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Rainfall variability and violence in rural Kenya: Investigating the effects of drought and the role of local institutions with survey data[☆]

Q2 Andrew M. Linke^{a,*}, John O’Loughlin^b, J. Terrence McCabe^c, Jaroslav Tir^d, Frank Witmer^e

Q3^a Department of Geography, University of Utah, United States

^b Institute of Behavioral Science, Department of Geography, University of Colorado Boulder, United States

^c Institute of Behavioral Science, Department of Anthropology, University of Colorado Boulder, United States

^d Institute of Behavioral Science, Department of Political Science, University of Colorado Boulder, United States

^e Department of Computer Science and Engineering, University of Alaska Anchorage, United States

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ABSTRACT

In the debate about possible linkages between global environmental change and violent conflict, the research is overwhelmingly based on analysis of aggregate data for administrative units, towns or villages, geographic grids, or other units of analysis. With some exceptions, researchers rarely examine social and political processes that might link weather and violence experiences at the scale of individuals or households. We remedy this shortcoming by analyzing survey data for 504 Kenyans living in three counties collected in November 2013. We probe respondents’ attitudes concerning perceived precipitation irregularities and their beliefs and economic activities. We find that in areas with reported worsening drought conditions, inter-community dialogue between ethnic groups has a pacifying conditional influence on support for the use of violence. The presence of local official rules regulating natural resource use consistently has no effect on beliefs about using violence where droughts are reported. To reduce possible bias in the reporting of drought conditions, our statistical models are estimated with controls for changes in measured vegetation health over time in survey sample areas. The moderating effect of inter-community dialogue on attitudes about violence under circumstances of environmental stress points to the importance of social and political contexts in studying connections between environmental change and conflict.

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1. A link between environmental change and violent conflict?

Q5 Substantial debate about the possible links between societal conflict and climate and/or environmental variability has been ongoing for over a decade with a significant uptick in the number of studies over the past several years. The consensus among scholars is that the relationship – where it emerges – is complex. Even in policy-related documents, the relationships are expected to take a variety of forms, and operate through a mixture of institutional and social mechanisms; these are, however, not usually tested

empirically against the observed record of political instability in the developing world. For example, language included in the 2014 *Quadrennial Defense Review* (QDR) states:

Climate change may exacerbate water scarcity and lead to sharp increases in food costs. The pressures caused by climate change will influence resources competition while placing additional burdens on economies, societies, and governance institutions around the world. These effects are threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability and social tensions – conditions that can enable terrorist activity and other forms of violence (QDR 2014, 8).

The QDR, serving as an example of similar policy documents, blends definitions of violence (including terrorism, but also others that are not defined) as well as the associated stressors (from “poverty” to “political instability”). This general conclusion about “threat multipliers” is also the main point in the latest IPCC Working Group II report of March 2014 (IPCC, 2014) and the recent report of the U.S. government-funded CNA Corporation Military Advisory Board (CNA, 2014).

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Q4 * Corresponding author. Tel.: +1 303 884 5038.
E-mail address: andrew.m.linke@colorado.edu (A.M. Linke).

Our goal in this study is to clarify some of the possible linkages between environmental/ecological variability, focusing on precipitation, and violent conflict, with a consideration toward the possibility that intervening and moderating societal influences might affect such a linkage. This is an overdue improvement upon well-known studies that propose causal associations (e.g. Hsiang et al., 2013), but that do not identify how or why the observed relationship exists nor do they explicate the causal mechanisms. There are important methodological and data differences between our study and existing research; our contributions to the debate are not only technical or merely a matter of presenting different data. In addition to testing whether the direct relationship exists, we also investigate the manner in which the weather–violence link may be moderated by formal and informal institutions. In line with the efforts of Maystadt and Ecker (2014), who report that environmental change is associated with violent events in Somalia through deviations in the market price for livestock, we strive to understand the conditional explanation for the outcome rather than presenting a simple bivariate association between weather and conflict even with controls for other factors. De Juan (2014) similarly tests a migration mechanism for the link between environmental change and conflict in southern Sudan. Ide et al. (2014) argue that the associations between environmental stress and conflict in Kenya will operate through a suite of social conditions that define vulnerability.

In this paper, we present the results of a survey of 504 individuals in three rural Kenyan counties to test several specific propositions, elaborated below, about the nuances of any possible linkages between recent changes in weather patterns and violent conflict. Kenya is an ideal test case because the country has a number of qualities that facilitate generalization to other sub-Saharan African states. The country is in the international middle-range in terms of per capita GDP. Populations in Kenya rely on a multiplicity of livelihood strategies, which means that our conclusions will not be based substantially on a case dominated by either pastoralism or agriculture alone. Kenya contains a variety of agro-ecological zones and finally, Kenya is relatively stable politically despite the presence of a large number of ethnic groups operating in an open multi-party political system; thus, it is not the case that our findings would be muddled by the many possible exogenous effects of (especially recent) large-scale civil war violence. Kenya's serious election violence in 2008 took place over six years ago and conflict related to the country's involvement in neighboring Somalia's instability is generally limited to the northeast, barring several terrorist attacks in and near Nairobi and Mombasa. The country has been the site of numerous previous studies linking violence and climate change (reviewed below) and our work thus complements both ethnographic and aggregate statistical work by reporting perspectives of individuals in the regions affected by climate change.

We specifically examine violent conflict in the following analysis. Our focus is attitudinal support for engaging in acts involving physical bodily harm or death. While contentious politics may exist between individuals, between small groups of individuals, and between either local and state government structures and individuals, we are most interested in the circumstances where these tensions increase support for overt physical violence that is distinct from protests, collective rallies, and other types of political expression.

2. Motivations for the research and specific propositions

Highly publicized studies in general science journals like *Nature* (Hsiang et al., 2011), *Science* (Hsiang et al., 2013), *Climatic Change* (Wischnath and Buhaug, 2014; Tol and Wagner, 2010), and *Proceedings of the National Academy of Science* (Burke et al., 2009; Buhaug, 2010; O'Loughlin et al., 2012, 2014a,b) have investigated the associations between climate anomalies and violence. Some

findings in this body of research have been deemed sensitive to analytical techniques and have even been questioned in an ongoing set of empirical re-analyses and debate (most recently, Ciccone, 2011; O'Loughlin et al., 2014b; Buhaug et al., 2014). Numerous recent articles in the field of conflict studies on this topic have origins in a diverse set of disciplinary backgrounds ranging from development economics and political science to anthropology and political geography (e.g. Hendrix and Salehyan, 2012; Koubi et al., 2012; Bohlken and Sergenti, 2010; Theisen et al., 2012; Deligiannis, 2012; Ember et al., 2012; Witsenburg and Adono, 2009; Fjelde and von Uexkull, 2012; Theisen, 2012; Lecoutere et al., 2010; Bogale and Korf, 2007; Schilling et al., 2012; Raleigh and Kniveton, 2012; Maystadt et al., 2015; Detges, 2014; von Uexkull, 2014; Böhmelt et al., 2014). These studies report a various range of findings, for example that drought leads to organized violence, that an abundance of rain increases the risk of violence, or that hotter than normal temperatures raises the likelihood of conflict. In studies with a more direct link to environmental science, research has also shown that migration – often a coping strategy for communities affected by drought – can be an effective option for mitigating loss, but that the effect varies across communities and is contingent on the details of changes in the physical landscape and in institutional structures operating within and around communities facing the decision to temporarily relocate (Goldman and Riosmena, 2013; Kniveton et al., 2012; De Juan, 2015); population movements often lead to direct tensions between the original and newcomer community that may escalate to violence. Further emphasizing the contextual and highly locale-specific character of migration in several Ethiopian sites, Morrisey (2013) argues that the influences of environmental and ecological change on mobility decisions are complex and most certainly include considerations for physical safety from violence.

Much of the research on the topic of climate change and violence (we highlight exceptions below) is, however, missing a key component of the proposed causal storyline. Most studies on the issue are based on aggregated, or remotely measured, climatological and violent conflict incidents data that are aggregated to some geographical unit of analysis. Even studies carried out at fine spatial and temporal resolutions (now generally preferred by researchers) do not incorporate empirical measurements of the beliefs of individuals within the relevant social processes of the proposed climate–violence link. A major shift in political violence research in recent years is a focus on gathering large-N structured survey data characterizing those who participate in violence (whether as victims or perpetrators), the motivation being an understanding of the beliefs and attitudes of populations where conflict emanates (e.g. Lyall et al., 2013; Blair et al., 2013; Oyefusi, 2008). There are multiple direct and indirect paths through which violent attitudes can translate into observed violent behavior (see also Linke et al., 2015). There is a good chance that somebody who willingly admits to approval of violence would engage in violence of some kind under circumstances of social stress. Even if the link is indirect, a person who supports the use of violence might be much less likely to report rumors of violent activity in order to prevent it if reports of pending attacks circulated by word of mouth. A person who openly supports the use of violence may even be willing to harbor or materially support people in the local area who engage in acts of violence, thus enabling violence perpetrated by others.

Our work follows others for sub-Saharan Africa who have asked survey respondents about willingness to join a rebel movement in the Niger delta (Oyefusi, 2008) or about participation in violent cattle-raiding in the Turkana-Pokot corridor region of northwestern Kenya (Schilling et al., 2012). Conflict does not erupt or emerge without perpetrators; others who have conducted fieldwork in studying environmental scarcity in sub-Saharan Africa have argued that it is “particularly relevant to look for behavioral evidence of the

relation between water scarcity and conflict and to assess *who is more likely to engage in water scarcity conflicts*" (Lecoutere et al., 2010). Schilling et al. (2012) also emphasize that individuals make decisions to engage in raiding, a logic that can be extended to land seizures or other forms of low-level violence that apply to agricultural livelihood strategies. This kind of microcosmic and individual-level behavioral research allows insights unavailable through aggregate-level unit events data and crude climatological metrics analysis.

