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Climate Change and Conflict

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Abstract

The link between climate change and conflict has been discussed intensively in academic literature during the past decade. This review aims to provide a clearer picture of what the research community currently has to say with regard to this nexus. It finds that the literature has not detected a robust and general effect linking climate to conflict onset. Substantial agreement exists that climatic changes contribute to conflict under some conditions and through certain pathways. In particular, the literature shows that climatic conditions breed conflict in fertile grounds: in regions dependent on agriculture and in combination and interaction with other socioeconomic and political factors such as a low level of economic development and political marginalization. Future research should continue to investigate how climatic changes interact with and/or are conditioned by socioeconomic, political, and demographic settings to cause conflict and uncover the causal mechanisms that link these two phenomena.

INTRODUCTION

The concept of national security was traditionally synonymous with the protection of the territorial integrity and political sovereignty of the state from external military aggression. However, with the end of the Cold War, this traditional conception of security was expanded to include resources, environmental and demographic issues, and in particular the so-called nonconventional threats such as resource scarcity, soil degradation, loss of biodiversity, and ozone depletion (Renner 2004). The emergence of the environmental security agenda linked the environment with notions of vulnerability, and associated these notions with the possibilities of conflict (Homer-Dixon 2001). In its Fourth Assessment Report (IPCC 2007, p. 2), the Intergovernmental Panel on Climate Change (IPCC) stated that "*warming of the climate system is unequivocal*" (emphasis added) and that climate change could become a major contributing factor to conflicts by exacerbating the scarcity of important natural resources, such as freshwater, and by triggering mass population dislocations (migration) due to extreme weather events, such as droughts and desertification, as well as rising sea levels. At the same time, a US governmental report elevated environmental issues to the forefront of the security agenda by identifying climate change as "potentially the greatest challenge to global stability and security, and therefore to national security" (CNA Corp. 2007). Subsequently, high-ranking policy makers including President Obama and the United Nations Secretary General Ban Ki-Moon, on many occasions, issued statements linking climate change to conflict.

With the acceleration of climate change and the focus on it as a security threat, the academic literature on climate change and conflict started to grow. During the last decade, numerous academic studies have sought to explore whether a climate change–conflict link exists and how climate change is—or could be—linked to conflict. Yet, while some scholars state that there is strong empirical evidence that climatic changes systematically increase conflict risk, others note that few empirical results are robust across studies.

The reason for this debate is easy to see in **Figure 1**. The Palmer Drought Severity Index map for the 2005–2014 period is overlaid by a map of all countries that experienced more than one civil conflict incident, i.e., a conflict with at least 25 battle-related deaths in a calendar year, in the 1989–2014 period.

The figure clearly shows that drought and civil conflict are correlated. A closer look, however, also reveals that drought and conflict coexist mostly in countries or regions that already suffer from adverse climatic changes, are highly dependent on agriculture for income and food generation, have few capabilities to cope with climatic changes, and are characterized by preexisting tensions and conflict (Ide et al. 2014). Hence, the relationship between climate change and conflict is more complex than the one depicted in this figure. In addition, a simple correlation between drought and conflict does not provide the causal explanation(s) needed to understand the mechanism(s) driving this relationship, which is what is ultimately required to assess the impact of climate change on future conflicts and help policy makers to prevent such conflicts.

In this article, I review the growing and diverse climate–conflict literature and suggest potential avenues for future research. I focus mostly, but not exclusively, on the quantitative literature, since recent research on climate change and conflict primarily employs quantitative large-N methods (see Ide 2017; this study also provides an excellent review of the research methods employed in the climate–conflict literature). I use the terms climate change, climate, climate variability, and climatic conditions to refer to climatic variables: temperature, precipitation/rainfall, and extreme weather events.

While most empirical studies claim to examine the relationship between climate change and conflict, they differ remarkably in the way they operationalize both concepts. Climate change is a large-scale, long-term shift in the planet's average temperatures and weather patterns. However, with the exception of a few studies that use data stretching back several centuries (e.g., Jia 2014,

