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From global to local, food insecurity is associated with contemporary armed conflicts

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Abstract Food security has attracted widespread attention in recent years. Yet, scientists and practitioners have predominately understood food security in terms of dietary energy availability and nutrient deficiencies, rather than in terms of food security's consequential implications for social and political violence. The present study offers the first global evaluation of the effects of food insecurity on local conflict dynamics. An economic approach is adopted to empirically evaluate the degree to which food insecurity concerns produce an independent effect on armed conflict using comprehensive geographic data. Specifically, two agricultural output measures – a geographic area's extent of cropland and a given agricultural location's amount of cropland per capita – are used to respectively measure the access to and availability of (i.e., the demand and supply of) food in a given region. Findings show that food insecurity measures are robustly associated with the occurrence of contemporary armed conflict.

Keywords Food security · Civil war · Resource scarcity · Agriculture · Social

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Introduction

A growing number of studies of environmental stressors and social conflict posit that future wars will be fought over diminishing resources (Miguel et al. 2004; Burke et al. 2009; O'Loughlin et al. 2012; Scheffran et al. 2012). Building on insights from these studies, as well as other suggestive accounts (e.g. Brinkman and Hendrix 2011; Hendrix and Brinkman 2013; Messer and Cohen 2006; Prunier 2008), the present study demonstrates empirically, for the first time, the existence of a systemic relationship between conflict on the one hand, and food (in) security on the other, both globally and locally. Specifically, highly disaggregated cropland-based measures of food insecurity are shown to produce a significant effect on the incidence of inter and intra-state armed conflict worldwide.

Unlike the majority of previous studies, which rely primarily on country-level indicators (Miguel et al. 2004; Burke et al. 2009; Scheffran et al. 2012; Buhaug 2010) or focus specifically on sub-Saharan Africa (Miguel et al. 2004; Burke et al. 2009; O'Loughlin et al. 2012; Buhaug 2010; Fjelde and Hultman 2014), the present approach uses geographic factors to estimate the regional sub-state distribution of conflict *globally*. Two agricultural output measures, the percent of cropland in a given region and the amount of cropland per capita within agricultural regions, are used to proxy for the demand and supply aspects of food security, respectively (Barrett 2010). Using logistic regression (i.e., logit) models, these measures are then paired with a large number of political, economic, and climatic indicators in order to estimate the direct effects of food security on violent conflict. Evidence suggests that conflict occurs in areas with higher access to, but lower availability of, food resources. Together these findings imply that food insecurity produces an independent effect on contemporary social and political conflict.

Theoretical motivation

While relatively little research directly addresses the relationship between food insecurity and conflict specifically, numerous studies have implied that such a relationship exists. For instance, in their analysis of the relationship between climate variability and conflict in Sub-Saharan Africa, Burke et al. found that "[t]emperature variables are strongly related to conflict incidence over our historical panel" (2009, 20,670. See also Miguel et al. 2004; Koubi et al. 2012). They further hypothesize that, "[t]emperature can affect agricultural yields both through increases in crop evapotranspiration (and hence heightened water stress in the absence of irrigation) and through accelerated crop development...reducing African staple crop yields by 10 %–30 % per °C of warming" (ibid. 20,672). Somewhat more cautiously, O'Loughlin et al. conclude that, "[o]ur study and other studies question the evidence that climatic variability is uniformly driving up the risk of conflict in sub-Saharan Africa," while also noting that "the positive association between instability and temperature may result from the harmful effects of high temperatures on food products such as maize" (2012, 18,347). While these conclusions were supported by subsequent studies (Raleigh and Kniveton 2012; Hendrix and Salehyan 2012; Hsiang and Meng 2014), other scholars question the validity of these findings and show that the incidence of conflict is primarily related to political and economic conditions (e.g. Buhaug 2010). In common with all these studies, however, is the insight that a major mechanism by which climate change increases the likelihood of conflict is through its effects on food supplies.

One important shortcoming of existing research on the relationship between climate and conflict is that extant studies rarely if ever evaluate the role of mediating factors, or analyze how resource scarcity impacts conflict (Theisen et al. 2013). To some extent, this gap has been at least partly filled by a small number of studies that highlight the importance of food scarcity. The emphasis of these studies is on the manners in which improving food security can mitigate conflict. For example, Hendrix and Brinkman (2013) note that in the Sahel, grievances over food motivate some individuals to join rebellions, while food denial can also be used as a tool for counter-insurgency. An earlier study by Messer and Cohen, who sought to identify the mechanisms by which globalization and free trade can help mitigate food security concerns, likewise notes that "conflict and food emergency countries overlap considerably" (2006, 31). Finally, the potential pacifying effects of food security have also not gone unnoticed by senior policy makers. For instance, the U.S. Department of State officially declared in a recent publication that "pursuing a range of specific initiatives in areas such as food security and global health.... will be essential to the future security and prosperity of nations and peoples around the globe" (2010, 33).

While these case-specific studies and policy statements highlight the potential saliency of the relationship between food resources and violence, little has been done in the way of examining this relationship systematically across different contexts. This deficiency is now being addressed by recent research into the relationship between food import prices and political stability, especially in developing countries. For instance, when studying the relationship between food prices and social unrest, Bellemare found that "rising food prices appear to cause food riots" (2015, 18). Hendrix and Haggard (2015) expand on Bellemare's study by focusing on the role of political institutions in mitigating the effect of global food prices on instability. They found that, "[g]lobal food prices are correlated with urban unrest in democracies, but not in autocracies" because "food policy in democracies is less biased in favor of urban constituencies" (2015, 145). From a different perspective, Weinberg and Bakker (2015) utilized domestic food prices as an indicator of citizen wellbeing. The authors found that social unrest is indeed more prevalent during periods of heightened food prices, with larger price increases being associated with more pronounced increases in social unrest (2015, 320).

These studies highlight an important mediating factor by which variation in food production can affect political instability, but they are also limited in two respects. First, the reliance on food imports may not capture the true effect of food insecurity in countries and regions where locals must, to a large extent, live off locally produced food. Second, the focus on the state as the unit of analysis limits one's ability to account for global and regional variations that might affect food security. In this respect, we echo Theisen et al.'s contention that "more work needs to be put into the geographical disaggregation of the effects of climate change since these effects will not follow national boundaries" especially as "[a]ctors and agency tend to be vaguely portrayed, or outright ignored, in the relevant empirical literature" (2013, 621–622).

