely self-sufficient until the 1960s). This is why we use rainfall variability to explore climate shocks on a subnational level (Hendrix & Salehyan, 2012; Raleigh & Kniveton, 2012; Theisen, 2012).

The prime hypothesis is that both droughts and excessive rainfall have reduced the productivity of arable land and that, in addition, droughts have reduced the availability of fresh water. The

[6] Climate change denotes a *long-term* lasting change of weather patterns over periods ranging from decades to hundreds of years, whereas a climatic shock denotes a rapid, annual and *short-term* extreme deviation from an expected annual observation.

hypothetical relationship thus takes a U-shaped form, as illustrated in Figure 1, and will be estimated accordingly (see Section 3). Deviations from the long-term rainfall mean are thought to have increased the probability of violent clashes between or within communities over increasingly scarce resources (Fasona & Omojola, 2005; Hussein *et al.*, 1999; Turner, 2004).

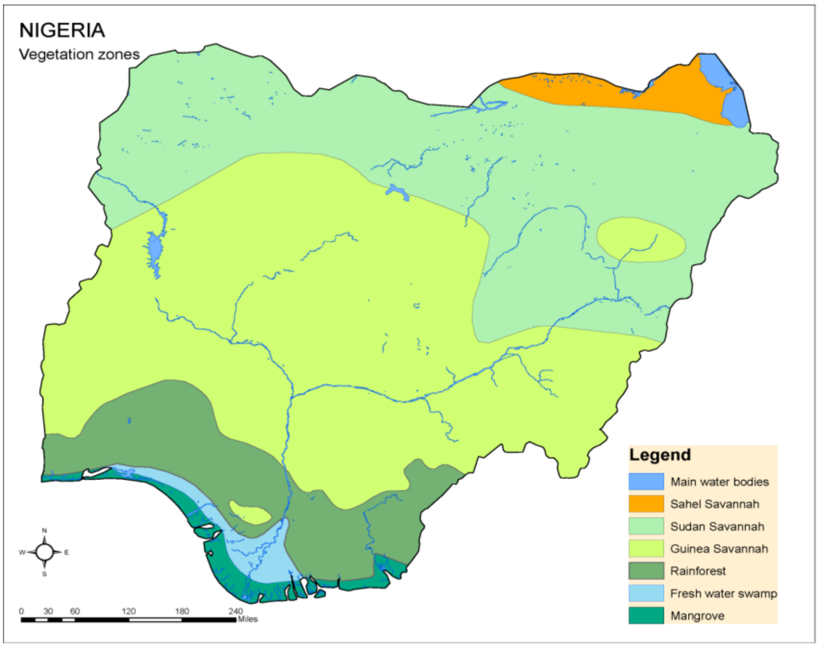
Figure 1. *Standardized rainfall deviation and conflict events*



The suggested climate–conflict relationship depends on many contextual factors. Although Nigeria lies entirely within the tropics, it covers different tropical agro-ecological zones, characterized by different rainfall patterns (see Map 1). Since temperatures fluctuate much less in tropical than in temperate climate zones, seasonal cultivation strategies and crop-specific harvests tend to depend primarily based on rainfall (Iloeje, 2001; Kowal & Kassam, 1978). Subsistence farmers, commercial farmers and pastoralists have come to specialize in different cropping systems in different agro-ecological zones; all of these variations have contributed to variegated conditions in terms of how people cope with climate-shock-induced scarcities. For instance, livestock breeding broadens the opportunities to store wealth, mediate risks and increase land productivity (Frankema, 2013). However, the presence of the tsetse fly has constrained cattle-keeping to only few parts of Nigeria (Alsan, 2012).

In the northern part of Nigeria, which is the Sudan–Sahel savannah, groundnuts were the principal colonial export crop, especially in the heavily populated provinces of Kano, Zaria and Sokoto. Groundnuts were combined with millet and guinea corn for human and animal consumption. To the south of the Sudanese savannah, the Guinean savannah, food production was dominated by cereals, roots and tubers, along with a wide range of complementary food crops. In “normal” years, this area produced a surplus of cassava, yam, guinea corn and millet, which were traded to other regions of Nigeria. Fasona and Omojola (2005) labeled the Guinean savannah as the “food basket of the nation”,[7] and argued that it is the most conflict-prone zone in Nigeria. Turner (2004) argued that the combination of highly vulnerable production systems in northern Nigeria, with a surplus area next door, increases the probability of widespread inter-communal conflict in cases of climate-induced scarcities in the North. The southern part of Nigeria stretches across the rainforest belt and the freshwater swamp zone. In this area, cash crops such as cocoa, palm oil, and tubers dominated agricultural production.

Map 1. *Agro-ecological zones in Nigeria*



Source: Iloeje & FAO 2001, created in ArcGIS.

In political terms, colonial Nigeria can be divided into three different areas that correspond with the British administrative divisions of the country (see map A-1, Appendix). The northern and western regions had established traditions of centralized power capable of exerting military influence and demanding allegiance and tribute from surrounding territories. The Muslim-dominated North was controlled by the long-established emirates of the Sokoto Caliphate, and was the largest region in terms of both area and population. Empire-building had been a feature of the region half a millennia before the arrival of Europeans (Iliffe, 1995) and was conditioned, amongst other things, by the absence of the tsetse fly, which allowed states to harness the potential of cavalry to carry their armies further and faster compared to their counterparts in the South (Reid, 2012).

The South can be roughly divided into two sections. In the West, a number of Yoruba kingdoms and the kingdom of Benin exercised changing degrees of central power. Although this region lacked political unity, states with sophisticated economic, political and cultural identities had already been developed since the 15th century (Iliffe, 1995). Their wealth was principally based on trade and tributes from subordinate territories (Eltis, 2000). On the contrary, in the East, political authority rarely extended

[7] The colonial officials named these regions the “Market Garden of Nigeria” (CO657/38: 72), because vast quantities of foodstuffs were exported to both the northern and southern provinces.

beyond the village level. The dominant group was the Igbo (referred to as Ibo by the British). This region was characterized, on the one hand, by some of the densest rural populations in sub-Saharan Africa and, on the other, by a lack of large centralized political units (Ohadike, 1991). The most significant problem that the British faced here was how to govern a territory that had no existing state apparatus by which they could induce local leaders to rule on their behalf. The colonial solution was the disastrous "Warrant Chief" system (Afigbo, 1972).[8] The political structure of colonial Nigeria can thus be roughly summarized as a highly centralized structure in the North, compared to a semi-centralized south-western area and a completely amorphous south-eastern area. From 1912 until 1920 there were a number of provincial reorganizations that set the boundaries, but this greater division remained until independence.

These differentiated structures are essential to understand why areas reacted differently to the encroachment of colonial rule. Especially in areas with weak pre-colonial states, centralization resistance was endemic (Falola, 2009). It may thus be expected that the East and areas of the North outside the Emirates were more prone to conflict per se, even if these conflicts were unrelated to climate shocks. Moreover, in the centralized state structures of the North, which were characterized by higher social cohesion (higher local accountability) and stronger political institutions (state legitimacy and capacity), the British applied a stricter version of indirect rule, in which the Islamic territories were granted a greater deal of autonomy.

Finally, there is empirical evidence that sees more politically centralized entities to be more coherent and less violent (Gennaioli & Rainer, 2007; Osafo-Kwaako & Robinson, 2013). The econometric results of this paper show that in areas where the institutional arrangements were weak and did not extend beyond the village level, the competition over land and water was more severe, and led to higher levels of inter-communal conflict. Whereas in areas where there was a central power capable of exerting its influence to other surrounding territories, climatic shocks did not give rise to as many instances of conflict.

2.3 Plausible mechanisms

In discussing the plausible mechanisms that link climate shocks to conflict in colonial Nigeria, it is important to emphasize that extreme rainfall shocks may work in both directions, either through *negative rainfall deviations* leading to drought, potential crop failures and freshwater shortages, or through *positive rainfall deviations*, which can damage crops through flooding, mudslides or waterborne crop diseases.[9]

In a *severe drought scenario*, farmers and pastoralists may get into conflict over access to fresh water (Gleick, 1993). Rainfall shortages can have a direct effect on the number of farm animals, as a result of starvation (humans consume fodder) or dying of thirst (Fafchamps *et al.*, 1998). Besides being a

[8] The principal was that village chiefs would rule on behalf of the British. They were, according to the 1906 political report, to be "selected from the most influential amongst the Native chiefs selected by the chiefs and people of the district and approved by the district commissioner" (CO592/4, p. 314). In practice, the selection of chiefs was extremely arbitrary and did not reflect local realities. Some were chosen in the aftermath of battle by officers pressed to head to the next settlement, and were simply the most suitable looking males who had not managed to escape to the bush.

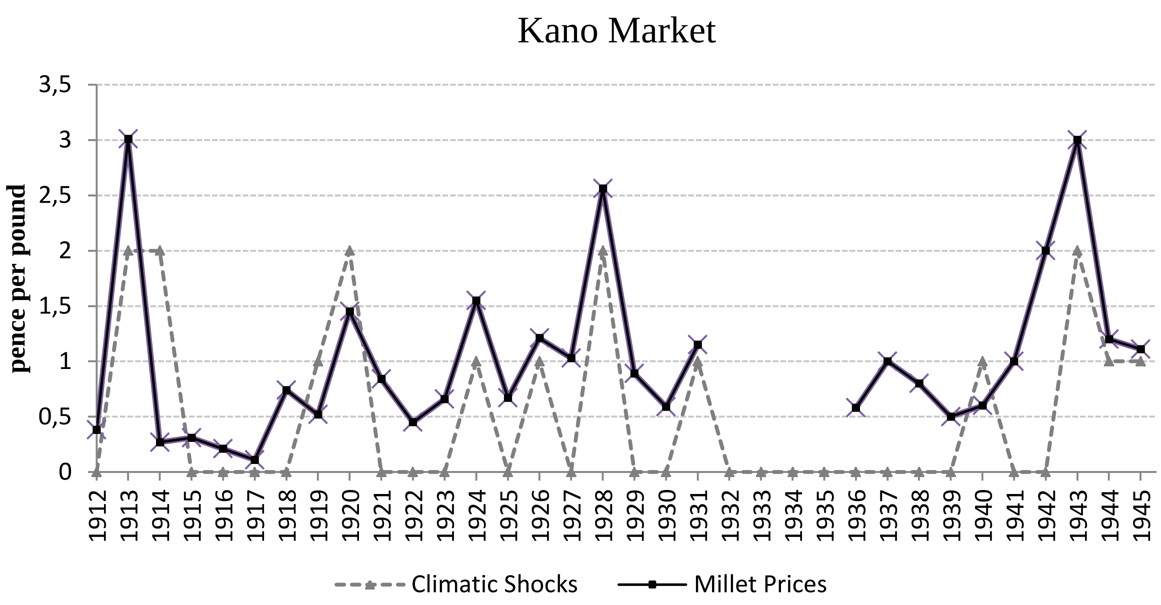
[9] The most notable waterborne disease in Nigeria was the "Black Pod Disease," which spread in the rainforest (cocoa zone) belt. This disease arises from exceptionally heavy and continuous rain, usually during the months of July to September. For example, it occurred in 1933 in Ondo (rainfall deviation +2.03), where the losses sustained by farmers in this area were very heavy; it was estimated that more than 30 percent of cocoa was destroyed by this disease (CO657/36).

source of meat and milk, livestock is also indispensable for crop cultivation (for instance, ploughing, harrowing). A sharp decline in farm animals can thus have a detrimental effect on non-animal food supplies as well (Fafchamps *et al.*, 1998; Jahnke & Jahnke, 1982). However, in addition, excessive rainfall may increase stress among different type of farmers. If floods, mudslides or waterborne diseases destroy harvests, they can also destroy part of the food stock for farm animals.

Another mechanism through which both types of rainfall shocks may lead to conflict is through increasing the *market price of food*. Food-price spikes can make food inaccessible (Glantz, 1988), and even the mere expectation of (climate-induced) crop failures can drive up prices. There is ample historical evidence of speculators (hoarders) who, in advance of an expected price spike, withheld their cereals from the markets in order to sell at higher prices in preindustrial Europe (Post, 1984), where centralized states were often taking action against these practices in order to prevent social disorder. There is evidence of hoarders in colonial Africa behaving in similar ways during years of widespread food security concerns (Devereux & Berge, 2000; Vaughan, 2007; Watts, 1983).

Market prices of foodstuffs in Nigeria were subject to seasonal fluctuations and could be doubled or halved within a year if one of the seasons failed to deliver (CO657/40). Figure 2 illustrates how millet prices in Kano (northern Nigeria) were concurrent with climatic-shock-related harvest conditions. Environmental security theory suggests that when societies face food shortages, price disputes emerge between rural producers and urban consumers that increase pressure on both sectors. The rising price of staple crops creates greater price inflation that undermines the purchasing power of urban dwellers (Berry, 1975; Hill, 1977; Shenton & Watts, 1979). For instance, the *Agricultural Annual Report* of colonial Nigeria in 1915 observed that "*...the total production of main food crop – yams, maize and millet – in many parts of Nigeria was undoubtedly lessened by the shortage in the early rains ... the shortage of rain had a serious effect on the crops on the poorer soils ... naturally the price of food in some of the larger towns has risen to an extent which could cause serious hardship*" (CO657/12: 17).

Figure 2. *Climatic shocks and millet prices*



Source: CO657/1-35

A third mechanism that can instigate or aggravate conflict is the migration of people out of affected areas towards lesser-affected areas. Increasing demographic pressure intensifies the competition over food, water or land. Particularly in countries with sharp ethnic or religious divisions, migration into "hostile," territory can easily create inter-communal tensions (Reuveny, 2007). For example, during the severe drought spells of 1928 in the Sudanese Sahel, people from the North were forced to move southward, in the hope of finding uncultivated land and more favorable climatic conditions (Watts, 1983). Colonial officers have observed many such movements, and stated that "*...an increase of 48,947 in the population is due chiefly to the return of many who had migrated from the province* (Kano) *owing to failure of the harvest*" (CO657/22: 46).