The discrepancy between individual-level mechanisms for violent conflict and aggregate-level data sources is not just a technical problem that can be fixed using alternative modeling strategies. Existing statistical research commonly incorporates fixed effects terms to restrict variation between independent and dependent variables to a set dimension (e.g. a single observation unit over time in panel time series data or a set of observations otherwise clustered within an administrative unit for cross-sectional analysis). The goal of such a research design is to account for unobserved or unmeasured influences on the proposed relationship (here, precipitation variability-to-conflict) and it is a common solution to handle omitted variable biases in modeling. Yet, it should be precisely our intention as researchers to understand the role of what would usually be considered an omitted variable by interacting the effects of climate or weather with other known qualities of particular localities. Our merger of individual and contextual levels in this paper achieves this goal.

As an example of the missing connection between individuals and aggregate data, consider the work of Fjelde and von Uexkull (2012) who find that drought increases the risk of communal violence across regions of sub-Saharan Africa, especially in areas with marginalized/excluded ethnic communities. But a contemporaneous alignment in the spatial and temporal trends for both precipitation and conflict indicators cannot genuinely ensure that people opt for violence as a strategy among many other possible actions because their livelihoods or physical security were affected by weather patterns. This link can only be inferred indirectly unless those people who are affected by droughts and violence are also polled on their experiences, activities, and beliefs. A major contribution of our paper is the use of survey data that explicitly asks individuals about violence and changes in climate/weather/environment that have taken place recently in their immediate geographical proximity. Though many researchers speculate about the activities of violence perpetrators, sympathizers, or victims based on aggregate data analysis, we are tapping directly into the experiences and perceptions of local survey participants.

A clear exception to the shortcomings of aggregate statistical work about changes in weather/ecology and violence are studies carried out in the human geography and anthropological tradition (e.g. Goldman and Riosmena, 2013; Morrissey, 2013; Eaton, 2008; McCabe, 2004; Turner, 1999, 2000, 2004; Bogale and Korf, 2011; Benjaminsen et al., 2009, 2012; Adano et al., 2012); these works pay close attention to the details of household level decision-making and activities as they relate to a family and community's environment, mobility, and experiences with existing political instability. But such anthropological and ethnographic studies do not share a common language or epistemological goal with the quantitative approach to violent conflict research; ethnographers are frequently critical of statistical studies because of the neglect of the character of local social settings and the perceived simplifying effects of using large structured surveys. We contribute to the ongoing debate about climate–conflict relationships (and epistemological and methodological preferences) by using a research design that balances the nuances of individual-, household-, and local-level characteristics with analysis of a sample that is large enough to allow generalization beyond a limited number of cases.

A second major contribution of our work is that we do not discount any link between climate/environmental change and violence that takes place in a social and political vacuum. Much of the scholarship studying this topic has been criticized for not carefully considering – and at worse completely ignoring – such social complexities (e.g. Raleigh et al., 2014; Salehyan, 2008). Ignoring these contextual level dynamics (or “controlling away” their effects via statistical methodology) is problematic since explanatory mechanisms for climate effects may only appear in careful, localized and nuanced research. In a global study, Sterzel et al. (2014), investigated the association between climate and violent political instability with due attention to variations in the social settings of conflict. They find that poverty and resource use interact in a complicated and nonlinear manner. Even within a single country (Kenya), disagreement between the general findings of Witsenburg and Adono (2009), who find that heavy rainfall correlates with more cattle raiding activity, and Ember et al. (2012), who provide evidence of an association between drought and livelihood violence, might be explained by the locations of the two studies in different physical geographical zones and in different ethno-cultural settings (a mix of communities on the edges of Samburu and mainly Turkana districts, respectively, for the respective fieldwork sites).

The effect of drought upon populations that have been systematically excluded from power in a country may be qualitatively different from the effects of drought for privileged groups within that country. Marginalized communities might have fewer resources for managing food shortages when they arise. These resources might relate to the provision of public goods, and in turn to vulnerability during times of social stress. Roads that allow for the transportation of supplies including food relief or feed for livestock are often absent or of poor quality in areas where politically excluded groups live. For representatives of populations that have been relegated to the political margins in a country, the capacity to lobby national leaders for assistance is limited when environmental disasters occur. Such an association between exclusion and the climate and violence linkage has been suggested but not directly examined case-by-case for the African continent (Theisen et al., 2012; Fjelde and von Uexkull, 2012). Other components of social circumstance in addition to political marginalization, such as poverty, historically tense inter-ethnic community tensions, or border disputes involving war-prone neighboring countries, are also important for understanding violent conflict and its relation to the environment. Our Kenyan case study is an empirical test of several specific elements of a general relationship, a conceptual framework that is similar to that of Adano et al. (2012, pp. 66–67), who strove to “develop an approach that combines physical environment and human agency mediated by social institutions in explaining why natural resources and violence are not always directly related.”

The pathway we propose can be represented in simplified form as: *drought* -> *scarcity/shortages* -> *remedy* -> *outcome*. In Kenya, Kaimba et al. (2011) show that drought influences the decision of household heads to move in Baringo County (the remedy), for example, creating an outcome in which they interact with other communities. The effect that the behavioral remedy – moving to find a resource elsewhere – has upon the social dynamics of an area is highly context-specific. The characteristics of the social setting for that remedy shape and condition the social outcome of any interactions among individuals or groups, an outcome that, of course, may in fact be peaceful. In Narok county in Kenya's southern Rift Valley where drought has recently occurred, local groups react to a scarcity of water and healthy pasture by moving elsewhere. As Adano et al. (2012, p. 74) argue, based on fieldwork in the Loita forest area of dryland Narok on the border of Kajiado county, “as long as the boundaries of the territories are undisputed and resource use is mediated and regulated by

customary laws, the sharing of seasonal pastures by the different Maasai sections poses no threat to any section.” In a similar vein, but with a more carefully developed conceptual model and empirical test, we concentrate on exactly the customary and official rules that may be key conditioning forces in the environment–conflict link.

Returning to our motivations for focusing on the individual scale of participants in conflict episodes, we consider what are the individual level motivations for supporting violence. What would a person stand to gain from committing violent acts against others? For agriculturalists and pastoralists, the effects of droughts may be similar in reducing food resources but the remedy that we conceive in a simple conceptual model above may be quite different for each. As we outline below, the remedy to a precipitation deficit often involves territorial mobility and control of land that is often viewed by parties as mutually exclusive in character. In other words, if a small *shamba* (farm) is stressed by lack of rainfall, the owner may seek a source of water elsewhere. Diverting some portion of a surface water source for irrigation, however, might be viewed as encroaching on the ability of another household nearby or downstream to use that water for the same purpose. The individual motivation for using or supporting violence in this case could be a rational decision on the part of one actor to evict the person who is viewed as unjustly diverting a water source from their property. The eviction of a person and family from land is the step where contentious politics translates into violence; the remedy, to follow the model above, may not translate into violence if a settlement for sharing the source of water is reached (if it is not viewed as mutually exclusive between the two parties).

For a pastoralist, the individual goals of participating in violence may be similar. Where rainfall deficits stress the health of livestock in community A, one remedy is to relocate to an area where water and pasture is available. Such an encroachment onto territory where others are grazing their livestock (community B) might be unwelcome depending on a number of considerations, including the general rapport between communities, the sizes of the herds grazing in the same general area, and the absolute availability of water and pasture at a given source. It is these considerations that determine whether the remedy for a rainfall deficit initiated by community A leads to actual violence between communities A and B. Whether the violence is being conducted by A to remove B from control of a source – a preemptive initiation – or by B against A for their actions – a reactive incident – the possibility of violence is still a rational reaction (remedy) to the drought conditions. Nevertheless, the presence of formal or informal rules that allow temporary access to healthier pastures may manage the situation, reducing the need for resorting to violence.

We strive to measure violence using a survey question gauging a respondent’s willingness to support or engage in violence; this acceptance of violence is necessary for either of the remedies outlined above to take a turn toward overt conflict. Violence does not occur without individual-level decisions, as we have elaborated. What if the conditions surrounding either remedy for violence presented above (the pastoralist and agrarian examples) mitigated conflict? What if relations between pastoralist communities A and B had recently been peaceful and they agreed to share access to a watering hole by hour of the day? In such a case, the context of the remedy could result in a pacific outcome.

Similar examples to that of Narok exist for other regions of Kenya, as well as neighboring countries. To manage inter-communal conflict, the reliance on informal arbitration is widespread across Kenya. In northern Kenya during dry years, the Ngisonyoka Turkana move with their livestock to the mountainous region in the south of their territory; meanwhile their traditional adversaries, the Pokot, move north bringing these two groups in close proximity to one another. When this occurs, elders from each ethnic community

frequently call for a joint meeting to discuss how to share resources and call for a temporary period of peace. McCabe (2004) witnessed and participated in these meetings and, although not always successful, incidences of violent conflict were certainly averted, ongoing conflicts terminated, and contests between groups subsequently lessened in their severity. Such meetings between communities and their importance within cycles of Kenyan conflict are further documented in Eaton (2008) and the development of sharing networks between communities is associated with peace during times of scarcity in the Somali region of Ethiopia as well (Bogale and Korf, 2007).

In the northern Tanzanian regions bordering Kenya, there is also evidence that informal institutions may mitigate potential disputes. In 2009, severe water shortages affected people and livestock along the border corridor. Tens of thousands of cattle and hundreds, if not thousands, of people migrated from southern Kenya and the border region to the Simanjiro plains and adjacent rangelands. The Simanjiro plains are home to Maasai agro-pastoralists and although the immigrants were also Maasai, they were from other sections, and had fought with each other in the past. Informal institutions among the Maasai facilitate passage across sectional boundaries and access to resources (water and pasture), under times of stress. Although the influx of thousands of cattle caused significant stress on the Maasai of Simanjiro, access was negotiated and no violent conflict occurred. In the border area between the Kipsigi Community of Bomet county and Abagusii community in Nyamira county, such forums have existed for years to deal with cattle-theft accusations and all general forms of land- and livelihood related violence in the region (Nyambane/Nairobi Star, 2011). In some cases, such as the Tana river region clashes between the Orma and Pokomo ethnic communities in mid-2012, citizens expressed a desire that peace committees rely on influential elders and not only on “politicians and administrators” (Nairobi Star, 2012).