The present paper complements these existing studies by focusing on one important (mediating) factor, food resources, and the geographic variation of conflict both cross-nationally and at the very local level. Whereas extant research on food prices and imports expands our understanding of the relationship between food, a staple commodity, and political resistance, our understanding of food security's relationship(s) with violent outcomes such as armed conflict is predominately subsumed under the hypothesized effects of trade and/or climate change. However, the implications of food insecurity for conflict are not only a feature of climate change and trade shocks, but also the result of population growth (e.g. Urdal 2005), local traditions and global increases in consumption, all of which exhibit significant amounts of variation independently of climatic factors. The focus on geographical variation at the highly disaggregated level thus provides an important complement to existing studies that focus on the nation-state as the main geographic unit of interest, while the emphasis on local food security as an independent variable highlights an important, yet understudied, potential correlate of armed conflict. Importantly, whereas many extant studies – with some exceptions (e.g. Hendrix and Haggard 2015; Weinberg and Bakker 2015) – focus on sub-Saharan Africa, here the relationship between food insecurity and political violence is analyzed on a *global* scale. This facilitates the identification of broader food security trends related to conflict that may be missed by analyses of specific regions.

Food insecurity and conflict

Attainable food security can be conceptualized along three pillars: access, availability, and utilization (Barrett 2010; World Health Organization 2015). The focus of the present analysis is primarily on "access" and "availability," under the assumption that – of the three pillars mentioned above – these are most likely to be contested via violent means. In broad terms, "access" refers to the ability of individuals to obtain food, as well as the presence or absence of safeguards for those who cannot obtain food by licit means. For example, the number of grocery stores in a given region is an example of the level of access to food available to individuals. Because food access reflects the actual global or regional distribution of food resources and the inequalities embedded therein, it is generally associated with the demand side of food security. "Availability" refers to the total amount of food that can be obtained in a given region (Hendrix and Brinkman 2013). The total amount of food sold by these aforementioned grocery stores thus corresponds to the level of food availability. Because food availability is directly related to improvements in the means of agricultural production, which affect the amount of food that *could* be produced, "availability" is commonly associated with the supply side of food security (Barrett 2010).

The relationship between access and availability is therefore codependent; if food is not available, neither is it accessible. However, the reverse is not true; while plenty of food can be available, many different factors might hinder access to it. To measure access, one must therefore adequately account for a myriad of possibilities governing the ability of individuals to secure adequate sustenance. To explain access to food, Barrett cites Nobel Laureate Amartya Sen, who writes that, "starvation is the characteristic of some people not *having* enough food to eat. It is not the characteristic of there *being* not enough food to eat. While the latter can be a cause of the former, it is but one of many *possible* causes" (2010, 825). For example, a person living in a major urban area within an advanced industrialized democracy might have a variety of grocery stores from which to procure food, suggesting that plenty of access to food exists. However, if the person is unable to afford to buy food, or if the nearest grocery store is located far away from her residence, she has limited access to it, regardless of availability. She might procure food by other means, such as theft or through visiting a soup kitchen, but her access to food is limited nonetheless. Correspondingly, if a series of floods were to strike the city where she resides, killing crops and preventing food supplies from reaching the city, little food will be available to this person, which again affects her ability to secure adequate sustenance. This happens regardless of the number of grocery stores that offer access to food products or her level of income, because no food will be available.

Although these constraints on food access and availability are often unlikely to lead to acute violence within advanced industrialized democracies – due to the existence of safeguards to those in need and a high degree of infrastructure that can transfer more food when needed – we contend that in many developing countries, which encompass a majority of the world's population and landmass, widespread limitations to food access and availability *can* affect the location of armed conflict. This is because such food insecurity-prone areas are likely to be characterized by three main attributes. First, rural regions in most countries have poor infrastructure, especially in relation to food security, including an absence of paved roads and refrigeration (FAO 2008). Individuals in these regions are therefore at a higher risk of having their immediate *access* to food impaired. As argued below, these dynamics will in turn ensure that any remaining areas exhibiting high food access will be sensitive to capture by armed groups and related actors given its relative scarcity.

A second attribute of regions with a high risk of food insecurity is a relative lack of sophisticated agricultural technology such as heavy machinery and efficient fertilizers (Barrett 2010; Kastner et al. 2012). While this technological gap is somewhat narrowing, current technology in the developed world is still limited in its ability to feed an increasing number of people, and this situation is much more dire for less developed regions (Kastner et al. 2012). Hence, technologically disadvantaged regions are much more likely to suffer from shortages of available, because less food can be produced there. By the same token, and controlling for food access, food *availability* is higher when more agricultural resources are available per person in the region, other things being equal, because this increases food supplies.

Lastly, underdeveloped regions are also more vulnerable to the effects of climatic variation, which can affect both access and availability (FAO 2008; Burke et al. 2009). From a food access perspective, the weak infrastructure that characterizes many of these regions (e.g. dirt roads) is much more likely to be destroyed due to extreme climatic effects such as flood. For instance, a report by the Food and Agricultural Organization of the United Nations states that, "climate variables also have an impact on physical/human capital – such as roads, storage and marketing infrastructure, houses, productive assets, electricity grids, and human health – which indirectly changes the economic and socio-political factors that govern food access" (2008, 12). From a food availability perspective, these regions might be at a higher risk of having decreased yields and thus reduced food production. For example, Burke et al. argue that, "[b]ecause the vast majority of poor African households are rural, and because the poorest of these typically derive between 60 % and 100 % of their income from agricultural activities, such temperature-related yield declines can have serious economic consequences for both agricultural households and entire societies that depend heavily on agriculture" (2009, 20,672).

Taking into account these three issues, individuals in many regions around the world are forced to rely on food produced and sold locally – which limits food access – and grown using relatively simple technology – which limits availability. This places these individuals at a high risk of experiencing food insecurity (Barrett 2010). Indeed, finely disaggregated analysis of global satellite data on land use shows that less developed regions are also much more likely to produce food for immediate and local consumption rather than for other uses such as fuels or feed (EarthStat 2015; see also Kastner et al. 2012). This is not to say that food imports are not important. Indeed, as recent studies (Bellemare 2015; Hendrix and Haggard 2015; Weinberg and Bakker 2015) have shown, food imports produce a significant effect on political instability. Rather, this study posits that in many of these less developed regions with low levels of infrastructure, food imports are less relevant to the daily diet of many around the world, compared with foodstuff that are locally grown and sold (see, e.g., Paarlberg 2000). The present study establishes that this necessity to rely on locally grown foods also places these regions at a higher risk of experiencing conflict *as a result* of food insecurity.

One reason is that conflict is inherently more likely to afflict rural regions, which might be also more prone to food insecurity. Many studies of civil conflict emphasize the primarily rural nature of this phenomenon, for example because "most civil conflicts are rural wars, fought primarily in rural areas by predominantly peasant armies" (Kalyvas 2004, 161) or because conflict-prone countries possess "limited administrative control of their peripheries" (Fearon and Laitin 2003, 88). While (civil) conflict might arise due to a large number of different political and economic reasons (Hegre and Sambanis 2006), this also means that underdeveloped rural regions around the world are at a higher risk of experiencing localized conflict. Because food resources – just like natural resources (Bannon and Collier 2004) – are necessary to recruit and support armed operations and because conflict is more likely in rural regions, it follows that warring factions will seek to secure food resources. This is because in many countries, both government and rebel troops are unlikely to enjoy regular logistic support (Henk and Rupiya 2001). Similar dynamics are evident among pastoralist in Kenya, Ethiopia, and Uganda, who seek to secure access to water resources, which results in a higher frequency of violence along well sites and during years of higher levels of rainfall (Detges 2014; Ember et al. 2014).