2.4 Cash crops: mitigating risk?

The extent to which specialization in cash crops has mitigated or aggravated the threat of climate-shock-induced conflict is prone to debate. In Vaughan's view (2007: 9 & 77), "*Commercialization has distorted 'subsistence' economies and destroyed the insurance mechanisms in-built in these, without replacing them with any new form of security*' and '*this ... [commercialization] ... had had an inhibiting effect on production, village food stocks had been run down, and one bad season was enough to topple down the country into disaster*". In the same vein, Watts (1983), pointed out that the capitalist development (and, in particular, crop commercialization) in Nigeria created an unprecedented vulnerability to famines. Through a closely documented analysis of the peasant society for both the pre-colonial and colonial Hausaland, Watts portrayed the pre-colonial African subsistence economy as self-sufficient, autonomous and cooperative. In this "moral economy",[10] mechanisms and social systems were developed to insure

[10] For a detailed description of the concept see (Thompson, 1971). Additionally, see (Scott, 1977) and Hydén (1980), who used the term "economy of affection" to describe similar pre-capitalist communal structures.

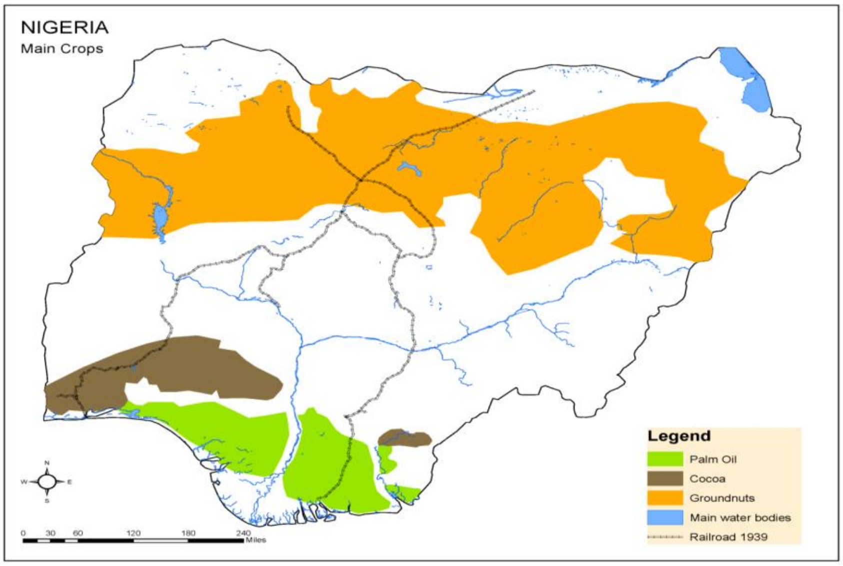
local peasants against possible food disasters by having a "set price" for essential foodstuffs in the market. This price-setting implied that it was more important to a community to have a traditional "fair" price rather than a "free" market, where surpluses could be sold at a higher price. Raynaut (1977) stressed how the social aspects of African farmers were profoundly disrupted by colonial rule, as it changed long-established methods of distribution and circulation of vital foodstuffs among communities. These methods were well respected within coherent collective groupings (families, ethnic and political units), and were in line with the socially established norms. According to Raynaut (1977), the introduction of cash crops limited the capacity of the African subsistence economies to withstand climate-induced food shortages.

On the other side of the debate, scholars have argued that crop commercialization provided the means not only to increase agricultural output, but also to increase farmers' incomes, thereby limiting the vulnerability of cash-crop farmers to the vagaries of climate. For example, Güsten (1968) argued that cash-crop areas could support both their rural and urban populations, since most cash-crop farmers, especially cocoa farmers, did not abandon food crops when extending their cash-crop plantations (see Map 2). In the same vein, Galletti *et al.* (1956) provided evidence from 187 families located around the cocoa belt in Southern Nigeria, which showed that 175 of them (almost 93 percent) produced some kind of food crop for consumption on the side, such as yams, maize and cassava (1956: 410-411). Berry (1975: 170–171) stated that "*...the fact that the cocoa belt as a whole imports food-stuffs need not imply that cocoa has supplanted food crop production in these areas; it may instead reflect increased consumption, owing to growing population or to higher incomes, or both.*" She based her argument on the potential increasing benefits reaped from (inter-regional) trade, and on the diversification of domestic production, to conclude that economic specialization (that is, crop commercialization) limited the vulnerability of the cash-crop areas.

Among colonial officers in the early years there existed a widespread consensus that tropical cash crops provided African farmers with a higher and more stable source of income compared to food crops (CO657/40). However, as colonial rule developed, the annual reports show that this consensus began to break down. The director of the 1930 agricultural report expressed considerable concerns regarding the cocoa farmers in southern Nigeria, who, according to him, were "*...taking up cocoa and ... considerably reducing their output of food crops*" (CO657/27). These concerns grew stronger as the crisis of the 1930s wore on. Eventually, the collapse of world market prices for tropical commodities led the colonial government to adopt the Ten Year Development Plan in Nigeria, which contained a deliberate investment plan for strengthening food security and increasing the productivity of the agricultural sector.[11]

[11] This plan included the provision of wells in rural areas, the construction of roads to open up the more inaccessible areas, the spread of education and agricultural science, the opening up of waterways, the provision of hospitals and other medical amenities, the installation of water supplies and electric light in the larger centres, and the replanning of towns (CO657/69-70).

Map 2. *Crop commercialization in Nigeria*



Source: Iloeje & FAO 2001, created in ArcGIS.

3. Data and method

In order to estimate the regression model, we use the system-generalized method of moments (system-GMM) developed by Bond *et al.* (2001), because it takes into account the time-series dimension of the data, the non-observable province-specific effects, a lagged dependent variable among the explanatory variables, and the possibility that all explanatory variables are endogenous (Roodman, 2006; Vieira *et al.*, 2012).[12] The functional form of the dynamic panel model can be summarized as follows:

$$\text{Conflict\_variable}_{i,t} = \gamma\ \text{Conflict\_variable}_{t-1} + \beta_1\ \text{rain\_dev}_{it} + \beta_2\ \text{rain\_dev\_SQ}_{it} + \delta Z'_{it} + \nu_i + \mu_t + \lambda X_i t + \varepsilon_{it}$$

$i = 1,...,20$ and $t = 1,\dots,34$

where $\text{Conflict\_variable}_{i,t}$ denotes the four different conflict variables in province i and year t. β_1 and β_2 are the coefficients of interest to be estimated. Z'_{it} is a vector of geographical, institutional and economic determinants of conflict – which need to be controlled for – measured during this period. Province fixed effects (ν_i) control for all time-invariant differences between provinces, and year fixed effects (μ_t) control for factors that may affect levels of conflict across all provinces in the same year; a good example of when higher incidences of conflict might be expected in a given year may be during the World War years, or years with extremely low export prices during the Great Depression. Moreover, $X_i t$ denotes a province-specific time trend; that is, an interaction term between observable province characteristics (ν_i) and a linear time trend (t). In this way, we control for the possibility that (a) colonial authorities have become more efficient in inhibiting conflict over time, and (b) previous conflicts have promoted distrust among certain social groups, in such a way that this distrust may affect future attitudes and conflict intensity between particular groups. ε_{it} is the error term. To address the autocorrelation concerns relating to

[12] Alternative econometric specifications were used for robustness (see Section 4.2).

climatic shocks, the standard errors are clustered at various levels: the province level, the year level, and both the province and the year level (two-way clustered).

The effect of climatic shocks are estimated on four continuous dependent variables: the number of prisoners admitted during the year,[13] the number of court cases,[14] the number of homicides, and a newly constructed index named socio-political conflict (SPC), which combines the former three variables using principal component analysis (PCA).[15] All of the dependent variables are standardized using provincial population estimates. The data was collected from the colonial bluebooks of statistics, administration reports and sessional papers.[16]

Rainfall anomalies are measured as the *annual standardized rainfall deviation* from the long-term mean over the years 1912–1945. The data was collected from 36 meteorological stations across Nigeria on a provincial level documented in the Administration Annual Reports.[17] Annual rainfall totals range from 120 inches in the South to less than 40 inches in parts of the extreme North (see Map A-3, Appendix).

The *rainfall deviation variable* is constructed using the following formula: $(X_{i,t} - \ddot{X}_i) / \sigma_i$, where $\ddot{X}_i$ is the long-term mean of each panel, $X_{i,t}$ is the annual rainfall in time t for province i, and σ_i is the standard deviation of each panel, that is for every i. The rainfall deviation variable ranges from -3.46 to 3.68, and has a mean of almost zero and a standard deviation of 1. The advantage of the standardization of the variable is that it accounts for cross-provincial differences, as well as for within-province variation.[18]

Throughout the empirical analysis, we test for both linear and curvilinear relationships between rainfall deviations and incidents of conflict.[19] From an econometric point of view, we expect no endogeneity between the dependent and the main explanatory variable, as conflict cannot affect rainfall. We also expect a low risk of omitted variable bias, since it is highly improbable for any unobserved feature to influence both the amount of rainfall and conflict simultaneously.[20] Moreover, we employ three sets of controls in order to avoid potential omitted variable bias, and to increase the explanatory power of the model. These three controls are: institutional, geographical and economic.

(a) Institutional controls

[13] This is a flow variable and yields the number of prisoners convicted each year.

[14] Taking a dispute (relating, for instance, to land) to court usually involves money, and most Nigerians (farmers and pastoralists) would see this option as a last resort. There are ways to avoid taking a case to court, for instance through local leaders, such as the warrant chiefs in Eastern Nigeria (Afigbo, 1972), or the *Jowros*, or noble Fulani pastoralists (Toulmin, 2009), or by raising the issue at community meetings. Therefore, this variable understates the number of disputes and will, if anything, underestimate the effect.

[15] The index is calculated with confirmatory PCA. Besides creating an index, PCA categorizes coincident variation among a set of variables, and is most suitable for extracting as much of the variance contained in a set of indicators as possible. For similar methods, (Alesina & Perotti, 1996) and (Ghate *et al.*, 2003).

[16] The series run from CO660/1 until CO660/35, and from CO657/1 until CO657/64, respectively.

[17] There is at least one meteorological station in each province. In provinces with more than one station, such as Kano, we have taken the mean.

[18] As compared to the percentage change of annual rainfall. This measure does not provide sufficient information on whether, for instance, a wet year is actually a year with excessive rainfall, or just a year that is wetter than the previous one (Ciccone, 2011).

[19] This is captured by including polynomials of degrees 2 and 3 in the regression analysis. Additional tests for estimating the non-monotonic correlation were used via the log of [*rainfall_deviation*] (results not presented).

[20] For a more detailed discussion of how income levels bias the estimated relationship between climate and conflict, when included, see (Hsiang *et al.*, 2013: 2-3).

Many studies have found a relationship between low (pre-) colonial centralization and various forms of resistance, hostility, agitation and political protest (Englebert, 2000; Gennaioli & Rainer, 2007; Huillery, 2011). We use a categorical variable [*political_structures*] to capture the variation across provinces, and expect a negative result. Easterly and Levine (1997) considered differences in ethnic fragmentation as a substantial explanation for divergences in political instability and conflict. We include a categorical variable of ethnic homogeneity [*ethnic_homogeneity*] to control for regional differences in ethnic composition.[21] We also control for the imposition of direct taxation [*direct_taxation*] in 1929, which has spurred anti-colonial sentiments in various places (Ekundare, 1973; Falola, 2009). Finally, we control for the number of police staff [*police_staff*], which varied over time, as we expect that more police officers would have been assigned to politically instable provinces (Killingray, 1986), and that part of their presence was related to tax collection (Clayton & Killingray, 1989).[22]

(b) Geographical controls

We expect access (distance) to the sea [*coastal_distance*][23] to mitigate the impact of climate shocks by offering cheaper access to international trade (Gallup *et al.*, 1999). Imports can mediate temporary shortages, and thus reduce conflict risks. In the same vain, we include a navigable river dummy [*river*], and expect a negative result in this regard. Finally, we include a categorical variable, [*agro-ecological_zones*], which ranges from 1–5, in order to control for differences in the resilience of agro-ecological zones to climatic shocks (Fenske & Kala, 2012; Kala *et al.*, 2012; Seo *et al.*, 2008).

(c) Economic controls

We expect that the construction of railways would reduce the potential magnitude of famines by opening up areas to food trades (Burgess & Donaldson, 2010). While some scholars have argued that railway construction related merely to the exportation of goods (Rodney, 1978), and may have been responsible for the 1913 famine in Kano (Apeldoorn, 1981: 32-35), others have argued that it was used for food distribution policies (Chaves *et al.*, 2013). In either case, there is a possible link between railway construction and conflict intensity. We therefore assign a dummy variable to every province with a train station [*railway*]. We control for levels of road density [*road_density*] following a similar reasoning (Mann, 1984, 2008), using a continuous variable of constructed roads for each province. Additionally, Herbst (2000) argued that higher investments in public infrastructure raises the opportunities for broadcasting state power. Hence, higher road-density levels can also be expected to be associated with quicker interventions by local police forces.[24]

[21] Finding disaggregated data on ethnic composition is an extremely difficult task, particularly in the context of Africa where migration, refugee flows and general demographic settlement patterns change over time. Therefore, we used numerous sources from varying years to tackle this task (see Table A-2).

[22] From an econometric point of view, this raises concerns relating to omitted variable bias. In any case, the [*police*] variable is treated as an endogenous explanatory variable, as is the case for every other variable used in the regressions. After performing several Granger reverse causality tests, evidence shows that more conflict leads to the recruitment of new police staff, and not the other way around.

[23] This is measured as the distance between the three major ports in Nigeria, namely, Lagos, Port Harcourt and Calabar, and every province's concentric cycle. The shortest distance is used in the regression analysis.

[24] We only included roads that are open all seasons, and hence could not be affected by excessive rainfall, mudslides and flooding.