There are thus both theoretical and empirical reasons to believe that rules governing the use of natural resources may reduce the likelihood of violence. Where principles for water use exist and sanctions for violating them are in place, these rules may steer communities away from violent conflict. Incorporating guidelines for resource use into our analysis also captures whether or not interventions that alter the practices of communities can help them to avert violence. Importantly, this is a move away from analysis that has overtones of environmental determinism because interventions are man-made, malleable, and dynamic; they can be changed if they are found to be currently ineffective and can be introduced in areas where they are absent. Regions of a country that are consistently experiencing droughts are not somehow doomed to endure conflict as if a lack of precipitation was the only cause of violence, perennial and perpetual in its devastating effect upon communities.

Examples of these institutional dynamics have already been studied at the international level, for instance in the context of water scarcity facing countries sharing transboundary rivers. Though no specific causal mechanisms are provided, several researchers have speculated that water scarcity will cause the so-called “water wars” of the future where countries fight over water resources such as the Nile or Euphrates rivers (e.g. Falkenmark, 1986; Gleick, 1993; Lonergan, 1997; Klare, 2001). Another vein of research argues that countries and societies are inherently adaptive and will develop policies for dealing with water scarcity. These include not only technical measures such as water conservation, but also political measures where riparian states enter into treaties to share and manage the common transboundary rivers (e.g. Wolf, 1998; Giordano and Wolf, 2003). Studies such as Tir and Ackerman (2009), Stinnett and Tir (2009) and Tir and Stinnett (2011) report that freshwater scarcity is among the key factors that prompts countries to pursue river-sharing treaties; furthermore, these treaties often contain institutional features that are meant precisely

to deal with violent conflict prevention and mitigation. Showing that political institutions can mitigate violent confrontations between riparian states even in the face of water scarcity, [Tir and Stinnett \(2012\)](#) provide strong evidence that natural resource–violent conflict relationships are far from deterministic.

The current Kenyan administration has rules in place to manage the use of water for crops and livestock. According to the Kenyan constitution of August 2010 article 43 (1) (d) “Every person has the right to clean and safe water in adequate quantities” (Republic of Kenya, 2010, p. 31). The function falls to the national government (sec. 4, Page 175): “Protection of the environmental and natural resources with a view to establishing a durable and sustainable system of development, including ... water protection, securing sufficient residual water, hydraulic engineering and the safety of dams.” (p. 175). At the same time “The functions and powers of the county are ... agriculture, including crop and animal husbandry.” (p. 176). In fact, the exact configuration of institutionalized rules for water use in specific locations across Kenyan regions is still under development. Because there are county-level government roles for water use in addition to the simplistic national-level promise for access, we ask about county-level governmental practices to measure the existence of institutional rules for resource management (details below).

Given the contemporary literature and the analytical shortcomings that characterize many studies of the putative climate–conflict linkage, we make several interrelated propositions. We measure the likelihood of violence for the propositions below using *support by individuals* for the use of violence. These propositions represent a merger of ecological and environmental effects with the moderating potential of certain contextual level circumstances that also influence political and social life.

First, where recent droughts are reported to be more severe or frequent than in the past, support for the use of violence will be higher than where drought is not reported to have been more severe.

Second, the effect of drought on support for the use of violence is moderated (decrease) by the presence of government rules regulating the use of natural resources.

Third, the effect of drought on support for the use of violence is moderated (decrease) by the presence of intercommunity dialogue.

3. Data

Our survey data were collected between 29 October and 9 November 2013 in Nakuru, Uasin Gishu, and Vihiga counties in the Rift Valley and Western areas of Kenya (sampling points are mapped in [Fig. 1](#)). The exact questions that we use in this analysis are presented in [Appendix](#) of the study. These areas were selected to be representative of mixed livelihood strategies of that region of Kenya and of three of the country's main ethnic communities – Kikuyu, Kalenjin, and Luo. Because communal violence in Kenya has often been attributed to inter-ethnic disputes, we wanted to make sure that we could account for this possible factor. In total, 504 respondents were interviewed within 23 smaller administrative units (wards) that served as enumeration areas (EA) within the counties.¹ Each team of three survey enumerators began a random walk pattern from the survey sampling point (SSP) in each EA. SSPs are usually an electoral polling place, such as a school, church, or municipality office. Each enumerator separately walked north, south, east, or west depending on the available paths (in rural areas) or roads

(in more densely populated places). Every fifth household was questioned. If there was no suitable respondent adult (meets gender balance quota, and Kenyan citizen of sound mind) available (or available to revisit within two hours), the enumerator walked to the next household and made another attempt. In total there were 665 attempts to complete the 504 surveys we use in our analysis, for an overall response rate of contacted households of 75.7%. Of those eligible to be surveyed, 9.52% of contacted individuals refused to be interviewed.

Of the three counties included in the survey, Nakuru has the largest population.² The area is ethnically mixed, though dominated by the grouping of Kalenjin populations in rural areas and with a mix of Kikuyu and other communities in Nakuru town (the largest city between Nairobi and Kisumu) and other population centers. Uasin Gishu is more rural, although the region is now connected to the southern areas with new and improved roads and the county's main town, Eldoret, is growing quickly as a trading and transportation center. Uasin Gishu is one of the areas with a substantial number of Kikuyu who grew up as first and second-generation residents of the area following the influx of that ethnic community into the area during Jomo Kenyatta's 1960s “settlement scheme” that allowed individuals to purchase land anywhere in the country. Disputes over land frequently erupt in the area and are associated with insecure land tenure ([Boone, 2012](#)). Northern and western areas of Uasin Gishu have some Luhya, though the population is mainly split between Kalenjin and Kikuyu. Vihiga, near Kisumu is a county with some Luo and Luhya, but many fewer Kalenjin. Vihiga, compared to the other counties, has been relatively peaceful in recent years, an important quality of the study as we do not concentrate on violent areas only. Reverse causality could confound the relationships that we test; violent areas may have different rules than non-violent areas, with no regard to the weather but also influencing the presence of violence and support for violence that we use as the outcome of interest.

There is a mix of pastoral and agricultural livelihoods across the three counties, though most of the population relies on mixed practices. Some are nominally pastoralist by cultural affinity, by maintaining a relatively small herd, but also farm maize or wheat on their property. Pastoralists in this area are also not likely to move as frequently or as far as other communities further north (e.g. Turkana, Pokot, Borana, or other group). This mixed-livelihood strategy is increasingly characteristic of households across Kenya and our findings are therefore instructive and generalizable in this regard. Social forces in settings outside of the Rift Valley region or in far eastern Kenya may be different and investigating similar models and comparative results across regions of the country is a valuable path for future research.

We investigate violence using a carefully worded question and present a robustness check (see [Appendix](#)) by combining it with a second question. Specifically, each individual was asked “Which of the following statements is closest to your view? Choose statement one or statement two. Statement one: The use of violence is never justified in Kenyan politics today. Statement two: In this country, it is sometimes necessary to use violence in order to make one's family well off.” Respondents may choose, among other responses, that they “Agree” or “Strongly agree” with either statement. A nearly identical question has been asked in dozens of sub-Saharan African countries on the Afrobarometer surveys and is considered a standard approach to measuring support for violence. We create a simple scale of 0, 1, 2 for the level or degree of support for violence with 1 representing respondents who agree with the use of violence and 2 indicating that a person strongly agrees with the use of violence.

¹ Our partners are in the Institute for Development Studies at the University of Nairobi, who carry out the widely used Afrobarometer surveys. Our sampling procedures were identical to those used by Afrobarometer.

² According to the 2009 census 1,603,325 people lived in Nakuru. Uasin Gishu and Vihiga have comparatively small population sizes, with 894,179 and 554,622 people, respectively.

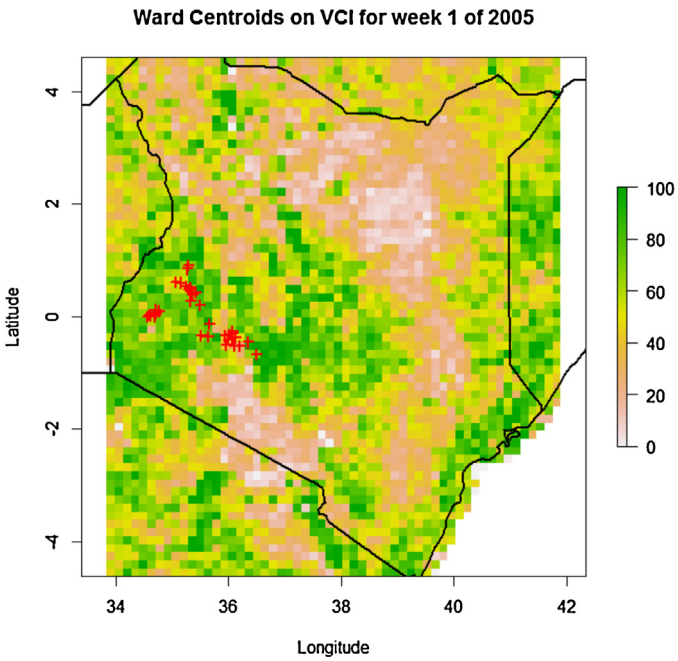


Fig. 1. Example vegetation condition index (VCI) for the first week of 2005 at a 16 km × 16 km grid cell resolution with the location of survey sample areas (administrative ward level) overlaid in red. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

Zero is the classification for the people who strongly agree or agree that violence is never justified in Kenya. In the wording of our survey questions, we clearly distinguish natural resource (often called livelihood) violence from the election violence that took place in 2007–2008. We drop “don’t knows” from our analysis.