Given that troops are frequently mobile rather than stationary, they do not have the ability to grow food for personal consumption, and as a result might prefer to rely on food grown locally in the region in which they operate. In other words, unsupported armed troops must secure access to food to guarantee their operation. For example, focusing on Sudan, Ethiopia, and Somalia, Rohwani et al. found "that conflicts are more frequent in regions with more vegetation" (2011, 221). This agricultural land can be owned by local civilians who grow food for personal consumption only or by larger producers who grow food for trade, both internationally and domestically. Especially in regions that do not have high levels of infrastructure and where mobilizing food resources or appropriating food aid is less possible, both government and rebel troops are forced to move into areas that offer access to food in order to support their operations. Hence, it is not only rural regions that are at a higher risk of experiencing conflict, but also and specifically agricultural ones. In these areas, low food access generally intensifies the incentives for troops to seek out the few remaining areas that do have high food access for sustenance, and potentially also for rent-extraction.

Building on this premise, the present study utilizes cropland to approximate the access aspect of food insecurity because in underdeveloped regions throughout much of the world and especially in conflict prone areas, croplands are the main locations where food can be obtained. Croplands are therefore in high *demand* by the warring factions: without access to food, troops cannot support themselves and military operations must cease. As a result, when conflict erupts in a country or region characterized by low food access, we should expect any remaining *high* food access points to *pull* conflict and active fighting towards these high access areas, given that this now scarce resource will provide the necessary fuel for, and a key prize to be had from, armed conflict. Hence, areas with more croplands should, counterintuitively, be associated with higher rates of active conflict and clashes, at least relative to areas with little to no food access altogether, once conflict or local tensions have set in.

However, and now assuming that a given region *does* have at least some degree of accessible cropland and hence food access, the level of importance that armed and unarmed actors attribute to existent croplands is affected by how much food is actually available in this region to support both troops and local populations. If the amount of food available to support each person in the region is reduced, then armed actors and potentially civilians alike will have higher incentives to actively fight over food supplies in order to secure availability. In contrast, if plenty of food is grown in cropland regions and it is enough to satisfy the high demand created by both armed troops and the local population, the violence resulting from food insecurity concerns should be reduced. In other words, decreased *supply* of food pushes demand – i.e. the imperative to obtain more access to food – up, which results in increased incidence of conflict over existing food resources.

Note that these arguments do not posit that cropland – in and of itself – is at a higher risk for conflict. The onset of violence, as mentioned above, is the result of many different conditions: political (Buhaug 2010; Fearon and Laitin 2003), economic (Hegre and Sambanis 2006; Collier and Hoeffler 2005), and social (Scheffran et al. 2012). Rather, it posits that within conflict prone regions and countries, areas with more access to food, or cropland, but less food availability per capita, may experience more conflict, all else equal. A variety of factors, ranging from political structures to economic development to better infrastructure and technology, distinguish the agricultural countryside of Iowa or northern France from that of the Sahel or northern India. The primary models discussed below employ different control variables to account for these different issues. In addition, several robustness models (reported in Tables S1 and S2 in the Robustness Section) further account for the potential that advanced industrialized democracies are effectively "immune" to (civil) war by treating such cases as "zero-inflated" and estimating this propensity alongside the primary relationships of interest, or estimating only regions that might be more prone to experiencing (climate change related) conflict.

The argument developed here complements current theories by underscoring the independent effect of food insecurity on conflict. Increased access to food resources gives belligerents increased opportunity for confrontation, while decreased availability gives them the willingness to fight over these resources. A better understanding of these violent dynamics can be achieved by highlighting the high premium armed actors place on securing food resources, which suggests – if current food security trends are correct (FAO 2008; Barrett 2010) – that we will see an increase in armed conflict related to food resources. The argument developed here accordingly suggests the following two hypotheses:

> H1: Higher demand, i.e. more access to food resources, increases the likelihood of (civil) conflict.
> H2: Higher supply, i.e. more availability of food per person within areas that offer access to food, decreases the likelihood of (civil) conflict.

Results

These expectations are evaluated using a *global* grid-cell sample encompassing 18 years of data between 1991 and 2008 (see *Materials and Methods*). The data are structured into a cell-year level dataset, where cells are the cross-sectional unit of interest, and are measured at the 0.5 × 0.5 decimal degree cell resolution[1] for the entire terrestrial globe (Tollefsen et al. 2012). This highly disaggregated geographical breadth – which covers the entire terrestrial earth rather than focusing on specific regions or continents – provides an important improvement over previous analyses of conflict, which have tended to be state-centric (e.g. Burke et al. 2009; Buhaug 2010; Buhaug et al. 2009), or focused only on a specific region (e.g. Burke et al. 2009; O'Loughlin et al. 2012; Buhaug 2010; Fjelde and Hultman 2014). *Conflict* is defined inclusively as any cell that experienced at least 25 annual combatant battle deaths arising from inter- or intrastate conflict, and coded zero otherwise. This threshold – which includes both wars between countries and domestic rebellions – has been used in past studies of this sort (Buhaug 2010; Gleditsch et al. 2002), and allows one to accommodate both high and low-level violent interactions within the context of competition for food resources. For summary purposes, averaged values for this variable are plotted for the 1991–2008 period in Fig. 1. A second outcome variable that only includes instances of intrastate conflict, termed *civil conflict*, is then examined separately. As the vast majority of conflict events during the 1991–2008 period correspond to civil conflicts, a second map for civil conflict is not reported here.

Table 1 reports the coefficient estimates of four logit models that each assesses the likelihood of cell-year conflict globally. Importantly, the majority of controls in these models – including all measures of (lagged) conflict, local ethnic diversity, economic wealth per capita (i.e., gross cell product per capita), all measures of weather and climatic conditions, but excluding the Polity and military expenditure variables – are measured at the *cell* level, rather than the *country* level, which accounts for spatial variation within countries (see *Materials and Methods*). Among these controls, all time varying independent and control variables were also lagged by one year. To account for the effects of time trends within the panel and analysis, all models presented below also include year fixed effects. Fixed effects for grid cell (or country) are not included in these models because the key explanatory variable of interest for this study (*cropland*) is time invariant and hence is perfectly collinear with these effects.

A related concern pertains to the advanced industrialized democracies cells within our global sample, which due to structural factors may be predisposed from ever experiencing outright (civil) war (Bagozzi et al. 2015). These cases are included in the analysis given the interest in evaluating the effects of food security *globally,* and given the recognition that such conflict-immune cells will raise the bar for identifying significant results, rather than

[1] i.e., cells of approximately 55 × 55 km at the equator (3025 km^2 area), which become slightly larger as one moves to the Poles.