The presence of livestock [*livestock*] may mitigate the effects of scarcity in a particular province, by providing an alternative source of food. In the same vein, more diversified agricultural production, which can be achieved by cultivating cash crops on the side, may also mitigate the impact of climate-induced resource scarcity in a particular province. Hence, we included a dummy variable [*Crop_type*] to control for this. Finally, it may be that areas with larger populations (Fearon & Laitin, 2003) and rapid demographic transformations (Urdal, 2005) are more prone to political disorder; thus, two continuous variables ([*population_density*] and [*population_growth%*]) are used to control for these effects, respectively.[25] In both instances, a positive correlation is expected.

Descriptive statistics of the variables used in the baseline and extended models are reported in the Table 1.[26] These statistics provide the context in which to assess the magnitudes of the econometric results.

Table 1. *Descriptive statistics*

Variable	Obs.	Mean	Std. Dev.	Min	Max
Conflict_index_SPC	512	0.008	1.000	-0.461	6.513
Prisoners_1000	620	1.103	2.059	0.004	15.344
CourtCases_1000	547	2.161	5.903	0.001	42.096
Homicides_1000	520	0.021	0.023	0.001	0.109
Rainfall_deviation	607	0.001	1.002	-3.351	3.102
Police_staff	603	162.816	203.801	0.000	940.000
Population_density	680	80.912	68.913	4.390	363.020
Population_growth (%)	660	1.820	14.589	-43.247	194.708
Agro-ecological_zones	680	2.600	0.970	1.000	4.000
Ethnic_homogeneity	680	0.670	0.141	0.400	1.000
Political_structures	680	2.300	0.781	1.000	3.000
Road_density	680	5.657	3.565	0.070	16.178
Coastal_distance	680	371.454	288.310	0.000	936.300

4. Empirical Results

The first set of regressions is reported in Table 2. The rainfall deviation square is highly statistically significant in all specifications, and confirms a U-shaped association between all four dependent conflict variables and climate shocks. In all the regressions, we included lags of the main explanatory variable in order to test whether climatic shocks in the preceding years (t-1) affect conflict at time t.[27] A statistically significant correlation here would mean that extreme weather variability is not the main trigger of

[25] The figures for the population of Nigeria are by all accounts widely inaccurate (Aluko, 1965; Frankema & Jerven, 2013). The general consensus is that they are huge underestimates, as colonial demographers did not work extensively outside of large towns or settlements and many people were understandably not keen on being counted, and therefore taxed. However, it also appears that the inaccuracies are fairly standard, and thus allow for at least a comparison of the relative populations of the different provinces under review.

[26] For a detailed description of all the control variables, their sources and comments, see Tables A-1 and A-2.

[27] Second- and third-order lags were used as well; the results did not change in any significant way (not reported).

conflict. However, the estimated coefficients of those lags do not indicate any significance, which supports the argument that climate shocks almost immediately translate into higher levels of conflict.

The control variables behave largely as expected, and their significance levels remain consistent among different econometric specifications. The police variable yields a positive and statistically significant coefficient. Road density yields a negative and significant coefficient. Finally, population growth yields an expected positive and significant sign.

Table 2. *Dependent variables and rainfall deviations*

Dependent variable	(1)	(2)	(3)	(4)
	Conflict_Index_SPC	Prisoners_1000	CourtCases_1000	Homicides_1000
Lagged_dependent (t-1)	0.1771	0.1869	0.2109	0.1087
	[5.99]***	[2.58]**	[2.71]**	[1.89]*
Rainfall_deviation	-0.0221	-0.0819	-0.0797	-0.0232
	[-0.29]	[-1.53]	[-1.38]	[-1.41]
Rainfall_deviationSQ	0.1878	0.2691	0.3562	0.0428
	[2.36]**	[3.86]***	[4.58]***	[3.76]***
Rainfall_deviation, lagged(t-1)	0.1045	0.1071	0.1242	0.0968
	[1.37]	[1.56]	[1.34]	[1.05]
Rainfall_deviationSQ, lagged(t-1)	0.0766	0.1151	0.1007	0.0397
	[0.59]	[0.77]	[0.64]	[0.81]
Police_staff	0.0036	0.0038	0.0035	0.0011
	[4.13]***	[3.75]***	[4.83]***	[2.66]**
Road_density	-0.0621	-0.0536	-0.0317	-0.0792
	[-2.53]**	[-2.23]**	[-2.06]**	[-2.16]**
Population_growth(%)	0.0032	0.0025	0.0022	0.0019
	[2.30]**	[1.98]**	[1.84]*	[1.80]*
Geographical controls	YES	YES	YES	YES
Fixed effects	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES
Province-specific effects	YES	YES	YES	YES
Number of Observations	484	522	522	498
Number of Provinces	20	20	20	20
Number of Instruments	27	28	29	28
AR1 statistics (p-value)	0	0	0	0
AR2 statistics (p-value)	0.296	0.318	0.378	0.348
Hansen test (p-value)	0.924	0.931	0.947	0.843

Notes: - System-GMM estimation for dynamic panel data-model. Sample period: 1912–1945.
- Corrected t-statistics are shown in brackets. Significance level at which the null hypothesis is rejected: ***, 1 percent; **, 5 percent; and *, 10 percent.
- Second (and latter) lags were used as instruments in the first-differenced equations, and their once-lagged first differences were used in the levels equation.
- Two-step results using robust standard errors corrected for finite samples using Windmeijer (2005) correction.
- Time dummies, province-specific effects and a time trend are included in all regressions. Geographical controls include distance to the coast, distance to the nearest port, and navigable river dummies.

The findings are straightforward, and confirm a direct and causal impact of climatic shocks on conflict. An example serves to highlight the potential magnitude that one particular climatic shock had on conflict levels. Column 4 of Table 2 displays a positive correlation between the main explanatory variable (estimated coefficient: +0.0428) and the number of homicides per 1000 of the population, suggesting that an additional increase of rainfall deviation led to an average of 62.4 additional homicides.[28]

[28] The derivative of $y(x)= 0.0428x^2 – 0.0232x – 0.51$ ==> $y'(x) = 0.062$. The "nlcom" command in Stata was used for verification, and exhibited a similar outcome.

Columns 1 through 9 of Table 3 show the results of the baseline regression model, adding various control variables one by one.[29] The results show that the estimated coefficient of rainfall deviation squared remains positive and statistically significant in all specifications, confirming a robust U-shaped climate–conflict relationship (using the Conflict_index_SPC). The agro-ecological zone variable yields the expected positive effect, but is not statistically significant. The railway dummy yields a negative, but insignificant, correlation. Direct taxation yields an expected positive sign, but is statistically insignificant. The ethnic homogeneity variable yields the expected negative sign, and is significant. Additionally, the dummy for livestock is statistically significant, indicating that there seems to be less conflict in the Northern provinces of Nigeria, where the absence of the Tsetse fly allows for (more) cattle keeping. The significant estimated coefficient of political centralization indicates that in cross-region variation differing political structures suggest considerable explanatory power, and confirms the idea that politically centralized entities are more coherent and less violent.

In column 9 of Table 3, a binary dummy is included in order to assess whether provinces with cash-crop producers, as compared to subsistence farmers, have experienced different degrees of conflict under similar climatic conditions. The type of crop dummy is statistically insignificant, and therefore is not further interpreted here; however, this distinction is further examined in the next set of regressions. Finally, in column 10 we have included all of the control variables described above in order to test whether the effect of climatic shocks on conflict disappears via the joint inclusion of these controls. The results did not change in any significant way. Finally, we tested for cross-sectional dependence after each of the above-mentioned set of regressions, as suggested, particularly with reference to GMM estimations, by Conley (1999) and De Hoyos and Sarafidis (2006).[30] The reason for this is that there may be a concern that shocks to one province may spill over into adjacent provinces, which could eventually provide inconsistent estimated coefficients. The results suggest that cross-dependence is not a major concern.

[29] This depicts a cautious way to avoid any multicollinearity bias in the estimated models. The variance inflation factor (VIF) test was used to assess the presence of multicollinearity; in all model specifications, no evidence of multicollinearity was detected.

[30] We followed a similar approach after the OLS and probit specifications in the robustness tests section by using Pesaran (2007) standard errors.

Table 3. *Conflict index and rainfall deviations*

Dependent variable Conflict_Index_SPC	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)	(10)
Conflict_Index_SPC, lagged (t-1)	0.1869	0.2109	0.1287	0.1766	0.2055	0.1679	0.2324	0.2114	0.1751
	[2.58]**	[3.71]***	[2.18]**	[2.74]**	[3.22]***	[2.81]**	[4.32]***	[6.09]***	[2.89]***
Rainfall_deviation	-0.0819	-0.0797	-0.0788	-0.0768	-0.0806	-0.0897	-0.0454	-0.0504	-0.0714
	[-1.53]	[-1.68]	[-1.41]	[-1.31]	[-1.43]	[-1.22]	[-0.82]	[-0.83]	[-1.03]
Rainfall_deviationSQ	0.2991	0.3062	0.3128	0.3221	0.3055	0.3044	0.2811	0.2718	0.2613
	[3.86]***	[4.58]***	[3.76]***	[3.75]***	[4.36]***	[4.19]***	[3.85]***	[3.32]***	[2.74]***
Rainfall_deviation, lagged(t-1)	0.1071	0.1242	0.0968	0.0959	0.1156	0.1101	0.1866	0.1545	0.1034
	[1.56]	[1.34]	[1.05]	[1.06]	[1.47]	[1.41]	[0.92]	[1.06]	[0.86]
Rainfall_deviationSQ, lagged(t-1)	0.1151	0.1007	0.1097	0.1009	0.1104	0.1054	0.0671	0.075	0.0987
	[0.77]	[0.64]	[0.81]	[0.61]	[0.78]	[0.73]	[0.63]	[0.73]	[0.54]
Police_staff	0.0038	0.0035	0.0029	0.0027	0.0037	0.0039	0.0031	0.0036	0.0027
	[3.75]***	[4.83]***	[2.66]**	[2.55]**	[3.68]***	[3.57]***	[4.66]***	[4.92]***	[3.11]***
Road_density	-0.0821	-0.0736	-0.0917	-0.0723	-0.0692	0.0319	-0.0529	-0.0431	-0.0248
	[-2.23]**	[-1.96]**	[2.16]**	[2.04]**	[-2.39]**	[2.08]**	[-1.71]*	[-2.14]**	[-2.09]**
Population_growth(%)	0.0018	0.0011	0.0022	0.0022	0.0019	0.0015	0.0013	0.0033	0.0028
	[2.05]**	[1.91]*	[2.01]**	[1.99]**	[1.88]*	[2.06]**	[1.85]*	[1.91]*	[1.94]*
Agro-ecological zones		0.1024							0.0824
		[1.24]							[1.31]
Railway			-0.1459						-0.1051
			[-0.55]						[-0.44]
Ethnic_homogeneity				-0.3107					-0.2156
				[-2.86]***					[-2.91]***
Livestock					-0.3998				-0.3011
					[-2.84]**				[-2.51]**
Direct_taxation						0.1902			0.1662
						[1.15]			[1.01]
Political_structures							-0.1063		-0.1433
							[-3.00]***		[-3.02]***
Crop_type								-0.1424	-0.1022
								[-1.34]	[-1.08]
Geographical controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Fixed effects	NO	NO	NO	NO	NO	NO	NO	NO	NO
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Province-specific effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Number of Observations	484	484	484	484	484	452	484	484	452
Number of Provinces	20	20	20	20	20	20	20	20	20
Number of Instruments	24	28	28	28	28	27	27	28	35
AR1 statistics (p-value)	0	0	0	0	0	0	0	0	0
AR2 statistics (p-value)	0.344	0.348	0.378	0.404	0.348	0.355	0.291	0.247	0.449
Hansen test (p-value)	0.854	0.931	0.947	0.928	0.917	0.982	0.917	0.817	0.921

Notes: - System-GMM estimation for dynamic panel data-model. Sample period: 1912–1945.
- Corrected t-statistics are shown in brackets. Significance level at which the null hypothesis is rejected: ***, 1 percent; **, 5 percent; and *, 10 percent.
Second (and latter) lags were used as instruments in the first-differenced equations, and their once-lagged first differences were used in the levels equation.
- Two-step results using robust standard errors corrected for finite samples using Windmeijer (2005) correction.
- Time dummies, province-specific effects and a time trend are included in all regressions. Geographical controls include distance to the coast, distance to the nearest port, and navigable river dummies.

4.1 Further explorations

This section will first outline the varying effects climatic shocks have on conflict, conditional on geographical, institutional and economic characteristics; it will then investigate whether the climate-to-conflict effect is symmetrical. A large body of literature has emphasized the role of agro-ecological zones (Seo *et al.*, 2008), pre-colonial structures (Acemoglu *et al.*, 2013; Osafo-Kwaako & Robinson, 2013) and crop commercialization (Berry, 1993; Falola, 1987) in shaping and explaining various instances of conflict.

Varying effects

Recent literature has suggested that some agro-ecological zones are less resilient to climatic shocks than others (Kala *et al.*, 2012; Seo *et al.*, 2008). This body of literature emphasizes the supply-side of environmental shocks and suggests that the harvests of crops in less resilient regions can more easily be destroyed (Fenske & Kala, 2012) As a result, extreme climatic shocks in these regions are more likely to jeopardize food security, raise resource competition over cropland and pastures, and trigger conflict.

According to Fasona and Omojola (2005), the Guinean savannah is the most conflict-prone ecological zones in Nigeria.[31] Fasona and Omojola provided ample evidence from the 1971–1980 drought spells in Nigeria, where communal conflict arose between the cattle-keeping Fulanis and the agriculturalists of the Guinean savannah over access to land. The Fulanis and their livestock drifted southward in search of water and food, which resulted in the destruction of the Guinean farmlands and spurred increased communal clashes – a description that does not differ much from similar drought spells during the colonial era (see Section 5.1). Even though there have been permanent tensions between farmers and herders, such issues have been more prevalent during years of higher rainfall deviations (Hussein *et al.*, 1999; Turner, 2004). Our results support this argument.

Column 1 in Table 4 shows the results of the baseline regression with the inclusion of the AEZ categorical variable. The insignificance of the estimated coefficients of this variable does not confirm an environmental deterministic hypothesis; thus, different agro-ecological zones by themselves cannot explain cross-regional conflict variation. However, when they interact with rainfall deviations from the long-term mean (column 2), differing agro-ecological zones gain more explanatory power, and one of these zones – the Guinean savannah – yields a positive and statistically significant relationship with conflict. The Guinean savannah interaction term also yields the highest estimated coefficient (+0.4491).