There is a chance that social desirability influences a respondent’s stated opinion about violence (or even the respondent’s stated personal experience with violence, which we also ask). We argue that concerns about such biases are addressed in part through the survey enumeration practices. Our enumerators present their letters of affiliation with the non-profit university, their academic research permissions, and explain carefully the purposes of the research; it would be difficult for a respondent to expect punishment directly from a survey enumerator in a setting of confidentiality. Nevertheless a person still may not have responded truthfully about supporting violence. In classic polling research it has been shown, for example, that respondents may not be forthcoming about whom they support in an election simply based on the possibility that the enumerator may judge their response. African American candidates for public office in the 1980s in the U.S. had lower electoral support compared to pre-election polling ratios because whites systematically hid biases, which directed their voting, from pollsters (Finkel et al., 1991; Hopkins, 2009). Carlson (2014) has shown that in a highly ethnicized political environment (as in Kenya), the enumerator-respondent dynamic can in fact affect reported preferences (in her research, for an individual campaigning for office). Because we ensure that survey respondents are anonymous, we believe that the single greatest possibility for a social desirability bias lies in the ethnic identity of the enumerator vis-à-vis the respondent. Because of ongoing tensions between residents of the area (including a highly publicized and controversial International Criminal Court trial being held at the Hague), a Kalenjin might be reluctant to openly support the use of violence to a Kikuyu interviewer in a survey in the central Rift Valley. To isolate a genuine link between our key indicators and support for the use of violence, we statistically control whether there is match between the ethnic/tribal identity of the respondent and the enumerator.

For relative perceptions of changes in the weather, we asked respondents four key questions about potential changes in rainfall patterns over the past ten years. As we explain below, we also include measured changes in environment in our analysis alongside the reported changes. First, “has the frequency of drought changed since approximately ten years ago? (for example, has the time between drought become shorter?)” Respondents who answered “Yes, there are more droughts than there were before” are considered to be living in a region that has been experiencing more frequent drought (coded as 1). Second, “has the severity of drought changed? (for example, when a drought comes, is it longer?)”. Those who replied “Yes, droughts are more severe than ten years ago” are considered to have experienced more severe drought than their peers (coded as 1). Respondents are presented with the option of answering “I am not sure there is no way to know if there has been a change.” The respondents reporting changes in drought do not include respondents who said that there is no way to know. We also exclude “don’t knows” systematically for each drought question and local governance/rules question (explained below), meaning the number of respondents (N) varies between models. We combine the two drought questions into a single indicator that captures whether the respondent reported drought conditions worsening for either wording of the questions. We believe that this alleviates concerns about specific meaning of questions and a respondent’s understanding of drought. We do this to increase internal consistency across a diverse population and to foster an intuitive and more generalizable result.

We investigate the presence of (in)formal institutions for management of disputes and contentious politics. To measure the presence of inter-community dialogue among localities in the three counties, we asked “do leaders of your ethnic community engage in peaceful dialogue/discussion about conflict and political violence with other ethnic communities in your area?” If dialogue “sometimes”, “frequently”, or “very frequently” takes place, the respondent is coded as exposed to conditions of dialogue (variable is coded 1). For our proposition about official governmental rules for natural resource use, we asked, “do local official/county (governmental) rules regulate the use of natural resources in your area?” Respondents who replied that rules existed for land and water management for either livestock grazing or agriculture were coded as living in a setting of government rules.

As controls in the models for the numerous alternative explanations of violence, we include age, education level (a binary defined as being above or below the completion of secondary school), and gender. It is possible that younger, male, and less-educated people are have different views about the use of violence than another segment of the Kenyan population and we wish to ensure that these influences are not mixed into our conclusions about the roles of climate and institutional factors. Furthermore, in our models of support for violence, we control for previous self-reported exposure to violence because there is potentially a socio-psychological relationship that exists across sectors of the population (e.g. pastoral vs. farming livelihood, etc.). Additionally, a pastoralist might experience violence as a function of mobility in the more arid areas of a country, but also as a function of interactions with other ethnic communities that maintain cultural norms and values (including the political economy of marriage) surrounding raiding activity. We use a random effects model that allows for variation across three counties to make estimates that allow for unobserved variation across these major administrative units. The random effects model absorbs variability in the relationship at the county level that might result from prior violence in addition to many other social factors. Finally, we include a control for low socioeconomic status that is defined as having responded “very bad” or “fairly bad” when asked, “in general, how would you describe: your own present living conditions?” A measurement that is specific

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Table 1

Descriptive statistics of the survey data for key indicators of interest, outcomes, and control variables. “Don’t knows” are removed from the violence and drought questions for all models but are systematically removed for the government rules (Panel A) and inter-community dialogue (Panel B) models.

	Max	Mean	Std Dev	Min
Panel (A) government rules models				
Violence support level	2	0.110	0.356	0
Reported drought worse	1	0.411	0.493	0
Government rules exist	1	0.448	0.498	0
Community dialogue exists	1	0.765	0.425	0
Pastoral livelihood	1	0.082	0.275	0
Age	84	37.782	13.305	18
Gender	1	0.499	0.501	0
Formal education	1	0.371	0.484	0
Low SES	1	0.334	0.472	0
Excluded ethnic community	1	0.431	0.496	0
Recent vio. victim	1	0.062	0.242	0
Ethnicity match	1	0.091	0.288	0
VCI change	0.275	−0.401	0.364	−0.864
SPI6 change (see Appendix)	0.658	0.206	0.282	−0.379
Dual vio. support (see Appendix)	1	0.057	0.232	0
Panel (B) inter-community dialogue models				
Violence support level	2	0.123	0.377	0
Reported drought worse	1	0.413	0.493	0
Government rules exist	1	0.539	0.499	0
Community dialogue exists	1	0.780	0.415	0
Pastoral livelihood	1	0.082	0.275	0
Age	87	37.510	13.760	18
Gender	1	0.493	0.501	0
Formal education	1	0.391	0.489	0
Low SES	1	0.343	0.475	0
Excluded ethnic community	1	0.425	0.495	0
Recent vio. victim	1	0.068	0.251	0
Ethnicity match	1	0.082	0.275	0
VCI change	0.275	−0.421	0.357	−0.864
SPI6 change (see Appendix)	0.658	0.193	0.284	−0.379
Dual vio. support (see Appendix)	1	0.063	0.243	0

to individual respondents is preferred in a setting where cash incomes may not be the norm and cultural practices related to food and medicine (other potential surrogates for socioeconomic status) vary among regions and communities. Descriptive statistics for each indicator are presented in Table 1 below. Because we drop don’t know responses systematically there is one set of statistics for the role of government rules (panel A) and a second for models of inter-community dialogue (panel B).

Many have relied upon reported or perceived drought in this body of literature (e.g. Schilling et al., 2012), including structured household surveys (e.g. Kaimba et al., 2011; Bogale and Korf, 2007). Nevertheless, as an important control for observed changes in environmental conditions (to account for the possibility of bias or error in reported drought), we characterize environmental changes using a satellite-based vegetation condition index (VCI; see Fig. 1). The VCI measures vegetation health at a fine spatial resolution across all of Kenya and is derived from the National Oceanic and Atmospheric Administration’s Advanced Very High Resolution Radiometer (AVHRR) sensor. The map in Fig. 1 shows an example week of the 16 km × 16 km resolution VCI data across Kenya. VCI values 0, 50, and 100 represent very poor, normal, and very good vegetation health, respectively. Red areas of the map were in very poor vegetative health during the corresponding week, while green areas are much healthier. We join the time series data from this map to the survey respondent locations and calculate a change in the VCI value from 2003 and 2004 (averaged, to allow for poor respondent memory) to 2013 and 2014 (averaged, to allow for some variation in a respondent’s understanding of the wording of the question). This single value indicates whether vegetation health is net positive or negative at the time of the survey when compared with a period ten years prior. VCI change and reported drought are not measuring the same thing twice (their correlation is not statistically significant,

$p = 3163$), confirming that our use of these data may eliminate possible biases in reported drought that are unrelated to actual precipitation. Existing research in East Africa has shown that “drying precipitation patterns only partially statistically explain the vegetation browning trends, indicating that other factors such as population pressures and land use changes might be responsible for the observed declining vegetation condition” (Pricope et al., 2013, p. 1525). Other than the individual level controls that we use, the most likely (observable) source of bias in survey respondents’ reporting of drought is a decline in local/regional vegetation condition that is not only explained by precipitation. Controlling for observed VCI changes over time accounts for this possible source of bias. In Appendix we also present results of our main models using Standard Precipitation Index (SPI) 6-month average deviations from long-term rainfall trends. In comparison to our VCI data, the SPI data are of poor spatial resolution (50 km × 50 km) and we include them as controls in robustness checks in Appendix; the main findings do not change.

4. Model estimation method

In order to account for the unique qualities of Kenyan regions in which survey respondents live, we use mixed fixed (control variables) – and random-effects models. We allow intercepts to vary across the three counties where we collect survey data. The relationship we model can be represented as, $Y_{ij} = \alpha_{0j} + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \beta_3 X_{3ij} + \varepsilon_{ij}$, for respondents $i = \{1, 2, 3, \dots, N\}$ and county level $j = \{1, 2, 3\}$. The term α_{0j} represents random intercepts across counties. Y_{ij} is the level of support for violence outcome (e.g. support for violent activities of 0, 1, or 2), β_1 is the effect of the precipitation indicator, and β_2 the influences of the locality-level institutions or social context variable. The vector of individual and regional controls is captured in X_{3ij} , which include education, gender, socioeconomic status indicator, among other variables. Unexplained error in the relationship is captured in ε_{ij} . We use a count estimator to capture the influences resulting in a shift toward greater support for violence (e.g. from level 0 to 1, or 1 to 2). We plot coefficient estimates of key model terms graphically and report the transformed effect estimates as percentages in the text of the article. In line with standard practice for using interaction terms in multiplicative regression analysis (Brambor et al., 2006) we report the marginal effects of each variable used in an interaction term.

5. Results

We present the results of our analysis in Figs. 2 and 3. Each coefficient estimate and 95% confidence interval are derived from a random-intercept multilevel model with all individual level controls described above. Model 1 corresponds to the role of local governmental rules and model 2 captures the effects of inter-community dialogue. Results for control variables are presented in Appendix.

We find no support for Proposition 1, which stated that worsening drought conditions would be associated with higher levels of support for the use of violence. This is the baseline precipitation–violence link estimate for what is a common argument in the literature surrounding environmental change and conflict. We later add key indicators for the mechanisms that moderate any proposed association between the two variables. Similar results for the basic relationship between violence and resource scarcity elsewhere in Kenya have been reported (Eaton, 2008; Witsenberg and Adano, 2009); rainy seasons are prone to violence in predominantly pastoral areas. It is possible that the longer-term precipitation effect revealed in our analysis is related to these arguments about the shorter-duration temporal seasonality of rains.