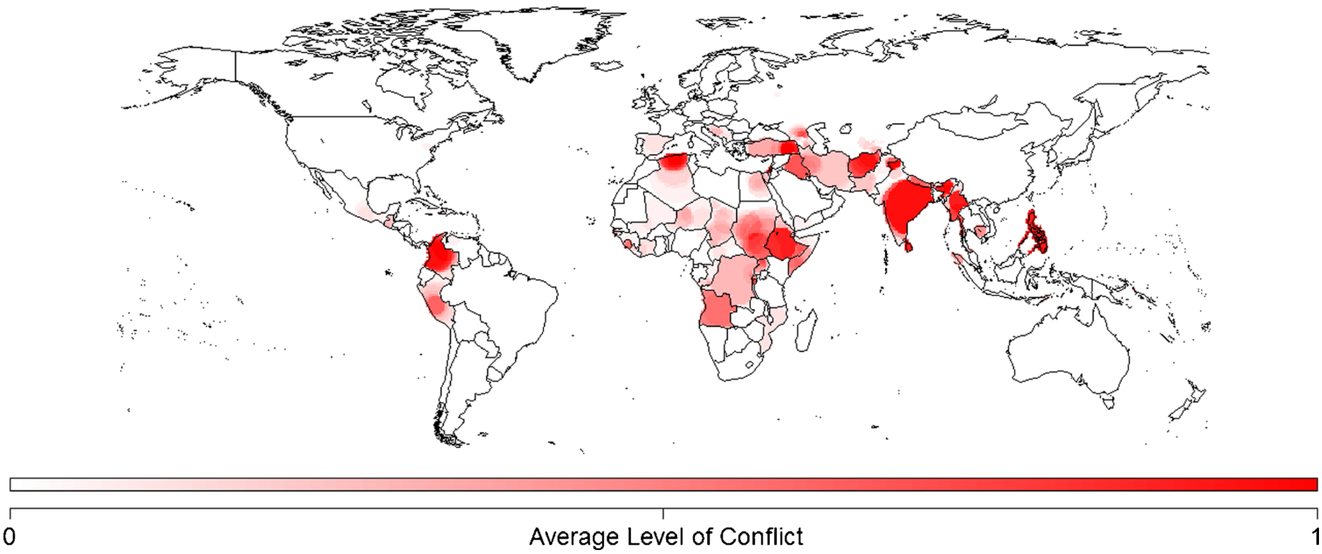

Fig. 1 Average levels of conflict, 1991–2008 sample

lowering it. Nevertheless, Table S1 in the Supplementary Material estimates a series of split population (i.e., zero-inflated) logit models that account for heterogeneity in the baseline propensity for cells (and countries) to experience *any* conflict via the combined effects of democracy, economic development per capita, and overall population presence. Table S1 indicates that even after accounting for the likelihood that many grid-cells may be effectively immune to (civil) conflict; the broader findings with respect to *cropland* and *ln cropland pc* remain. The same is true for a subsample consisting only of tropical regions, presented in Table S2.

Returning to the main results (Table 1), the dependent variable in Models 1 and 3 (*conflict*) corresponds to annual grid-level incidences of both inter or intra-state conflict, whereas Models 2 and 4 examine the annual incidence of civil (i.e.,

Table 1 Logit coefficient estimates of the likelihood of conflict by cell-year, 1991–2008

	Model 1: Any conflict	Model 2: Civil conflict	Model 3: Any conflict	Model 4: Civil conflict
Cropland	0.001** (0.0003)	0.001** (0.0003)	.	.
Ln Cropland Pc	.	.	-23.838** (3.458)	-23.605** (3.456)
Lag Conflict	4.823** (0.015)	.	4.959** (0.017)	
Lag Civil Conflict	.	4.836** (0.016)	.	4.974** (0.017)
Ln Travel Time	0.220** (0.011)	0.206** (0.011)	0.337** (0.013)	0.322** (0.013)
Ln Cell Area	1.697** (0.065)	1.675** (0.065)	1.242** (0.066)	1.229** (0.066)
Ln GCP	-0.089** (0.013)	-0.082** (0.013)	-0.052** (0.014)	-0.046** (0.014)
Ln Precipitation	-0.248** (0.009)	-0.240** (0.009)	-0.267** (0.011)	-0.258** (0.011)
Drought	-0.047** (0.009)	-0.046** (0.009)	-0.087** (0.010)	-0.086** (0.010)
Temperature	0.054** (0.001)	0.055** (0.001)	0.053** (0.001)	0.054** (0.001)
Ln Border Distance	-0.008 (0.006)	-0.004 (0.006)	-0.010 (0.006)	-0.006 (0.006)
Ethnic Diversity	0.084** (0.005)	0.086*** (0.005)	0.120** (0.005)	0.121** (0.005)
Polity	0.001 (0.001)	0.002 (0.001)	-0.002 (0.001)	-0.003* (0.001)
Ln Military Expenditure	-0.015** (0.004)	-0.017** (0.004)	-0.008 (0.005)	-0.009 (0.005)
Ln Population	0.330** (0.006)	0.322** (0.006)	0.331** (0.007)	0.323** (0.007)
Constant	-20.860** (0.468)	-20.610** (0.492)	-18.176** (0.506)	-18.001** (0.505)
Observations	867,272	867,272	537,593	537,593
AIC	175,925.9	174,891.6	146,236.0	145,413.7
BIC	176,287.8	175,253.5	146,583.1	145,760.7

* $p < 0.05$; ** $p < 0.01$. Cell values are logistic regression coefficient estimates with standard errors in parentheses. Year fixed effects included in each regression though not reported here. All time varying covariates are lagged by one year

intrastate) conflict exclusively (*civil conflict*). For each dependent variable, two explanatory variables are used to capture food insecurity. The first, referred to as *cropland*, measures the percentage of land area dedicated to agriculture within a given cell.[2] For summary purposes, cropland is plotted across the entire 1991–2008 period in Fig. 2. This variable corresponds to the *access* pillar of food security. The second variable that is used to capture food insecurity is *ln cropland pc*, which measures the amount of cropland per person within cells that contain at least some degree of cropland. Importantly, for this variable and its analysis, cells with zero cropland land-area are omitted to account for cases where no locally grown food is available. As such, this measure corresponds to the *availability* pillar food security.

In general terms, the two measures are expected to have opposite signs: *cropland*, as a measure of demand, should be positively related to conflict, while *ln cropland pc*, as a measure of supply, should have a negative effect. For *cropland*, a positive coefficient is expected because food insecurity concerns, when present, push individuals and groups to fight over areas that offer access to agricultural produce. This in turn gives belligerents increased *opportunity* for confrontation. A negative effect for *ln cropland pc* is expected because, among those areas that *do* have cropland – i.e., areas that do offer access to food – less cropland per capita implies less food-availability for each individual in that location, and hence more of the grievances that motivate and sustain participation in political violence. Decreased availability hence gives combatants the *willingness* to fight over these resources. This is consistent with the conceptualization of food security used by many nongovernmental organizations and policymakers working in this arena, who note for example that "[i] ncreases in food production, per hectare of land, have not kept pace with increases in population [... a]s a result, per-capita cropland has fallen by more than half since 1960, and per-capita production of grains, the basic food, has been falling worldwide for 20 years" (Worldwatch Institute 2013).