In column 3 of Table 4, the significant estimated coefficient of the political centralization variable suggests that different political structures matter in mediating climate-induced conflict. This finding corroborates with previous literature that sees more politically centralized entities to be more coherent and less violent (North *et al.*, 2009; Osafo-Kwaako & Robinson, 2013). Furthermore, we include two interaction terms to capture whether different political entities react differently to the occurrence of climatic shocks. It seems that there are more climate-induced conflicts in areas with weak pre-colonial institutions (in this case the eastern provinces), compared to areas with strong pre-colonial institutions (in this case the provinces around the Sokoto Caliphate).

In column 6 of Table 4, the results show that different types of crops do not account for conflict variation across provinces unless they are affected by a climatic shock. The dummy variable of food crop does not yield a significant correlation. In column 7, however, the estimated coefficients indicate that the provinces in which food crops are cultivated, while being affected by extreme climatic shocks, witnessed higher levels of conflict compared to the cash-crop areas. These results do not confirm the alleged disruptive and calamitous impact of crop commercialization on African farmers, and suggest that in the Nigerian case, the introduction of new cash crops neither destroyed the insurance mechanisms nor intensified the risk of food shortages. On the contrary, it seems that crop commercialization limited the vulnerability to climate shocks because it diversified production and income, which enabled farmers to reap the increasing benefits from inter-regional and international trade. These findings confirm Berry (1975) argument and counter those of Watts (1983) and Vaughan (2007). It should be noted here that this

[31] This claim has been also confirmed by conflict statistics presented by Fjelde (2009).

conclusion does not provide evidence with respect to whether crop commercialization was good or bad for the African farmers in the long run; rather, it argues that the vulnerability of the cash-crop areas was considerably reduced due to agricultural diversification.

Symmetrical effect

The curvilinear (U-shaped) climate–conflict relationship is not fully symmetrical. Although the estimated coefficients in columns 7 and 8 of Table 4 are both statistically significant, their coefficients vary considerably.[32] It appears that conflict has been more acute in wetter years (+0.108) than in drier years (+0.064). This result is in line with Theisen (2012) findings for Kenya. A possible explanation for this (perhaps somewhat counterintuitive) finding is that in years of excessive rainfall farmers would lose their entire harvest in a very short time (such as a couple of days), whereas in years of drought farmers could hope and wait for late rains. Therefore, in the former scenario farmers may be more directly concerned with survival and fighting than in a drought scenario, which results in an increase to the conflict timeframe. Another possible explanation may be that excessive rainfall destroys infrastructure, particularly unpaved roads, thereby limiting the ability of colonial police patrols and military escorts to respond quickly to violence.

[32] The statistical significance of the effect is slightly lower for positive climatic shocks. This variable is significant at a 10 percent level.

Table 4. *Interaction terms and rainfall deviations*

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Conflict_Index_SPC								
Conflict_Index_SPC, lagged (t-1)	0.2109	0.1645	0.2324	0.2354	0.1689	0.1619	0.2872	0.2751
	[3.71]***	[2.64]**	[4.32]***	[3.60]***	[3.50]***	[2.86]**	[5.23]***	[6.24]***
Rainfall_deviation	-0.0797	-0.0827	-0.0454	-0.0211	-0.0242	-0.0741		
	[-1.68]	[-1.38]	[-0.82]	[-0.29]	[-0.38]	[-1.29]		
Rainfall_deviationSQ	0.3062	0.3938	0.2811	0.1654	0.2525	0.3456		
	[4.58]***	[2.31]**	[3.85]***	[3.16]***	[2.68]**	[5.76]***		
Rainfall_deviation, lagged(t-1)	0.1242	0.1228	0.1866	0.0836	0.1545	0.1218		
	[1.34]	[1.06]	[0.92]	[0.47]	[0.53]	[1.26]		
Rainfall_deviationSQ, lagged(t-1)	0.1007	0.0965	0.0671	-0.0081	0.0519	0.1153		
	[0.64]	[0.75]	[0.63]	[-0.10]	[0.85]	[1.10]		
Police_staff	0.0035	0.0043	0.0031	0.0026	0.0034	0.0039	0.0018	0.0017
	[4.83]***	[2.93]***	[3.66]***	[2.24]**	[4.14]***	[4.95]***	[4.31]***	[3.19]***
Road_density	-0.0736	-0.0641	-0.0529	-0.0234	-0.0717	-0.0692	-0.0178	-0.0175
	[-1.96]**	[-1.79]*	[-1.71]*	[-2.21]**	[-1.89]*	[-1.80]*	[-1.44]	[-1.75]*
Population_growth(%)	0.0011	0.0091	0.0013	0.0037	0.0017	0.0011	0.0005	0.0001
	[1.91]*	[1.87]*	[1.85]*	[0.67]	[2.01]**	[1.88]*	[0.33]	[0.02]
Agro-ecological zones	0.1024							
	[1.24]							
Dummy_mangrove_swap								
Rainforest^		-0.5585						
		[-1.03]						
Dummy_rainforest		0.0467						
		[0.19]						
Guinean_Savannah^		0.4491						
		[2.33]**						
Dummy_Guinean_Savannah		0.4613						
		[3.99]***						
Sudan_Savannah^		-0.3964						
		[-1.76]*						
Dummy_Sudan_savannah		-0.2346						
		[-1.34]						
Political_structures			-0.1063					
			[-3.00]***					
West_medium_centralized^^				-0.1495				
				[-0.77]				
Dummy_medium_centralized				-0.1421				
				[-0.24]				
North_high_centralized^^				-0.1559				
				[-1.98]**				
Dummy_high_cenralized				-0.3785				
				[-2.44]**				
Dummy_food_crop					-0.0406	0.3697		
					[-0.29]	[1.98]**		
Food_crop^^^						0.3084		
						[2.53]**		
Negative_climatic_shock(Drought)							0.0639	
							[1.94]*	
Positive_climatic_shock(Excessive)								0.1077
								[2.03]**
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Geographical controls	YES	YES	YES	YES	YES	YES	YES	YES
Fixed effects	NO	NO	NO	NO	NO	NO	NO	NO
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
Province-specific effects	YES	YES	YES	YES	YES	YES	YES	YES
Number of Observations	484	484	484	484	484	484	484	484
Number of Provinces	20	20	20	20	20	20	20	20
Number of Instruments	24	33	27	32	30	29	34	34
AR1 statistics (p-value)	0	0	0	0	0	0	0	0
AR2 statistics (p-value)	0.344	0.384	0.291	0.302	0.301	0.652	0.329	0.303
Hansen test (p-value)	0.854	0.927	0.917	0.958	0.977	0.923	0.971	0.926

Notes: - System-GMM estimation for dynamic panel data-model. Sample period: 1912–1945.
- Corrected t-statistics are shown in brackets. Significance level at which the null hypothesis is rejected: ***, 1 percent; **, 5 percent; and *, 10 percent.

Second (and latter) lags were used as instruments in the first-differenced equations, and their once-lagged first differences were used in the levels equation.
- Two-step results using robust standard errors corrected for finite samples using Windmeijer (2005) correction.
- Time dummies, province-specific effects and a time trend are included in all regressions. Geographical controls include distance to the coast, distance to the nearest port, and navigable river dummies. Controls include all variables used in Table 3.
- (^) denotes four interaction terms: mangrove swamp, rainforest, Guinean savannah and Sudan savannah. These were constructed by multiplying one continuous [*rainfall_deviation*] and one categorical variable [*agro-ecological_zones**].
- (^^) denotes three interaction terms: high, moderate and low centralized political structures. These were constructed by multiplying one continuous [*rainfall_deviation*] and one categorical variable [*political_structures**].
- (^^^) denotes two interaction terms: cash- and food-crop provinces. These were constructed by multiplying one continuous [*rainfall_deviation*] and one dummy variable [*crop_type**].

4.2 Robustness tests

We performed a number of additional robustness checks on the results presented in Table 5. First, we re-estimated the linkage between rainfall deviation and incidences of conflict using two alternative econometric specifications. The first is a Pooled-OLS with fixed effects, and the second is a probit model. It should be stated here that the probit model required some modifications to the dataset, and in particular to the dependent variable, as it had to be made binary. Therefore, we constructed three new dependent variables of conflict [*Bin_Prisoners, Bin_Homicides and Bin_CourtCases*] to estimate the probit model, including both time and fixed-effects, as well as province-specific effect dummies.[33] The main results remained unchanged (Table 5).[34]

Holding all other control variables to their mean, we find that a one standard deviation increase from mean rainfall increases the probability of homicides (that is, more than 25 deaths) by 47.9 percent. A two standard deviation increase from mean rainfall increases the probability of homicides by 74.3 percent. These percentages confirm this paper's underlying hypothesis that rainfall deviations from the long-term mean increase the probability of violent conflict. The probability remains low when the deviation is moderate (one deviation point), and increases gradually and significantly when the deviation becomes severe (two deviation points).

To avoid any effect driven by outliers, we used a 25-year "rolling window" for panel estimations, and for every regression we added one year observation at the end of the sample and dropped one at the beginning. Rainfall deviation squared passes all of the relevant robustness tests, and is statistically significant in all specifications. Finally, we split our dataset into various categories based on the interaction terms used in the varying effects section, and ran separate regressions on each sub-sample (Brambor *et al.*, 2006). The results did not change in any significant way (results not reported).

[33] The Bin_Homicides variable is set to 0 when less than 25 deaths per year occur, and to 1 otherwise, following relevant literature (Fjelde & von Uexkull, 2012; Hendrix & Salehyan, 2012).The same modification was followed for Bin_Prisoners and Bin_CourtCases to fit the econometric specifications.
[34] We used the "mfx" command in Stata to estimate the marginal effects of climatic shocks on conflict (results not presented).

Table 5. *Robustness tests*

Dependent variable	(1)	(2)	(3)	(4)
	OLS	OLS	Probit	Probit
	Conflict_Index_SPC	CourtCases_1000	Bin_Prisoners	Bin_Homicides
Lagged_dependent (t-1)	-0.0026	0.1321	0.3573	-0.7098
	[-0.02]	[1.73]*	[1.20]	[-1.46]
Rainfall_deviation	-0.0296	-0.0611	-0.4635	-0.5191
	[-0.67]	[-0.37]	[-1.62]	[-1.53]
Rainfall_deviationSQ	0.1891	0.4171	0.6516	0.5432
	[2.88]**	[2.94]***	[4.11]***	[4.01]***
Rainfall_deviation, lagged(t-1)	0.1326	0.8243	-0.1116	-0.3918
	[1.11]	[1.38]	[-0.30]	[-1.11]
Rainfall_deviationSQ, lagged(t-1)	0.0736	0.5073	-0.5804	0.5713
	[1.65]	[0.94]	[-1.36]	[1.38]
Police_staff	0.0031	0.0039	0.0159	0.0165
	[3.61]***	[3.01]***	[4.30]***	[3.83]**
Road_density	-0.0519	-0.0402	-0.0385	-0.0278
	[-1.85]*	[-1.64]	[0.11]	[-1.50]
Population_growth(%)	0.0005	-0.0023	0.0054	0.0018
	[1.07]	[-0.91]	[0.73]	[0.25]
Controls	YES	YES	YES	YES
Geographical Controls	YES	YES	YES	YES
Fixed effects	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES
Number of Observations	484	522	522	498
Number of Provinces	20	20	20	20
R^2	0.51	0.58	0.61	0.63

Notes: - Pooled-OLS (fixed-effect) and probit specifications are used. Sample period: 1912–1945.
- Corrected t-statistics are shown in brackets. Significance level at which the null hypothesis is rejected: ***, 1 percent;**, 5 percent; and *, 10 percent.
- Geographical controls include distance to the coast, distance to the nearest port, and navigable river dummies. Controls include all variables used in Table 3.
- Time dummies, province-specific effects and a time trend are included in all regressions.

5. Qualitative evidence

In this section we back up our regression results with qualitative historical evidence. We use historical newspapers and government reports to explore food shortages, crop-price spikes and outbreaks of violence. We combine and triangulate data from these historical sources in three stages. First, by looking at the rainfall patterns of a particular year and indicating whether moderate and/or severe climatic shocks occurred. For this, we follow the Standardized Precipitation Index[35] classification (Wu *et al.*, 2005) to categorize different-magnitude shocks into three groups: (1) when the deviation is more than ±1, it is considered to be a mild shock; (2) more than ±1.5 indicates a moderate shock; and (3) more than ±2 is seen as an extreme shock (see Tables A-4a, b, c). Second, we use information from the annual agricultural reports from the colonial government to investigate whether these climatic shocks actually led to deficient harvests and to crop-price spikes. Third, turning to those years and provinces which were severely

[35] The Standardized Precipitation Index is based on the probability of recording a given amount of precipitation, where the probabilities are standardized so that an index of zero indicates the median precipitation amount (half of the historical precipitation amounts are below the median, and half are above). As the dry or wet conditions become more severe, the index becomes more negative or positive (Guttman, 1999).

affected, we read through the police, prison and military reports and use the statistics to back up the underlying mechanisms and hypotheses.

For the period 1912–1945, we documented 203 shocks in the whole of colonial Nigeria; 97 of these were owing to excessive rainfall, and 107 were due to mild, moderate or extreme droughts. There were six climatic shocks per year on average. Naturally, these shocks were not evenly spread out. In 1916, 1929 and 1935 there were no shocks of any serious magnitude. In 1913, on the other hand, the situation was disastrous, with extreme droughts extending across large parts of West Africa. It is worth noting that the colonial reports only recorded conflicts of major importance (CO657/17: 67); that is, outbreaks of violence that were a serious concern to the authorities as they potentially threatened the colonial social order. We will now focus on two extreme cases to assess the causal mechanisms tested in this study in greater detail.