When we interact the terms for perceived changes in drought conditions over time with our key indicator for the presence of

Influence of reported drought on support for violence (without VCI change control)

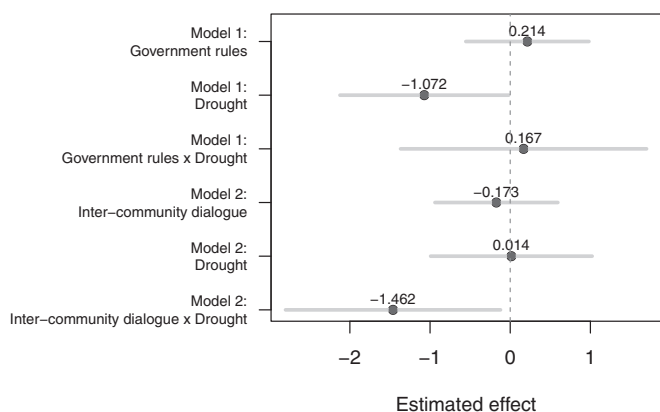


Fig. 2. The effects of drought indicators upon support for the use of violence in a random intercept (County scale) multilevel Poisson model of no support (0), weak support (1), and strong support (2). Each coefficient estimate (log odds) is a component of corresponding models 1 or 2, which both include all individual-level controls (reported in Appendix). Where the gray 95% confidence interval crosses the dashed vertical zero line there is no statistically significant association with the outcome. We report percentages in the main text.

Influence of reported drought on support for violence (with VCI change control)

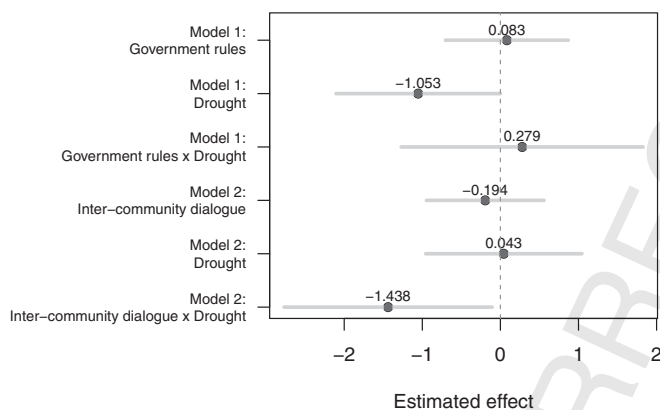


Fig. 3. Controlling for changes in the vegetation condition index (VCI), the effects of drought indicators upon support for the use of violence in a random intercept (County scale) multilevel Poisson model of no support (0), weak support (1), and strong support (2). Each coefficient estimate (log odds) is a component of corresponding models 1 or 2, which both include all individual-level controls (reported in Appendix). Where the gray 95% confidence interval crosses the dashed vertical zero line there is no statistically significant association with the outcome. We report percentages in the main text.

government rules for the management of natural resources, we find no support for Proposition 2. There is no evidence that government rules for the use of natural resources has a moderating role on the link between drought and support for violence. Interestingly, Fig. 2 shows that drought in the absence of formal government rules has a negative association with support for using violence, reducing the level of support for violence by roughly 65% ($1 - e^{-1.072}$). That government rules do not have a conditional negative influence on violence when droughts are reported to be worse should not be a surprise. It is possible that government institutions are not flexible enough to adapt to changes on the ground. In field experiments in Tanzania, Lecoutere et al. (2010, p. 1) argue specifically that “water governance institutions entail exclusionary elements”, and this may

be part of their ineffectiveness in resolving disputes. It is plausible that institutions and their elected members poorly represent constituents in a government lacking capacity to deliver services and even physical security, such a possibility could be a valuable avenue of future research. The Kenyan political system, including county governance, has also been in a state of flux since the country adopted a new constitution in 2010. Our respondents were offered the option of expressing the fact that do not know about governmental rules and these respondents are not lumped in with those who replied that there were official rules in place. Nevertheless, it is possible that new rules have not had time to become effective, which suggests that future investigation of this finding is warranted.

Turning to Proposition 3, we estimate the influence of inter-community dialogue alongside worsening drought conditions. Dialogue between communities (informal institutional interactions) in a respondent’s area has a dampening (reducing) influence on the effect of reported changes in drought frequency and severity upon violence support (reduction of roughly 76%, with $1 - e^{-1.462}$). Supporting our rejection of Proposition 1, model 2 results suggest that drought is not associated with increased levels of support absent inter-community dialogue. Interestingly, our results suggest that inter-community dialogue alone – without reported drought becoming more severe – does not have the inhibiting effect that we observe under conditions of worsening local drought. Using cross-sectional data, we understand this estimate to be one that tests the contemporaneous presence of these two conditions. Concurrent social forces have a single influence when temporal sequencing (moderating vs. mediating) cannot be investigated in thorough detail. Yet, this finding is an interesting complement to some existing research (referred to above) finding that drought reduces conflict risks relative to wet periods; our contribution to that research indicates that this unfolds when communities engage in dialogue.

A robust collection of social science research suggests that dialogue and forums for dispute resolution matter systematically when they are needed the most. Ostrom (1990), for example explains this in terms of governing natural resource commons and the development of rules and norms. More pertinent for the topic of our study, Tir and Ackerman (2009) find that water scarcity is a strong predictor of institutional cooperation in the form of formal sharing agreements (treaties). While there are a number of potential sources for dispute in Kenya, they may not operate in the same manner as environmental change. Perhaps land tenure disputes in the Rift Valley are so contentious that communities are too polarized by experience and opinion to come to the table and speak? Inter-community dialogue may not apply to general crime and associated views of violence because perpetrators are unknown. Alternatively, nighttime theft from shop, for example, may or may not be an inter-community issue at all, instead being an intra-community problem related to poverty. Arguably, it is mainly when communities must confront one another as a result of scarcity or must share territory that they interact in meaningful ways and forums for dialogue begin to have their strongest influences.

While our results have an interesting caveat worth investigating in future research, the general finding offers strong support for the argument that community dialogue works as an informal, but important, institution to mitigate violent conflict risk. In contrast to government/formal institutions, local informal dialogue is probably more flexible and adaptive to the changing circumstances. Similar effects have been observed in Ethiopia by Bogale and Korf (2007), where sharing access to land during times of scarcity results in lower levels of communal violence. Similarly, for a different region of Kenya, Schilling et al. (2012, p. 6) make a strong case that peaceful outcomes depend “on whether a community is able to establish reliable agreements with the neighboring community.”

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To examine whether our finding about the weather–violence link is robust, we estimate models similar to those in Fig. 2 above using a control for changes in vegetation conditions (VCI) in our enumeration areas over time. This is the strongest possible source of bias (or error) in reported perceptions of drought among the sampled population that it is not related only to rainfall. The general conclusions drawn from Fig. 3 mirror our earlier results, though the magnitude of the effect estimates is reduced.

6. Conclusion

In this study, we find little evidence in three Kenyan counties (Nakuru, Uasin Gishu, and Vihiga) that reported worsening of drought over a decade at a local level is associated with support for the use of violence. To probe the relationships in detail, we presented an argument that government rules for natural resource use and, separately, inter-ethnic community dialogue between groups reduce conflict risk in these areas. As an important contribution to the literature on this topic, our study contributes to an explanation that has not been clearly identified in aggregate level statistical studies that dominate the academic discourse on linkages between climate change, environmental variability, and ecological degradation and violent conflict. The particular qualities of the social context help determine social outcomes related to environmental and ecological change.

We find that the existence of formal, institutionalized, governmental rules has no moderating and ameliorative effect on the potential for drought to lead to increased support for violence. In contrast to the role of government rules in our survey areas, however, there is evidence that where drought is reported to be getting worse, inter-community dialogue is associated with lower levels of support for the use of violence. This finding is in line with our expectations and points toward the value of community dialogue in promoting peace in the presence of scarcity. Our finding for the role of inter-community dialogue strongly suggests that physical insecurity does not arise as a reaction to drought in social and political vacuums.

The goal of our future research will be to understand the mechanisms operating within communities that leads to a drought-dialogue conditional effect on violence where drought alone, and inter-community dialogue alone, do not emerge as

strong predictors of violence. The conditional effects that we have identified in our results could be partly a function of our sampling areas within Kenya. Our model accounts for variation between the three counties but it is possible that social dynamics in other regions of Kenya or in the broader region of sub-Saharan Africa influence the salience of a dialogue effects when areas are hit by drought; rampant cattle raiding in purely pastoralist areas might represent a meaningfully distinct social setting where dialogue takes a fundamentally different form and relates to violent outcomes in varying ways. While some intra-ethnic community dialogue may also be important for understanding environmental change effects (e.g. between landholders and tenants of the same ethnic group), this is beyond the scope of the current article. Extensions of this research could identify which types of community dialogue (to the extent that they vary) are most effective in dampening violent preferences under conditions of scarcity. Future inquiries might also be able to identify if there are degrees of community-dialogue that are most helpful beyond only capturing the effects of whether or not they simply exist.

Uncited references

Barron et al. (2009), Delgiannis (2012), Maysdat et al. (2014), Nyambane (2011), Uganai and Kogan (1998) and Wolf et al. (2003).

Appendix

A.1. Control variable estimates from main models

In Table A1 we present the control variable coefficient estimates alongside the main results of interest for models 1–2 of both Figs. 2 and 3 in the main text.

A.2. Standard Precipitation Index (6-month) control

In this section we test the effect of controlling for the measured precipitation record in the model of perceived drought effects upon

Table A1

Control variable coefficient estimates (log odds) and main results for the full models of main text Figs. 2 (without change in Vegetation Condition Index (VCI) included as a control) and 3 (with VCI included as a control).