The hypothesized relationship between food insecurity and conflict is evaluated against benchmark explanations of conflict risk: socio-political indicators, economic development, conflict history, and climatic variation. The control variables *lag conflict* and *lag civil conflict* measure the cell-level incidence of conflict and civil conflict, respectively, during the previous year, and allow for the modeling the effects of said food security measures on the instantaneous change in each conflict measure in year *t*. The variable *ethnic diversity* accounts for the number of distinct ethnic groups found within each individual cell. The variable *ln cell area* measures the area in logged square kilometers of a given cell. The variable *ln GCP* measures the natural log of the gross product of a given cell and is used as a cell-level economic indicator. The variable *ln precipitation* measures the natural log of the previous year's amount of rainfall in a given cell. The variable *drought* measures the extent of drought experienced by a given cell during the previous year. The variable *temperature* measures the average temperature in a given cell during the previous year. The variable *ln population* records an estimate of the number of people living in a given cell in the previous year. The variable *ln border distance* measures the logged distance in kilometers to the nearest border. Importantly, all these variables are measured at the cell level, which – as mentioned above – accounts for the observed variation of conflict within countries and verifies that the effect of each model's food insecurity measure captures regional variation in conflict.

In addition to cell level measures, some relevant country level indicators are also included. *Polity* is a widely used country-level measure of political regime type, and is measured annually, where higher values roughly correspond to more democratic regimes (Marshall et al. 2013). The variable *ln military expenditure* measures to the average amount (in US dollars) spent on national security by a country during the previous year. Summary statistics for all variables are presented in the Supporting Information (Table S4). To assess model fit, Akaike information criterion (AIC) and Bayesian information criterion (BIC) scores are reported for each model, with lower scores corresponding to a better fitting model. Note that for each model two smaller specifications are estimated. These specifications are reported in the Supporting Information (Tables S4 and S5).

Model 1 evaluates the effect of cropland on *conflict* once the aforementioned political, economic, and climate-related factors are taken into account. *Cropland* is positively and significantly (to a $p < 0.01$ level) associated with the incidence of conflict, which suggests that localized conflict favors regions that offer more access to food. This finding is robust to the inclusion of average temperature, rainfall and drought in the logistic regression, which suggests that the effect of cropland is independent to that of purely climatic factors. As one can see, this effect is also robust to the inclusion of political and economic controls, as well as population and urbanization measures.

Model 2 evaluates a similar scenario, only in this case the focus is on the effect of cropland on civil conflict. Similar to above, *cropland* has a positive and significant (to a $p < 0.01$ level) association with *civil conflict*, even after political, economic and development indicators, along with climate-related variables, are taken into account. In sum, the analyses presented in Models 1 and 2 suggest that more access to, or more demand for, food resources is positively related to conflict, independently of the association of conflict with other economic, political, population, or climate-related indicators.

Models 3 and 4 evaluate the effect of cropland per capita on *conflict* within those only those terrestrial

[2] Other studies have used cropland in a fashion somewhat similar to its use here, e.g. Theisen 2012; Rowhani et al. 2011.

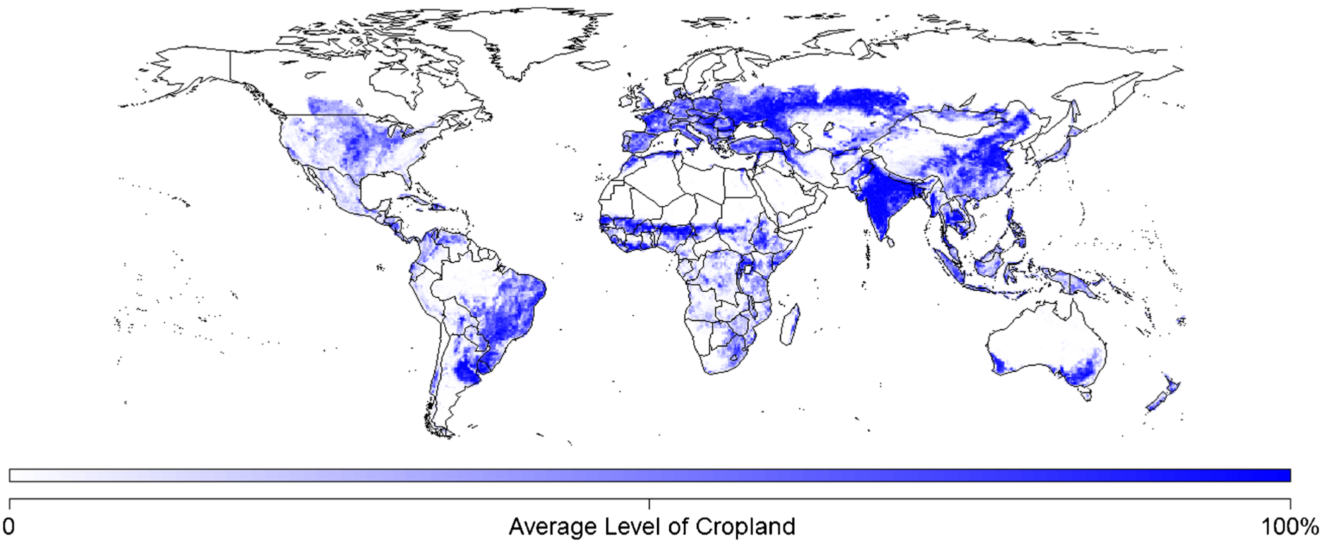

Fig. 2 Average levels of cropland, 1991–2008 sample

grid-cells that have at least some degree of cropland. In Model 3, *ln cropland pc* is negatively and significantly (to a $p < 0.01$ level) associated with the incidence of conflict, an effect that is robust to the inclusion of the same controls used in the previous models. Similarly, *ln cropland pc* is negatively and significantly (to a $p < 0.01$ level) associated with the incidence of civil conflict in Model 4, which suggests that the negative and strong effect of food availability holds across a variety of conflict outcomes. All in all, Models 3 and 4 suggest that more availability, or more supply, of food resources is negatively related to conflict, independently of the association of conflict with other economic, political, population, or climate-related indicators. That is, within agricultural areas, less cropland per person corresponds to more intra and inter-state conflict.