5.1 The 1913 drought and the 1935 "feast"

A quick look at the rainfall deviation tables (A-4 a, b, c) highlights, on the one hand, the severe drought spells during 1913 which led to a widespread famine, and, on the other hand, the absence of any moderate or severe shock in 1935. At the end of the harvest period the *Nigerian Pioneer* of September 4, 1913, mentioned: "*The absence of rain seems general throughout Nigeria, and is causing some uneasiness. Should there be no adequate rainfall during the later rains, the ensuing harvest will be of a poor description*" – a speculation that became true later that year. In 1913, there were many moderate and severe climatic shocks in several provinces. In Kano, for example, there was an extreme drought (rainfall deviation: -2.40). According to the Agriculture Report (CO657/1: 10): "*the rainfall during the year was abnormally low and, in consequence, agriculture suffered throughout the country, but more particularly in the province of Kano where the failure of the food crops caused a famine*".

The social consequences of this drought became visible in a sharp increase of prisoners and court cases during the year. The number of prisoners admitted to government jails in the Kano province was 455, as compared to 212 in 1912 (an increase of 114 percent) and 190 in 1911; 13 of these prisoners were incarcerated for debt, 39 for security reasons, and 403 were sentenced to penal imprisonment. It is worth noting that out of the total number of offenders serving sentences of penal imprisonment there were 288 for terms over two years, while the same figure during the preceding year was just 68. These statistics depict how local inhabitants responded to the 1913 famine. The military operations report of that year summarized that "*...a patrol was despatched to the Fagge district of the Kano Province in September, where inter-tribal fighting was taking place and some towns were reported to be in a state of anarchy. There were numerous casualties – 39 natives killed, and 7 wounded...*" (CO657/1: 32).

Looking back on the 1913 famine in Kano, Hastings (1925: 111) noted: "*...the ghost of famine stalked aboard through Kano and every other part. The stricken people tore down the ant hills in the bush to get the small grains and chaff within these storerooms. They wandered everywhere collecting the grass burrs of the kerangia to split the center pod and get the tiny seed. They made use of every poor resource their ingenuity could think of, and ravenous in their hunger, seized on anything they could steal or* *plunder* [...] *for the pasture had dried up and cattle were just skin and bone...*". This is a vivid description of what was happening in a province severely affected by famine. Local inhabitants, in need for food, plundered and stole everything in their way (that is, committed praedial larceny).

Turning to the local market conditions for buying food, Table 6 demonstrates the price spike for millet, which rose to an incredible high of 3d per pound (CO657/1: 45). Other grain prices in rural markets exhibited an increase of at least ten times above 1911 levels. The fact that millet prices, and prices of cereals in general, spiked dramatically meant that the vast majority of people were without food, or the means for obtaining it. The urban poor and other low-income groups must have suffered terribly due to food price inflation.

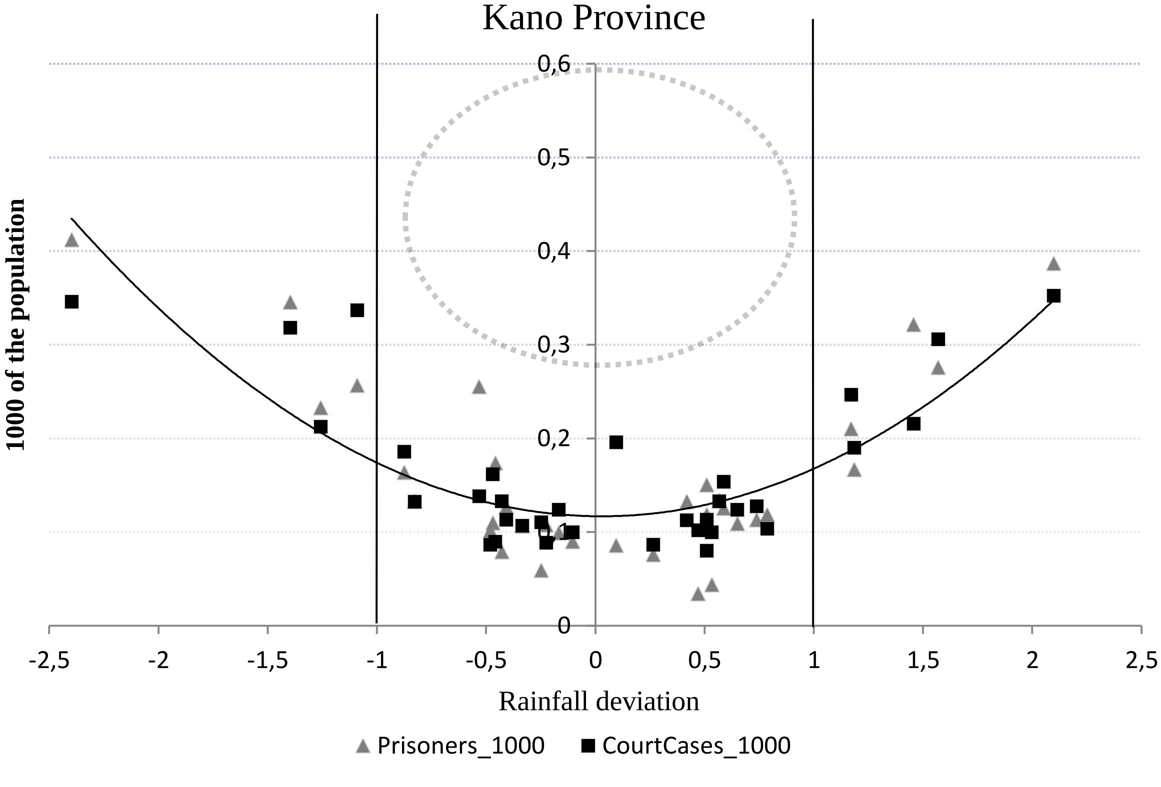
Table 6. *Cereal price data in Kano Market (millet)*

Year	Price (pence per pound)
1911	0.11
1912	0.38
1913	3.01
1914	0.27

Source: CO657/1

Figure 3 shows how rainfall deviation is related to a higher numbers of prisoners and court cases, whereas in "normal" years such levels were not recorded.[36]

Figure 3. *Rainfall deviation and conflict*



[36] It should be stated here that, of course, not all climatic shocks lead to violence. The Colonial Nigerian historiography has been rich and filled with notable conflict events that were not climate-induced, such as the Egba rebellion against taxation in the West in 1918, or the Women's War in the East in 1929. Nevertheless, tax and major historical event dummies are included in the empirical analysis to control for any omitted variable bias.

Kano province was not the only area affected by the drought of 1913. In Bornu province (rainfall deviation: -1.65), a moderate drought also resulted in a severe food crisis. The lack of food supplies induced migration to other provinces – a trend confirmed by the population figures shown in Table 7. It seems that local inhabitants drifted southward, depopulating Bornu and seeking for more favorable climatic conditions, and relatively better lands to cultivate (see Table 7). However, for those who stayed behind, the Chief Commissioner of the native authority prison stated: "*there was an increase in the number of prisoners ... this was due mainly to the growth of praedial larceny that last year's food shortage brought about*" (CO657/1: 69).

Table 7. *Population, Bornu province*

Year	Population
1910	674,000
1911	672,342
1912	513,388
1913	481,759
1914	626,500
1915	700,451

Source: CO657/1-4

The Bauchi province faced a moderate climatic shock as well (rainfall deviation: -1.64). The police report noted that: :*a police patrol was sent to the Tangali District of the Bauchi Province, in November, to deal with a section of pagans who had set upon a native official and a peaceful village, killing 11 and wounding 12 of them. 9 of the aggressors had been killed and several wounded in the affray. 9 more were killed and 7 wounded when opposing the patrol"* (CO657/1: 53).

A systematic look at the reported judicial, prison population and criminal statistics reveals a high year-to-year variation in almost all provinces. For instance, the judicial statistics show that in the aforementioned northern provinces the number of offences against the police dropped from 2967 in 1913 to 2246 in 1914, and that the number of people brought before the Magistrates decreased from 2892 to 2190, a reduction of ca. 25 percent. The annual prisoners' report also confirms that the largest daily prisoner averages could be found in the Kano and the Bornu provinces in 1913 (CO657/1: 50).

The "*feast* "of 1935

Unlike years of extreme weather fluctuations, there have also been seasons with favorable climatic conditions and exceptionally good yields.[37] The outstanding feature of 1935 was the gradual revival in trade and general prosperity following the great depression, which was accompanied by abundant harvests (CO657/40). Prices of most staple products had recovered, and confidence in the economy had

[37] Note the absence of any minor or major climatic shock in Tables A-4a, b, c. One can easily distinguish the three relatively good years as 1916, 1929 and 1935, during which no moderate or severe climatic shocks occurred. We did not select 1916 or 1929, for numerous reasons; the main one was that both years could be affected by remarkable external factors. For example, in 1916 World War I had already started, and the West African Campaign had not yet finished, while 1929 was the year of the Great Depression and the outbreak of the Women's War in the eastern part of Nigeria.

been restored. Commercial exports showed an increase of over 30 percent compared to 1934, and exports from both southern and northern Nigeria reached peak levels. Reading through the provincial reports of the year, one can see how local inhabitants, in various provinces, reacted and expressed their satisfaction with the abundance of that year's harvest as a result of well-spread rainfall.[38] The colonial officer of agriculture stated: "*since the bulk of the population is agriculturalist the welcome increase in prices paid for farm produce has resulted in a corresponding increase in the amount of money in circulation and in the greater prosperity of the people generally*" and added that this was also the case for provinces that had no export crops and were usually poorer (CO657/40: 64). A brief look at the exports of principal cash crops confirms the favorable weather conditions of that year (see Table 8).

Table 8. *Commercial activity*

Years	**Cocoa exports** (tons)	**Cotton exports** (bales)	**Total Exports** (£)
1931	48,700	14,000	15,282,228
1932	55,000	5,000	16,671,494
1933	68,400	22,000	15,066,982
1934	63,300	23,000	14,237,480
1935	77,200	50,000	19,336,855

Source: CO657/40.

A "favorable" environment is also portrayed in the military and police reports of the year, where the former summarized: "*there were no serious disturbances during the year*" and the latter: "*A total prison population of 33,005 was borne on the registers during the year 1935, as compared with 38,259 in the preceding year – a decrease of 5,254.*" It is worth noting here that the number of prisoners convicted for debt in 1935 sharply decreased (by around 35 percent) in comparison to 1934. This indicates the general prosperity across Nigeria that year, where local farmers, after a rich harvest, were able to pay the compulsory tax burden asked by the colonial authorities, and intense competition over potentially scarce resources was avoided. The severity of crimes also lessened. According to the relevant police report (CO657/40: 163), "*there were twenty-six executions during the year as compared with sixty-seven in 1934 – a decrease of 41*" (ca. 61 percent). Finally, no police patrols were required to be dispatched (CO657/40: 145), and there was a marked decrease in offences against property (CO657/40: 153).

5.2 Between the extremes

After examining two extreme years, we will now focus on the variation between "moderate" years, and highlight outbreaks of violence following the three-stage approach discussed above. For instance, we will examine the two climatic shocks in Ondo and Ogoja provinces in 1923, a year which, according to the colonial officials "*can be overall regarded as being a prosperous one regarding local farmers*" (CO 657/9: 12). In Ogoja, the rainfall deviation of +2.14, marked a severe shock. The police report of 1923 stated that "*three escorts for major purposes*" had been sent to the province during the year, all of whom

[38] Bornu people, for example, observed that "*the harvest was the best for years; in the memory of man never have the rivers been so abundantly prolific, the calves in the herds of the cattle-owners never so plentiful, and crops have been well above average*" (CO657/46: 62)

were accompanied by a high-ranked commissioner of the police. In particular, "*in July ... a party of Bamenda traders en route from Ikom to Ogoja were brutally murdered on the main road when passing through the Bansara country ..., an escort of 25 other ranks was despatched with the District Officer to investigate the matter. The result was that twenty people were arrested and returned for trial, several of whom were executed*." Further, it was reported that, "*other escorts for minor purposes were also supplied in the Ogoja province in September ... in keeping the peace between the Afungbonga and Obubra tribes*" (CO657/9: 43). Crime statistics in the Ondo province (rainfall deviation: -1.74) recorded a substantial increase, "*where there were 15 murders as against none in the preceding year,*" and the number of prisoners doubled from 205 to 417 (CO657/9: 44).

In 1918, the political report referred to disturbances in the Egba region (Abeokuta province, rainfall deviation: +1.51) "*this* [Egba] *rising was very sudden and there were signs that it had been organized by persons of education and intelligence* [telegraph wires had been cut and the railways sabotaged], *a large number of troops were required to restore order*," and this led to "*a serious loss of life among the malcontents*" (CO657/4: 38).

Another example is taken from the Kano province in 1920, where prices rose locally to as high as ₤40 per ton, and heavy losses were sustained by trading firms who were unable to ship their stocks before the slump occurred (CO657/6). When prices were very low, products such as groundnuts would not bear the cost of transport from places far removed from the railway (CO657/6: 7). The reduced yield of groundnuts can be attributed to climatic causes: "*Kano farmers were unfortunate in experiencing a drought just after sowing, while subsequently the exceptionally heavy rains damaged the crop*..." (CO657/9: 15). Turning to the criminal statistics of the year, the amount of stolen property was the highest ever recorded at ₤2.221. In the following year, Kano's figure for stolen property decreased by ca. 60 percent – lower than that of 1920.

The provincial report of 1926 in the Benue province (rainfall deviation: -1.87) recounted: "*there was a food shortage in several Benue Districts for a considerable part of the year, and unfortunately there is the possibility of a recurrence in 1927*," and continued "*...disturbances entailing the use of armed force occurred during the year ... on one occasion an attempt was made to ambush the Political Officer*." The *Nigerian Pioneer* of 30 March 1926 confirmed the prevalent disorder in the province: "*... a mob attacked the police station and the police were compelled to fire with the result that one rioter was killed*," and later that year (April 13, 1926), "*most of the leaders of the agitation had been arrested and brought to trial, the Native Courts had been re-opened and trade began to resume its normal course*." Additionally, in the Bauchi, where there was a significant drought (-1.51) in the same year, the number of provincial court cases increased by ca. 40 percent.