	Without VCI control				With VCI control			
	Model 1		Model 2		Model 1		Model 2	
	Est	StdEr	Est	StdEr	Est	StdEr	Est	StdEr
(Intercept)	−1.505	0.656**	−1.565	0.658**	−1.762	0.669***	−1.611	0.613***
Government rules	0.214	0.392			0.083	0.401		
Community dialogue			−0.173	0.391			−0.194	0.384
Drought	−1.072	0.537**	0.014	0.514	−1.053	0.537**	0.043	0.511
VCI change					−0.886	0.567	−0.657	0.477
Age	−0.025	0.015*	−0.021	0.013*	−0.024	0.015*	−0.021	0.012*
Pastoral	1.022	0.472**	1.238	0.393***	1.053	0.468***	1.250	0.389***
Gender	−0.118	0.330	−0.053	0.293	−0.136	0.327	−0.088	0.291
Formal education	0.458	0.341	0.441	0.294	0.430	0.343	0.397	0.296
Low SES	−0.537	0.407	−0.293	0.334	−0.582	0.405	−0.331	0.334
Recent violence victim	−0.769	1.023	0.796	0.451†	−0.736	1.023	0.760	0.451†
Excluded group	0.578	0.355	0.393	0.357	0.365	0.361	0.149	0.300
Ethnicity match	0.306	0.470	0.619	0.410	0.297	0.470	0.570	0.409
Government rules × drought	0.167	0.783			0.279	0.790		
Community dialogue × drought			−1.462	0.684**			−1.438	0.680**

Note: “Don’t know” responses for moderating variables dropped from each respective model; County-level random intercepts.

* $p \leq .05$.
** $p \leq .01$.
*** $p \leq .001$.

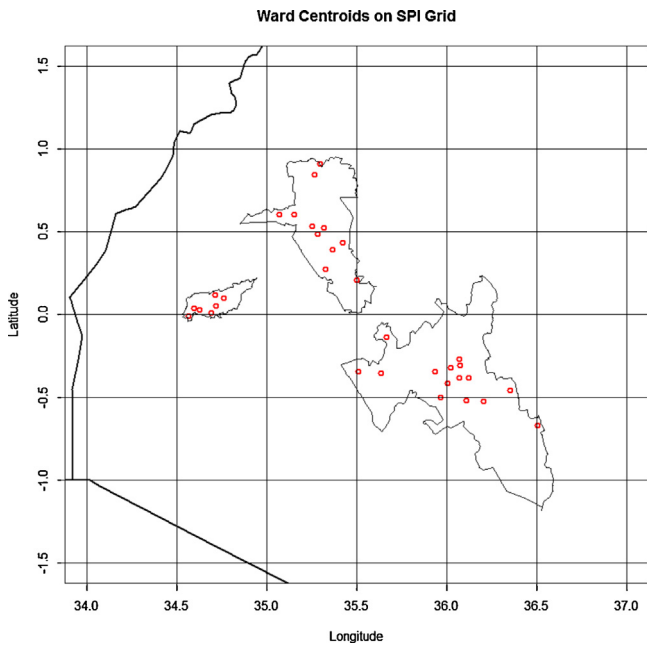


Fig. A1. 50 km × 50 km grid cells containing the precipitation deviation data (SPI6) and the counties (outline) and enumeration areas (red) where the survey was carried out. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

support for violence. We use Standard Precipitation Index 6-month (SPI6) average deviation from the long-term trend between 1949 and 2013. Our precipitation data are from the University of East Anglia Climate Research Unit (Harris et al., 2014). The raw data are weekly but we create an annual value. We then measure an SPI6 difference between the precipitation ten years ago (see question wording) and the precipitation conditions at the time of the survey in October and November 2013. Because respondents' memories of conditions ten years ago could be vague, we average 2003 and 2004

(representing precipitation 10 years ago) and also average 2012 and 2013 (representing conditions now). If precipitation was the same during the two time periods the net change is 0. Positive values represent greater precipitation than 10 years ago (in standard deviations) and negative values represent less precipitation. We make no crude threshold distinction for what constitutes a “drought” (e.g. one standard deviation) and use the raw precipitation deviation value as a control. A map of the survey enumeration area centerpoints and grid cells containing SPI6 time series data is presented in Fig. A1.

Reproducing our main text analysis with the SPI6 data as a control, we draw the same conclusions. As Fig. A2 illustrates, the interaction term inter-community dialogue when drought is reported to be worse still has a negative (at roughly 76%, with $1 - e^{-1.45}$) and statistically significant effect on support for violence. The influence of local government rules in areas with worsening drought is similar to our main finding, that is, not-statistically significant.

A.3. Combined violence indicator

In this section, we combine two questions about the use of violence into a single indicator of support for its use. To be sure that a person genuinely supports violence without the measure being dependent on a single question or type of violence we now switch the outcome to be support for both forms of violence. The new question measures not only support for violence “to make one’s family well off”, but in support for a general “just cause” (see specific wording of question below). This variable is binary in contrast to the main analysis above and the random intercept multilevel model is therefore a logistic regression. Only 30 respondents support both kinds of violence. We test the binary outcome model of violence both with and without the VCI change control. The general conclusion from our main analysis holds (see Figs. A3 and A4); drought in the presence of inter-community dialogue has a strong negative influence on support for the use of violence.

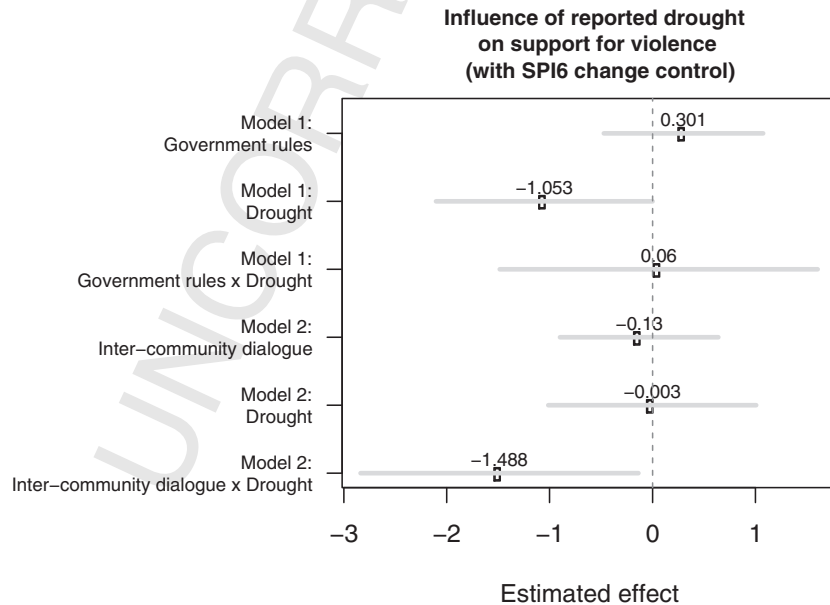


Fig. A2. The effects of drought indicators upon support for the use of violence in a random intercept (County scale) multilevel Poisson model of no support (0), weak support (1), and strong support (2) for violence using observed precipitation change (SPI6) as a control instead of vegetation health (VCI). Each coefficient estimate (log odds) is a component of corresponding models 1 or 2, which both include all individual-level controls (reported in Appendix). Where the gray 95% confidence interval crosses the dashed vertical zero line there is no statistically significant association with the outcome.

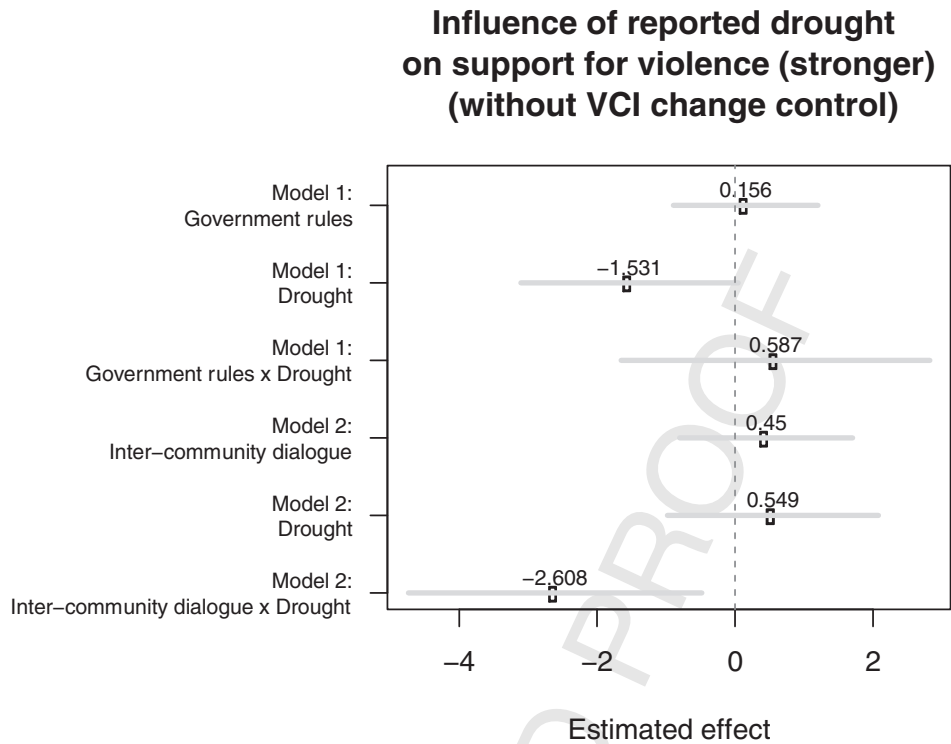


Fig. A3. The effects of drought indicators upon support for the use of violence in a random intercept (County scale) multilevel logistic model of no support (0) and support (1) for a combined indicator of violence using two questions. Each coefficient estimate (log odds) is a component of corresponding models 1 or 2, which both include all individual-level controls (reported in Appendix). Where the gray 95% confidence interval crosses the dashed vertical zero line there is no statistically significant association with the outcome.