What do these findings indicate about the variation in the risk of conflict and civil conflict? Firstly, all four models support the argument that a significant relationship exists between food insecurity and conflict. More specifically, these findings suggest that, for an average country, the baseline risk of conflict and civil conflict increases in regions that provide at least some access to food – supporting the expectation that global demands for food should generally direct conflict towards agricultural areas. At the same time, within agricultural areas, conflict is intuitively more likely to arise in regions where the levels of food per capita are low – that is, where food supplies are scarce. Secondly, and in line with previous research (Burke et al. 2009; O'Loughlin et al. 2012; Hsiang and Meng 2014; Hendrix and Salehyan 2012), warmer regions and areas with lower precipitation were significantly more likely to experience conflict. This supports the argument that food scarcity can serve, to some extent, as a mediating factor for the effects of climate variables, in addition to the independent impact of food insecurity related concerns on conflict. Thirdly, as extant studies (e.g., Hegre and Sambanis 2006) suggest, poorer regions are more likely to experience conflict, as are more ethnically diverse regions, although it appears that higher levels of democracy do not translate into more peace once cell level characteristics are taken into account.[3] Perhaps unsurprisingly, regions with larger populations are more likely to experience conflict, as are more rural regions, as some scholars have argued (Fearon and Laitin 2003; Kalyvas 2006; Buhaug et al. 2009).

In sum, four models involving different explanatory variables have been utilized to examine two conceptualizations of conflict as an outcome of interest. The results strongly support extant arguments that access to and availability of food are each associated with an increased occurrence of armed conflict. This evidence does not negate previous explanations of conflict that emphasize the importance of political and economic development or climactic variation. However, by highlighting the strong association between food access and availability on one hand, and local political violence on the other, the above findings do show that these past expositions (e.g. Miguel et al. 2004; Burke et al. 2009; Hsiang and Meng 2014) in and of themselves are insufficient to fully explain the likelihood of local level conflict. Simply put, the present study confirms that there exists a systematic, and global,

[3] Note that this lack of significant correlation might be the result of the autocorrelation produced by many different cells having similar values on these state-level variables, which can produce Type II errors and thus serves as an additional robustness measure in this analysis.

relationship between food insecurity on one hand, and the occurrence and persistence of social conflict on the other.

Discussion

What do these findings imply about the effect of food insecurity and conflict? Naturally, even the most detailed and elaborate models are simplistic, especially when containing as diverse a range of observations as those examined above. Nevertheless, in terms of conditional probabilities, all models show a statistically significant first difference change of approximately +92 % in the probability of conflict when a high risk scenario is simulated for an average cell.[4]

The conditional probabilities discussed above highlight the inherent complexity of social systems, as a phenomenon as notable as violent conflict ultimately arises due to a variety of stressors. Therefore, it should be emphasized that the above findings should not be interpreted as explaining conflict *onset*. Conflict can erupt due to various political (Buhaug 2010; Fearon and Laitin 2003) or economic (Hegre and Sambanis 2006; Collier and Hoeffler 2005) reasons – which may or may not be related to food insecurity – that are beyond the scope of this paper. Rather, the present study more simply suggests that political violence will have a higher likelihood of concentrating in regions that (i) offer more access to food resources and (ii) face low levels of food availability within areas that offer some access to food resources.

This study adopts an economic perspective on food security to explain this variation in the concentration of social conflict. From the demand side, violent conflict is most likely to revolve primarily around access to food sources. When food insecurity produces higher demands for food, these demands will directly compel groups and individuals to seek out and fight over existing food resources, rather than leading these actors to pursue and fight over geographic areas that lack any (or have very little) agricultural resources. Thus, access to croplands and food is a necessary condition for food insecurity-induced conflict, which is confirmed in the cropland analyses presented here. From the supply side, and within those areas that do already offer access to agriculture and/or food, conflict is most likely to occur in regions that offer lower levels of food availability, or insufficient food supplies. This is because lower food availability (or supplies) in these contexts directly implies higher levels of resource scarcity, which can engender social grievances, and ultimately, social and political conflict (Brinkman and Hendrix 2011; Hendrix and Brinkman 2013). More broadly, several causal mechanisms could plausibly link food security and social conflict.

For one, conflict in regions with higher food access and lower availability might arise as a principal outcome of food insecurity. This approach is most directly in tune with the body of research concerned with the resource scarcity-based security implications of climate change (e.g. Miguel et al. 2004; Burke et al. 2009; O'Loughlin et al. 2012), as well as with broader studies of conflict dynamics and food security in both rural and urban contexts (Brinkman and Hendrix 2011; Hendrix and Brinkman 2013; Messer and Cohen 2006). From this perspective, individuals and groups actively fight with one another due to food insecurity-induced grievances, which may manifest in groups' attempts to overthrow existing political structures, or in these actors' efforts to more directly seize and control available (but scarce) agricultural resources in an effort to better guarantee long-term food security for their constituents. If future global projections for population growth, consumption, and climate change hold true, then these dynamics suggest that incidences of violent conflict over food scarcity and food insecurity may increase as individuals and groups fight over a continuously shrinking pool of resources, including food.

A second mechanism involves the existence of logistic support in conflict-prone regions, or lack thereof. Throughout history and well into the nineteenth century, armies living off the land have been a regular characteristic of warfare. The utilization of motorized transport vehicles and airlifts has significantly reduced the need of modern militaries to rely on local populations for support, at least among modernized, highly technological militaries (Kress 2002, 12–13). However, given the bureaucratic and economic capabilities required to maintain such systems, the majority of state and non-state armed groups in the developing world are still unlikely to be supported by well-developed logistic supply chains (Henk and Rupiya 2001). Taking into account the consistent relationship between economic welfare and conflict (Hegre and Sambanis 2006; Fearon and Laitin 2003), unsupported warring groups on all sides of a conflict may move into regions that offer more access to cropland in order to forage and pillage to support themselves, which in turn produces higher incidences of hostilities, especially if there is not much food per person available within these fertile regions. Hence, violent conflict in this case is not the direct result of food insecurity, but rather is shaped by food insecurity concerns.

The identified relationships between food security and conflict are robust across numerous alternative model specifications, and imply an independent effect of food insecurity in shaping conflict dynamics and conflict risk. Especially when considered alongside current, and projected, climatic and political-economic conditions, this linkage suggests that

[4] A high risk scenario is drawn from 1000 simulations in which all variables with a positive association were changed from 0 to 1 (for binary variable) or from their 25th to their 75th percentiles (for continuous variables), while variables with a negative association where changed from 1 to 0 (for binary variable) or from their 75th to their 25th percentiles (for continuous variables). Year fixed effects were held to their modal values.

countries could see an increase in localized conflict worldwide in the coming years. However, this anticipated trend should be considered with caution for several key reasons.