The agricultural report noted that: "*famine conditions in some of the Northern provinces caused some distress ... and food prices became greatly inflated*" (CO657/17: 14); further, "*the conditions were certainly not such as is conveyed by the word famine, but there was a definite shortage which caused the price of grain to soar to three or four times the normal price*" (CO657/17: 17). The consequences of these high food prices can be depicted through the annual police report of 1926, which noted that "*...of the* *seventy-eight offences of homicide in the whole of Northern Nigeria, fifty-nine were cases of murder. The very great majority of these cases, namely forty-four, occurred in the pagan districts of Benue and Bauchi provinces...*" (CO657/17: 107) – this represents a shocking 75 percent of the total registered murder cases.

On the other hand, 1916 was marked overall as a good year concerning crop yields due to favorable weather conditions, and the result was an "*abundance of food crops of every description*" (CO657/6: 13). This led to a decrease of imported foodstuffs: "*there was a marked diminution in the quantities and values of the imported foodstuffs shown ... the quantity imported in 1916 was only 53% of that imported in 1915*" (CO657/4: 27), while 1916 saw "*unprecedented prosperity to the Natives of the Northern Provinces*." The prices of cash crops were also good for farmers. The agricultural report summarized: "*Ground-nuts and cotton – the two principal crops grown for export – had been commanding prices ranging from 300 to 400 per cent above the preceding years. This is due to an exceptionally favorable season with frequent showers up to the end of October and the more generous use of manure. A late shower in October was highly beneficial to the cotton and ground nut crop, which promises to be a record one*" (CO657/4). The military report reflected these prosperous conditions: "... *from the military standpoint the year may be regarded as a quiet one*" (CO657/4: 4). No events of major importance were mentioned in this year's police and military reports.

6. Conclusion

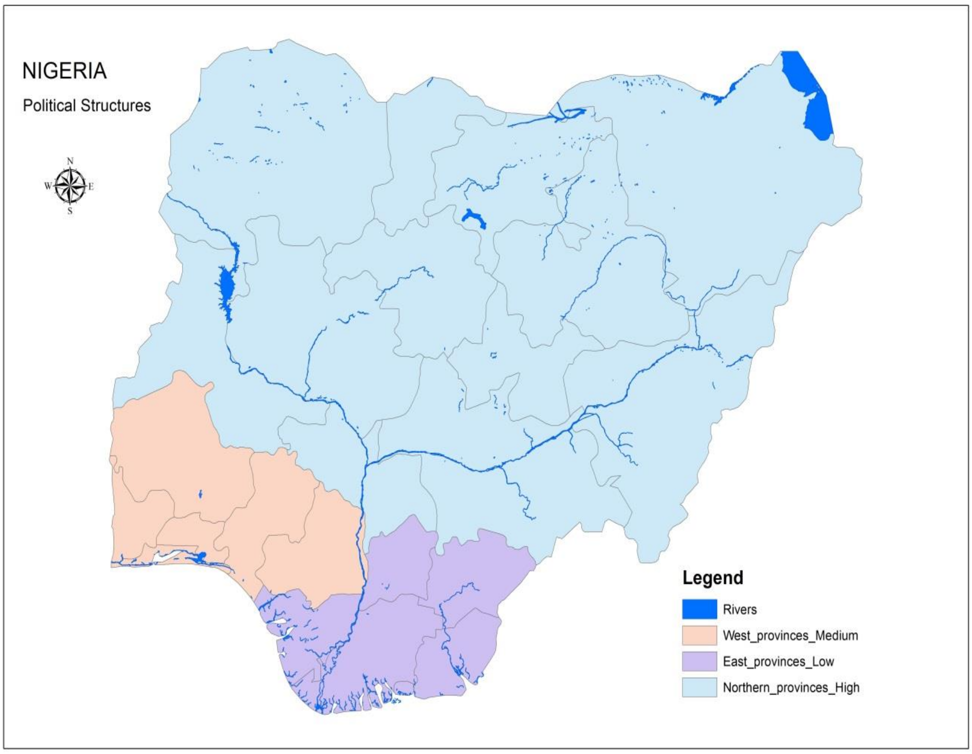
This study has investigated the linkage between climatic shocks and the incidence of conflict in colonial Nigeria. It makes several contributions to the current literature. We measured climatic shocks through deviations from long-term rainfall patterns in a nonlinear (U-shaped) relation, capturing both drought and excessive rainfall, and also introduced a new set of continuous conflict variables. We argued that climatic shocks enhanced competition over scarce resources, which led to disputes and clashes on a smaller intercommunal scale; in spite of their calamitous impact on civilian life and property, non-state intercommunal conflicts have received limited attention in the literature to date. The study also dealt with a historical setting that has not yet been subjected to this kind of analysis, and presented a considerable amount of detailed qualitative evidence to add robustness to the econometric results and to obtain a more thorough understanding of the important mechanisms contributing to the outbreak of conflict. This supplementary analysis provided evidence to support the suggested mechanisms leading from climate shocks to conflict in the context of colonial Nigeria. Finally, the study expanded the existing research agenda to historical periods by merging the theoretical and empirical insights of the environmental security and the economic historical literature.

Overall, the results indicate that there exists a robust and significant relationship between rainfall deviations and conflict intensity, which tends to be stronger in agro-ecological zones that are least resilient to climatic variability (such as Guinean savannah), and where (pre-) colonial political structures were less centralized. There is tentative evidence that the relationship is weaker in areas that specialize in the production of export crops (such as cocoa, palm oil and, groundnuts) compared to subsistence farming areas, suggesting that agricultural diversification acted as an insurance mechanism against the whims of nature.

Several long-term implications stem from the results of this study, and need to be further investigated. For instance, future studies could explore the extent to which the introduction of new cash crops (such as cacao) or the expansion of existing cash crops (including palm oil, rubber, and cotton) in Africa destroyed the traditional insurance mechanisms of farmers. The results from this paper seem to suggest that crop commercialization provided the means to increase farmers' income through the additional benefits reaped from international and inter-regional trade, and in turn this diversified farmers' production and limited the vulnerability of the cash-crop areas to the vagaries of climate. However, this is still appears to be prone to debate. Future questions to explore could include the following: Have cash crops mitigated or aggravated the threat of climate-induced conflict over time? Have ordinary Africans actually benefited from such developments? Have areas with a substantial cash-crop export sector performed better in declining poverty rates over the long run, compared to areas primarily dedicated to food crops?

7. APPENDIX

Map A-1. *Political structures of Nigeria*

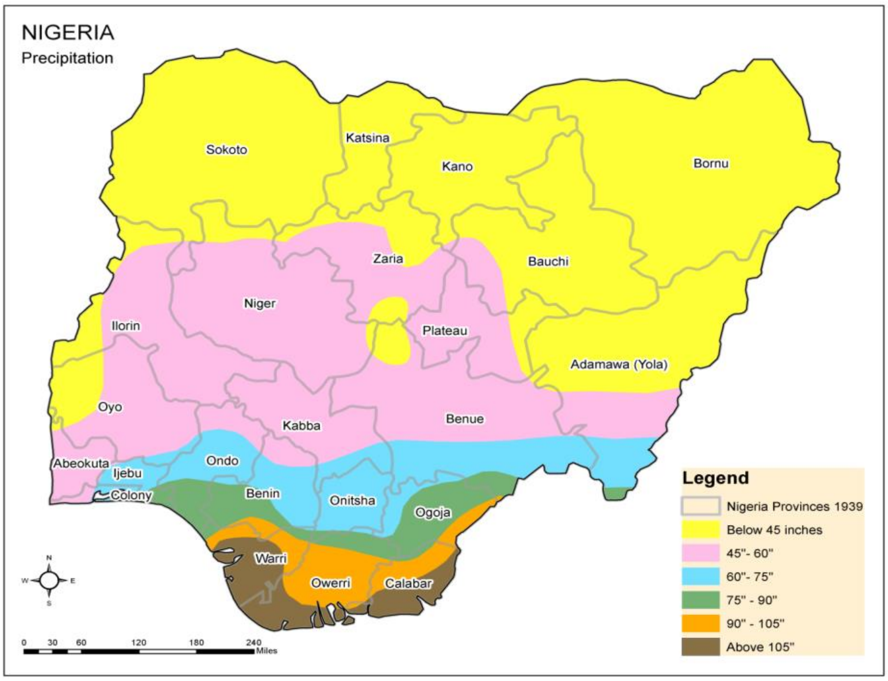


Source: created in ArcGIS.

Map A-2. *Provinces of Nigeria in 1939*

Source: CO657/6 Nigeria, created in ArcGIS.

Map A-3. *Average precipitation map of Nigeria*



Source: Land and Survey Department Lagos, Nigeria 1939 (CO657/46), created in ArcGIS.

Table A-1. *Classifications*

Colonial Province	Area (in Square Miles)	Ethnic Homogeneity	Agro-Ecological Zone	Political Structure	Cash Crop
(1)	(2)	(3)	(4)	(5)	(6)
Southern Nigeria					
Colony	1410	0.7	Freshwater Swamp/Mangrove	Medium	-
Oyo	14216	1.0	Rainforest	Medium	Cocoa
Ondo	7165	0.8	Rainforest	Medium	Cocoa
Abeokuta	5007	0.7	Rainforest	Medium	Cocoa
Calabar	6331	0.5	Freshwater Swamp/Mangrove	Low	Palm Oil/Kernel
Owerri	9970	0.7	Rainforest	Low	-
Warri	7704	0.6	Freshwater Swamp/Mangrove	Low	Palm Oil/Kernel
Benin City	8589	0.8	Rainforest	Medium	-
Onitsha	5510	0.6	Guinea Savannah	Medium	Palm Oil/Kernel
Ogoja	8295	0.3	Rainforest	Low	Palm Oil/Kernel

Northern Nigeria					
Sokoto	39965	0.7	Sudan Savannah	High	Groundnuts
Kano	17602	0.6	Sudan Savannah	High	Groundnuts
Lokoja (Kabba)	10953	0.8	Guinea Savannah	High	-
Bornu	45747	0.2	Sudan Savannah	High	Groundnuts
Yola (Adamawa)	33620	0.1	Sudan Savannah	High	-
Bauchi	26120	0.2	Guinea Savannah	High	-
Zaria	16488	0.4	Guinea Savannah	High	Groundnuts
Ilorin	17644	0.8	Guinea Savannah	High	-
Niger	25178	0.5	Guinea Savannah	High	-
Benue	29443	0.4	Guinea Savannah	High	-

Table A-2. *Controls and their sources*

Variable	Source	Comment
	Geographical Controls	
Navigable rivers	Digital Chart of the World (Danko, 1992) http://data.geocomm.com/	
Distance to coast	World Topographic Map www.arcgis.com	Distances computed in ArcGIS
Distance to nearest ports	World Topographic Map www.arcgis.com	Distances computed in ArcGIS
Agro-ecological zones	Iloeje & FAO (2001)	A province is classified as an agro-ecological zone when >80 percent of its surface lies within that zone
	Other Controls	
Road density	Colonial Archives, Transportation Report	Roads open all season (measured in miles)
Railway stations	Colonial Archives, Transportation Report	Assigned "1" for every province with a train station and "0" for every province with no railway service
Direct taxation	Colonial Archives, Falola (2009)	Assigned "1" for every year after the imposition of direct taxation in each province
Ethnic homogeneity	Obikili (2012), Murdock (1969),	Four different sources were used to calculate this

	DHS Survey http://www.measuredhs.com, Afrobarometer http://www.afrobarometer.org/ Weidmann *et al.* (2010)	variable, which ranges from 0–1; 1 denotes the most homogeneous province, dominated by only one ethnic group. We follow the same classification as these sources and include ethnic groups that account for more than >5 percent of each province's total population.
Livestock	Colonial Archives, (Bourn *et al.*, 1994).	Dummy variable. Assigned "1" for every province in which the absence of the Tsetse fly made it possible to raise livestock
Political structures	Colonial Archives, Afigbo (1972); Ekundare (1973); Iliffe (1995); Osafo-Kwaako and Robinson (2013)	As suggested by these sources, we created a categorical dummy, ranging from 1–3; 3 denotes high centralization, 2 denotes medium and 1 denotes low
Type of crop	Colonial Archives, (1975); Fasona and Omojola (2005); Güsten (1968); Hill (1977); (2001); Watts (1983)	We obtained detailed information in order to map the economic activity, and then assigned "1" to provinces with cash-crop production and "0" to provinces with solely food-crop production

Table A-3. *Rainfall statistics*

Colonial Province	Meteorological Station	Rainfall Min.	Rainfall Max.	Rainfall Average	Rainfall Range
(1)	(2)	(3)	(4)	(5)	(6)
Southern Nigeria					
Colony	Lat: 6° 27' 00" N Long: 3° 24' 00" E	38.2	115.5	69.4	77.3
Oyo	Lat: 7° 51' 00" N Long: 3° 55' 00" E	20.9	73.9	46.4	53.0
Ondo	Lat: 7° 06' 00" N Long: 4° 50' 00" E	31.6	97.0	58.6	65.4
Abeokuta	Lat: 7° 08' 26" N Long: 3° 20' 24" E	27.7	89.4	47.1	61.7
Calabar	Lat: 4° 58' 00" N Long: 8° 19' 00" E	90.0	190.2	117.4	100.3
Owerri	Lat: 5° 29' 00" N Long: 7° 03' 00" E	76.4	141.4	99.4	65.0
Warri	Lat: 5° 31' 00" N Long: 5° 44' 00" E	83.5	141.2	107.7	57.7
Benin City	Lat: 6° 20' 00" N Long: 5° 26' 00" E	50.3	90.2	76.8	39.9
Onitsha	Lat: 6° 10' 00" N Long: 6° 47' 00" E	55.7	102.1	77.2	46.3
Ogoja	Lat: 6° 39' 30" N Long: 8° 44' 00" E	45.7	106.0	76.6	60.2
Northern Nigeria					