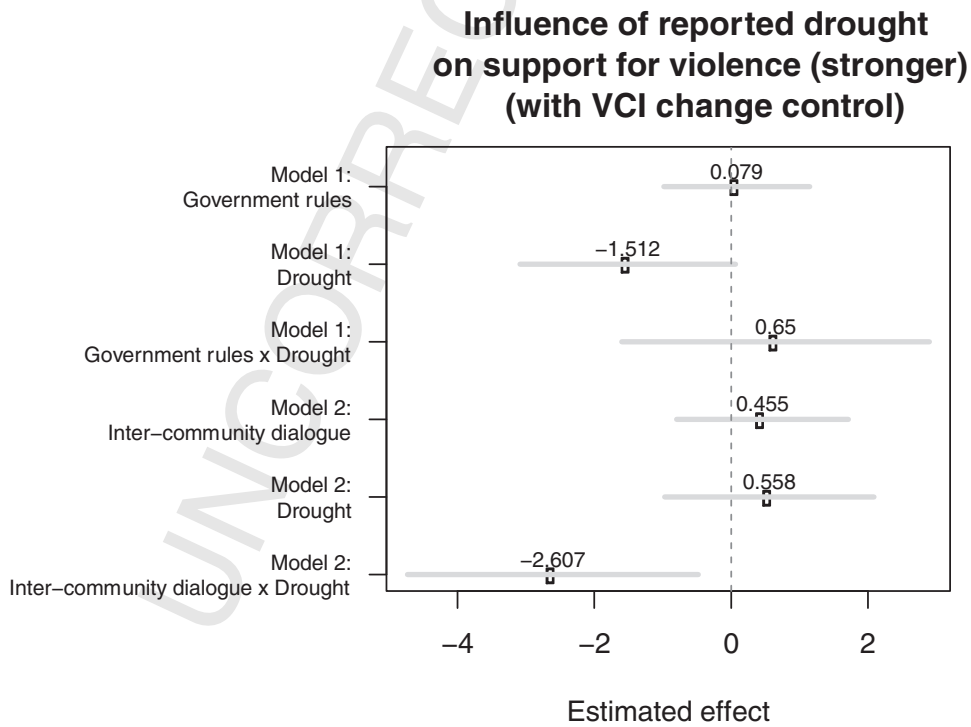


Fig. A4. Controlling for changes in the vegetation condition index (VCI), the effects of drought indicators upon support for the use of violence in a random intercept (County scale) multilevel logistic model of no support (0) and support (1) for a combined indicator of violence using two questions. Each coefficient estimate (log odds) is a separate model (key indicator name on the left) including all individual-level controls. Where the gray 95% confidence interval crosses the dashed vertical zero line there is no statistically significant association with the outcome.

A.4. Survey questions analyzed (controls and key indicators)

Q: How old are you?

Q: Sex/gender of the respondent? [Interviewer: fill in]

Male	1	Female	2
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Q: What is the highest level of education you have completed (finished)?

No formal schooling	0
Informal schooling only (including Koranic schooling)	1
Some primary schooling	2
Primary school completed	3
Some secondary school/high school	4
Secondary school completed/high school completed	5
Post-secondary qualifications, other than university e.g. a diploma or degree from polytechnic or college	6
Some university	7
University completed	8
Post-graduate	9
Refused to answer [DNR]	98
Don't know or cannot say [DNR]	99

Q: What livelihood activity do you PRIMARILY depend upon for your livelihood?

Livestock keeping	1
Trade in livestock and livestock goods	2
Crop Farming	3
Trade in harvested crops and agricultural goods	4
Small business (non-agriculture or livestock goods)	5
Tourism	6
Salaries and/or waged labor	7
Other (Record)	95

Q: What is your ethnic community, cultural group or tribe? Interviewer: enter respondent's exact response. If respondent did not identify any group on this question – that is, if they "Refused to answer" (98), said "Don't know" (99), or "Kenyan only" (90) – then the interviewer marked "Not applicable" for questions about relative group status compared with others (later).

Kikuyu	300	Meru/Tharaka	306	Sabaot	316
Luo	301	Masai	307	Rendlile	317
Luhya	302	Samburu	308	Pokomo	318
Kamba	303	Mijikenda	309	Mbeere	319
Kalenjin	304	Taita	310	Kuria	320
Kisii	305	Somali	311	Borana	321
Kenyan only or doesn't think in those terms	90	Pokot	312	Arabic	322
Other (record)	95	Turkana	313	Oromo	323
Refused to answer	98	Embu	314	Asian	324
Don't know	99	Teso	315		

Q: In general, how would you describe: Your own present living conditions?

[Interviewer: Read the responses in reverse order (e.g. 5, then 4, then 3, ..., 1)]

Very bad	Fairly bad	Neither good	Fairly good	Very good	Refused to answer	Don't know or cannot say
1	2	3	4	5	98	99

Q: Do LOCAL OFFICIAL/COUNTY (GOVERNMENTAL) rules regulate the use of natural resources in your area? (Choose all that apply)

Yes (land for grazing)	1
Yes (water for livestock)	2
Yes (land for agriculture)	3
Yes (water for agriculture)	4
There are no LOCAL OFFICIAL/COUNTY (GOVERNMENTAL) rules in place in this area	5
Refused to answer [DNR]	98
Don't know or cannot say [DNR]	99

Q: In your opinion, do you think that the FREQUENCY of drought is changing since approximately 10 years ago? (For Example: Has the time between droughts become shorter?)

1= Yes, there are more droughts than there were before	1
2= Yes, there are fewer droughts than there were before	2
3= No, there has been no change in the frequency of drought	3
4= I am not sure, there is no way to tell if there has been a change	4
Refused to answer [DNR]	98
Don't know or cannot say [DNR]	99

Q: In your opinion, do you think that the SEVERITY of drought is changing? (For Example: When a drought comes, is it longer?)

Yes, droughts are more severe than 10 years ago	1
Yes, droughts are less severe than before	2
No, there has been no change in the severity of drought	3
I am not sure, there is no way to tell if there has been a change	4
Refused to answer [DNR]	98
Don't know or cannot say [DNR]	99

Q: Which of the following statements is closest to your view? Choose Statement 1 or Statement 2.

Statement 1: The use of violence is never justified in Kenya today.

Statement 2: In this country, it is sometimes necessary to use violence in order TO MAKE ONE'S FAMILY WELL OFF.

Agree very strongly with Statement 1	Agree with Statement 1	Agree with Statement 2	Agree very strongly with Statement 2	Agree with neither	Refused to answer [DNR]	Don't know or cannot say [DNR]
1	2	3	4	5	98	99

Q: Do leaders of your ethnic community engage in peaceful dialogue/discussion about conflict and political violence with other ethnic communities in your area?

Very frequently	Frequently	Sometimes	Never	Such options do not exist in this area	Refused to answer [DNR]	Don't know or cannot say [DNR]
1	2	3	4	5	98	99

IQ: Interviewer ethnicity/home background

Question used only in the appendix:

Q: Which of the following statements is closest to your view? Choose Statement 1 or Statement 2.

Statement 1: The use of violence is never justified in Kenyan politics today.

Statement 2: In this country, it is sometimes necessary to use violence in SUPPORT OF A JUST CAUSE.

Agree very strongly with Statement 1	Agree with Statement 1	Agree with Statement 2	Agree very strongly with Statement 2	Agree with neither	Refused to answer [DNR]	Don't know or cannot say [DNR]
1	2	3	4	5	98	99

References

Adano, W.R., Dietz, T., Witsenburg, K., Zaaf, F., 2012. Climate change, violent conflict and local institutions in Kenya's drylands. *J. Peace Res.* 49, 65–80.

Barron, P., Kaiser, K., Pradhan, M., 2009. Understanding variations in local conflict: evidence and implications from Indonesia. *World Dev.* 37, 698–713.

Benjaminsen, T., Alinon, K., Buhaug, H., Buseeth, J.T., 2012. Does climate change drive land-use conflicts in the Sahel? *J. Peace Res.* 49, 97–111.

Benjaminsen, T., Maganga, F., Abdallah, J., 2009. The Kilosa killings: political ecology of a farmer–herder conflict in Tanzania. *Dev. Change* 40, 423–445.

Blair, G., Fair, C.C., Malhotra, N., Shapiro, J.N., 2013. Poverty and support for militant politics: survey evidence from Pakistan. *Am. J. Polit. Sci.* 57, 30–48.

Bohlsen, A., Sergenti, E., 2010. Economic growth and ethnic violence: an empirical investigation of Hindu–Muslim riots in India. *J. Peace Res.* 47, 589–600.

Böhmelt, T., Bernauer, T., Buhaug, H., Gleditsch, N.P., Tribaldos, T., Wischnath, G., 2014. Demand, supply, and restraint: determinants of domestic water conflict and cooperation. *Glob. Environ. Change* 29, 337–348.

Boone, C., 2012. Land conflict and distributive politics in Kenya. *Afr. Stud. Rev.* 55, 705–703.

Bogale, A., Korf, B., 2007. To share or not to share? (Non-)violence, scarcity and resource access in Somali region, Ethiopia. *J. Dev. Stud.* 43, 743–765.

Burke, M., Miguel, E., Satyanath, S., Dykema, J., Lobell, D., 2009. Warming increases risk of civil war in Africa. *Proc. Natl. Acad. Sci. U. S. A.* 106, 20670–20674.

Buhaug, H., 2010. Climate not to blame for African civil wars. *Proc. Natl. Acad. Sci. U. S. A.* 107, 16477–16482.

Buhaug, H., et al., 2014. One effect to rule them all? A comment on climate and conflict. *Clim. Change*. <http://dx.doi.org/10.1007/s10584-014-1226-1>.

Carlson, E., 2014. Social desirability and bias in reported vote preferences in African surveys. *Afrobarometer Working Paper No. 144*. Available at: <http://www.afrobarometer.org/publications/working-papers/item/1389-social-desirability-bias-and-reported-vote-preferences-in-african-surveys>.

Ciccone, A., 2011. Economic shocks and civil conflict: a comment. *Am. Econ. J. Appl. Econ.* 3, 215–227.

CNA, 2014. CNA Military Advisory Board. National Security and the Accelerating Risks of Climate Change. CNA Corporation, Alexandria, VA. Available at: http://www.cna.org/sites/default/files/MAB_2014.pdf.

Delgiannis, T., 2012. The evolution of environment-conflict research: toward a livelihood framework. *Glob. Environ. Polit.* 12, 78–100.