Firstly, the conceptualization of food security along the dimensions of access and availability used in this study does not fully capture several aspects of food security such as refrigerated food, which can increase the amount of food available per capita and food's degree of accessibility to different individuals. Although this is unlikely to affect the robustness of the findings presented here, as the majority of conflicts takes place in countries and regions where little-to-no refrigeration exists, this concern deserves future consideration. Additionally, the increase in "land grabbing" for the purposes of non-food oriented agricultural resources (e.g., ethanol) or exports production since 2008 (De Schutter 2011) has potential implications for this study's findings. While 2008 is the final year in the sample and analysis above, this remains an important area for future research. Nevertheless, as the robustness model presented in Table S3 shows, food and agricultural imports produce a positive effect on the likelihood of conflict, but do not substantially diminish the significant effects of *cropland* and *cropland pc*. This suggests that the access to and availability of food resources grown locally play an important role in social conflict, which is independent of that of food obtained via other means. Examining the interaction between (the distribution of) food and agricultural imports and local food resources, as for example based upon the dependencies of rebel groups or private organizations on these resources or lack thereof, is a potential valuable extension on this study's conclusions, and might uncover important dynamics of violence that the present analysis cannot specifically identify.

Secondly, as was stated earlier, the effects of food insecurity on conflict, and indeed conflict in and of itself, are the result of complicated interactions between various factors, and primarily between political and economic features (Hendrix and Brinkman 2013; Buhaug 2010; Hegre and Sambanis 2006; Fearon and Laitin 2003; Kalyvas 2006). Hence, while interpreting the present findings as evidence that access to food resources and food availability shapes local conflict dynamics, this study does not expound on these findings as a complete picture of future socioeconomic developments in this arena, nor does it account for agricultural modifications that might affect or indeed reverse these trends. Lastly, note that this study is focused primarily on the *spatial* variation governing the distribution of conflict worldwide. While the analyses presented above do account for temporality, they do not fully examine temporal and seasonal variation specifically. Food access and availability can change from one year to the next, or from one season to the next, while the degree of food imports and commodity prices may vary on a daily basis. Hence, an especially valuable direction of future research would be to explore different aspects of this temporal variation, and the ways in which food import prices interact with food produced locally to affect conflict.

Materials and methods

The geolocated data used for this analysis were obtained from the PRIO-Grid dataset (Tollefsen et al. 2012). The PRIO-grid measures a variety of spatial data at the 0.5 × 0.5 decimal degree resolution, or a geographic squared "cell" of roughly 55 × 55 km at the equator (3025 km^2 area), which decreases with higher latitudes. This dataset thereby allows one to capture the variation of specific geographic and economic phenomena globally (excluding oceans, Antarctica, and the Arctic) at the very local level. For illustration purposes, the global coverage of the PRIO-Grid dataset is presented in Fig. S1. Crucially, the majority of the variables of interest (*cropland*, *ln cropland pc*, *lag conflict*, *lag civil conflict*, *ln travel time*, *ln cell area*, *ln GCP*, *ln precipitation*, *drought*, *temperature*, *ln border distance*, *ethnic diversity*, and *ln population*) are measured at the *cell*, and not country, level.

Models 1–4 are estimated using logistic regression. To account for potential time dependencies, binary variables (i.e., fixed effects) for each year covered in the data (1991–2008) were included in these models. The measures utilized in the cell-level dataset analyzed here were collected from various databases. The *continuous* cropland measure was operationalized as the *percentage of a given cell's area* whose land cover class was denoted as (irrigated and non-irrigated) cropland by the Globcover 2009 project (Bontemps et al. 2009). The categories considered as cropland are hence post-flooding or irrigated cropland, rainfed cropland, mosaic cropland (50–70 %) / vegetation (grassland, shrubland, forest) (20–50 %), and mosaic vegetation (grassland, shrubland, forest) (50–70 %) /cropland (20–50 %) (Bontemps et al. 2009, 4.1). Note that although this variable is coded only for 2009, it is unlikely to vary for the temporal period covered by the data. The cropland per capita measure was operationalized as the natural log of the amount of cropland available to support one person in a given cell, for all cells that were denoted as including some percentage of cropland by the Globcover 2009 project (Bontemps et al. 2009). The human population-level found in a cell during the previous year was used to construct cropland per capita. This population measure, and the interpolation approach that was used to obtain yearly values for it, are described immediately below.

Conflict measures, as well as temperature, drought, precipitation, ethnic diversity, travel time, distance to nearest border, cell area, gross cell product, and population, were obtained from the PRIO-GRID project (Tollefsen et al. 2012), with the latter five variables logged prior to including each in the analysis. Conflict and civil conflict were defined as cell years experiencing a war with at least 25 intentional deaths of combatants, meaning that no deaths resulting from collateral damages or civilian casualties are counted under this definition. The ethnic diversity measure is operationalized as a count of the number of politically relevant ethnic groups settled in a particular cell (Wucherpfennig et al. 2011; Tollefsen et al. 2012). The cell level variables for population and gross cell product were originally measured by Nordhaus (2006) for the years 1995, 2000, and 2005 and then interpolated to the yearly level using a last value carried forward approach. The political regime measure Polity2 was obtained from the Polity IV dataset (Marshall et al. 2013). Military expenditure data were obtained from the Correlates of War (COW) project (Singer et al. 1972), and logged. The measures of agricultural raw material imports (excluding fuel, fertilizer, minerals, and ores) and food imports used in the Supplementary Materials were each operationalized as a share of total material imports during the previous calendar year (World Bank 2015).

The logistic regression analyses, first difference calculations, and most robustness models were conducted using the R statistical package version 3.1.1. The split population models reported in the Supporting Information were calculated in Stata 13 using the code developed by Beger et al. (2011).

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Compliance with ethical standards

Author contributions Ore Koren developed the theory for the paper and conducted primary analysis. Benjamin Bagozzi constructed datasets for the paper and conducted secondary analysis. Ore Koren and Benjamin Benjamin wrote the paper.

Data and materials availability All replication data and files can be found on Harvard's Dataverse.

Competing interest The authors declare no competing interests.

References

Achen, C. H. (2005). Let's put garbage-can regressions and garbage-can probits where they belong. *Conflict Management Peace Science, 22*, 327–339.

Bagozzi, B. E., Hill, D. W., Moore, W. H., & Mukherjee, B. (2015). Modeling two types of peace: the zero-inflated ordered Probit (ZiOP) model in conflict research. *Journal of Conflict Resolution, 59*(4), 728–752.

Bannon I & P Collier, eds. (2004) Natural resources and violent conflict: options and actions. The World Bank.

Barrett, C. B. (2010). Measuring food insecurity. *Science, 327*, 825–828.

Beger, Andreas, Jacqueline H. R. DeMeritt, Wonjae Hwang, and Will H. Moore. 2011. "The split population logit (SPopLogit): modeling measurement bias in binary data." Working Paper. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1773594 (accessed May 20, 2011).

Bellemare, M. F. (2015). Rising food prices, food price volatility, and social unrest. *American Journal of Agricultural Economics, 97*, 1–21.

Bontemps S, Defourny P, & Van Bogaert E (2009) Globcover 2009 Products Description and Validation Report. European Space Agency.

Brinkman H, & Hendrix CS (2011) Food Insecurity and Violent Conflict: Causes, Consequences, and Addressing the Challenges. Occasional Paper no. 24, World Food Programme.