Sokoto	Lat: 13° 02' 10" N Long: 5° 14' 46.9" E	16.3	48.4	27.7	32.2
Kano	Lat: 12° 00' 00" N Long: 8° 33' 00" E	19.1	46.5	35.7	27.5
Lokoja (Kabba)	Lat: 10° 33' 40" N Long: 7° 24' 30" E	35.2	77.5	50.1	42.3
Bornu	Lat: 11° 47' 00" N Long: 13°11' 00" E	15.8	34.3	25.9	18.5
Yola (Adamawa)	Lat: 9° 12' 28.9" N Long: 12° 20' 30" E	21.8	44.0	36.3	22.3
Bauchi	Lat: 10° 18' 54.66" N Long: 9° 49' 27.55" E	28.3	64.2	43.5	36.0
Zaria	Lat: 11° 06' 10.38" N Long: 7° 42' 57.44" E	26.7	70.7	42.7	44.0
Ilorin	Lat: 8° 30' 26.77" N Long: 4° 34' 53.9" E	36.3	66.3	49.7	30.0
Niger	Lat: 9° 38' 00" N Long: 6° 30' 00" E	32.8	70.6	51.2	37.7
Benue	Lat: 7° 44' 11" N Long: 8° 31' 15" E	25.1	78.7	49.5	53.6

Table A-4. *Rainfall deviation tables*

Table A-4a. *First decade of the dataset*

Southern Provinces	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Colony	-1.69	-0.48	0.02	1.31	-0.49	2.82	-0.88	-1.21	-0.93	-1.82	1.05
Oyo	-0.43	-0.83	-0.13	0.71	1.08	0.86	-0.29	-0.60	-0.21	1.18	-0.31
Ondo	0.50	-0.18	-0.50	0.03	0.20	1.09	1.04	-1.05	-0.89	-0.56	-1.25
Abeokuta	-1.29	0.21	-0.18	-0.38	0.84	0.23	1.51	0.39	0.94	-1.64	-0.60
Calabar	-0.23	0.58	0.05	0.97	-0.38	-0.06	-0.04	-1.15	-0.59	-0.87	-0.28
Owerri	-1.08	-1.67	-1.19	0.84	0.87	1.68	0.07	0.34	-0.36	-0.23	-0.60
Warri	0.19	0.31	-0.16	2.16	-0.23	0.57	0.34	-0.89	-0.18	-0.02	-0.34
Benin City	0.12	-0.73	0.09	-1.34	-0.46	0.44	-0.02	0.18	-0.31	1.31	-0.32
Onitsha	-1.90	-2.60	1.58	0.52	-0.35	1.73	-0.97	-3.35	-1.24	-0.19	0.70
Ogoja	-1.25	-1.01	-1.30	0.91	-0.64	-1.80	0.26	1.24	1.61	0.25	0.54

Northern Provinces	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Sokoto	-1.04	-1.52	-0.15	0.02	-0.39	-1.05	0.44	1.35	0.20	0.70	0.86
Kano	-0.94	-2.40	-1.87	-0.11	0.47	-0.25	0.73	-0.47	-1.56	0.10	-0.33
Kabba	-0.07	-0.50	-0.16	1.04	1.14	-0.33	-0.60	-0.67	0.49	0.63	0.13
Bornu	-1.09	-1.65	-0.22	-0.38	-0.07	-0.58	1.75	-1.30	-1.53	0.42	-1.51
Yola (Adamawa)	0.07	-0.34	-1.38	-0.25	0.59	-1.14	0.91	1.17	-0.89	0.65	0.47
Bauchi	-0.25	-1.64	0.11	0.21	0.77	1.60	2.23	-0.14	-0.53	-0.56	1.13
Zaria	0.02	-1.07	-0.15	-0.36	0.78	-0.22	-0.91	-1.63	0.05	-0.08	0.28
Ilorin	-1.32	-0.71	-0.18	-0.16	0.33	1.19	-0.45	-0.35	1.24	1.45	-1.15
Niger	-0.68	-0.38	-0.04	-0.42	0.78	-0.55	0.35	-1.79	0.41	0.76	-0.67
Benue	-0.08	-0.10	0.02	2.32	-0.05	-0.33	-1.31	-0.17	-1.35	0.03	-1.08

Table A-4b. *Second decade of the dataset*

Southern Provinces	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933
Colony	0.18	-1.12	0.47	0.44	0.60	0.63	1.10	0.18	0.90	-1.23	0.44
Oyo	-0.11	0.22	-0.02	0.03	-1.53	1.57	0.38	2.27	0.26	0.06	1.23
Ondo	-1.74	-0.83	-0.70	-0.78	-0.77	-1.45	0.17	0.34	0.43	-0.15	2.06
Abeokuta	0.81	-0.41	1.28	-0.72	-0.38	-0.39	-0.07	0.39	-0.04	0.06	1.26
Calabar	-0.53	1.35	0.53	-0.62	3.68	1.23	0.56	-0.55	0.78	-1.35	0.54
Owerri	-0.80	0.77	-0.87	-0.43	0.64	0.80	0.72	2.04	0.69	-1.38	1.43
Warri	-1.03	-0.07	-0.48	-1.68	1.21	0.73	0.76	0.66	0.99	-0.42	-0.81
Benin City	-0.13	0.42	-0.24	-0.40	0.16	0.25	0.78	0.94	0.61	-1.55	0.01
Onitsha	0.44	-0.37	1.09	-0.15	-0.09	0.88	0.95	-0.66	2.20	0.27	1.74
Ogoja	2.14	1.48	0.45	-0.41	-0.61	-3.46	-0.29	0.99	-0.29	-1.35	-0.01
Northern Provinces	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933
Sokoto	-0.33	0.57	-0.15	-0.67	0.25	-1.03	0.23	-0.40	-0.28	0.67	0.44
Kano	-0.41	-1.10	-0.23	-1.17	-0.77	-0.10	1.09	0.51	1.57	0.57	-0.46
Kabba	-0.67	1.72	1.71	1.23	2.83	0.87	0.81	-1.32	-0.33	-0.68	-0.63
Bornu	-0.01	1.20	-1.09	-1.49	0.12	0.12	0.30	0.45	0.87	-0.01	0.02
Yola (Adamawa)	0.22	0.32	0.92	-2.37	2.00	0.65	1.05	-0.10	-0.60	0.11	-0.15
Bauchi	1.04	1.01	-0.56	-1.51	-0.41	-1.65	0.39	-0.48	-1.23	1.50	0.43
Zaria	-0.32	0.03	0.15	-0.47	-1.25	-0.27	0.65	-0.15	0.33	0.37	1.28
Ilorin	0.46	1.07	1.24	0.39	0.52	-0.05	0.27	-0.32	-0.04	-1.19	1.98
Niger	0.37	1.62	0.31	-0.29	0.04	0.37	0.35	1.67	1.48	-0.81	0.67
Benue	-1.81	0.41	-0.33	-1.87	-0.21	-1.87	0.18	1.13	-1.81	0.92	2.15

Table A-4c. *Last decade of the dataset*

Southern Provinces	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
Colony	1.38	0.55	-0.38	0.79	-0.59	-0.31	1.75	0.84	0.63	1.41	-0.48	-0.54
Oyo	0.29	0.52	-0.60	-0.18	-0.32	-0.04	0.11	0.23	-0.40	-1.67	0.73	-1.34
Ondo	2.10	1.02	0.05	0.00	1.08	-0.46	1.41	1.24	0.03	0.09	-0.05	-0.39
Abeokuta	0.89	-0.27	-1.25	-0.16	-0.38	0.11	0.38	-1.58	-0.97	-0.28	0.02	-0.46
Calabar	-1.12	1.22	0.21	-1.08	-0.26	-0.66	0.11	0.00	1.36	0.53	-1.62	1.04
Owerri	-0.50	-0.40	-1.72	-1.36	0.20	0.19	0.61	-0.03	-0.40	1.29	0.36	0.02
Warri	-0.07	-0.64	-1.53	-0.39	-1.69	0.44	-1.55	-0.67	0.38	0.19	-1.32	0.08
Benin City	-0.29	0.76	-0.29	0.92	0.53	0.29	-0.47	2.15	-0.11	1.59	-0.35	0.00
Onitsha	0.80	0.72	-2.70	0.57	0.95	3.03	0.77	0.18	0.35	-0.32	-0.18	-1.95
Ogoja	2.05	0.01	-1.27	-0.12	0.13	0.27	-1.67	-0.35	-0.52	-0.01	-0.19	-2.09
Northern Provinces	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
Sokoto	-1.33	0.27	1.42	0.13	0.33	-0.25	-0.58	-1.78	-0.17	-0.08	0.33	0.28
Kano	-0.43	0.18	0.42	-0.97	-0.34	1.19	0.79	-0.43	1.28	0.15	0.79	0.64
Kabba	0.34	1.16	-0.40	-1.53	-0.30	-1.33	-0.47	-0.18	-1.33	-0.67	-1.60	-0.31
Bornu	0.81	-0.68	0.84	-0.29	0.56	-0.33	-1.37	0.12	0.14	-1.44	0.17	0.33
Yola (Adamawa)	1.25	0.49	1.11	-0.21	-1.15	-0.88	0.63	1.11	-0.14	-0.03	0.28	-1.14
Bauchi	1.53	0.44	0.82	-1.57	0.62	0.88	-1.17	0.12	-1.52	-1.25	0.08	0.12
Zaria	3.09	0.37	-0.83	0.25	-0.61	-1.28	-2.49	0.07	-0.73	0.33	-1.06	1.36
Ilorin	-0.67	0.64	-1.16	1.28	-1.57	-0.57	-0.57	1.39	-0.37	1.07	0.86	0.33
Niger	0.62	-0.92	-0.17	-0.14	-0.43	-0.43	-0.43	0.29	-0.09	-0.15	-1.32	-1.77
Benue	0.29	0.54	-0.40	1.17	-1.46	0.22	-1.46	0.14	0.55	-2.13	0.20	0.38

8. Bibliography

Acemoglu, D., Reed, T., & Robinson, J. A. (2013). 'Chiefs: Economic Development and Elite Control of Civil Society in Sierra Leone'. *Forthcoming, Journal of Political Economy*.

Adano, W. R., Dietz, T., Witsenburg, K., & Zaal, F. (2012). 'Climate change, violent conflict and local institutions in Kenya's drylands'. *Journal of Peace Research,* **49**(1): 65-80.

Afigbo, A. E. (1972). *The Warrant Chiefs: indirect rule in southeastern Nigeria, 1891-1929*: Cambridge Univ Press.

Alesina, A., & Perotti, R. (1996). 'Income distribution, political instability, and investment'. *European Economic Review,* **40**(6): 1203-1228.

Alsan, M. (2012). *The Effect of the TseTse Fly on African Development*. Harvard University.

Aluko, S. (1965). 'How Many Nigerians? An Analysis of Nigeria's Census Problems, 1901–63'. *The Journal of Modern African Studies,* **3**(03): 371-392.

Apeldoorn, G. v. (1981). *Perspectives on drought and famine in Nigeria*: George Allen and Unwin.

Baechler, G. (1999). *Violence through environmental discrimination: Causes, Rwanda arena, and conflict model* (Vol. 2): Springer.

Barnett, J. (2003). 'Security and climate change'. *Global Environmental Change,* **13**(1): 7-17.

Benjaminsen, T. A., Alinon, K., Buhaug, H., & Buseth, J. T. (2012). 'Does climate change drive land-use conflicts in the Sahel?'. *Journal of Peace Research,* **49**(1): 97-111.

Berry, S. (1975). *Cocoa, Custom and Socio-Economic Change in Rural Western Nigeria*: Oxford University Press.

Berry, S. (1993). *No condition is permanent: The social dynamics of agrarian change in sub-Saharan Africa*: University of Wisconsin Pres.

Blakeslee, D., & Fishman, R. (2013). 'Rainfall Shocks and Property Crimes in Agrarian Societies: Evidence from India'. *Available at SSRN 2208292.*

Bond, S., Hoeffler, A., & Temple, J. (2001). *GMM estimation of empirical growth models* (Vol. 3048): Centre for Economic Policy Research London.

Bourn, D., Wint, W., Blench, R., & Woolley, E. (1994). 'Nigerian livestock resource survey'. *World Animal Review (FAO).*

Bowden, S., Chiripanhura, B., & Mosley, P. (2008). 'Measuring and explaining poverty in six African countries: A long-period approach'. *Journal of international development,* **20**(8): 1049-1079.

Brambor, T., Clark, W. R., & Golder, M. (2006). 'Understanding interaction models: Improving empirical analyses'. *Political Analysis,* **14**(1): 63-82.

Bruinsma, J. (2009). *The resource outlook to 2050.* Paper presented at the expert meeting on "How to Feed the World in 2050, Rome: Food and Agriculture Organization of the United Nations.

Buhaug, H. (2010). 'Climate not to blame for African civil wars'. *Proceedings of the National Academy of Sciences,* **107**(38): 16477-16482.

Buhaug, H., & Lujala, P. (2005). 'Accounting for scale: Measuring geography in quantitative studies of civil war'. *Political Geography,* **24**(4): 399-418.

Burgess, R., & Donaldson, D. (2010). 'Can openness mitigate the effects of weather shocks? Evidence from India's famine era'. *The American economic review*: 449-453.

Burke, M. B., Miguel, E., Satyanath, S., Dykema, J. A., & Lobell, D. B. (2009). 'Warming increases the risk of civil war in Africa'. *Proceedings of the National Academy of Sciences,* **106**(49): 20670-20674.

Chaves, I. N., Engerman, S. L., & Robinson, J. A. (2013). Reinventing the Wheel: The Economic Benefits of Wheeled Transportation in Early British Colonial West Africa: National Bureau of Economic Research.

Ciccone, A. (2011). 'Economic shocks and civil conflict: A comment'. *American Economic Journal: Applied Economics,* **3**(4): 215-227.

Clayton, A., & Killingray, D. (1989). *Khaki and blue: Military and police in British colonial Africa*: Ohio University Center for International Studies Athens, OH.

Conley, T. G. (1999). 'GMM estimation with cross sectional dependence'. *Journal of econometrics,* **92**(1): 1-45.

Dalby, S. (2002). *Environmental security* (Vol. 20): University of Minnesota Press.