De Juan, A., 2015. Long-term environmental change and geographical patterns of violence in Darfur, 2003–2005. *Polit. Geogr.* 45, 22–33.

Detges, A., 2014. Close-up on renewable resources and armed conflict. The spatial logic of pastoralist violence in northern Kenya. *Polit. Geogr.* 42, 57–65.

Eaton, D., 2008. The business of peace: raiding and peace work along the Kenya–Uganda border (part I). *Afr. Aff.* 107, 89–110.

Ember, C.R., Adem, T.A., Skoggard, I., Jones, E.C., 2012. Livestock raiding and rainfall variability in Northwestern Kenya. *Civil Wars* 14, 159–181.

Falkenmark, M., 1986. Freshwaters as a factor in strategic policy and action. In: Westing, A.H. (Ed.), *Global Resources and International Conflict: Environmental Factors in Strategic Policy and Action*. New York, Oxford University Press, pp. 85–113.

Finkel, S., Guterbock, T., Borg, M., 1991. Race-of-interviewer effects in a pre-election poll in Virginia 1989. *Public Opin. Q.* 55, 313–330.

Fjelde, H., von Uexkull, N., 2012. Climate triggers: rainfall anomalies, vulnerability and communal conflicts in sub-Saharan Africa. *Polit. Geogr.* 31, 444–453.

Giordano, M.A., Wolf, A.T., 2003. Sharing waters: post-Rio international water management. *Nat. Resour. Forum* 27, 163–171.

Gleick, P.H., 1993. Water and conflict: fresh water resources and international security. *Int. Secur.* 18, 79–112.

Harris, I., Jones, P.D., Osborn, T.J., Lister, D.H., 2014. Updated high-resolution grids of monthly climate observations – the CRU TS3.10 dataset. *Int. J. Climatol.* 34, 623–642.

Hendrix, C., Salehyan, I., 2012. Climate change, rainfall, and social conflict in Africa. *J. Peace Res.* 49, 35–50.

Hopkins, D.J., 2009. No more wilder effect, never a Whitman effect: when and why polls mislead about black and female candidates. *J. Polit.* 71, 769–781.

Hsiang, S., Burke, M., Miguel, E., 2013. Quantifying the influence of climate on human conflict. *Science* 341. <http://dx.doi.org/10.1126/science.1235367>.

Hsiang, S., Meng, K., Cane, M., 2011. Civil conflicts are associated with the global climate. *Nature* 476, 438–441.

Ide, T., Schilling, J., Link, J.S.A., Scheffran, J., Ngairuiya, G., Weinzierl, T., 2014. On exposure, vulnerability and violence: spatial distribution of risk factors for climate change and violent conflict across Kenya. *Glob. Environ. Change* 43, 68–81.

IPCC, 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Intergovernmental Panel on Climate Change. Available at: <http://www.ipcc.ch/report/ar5/wg2/>

Kaimba, G.K., Njehia, B.K., Guliye, A.Y., 2011. Effects of cattle rustling and household characteristics on migration decisions and herd size amongst pastoralists in Baringo District, Kenya. *Pastoralism* 1, 1–16.

Klare, M.T., 2001. *Resource Wars: The New Landscape of Global Conflict*. Metropolitan, New York.

Kniveton, D.R., Smith, C.D., Black, R., 2012. Emerging migration flows in a changing climate in dryland Africa. *Nat. Clim. Change* 2, 444–447.

Koubi, V., Bernauer, T., Kalbhenn, A., Spilker, G., 2012. Climate variability, economic growth, and civil conflict. *J. Peace Res.* 49, 113–127.

- 1038 Lecoutere, E., D'Exelle, B., Van Campenhout, B., 2010. Who engages in water scarcity
1039 conflicts?. A field experiment with irrigators in semi-arid Africa. MICROCON
1040 Research Working Paper 31. MICROCON, Brighton.
- 1041 Linke, A.M., Schutte, S., Halvard, B., 2015. Population attitudes and the spread of
1042 political violence in sub-Saharan Africa. *Int. Stud. Rev.* 17, 26–45.
- 1043 Lonergan, S.C., 1997. Water resources and conflict: examples from the Middle East.
1044 In: Gleditsch, N.P. (Ed.), *Conflict and the Environment*. Dordrecht, Kluwer, pp.
1045 374–384.
- 1046 Lyall, J., Blair, G., Imai, K., 2013. Explaining support for combatants during wartime:
1047 a survey experiment in Afghanistan. *Am. J. Polit. Sci.* 57, 30–48.
- 1048 Maystadt, J.-F., Ecker, O., 2014. Extreme weather and civil war: does drought fuel
1049 conflict in Somalia through livestock price shocks? *Am. J. Agric. Econ.* 96,
1050 1157–1182.
- 1051 Maysdat, J.F., Calderone, M., You, L., 2014. Local warming and violent conflict in
1052 North and South Sudan. *J. Econ. Geogr.* 15, 649–671.
- 1053 McCabe, J.T., 2004. *Cattle Bring Us to Our Enemies*. University of Michigan Press,
1054 Ann Arbor.
- 1055 Morrissey, J.W., 2013. Understanding the relationship between environmental
1056 change and migration: the development of an effects framework based on
1057 the case of northern Ethiopia. *Glob. Environ. Change* 23, 1501–1510.
- 1058 Nairobi Star, 2012. Elders call for division of resources in Tana August 28th, 2012.
- 1059 Nyambane, A., 2011. Elders Councils Root for Peace. Nairobi Star September 3rd,
1060 2011.
- 1061 O'Loughlin, J., Linke, A.M., Witmer, F., 2014a. Effects of temperature and precipita-
1062 tion variability on the risk of violence in sub-Saharan Africa, 1980–2012. *Proc.
1063 Natl. Acad. Sci. U. S. A.* 111, 16712–16717.
- 1064 O'Loughlin, J., Linke, A.M., Witmer, F., 2014b. Modeling and data choices sway
1065 conclusions about climate-conflict links. *Proc. Natl. Acad. Sci. U. S. A.* 111,
1066 2054–2055.
- 1067 O'Loughlin, J., Witmer, F., Linke, A.M., Laing Gettleman, A., Dudhia, J., 2012. Climate
1068 variability and conflict risk in East Africa, 1990–2009. *Proc. Natl. Acad. Sci. U. S.
1069 A.* 109, 18344–18394.
- 1070 Ostrom, E., 1990. *Governing the Commons: The Evolution of Institutions for
1071 Collective Action*. Cambridge University Press, Cambridge.
- 1072 Oyefusi, A., 2008. Oil and the probability of rebel participation among youths in the
1073 Niger Delta of Nigeria. *J. Peace Res.* 45, 539–555.
- 1074 Pricope, N.G., Husak, G., Lopez-Carr, D., Funk, F., Michaelsen, J., 2013. The climate-
1075 population nexus in the East African Horn: emerging degradation trends in
1076 rangeland and pastoral livelihood zones. *Glob. Environ. Change* 23, 1525–1541.
- 1077 Raleigh, C., Kniveton, D., 2012. Come rain or shine: an analysis of conflict and
1078 climate variability in East Africa. *J. Peace Res.* 49, 51–64.
- Raleigh, C., Linke, A., O'Loughlin, J., 2014. Extreme temperatures and violence. *Nat. Clim. Change* 4, 76–77.
- Salehyan, I., 2008. From climate change to conflict? No consensus yet. *J. Peace Res.* 45, 315–326.
- Schilling, J., Opiyo, F., Scheffran, J., 2012. Raiding pastoral livelihoods: motives and effects of violence conflict in north-western Kenya. *Pastoralism* 2, 2–25.
- Sterzel, T., Ludeke, M., Kok, M., Walther, C., Stieze, D., de Soysa, I., Lucas, P., Janssen, P., 2014. Armed conflict distribution in global drylands through the lens of a typology of socio-ecological vulnerability. *Reg. Environ. Change* 14, 1419–1435.
- Stinnett, D.M., Tir, J., 2009. The institutionalization of river treaties. *Int. Negot.* 14, 229–251.
- Tir, J., Ackerman, J.T., 2009. Politics of formalized river cooperation. *J. Peace Res.* 46, 623–640.
- Tir, J., Stinnett, D.M., 2012. Weathering climate change: can institutions mitigate international water conflict? *J. Peace Res.* 49, 211–225.
- Tir, J., Stinnett, D.M., 2011. The institutional design of riparian treaties: the role of river issues. *J. Confl. Resolut.* 55, 606–631.
- Theisen, O.M., 2012. Climate clashes? Weather variability, land pressure, and organized violence in Kenya, 1989–2004. *J. Peace Res.* 49, 81–96.
- Theisen, O.M., Holterman, H., Buhaug, H., 2011/2012. Climate wars? Assessing the claim that drought breeds conflict. *Int. Secur.* 36, 79–106.
- Turner, M.D., 2004. Political ecology and the moral dimensions of resource conflicts: the case of farmer–herder conflicts in the Sahel. *Polit. Geogr.* 23, 863–889.
- Turner, M.D., 2000. Drought, domestic budgeting, and changing wealth distribution within Sahelian households. *Dev. Change* 31, 1009–1035.
- Turner, M.D., 1999. Conflict, environmental change, and social institutions in dryland Africa: limitations of the community resource management approach. *Soc. Nat. Resour.* 12, 643–657.
- Unganai, L.S., Kogan, F.N., 1998. Drought monitoring and corn yield estimation in Southern Africa from AVHRR data. *Remote Sens. Environ.* 63, 219–232.
- von Uexkull, N., 2014. Sustained drought, vulnerability and civil conflict in sub-Saharan Africa. *Polit. Geogr.* 43, 16–26.
- Wischnath, G., Buhaug, H., 2014. On climate variability and civil war in Asia. *Clim. Change* 122, 709–721.
- Witsenburg, K.M., Adono, W.R., 2009. Of rain and raids: violent raiding in northern Kenya. *Civil Wars* 11, 514–538.
- Wolf, A.T., 1998. Conflict and cooperation along international waterways. *Water Policy* 1, 251–265.
- Wolf, A.T., Yoffe, S.B., Giordano, M., 2003. International waters: identifying basins at risk. *Water Policy* 5, 29–60.