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

Buhaug, H., Gates, S., & Lujala, P. (2009). Geography, rebel capability, and the duration of civil conflict. *Journal of Conflict Resolution, 53*, 544–569.

Burke, M., Miguel, E., Satyanath, S., Dykem, J., & Lobell, D. (2009). Warming increases the risk of war in Africa. *Proceedings of the National Academy of Sciences, 106*, 20670–20674.

Collier, P., & Hoeffler, A. (2005). Resource rents, governance, and conflict. *Journal of Conflict Resolution, 49*, 625–633.

De Schutter, O. (2011). How not to think of land-grabbing: three critiques of large-scale investments in farmland. *Journal of Peasant Studies, 38*, 249–279.

Detges, A. (2014). Close-up on renewable resources and armed conflict: the spatial logic of pastoralist violence in northern Kenya. *Political Geography, 42*, 57–65.

EarthStat (2015) Food Versus Fuel and Feed. Global Landscape Initiative, Institute on The Environment University of Minnesota and University of British Columbia. http://www.earthstat.org (accessed 10 November, 2015)

Ember, C. R., Skoggarda, I., Adema, T. A., & Faas, A. J. (2014). Rain and raids revisited: disaggregating ethnic group livestock raiding in the Ethiopian-Kenyan border region. *Civil Wars, 16*, 300–327.

Food and Agriculture Organization of the United Nations (FAO) (2008). *Climate change and food security: a framework document.* Rome: Food and Agriculture Organization of the United Nations.

Fearon, J. D., & Laitin, D. D. (2003). Ethnicity, insurgency, and civil war. *The American Political Science Review, 97*, 75–90.

Fjelde, H., & Hultman, L. (2014). Weakening the enemy: a disaggregated study of violence against civilians in Africa. *Journal of Conflict Resolution, 58*, 1230–1257.

Gleditsch, N. P., Wallensteen, P., Eriksson, M., Sollenberg, M., & Strand, H. (2002). Armed conflict 1946-2001: a new dataset. *Journal of Peace Research, 39*, 615–637.

Hegre, H., & Sambanis, N. (2006). Sensitivity analysis of empirical results on civil war onset. *Journal of Conflict Resolution, 50*, 508–535.

Hendrix, C. S., & Brinkman, H. (2013). Food security and conflict dynamics. *Stability, 2*, 1–18.

Hendrix, C. S., & Haggard, S. (2015). Global food prices, regime type, and urban unrest in the developing world. *Journal of Peace Research, 52*, 143–157.

Hendrix, C. S., & Salehyan, I. (2012). Climate change, rainfall, and social conflict in Africa. *Journal of Peace Research, 49*, 35–50.

Henk, D. W., & Rupiya, M. R. (2001). *Funding defense: challenges of buying military capability.* Carlisle, PA: Sub-Saharan Africa. U.S. Army War College Strategic Studies Institute.

Hsiang, S. M., & Meng, K. C. (2014). Reconciling disagreement over climate-conflict results in Africa. *Proceedings of the National Academy of Sciences, 111*, 2100–2103.

Kalyvas, S. N. (2004). The urban bias in research on civil war. *Security Studies, 13*, 160–190.

Kalyvas, S. N. (2006). *The logic of violence in civil war.* Cambridge, MA: Cambridge University Press.

Kastner, T., Rivas, M. J. I., Koch, W., & Nonhebel, S. (2012). Global changes in diets and the consequences for land requirements for food. *Proceedings of the National Academy of Sciences, 109*, 6868–6872.

Koubi, V., Bernauer, T., Kalbhenn, A., & Spilker, G. (2012). Climate variability, economic growth, and civil conflict. *Journal of Peace Research, 49*, 113–127.

Kress, M. (2002). *Operational logistic: the art and science of sustaining military operations*. Norwell, MA: Kluwer Academic Publishers.

Marshall MG, Jaggers K, & Gurr TR (2013) Polity IV project: political regime characteristics and transitions, 1800–2012. Technical Report.

Messer E, & Cohen MJ (2006) Conflict, Food Insecurity, and Globalization. FCND Discussion Paper 206, International Food Policy Research Institute.

Miguel, E., Satyanath, S., & Sergenti, E. (2004). Economic shocks and civil conflict: an instrumental variables approach. *Journal of Political Economy, 112*, 725–753.

Nordhaus, W. D. (2006). Geography and macroeconomics: new data and new findings. *Proceedings of the National Academy of Sciences, 103*, 3150–3517.

O'Loughlin, J., Witmer, F. D. W., Linke, A. M., Laing, A., Gettelman, A., & Dudhia, J. (2012). Climate variability and conflict risk in East Africa, 1990–2009. *Proceedings of the National Academy of Sciences, 109*, 18344–18349.

Paarlberg, R. L. (2000). The global food fight. *Foreign Affairs, 79*, 24–38.

Prunier, G. (2008). *Darfur: a twenty-first century genocide* (Third ed.). Ithaca, NY: Cornell University Press.

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

Rowhani, P., Degomme, O., Guha-Sapir, D., & Lambin, E. F. (2011). Malnutrition and conflict in East Africa: the impacts of resource variability on human security. *Climate Change, 105*, 207–222.

Scheffran, J., Brzoska, M., Kominek, J., Link, P. M., & Schilling, J. (2012). Climate change and violent conflict. *Science, 336*, 869–871.

Singer, J. D., Bremer, S., & Stucky, J. (1972). Capability distribution, uncertainty, and major power war. In B. Russett (Ed.), *Peace, war, and numbers* (pp. 1820–1965). Beverly Hills CA: Sage.

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

Theisen, O. M., Gleditsch, N. P., & Buhaug, H. (2013). Is climate change a driver of armed conflict? *Climatic Change, 117*, 613–625.

Tollefsen, A. F., Strand, H., & Buhaug, H. (2012). PRIO-GRID: a unified spatial data structure. *Journal of Peace Research, 49*, 363–374.

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

US Department of State (2010). *National Security Strategy of the United States. Office of the President of the United States*. DC: Washington.

Weinberg, J., & Bakker, R. (2015). Let them eat cake: food prices, domestic policy and social unrest. *Conflict Management Peace Science, 32*, 309–326.

World Bank (2015) World Development Indicators. Washington, D.C.: The World Bank (producer and distributor). http://data.worldbank.org/data-catalog/world-development-indicators

World Health Organization (2015) Trade, Foreign Policy, Diplomacy and Health: Food Security. http://www.who.int/trade/glossary/story028/en/ (accessed 12 June, 2015).

Worldwatch Institute (2013). *World Population, Agriculture, and Malnutrition*. .http://www.worldwatch.org/node/554 (accessed 5 May 2015

Wucherpfennig, J., Weidman, N. B., Giardin, L., Cederman, L.-E., & Andreas, W. (2011). Politically relevant ethnic groups across space and time: Introducing the GeoEPR dataset. *Conflict Management Peace Science, 20*(10), 1–15.