Danko, D. M. (1992). ‘The digital chart of the world project’. *Photogrammetric engineering and remote sensing,* **58**(8): 1125-1128.
Davis, C. (2010). ‘Climate change and civil war’. *African Security Review,* **19**(1): 64-72.
De Hoyos, R. E., & Sarafidis, V. (2006). ‘Testing for cross-sectional dependence in panel-data models’. *Stata Journal,* **6**(4): 482-496.
Dercon, S. (2004). ‘Growth and shocks: evidence from rural Ethiopia’. *Journal of Development economics,* **74**(2): 309-329.
Dercon, S., & Krishnan, P. (2000). ‘Vulnerability, seasonality and poverty in Ethiopia’. *The Journal of Development Studies,* **36**(6): 25-53.
Devereux, S., & Berge, K. (2000). *Famine in the twentieth century*: Institute of Development Studies Brighton.
Easterly, W., & Levine, R. (1997). ‘Africa's growth tragedy: policies and ethnic divisions’. *The Quarterly Journal of Economics,* **112**(4): 1203-1250.
Ekundare, O. (1973). *An Economic History of Nigeria 1860-1960*: NY: Africana Publications. Co., 1973.
Eltis, D. (2000). *The rise of African slavery in the Americas*: Cambridge University Press.
Englebert, P. (2000). ‘Pre-colonial institutions, post-colonial states, and economic development in tropical Africa’. *Political Research Quarterly,* **53**(1): 7-36.
Fafchamps, M., Udry, C., & Czukas, K. (1998). ‘Drought and saving in West Africa: are livestock a buffer stock?’. *Journal of Development economics,* **55**(2): 273-305.
Falola, T. (1987). *Britain and Nigeria: Exploitation or Development*. London and New Jersey: Zed Books Ltd.
Falola, T. (2009). *Colonialism and violence in Nigeria*: Indiana University Press.
Faris, S. (2009). ‘Forecast: The Surprising--and Immediate--Consequences of Climate Change’. *New York: Henry Holt*.
Fasona, M. J., & Omojola, A. (2005). *Climate change, human security and communal clashes in Nigeria.* Paper presented at the Human Security and Climate Change Conference, Asker, Norway.
Fearon, J. D., & Laitin, D. D. (2003). ‘Ethnicity, insurgency, and civil war’. *American political science review,* **97**(1): 75-90.
Fenske, J., & Kala, N. (2012). ‘Climate, ecosystem resilience and the slave trade’. *CEPR Discussion Paper 9449*.
Fieldhouse, D. K. (1999). *The West and the Third World: trade, colonialism, dependence, and development*: Blackwell Oxford.
Fjelde, H. (2009). *Sub-National Determinants of Non-State Conflicts in Nigeria, 1991-2006 Sins of Omission and Commission: The Quality of Government and Civil Conflict.* Doctoral Thesis, Report.
Fjelde, H., & von Uexkull, N. (2012). ‘Climate triggers: Rainfall anomalies, vulnerability and communal conflict in sub-Saharan Africa’. *Political Geography,* **31**(7): 444-453.
Frankema, E. (2013). *Africa and the green revolution: a global historical perspective*: Wageningen University, Wageningen UR.
Frankema, E., & Jerven, M. (2013). ‘The missing link: reconstructing African population growth, 1850-present’. *Economic History Review (accepted)*.
Frankema, E., & Waijenburg, M. V. (2012). ‘Structural impediments to African growth? New evidence from real wages in British Africa, 1880–1965’. *The Journal of Economic History,* **72**(04): 895-926.
Galletti, R., Baldwin, K. D. S., Dina, I., & Board, N. C. M. (1956). *Nigerian cocoa farmers: an economic survey of Yoruba cocoa farming families*: Board by Oxford University Press.

Gallup, J. L., Sachs, J. D., & Mellinger, A. D. (1999). 'Geography and economic development'. *International Regional Science Review,* **22**(2): 179-232.
Gennaioli, N., & Rainer, I. (2007). 'The modern impact of precolonial centralization in Africa'. *Journal of Economic Growth,* **12**(3): 185-234.
Ghate, C., Le, Q. V., & Zak, P. J. (2003). 'Optimal fiscal policy in an economy facing socio-political instability'. *Review of Development Economics,* **7**(4): 583-598.
Glantz, M. H. (1988). *Drought and hunger in Africa*: CUP Archive.
Gleditsch, N. P. (1998). 'Armed conflict and the environment: A critique of the literature'. *Journal of Peace Research,* **35**(3): 381-400.
Gleick, P. H. (1993). 'Water and conflict: Fresh water resources and international security'. *International security,* **18**(1): 79-112.
Güsten, R. (1968). *Studies in the staple food economy of western Nigeria: With 32 maps*: Weltforum Verlag.
Guttman, N. B. (1999). 'Accepting the standardized precipitation index: a calcualation algorithm'. *JAWRA Journal of the American Water Resources Association,* **35**(2): 311-322.
Hagmann, T. (2005). 'Confronting the concept of environmentally induced conflict'. *Peace, Conflict and Development,* **6**(6): 1-22.
Hastings, A. C. G. (1925). *Nigerian days*: John Lane.
Hendrix, C. S., & Glaser, S. M. (2007). 'Trends and triggers: Climate, climate change and civil conflict in Sub-Saharan Africa'. *Political Geography,* **26**(6): 695-715.
Hendrix, C. S., & Salehyan, I. (2012). 'Climate change, rainfall, and social conflict in Africa'. *Journal of Peace Research,* **49**(1): 35-50.
Herbst, J. (2000). *States and power in Africa: comparative lessons in authority and control*: Princeton University Press.
Hill, P. (1977). *Population, prosperity, and poverty: Rural Kano, 1900 and 1970*: Cambridge University Press Cambridge.
Homer-Dixon, T. F. (1999). *Environment, scarcity, and conflict*: Princeton, NJ: Princeton University Press.
Homer-Dixon, T. F. (2010). *Environment, scarcity, and violence*: Princeton University Press.
Hsiang, S. M., Burke, M., & Miguel, E. (2013). 'Quantifying the influence of climate on human conflict'. *Science,* **341**(6151): 53-67.
Huillery, E. (2011). 'The Impact of European Settlement within French West Africa: Did pre-colonial prosperous areas fall behind?'. *Journal of African Economies,* **20**(2): 263-311.
Hussein, K., Sumberg, J., & Seddon, D. (1999). 'Increasing violent conflict between herders and farmers in Africa: claims and evidence'. *Development Policy Review,* **17**(4): 397-418.
Hydén, G. (1980). *Beyond Ujamaa in Tanzania: underdevelopment and an uncaptured peasantry*: University of California Pr.
Iliffe, J. (1995). *Africans: the history of a continent*: Cambridge University Press.
Iloeje, N. P. (2001). *A new geography of Nigeria.* : New Revised Edition. Longman Nigeria PLC.
Jahnke, H. E., & Jahnke, H. E. (1982). *Livestock production systems and livestock development in tropical Africa* (Vol. 35): Kieler Wissenschaftsverlag Vauk Kiel.
Johnstone, S., & Mazo, J. (2011). 'Global warming and the Arab Spring'. *Survival,* **53**(2): 11-17.
Kahl, C. H. (2006). *States, scarcity, and civil strife in the developing world*: Princeton University Press.
Kala, N., Kurukulasuriya, P., & Mendelsohn, R. (2012). 'The impact of climate change on agro-ecological zones: evidence from Africa'. *Environment and Development Economics,* **17**(6): 663.
Killingray, D. (1986). 'The maintenance of law and order in British colonial Africa'. *African Affairs,* **85**(340): 411-437.

Klomp, J., & Bulte, E. (2012). *Climate Change, Weather Shocks and Violent Conflicts: A Critical Look at the Evidence.* Paper presented at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, August.

Koubi, V., Bernauer, T., Kalbhenn, A., & Spilker, G. (2012). 'Climate variability, economic growth, and civil conflict'. *Journal of Peace Research,* **49**(1): 113-127.

Kowal, J. M., & Kassam, A. H. (1978). *Agricultural ecology of savanna. A study of West Africa*: Oxford University Press.

Mann, M. (1984). 'The autonomous power of the state: its origins, mechanisms and results'. *European Journal of Sociology,* **25**(02): 185-213.

Mann, M. (2008). 'Infrastructural power revisited'. *Studies in Comparative International Development (SCID),* **43**(3): 355-365.

Miguel, E., Satyanath, S., & Sergenti, E. (2004). 'Economic shocks and civil conflict: An instrumental variables approach'. *Journal of political Economy,* **112**(4): 725-753.

Moradi, A. (2009). 'Towards an objective account of nutrition and health in colonial Kenya: a study of stature in African army recruits and civilians, 1880–1980'. *The Journal of Economic History,* **69**(03): 719-754.

Murdock, G. P. (1969). *Ethnographic atlas*: University of Pittsburgh Press.

North, D. C., Wallis, J. J., & Weingast, B. R. (2009). *Violence and social orders: a conceptual framework for interpreting recorded human history*: Cambridge University Press.

Obikili, N. (2012). 'The Impact of the Slave Trade on Literacy in Africa: Evidence from the Colonial Era'. *Economic Research Southern Africa Working Paper Series No. 378.*

Ohadike, D. C. (1991). *The Ekumeku movement: Western Igbo resistance to the British conquest of Nigeria, 1883-1914*: Ohio University Press Athens.

Osafo-Kwaako, P., & Robinson, J. A. (2013). 'Political centralization in pre-colonial Africa'. *Journal of Comparative Economics,* **41**(1): 6-21.

Pesaran, M. H. (2007). 'A simple panel unit root test in the presence of cross-section dependence'. *Journal of Applied Econometrics,* **22**(2): 265-312.

Post, J. D. (1984). 'Climatic variability and the European mortality wave of the early 1740s'. *The Journal of interdisciplinary history,* **15**(1): 1-30.

Raleigh, C., & Kniveton, D. (2012). 'Come rain or shine: An analysis of conflict and climate variability in East Africa'. *Journal of Peace Research,* **49**(1): 51-64.

Raleigh, C., Linke, A., Hegre, H., & Karlsen, J. (2010). 'Introducing ACLED: An Armed Conflict Location and Event Dataset Special Data Feature'. *Journal of Peace Research,* **47**(5): 651-660.

Raynaut, C. (1977). 'Lessons of a crisis'. *Drought in Africa,* **2**: 17.

Reid, R. J. (2012). *Warfare in african history* (Vol. 6): Cambridge University Press.

Reuveny, R. (2007). 'Climate change-induced migration and violent conflict'. *Political Geography,* **26**(6): 656-673.

Rodney, W. (1978). *How Europe Underdeveloped Africa*: Bogle-L'Ouverture Publications, Howard University Press.

Roodman, D. (2006). 'How to do xtabond2: An introduction to difference and system GMM in Stata'. *Center for Global Development working paper*(103).

Ross, M. L. (2004). 'What do we know about natural resources and civil war?'. *Journal of Peace Research,* **41**(3): 337-356.

Scott, J. C. (1977). *The moral economy of the peasant: Rebellion and subsistence in Southeast Asia*: Yale University Press.

Seo, S., Mendelsohn, R., Kurukulasuriya, P., Dinar, A., & Hassan, R. (2008). 'Differential adaptation strategies to climate change in African cropland by agro-ecological zones'. *Environmental & Resource Economics,* **43**(3): 313-332.

Shenton, B., & Watts, M. (1979). 'Capitalism and hunger in Northern Nigeria'. *Review of African political economy,* **6**(15-16): 53-62.

Sternberg, T. (2012). 'Chinese drought, bread and the Arab Spring'. *Applied Geography,* **34**: 519-524.

Sundberg, R., Eck, K., & Kreutz, J. (2012). 'Introducing the UCDP Non-State Conflict Dataset'. *Journal of Peace Research,* **49**(2): 351-362.

Theisen, O. M. (2012). 'Climate clashes? Weather variability, land pressure, and organized violence in Kenya, 1989–2004'. *Journal of Peace Research,* **49**(1): 81-96.

Thompson, E. P. (1971). 'The moral economy of the English crowd in the eighteenth century'. *Past & present,* **50**(1): 76-136.

Tietenberg, T. H., & Lewis, L. (2000). *Environmental and natural resource economics*: Addison-Wesley Reading, MA.

Toulmin, C. (2009). 'Securing land and property rights in sub-Saharan Africa: the role of local institutions'. *Land Use Policy,* **26**(1): 10-19.

Turner, M. D. (2004). 'Political ecology and the moral dimensions of "resource conflicts": the case of farmer–herder conflicts in the Sahel'. *Political Geography,* **23**(7): 863-889.

Urdal, H. (2005). 'People vs. Malthus: Population pressure, environmental degradation, and armed conflict revisited'. *Journal of Peace Research,* **42**(4): 417-434.

Vaughan, M. (2007). *The story of an African famine: Gender and famine in twentieth-century Malawi*: Cambridge University Press.

Vieira, F., MacDonald, R., & Damasceno, A. (2012). 'The role of institutions in cross-section income and panel data growth models: A deeper investigation on the weakness and proliferation of instruments'. *Journal of Comparative Economics,* **40**(1): 127-140.

Watts, M. (1983). *Silent Violence: Food Famine and Peasantry in Northern Nigeria* (Vol. 18). Berkeley. Cal.: University of California Press.

Weidmann, N. B., Rød, J. K., & Cederman, L.-E. (2010). 'Representing ethnic groups in space: A new dataset'. *Journal of Peace Research,* **47**(4): 491-499.

Windmeijer, F. (2005). 'A finite sample correction for the variance of linear efficient two-step GMM estimators'. *Journal of econometrics,* **126**(1): 25-51.

Wu, H., Hayes, M. J., Wilhite, D. A., & Svoboda, M. D. (2005). 'The effect of the length of record on the standardized precipitation index calculation'. *International Journal of Climatology,* **25**(4): 505-520.

Statistical yearbooks and government reports:

The Colony and Protectorate of Nigeria, Blue Book. Lagos: Government Printing Office, various issues, retrieved from The National Archives, London.

____________ Annual Report. Lagos: Government Printing Office, various issues, retrieved from The National Archives, London.