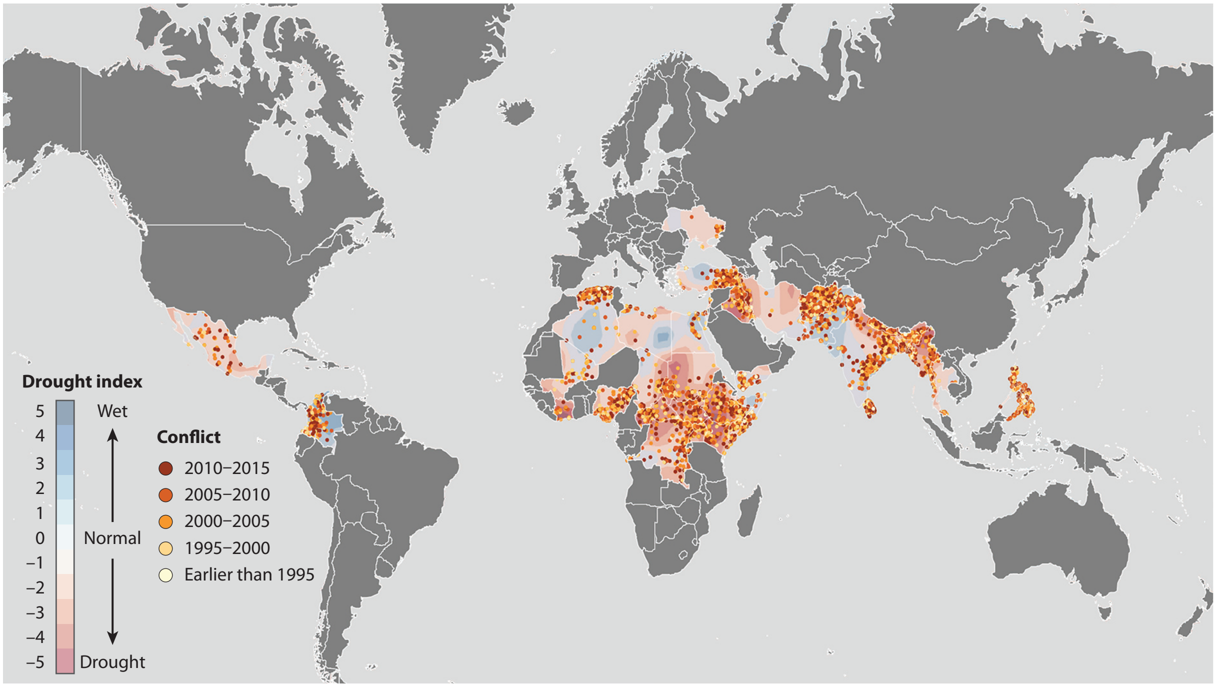

Figure 1

Palmer Drought Severity Index (2005–2014) and location of armed conflict events (1989–2014). Results are screened for countries with more than one recorded armed conflict event per year. Data taken from the National Oceanic and Atmospheric Administration (NOAA PDSI) and Uppsala Conflict Data Program Georeferenced Event Dataset (UCDP GED).

Zhang et al. 2011), most focus on the effect of short-term changes in weather patterns or climate variability—e.g., temperature (Bollfrass & Shaver 2015), precipitation/rainfall (Salehyan & Hendrix 2014), drought (Von Uexkull 2014), or natural disasters such as floods and storms (Ghimire & Ferreira 2016)—on conflict. Several scholars are skeptical whether the findings of such research could be extrapolated to the impacts of climate change on conflict, since an increase in temperature of 2°C in a certain month may have very different impacts than a long-term 2°C shift in the world mean temperature (e.g., Buhaug 2015). Nonetheless, examining the effects of a period of persistent high temperature could yield useful, though imperfect, insights into the effects of global warming in the short to medium term.

Conflict is also operationalized in many different ways. Some studies refer to violent acts that occur between individuals (interpersonal conflict), usually described as crimes, such as murder, assault, rape, and robbery (Mares & Moffetti 2016); others study violent acts between groups of individuals (intergroup conflict). Intergroup conflict encompasses conflict between states (Devlin & Hendrix 2014); violence against the government [civil war, defined by >1,000 battle-related deaths (Burke et al. 2009), and civil conflict, defined by at least 25 battle-related deaths (Von Uexkull et al. 2016)]; intercommunal violence (conflict between competing groups within a state) (Detges 2016); low-intensity conflict or social conflict, e.g., protests and riots (Bellemare 2015); and political repression (Wood & Wright 2016). Given that the literature does not specify any standard violent reaction to climatic changes, in this review I include all types of conflict.

Studies also differ with regard to geographic and temporal scales. Some look at conflict using the entire country as the unit of analysis (Buhaug et al. 2015); others focus on subnational units.

Examples of subnational units include administrative areas (Detges 2016); grid cells (Maystadt et al. 2015); and locations of conflict (Raleigh & Kniveton 2012), ethnic group(s) (Ember et al. 2014), or disasters (Nardulli et al. 2015). Measures of climate variability range from annual changes in temperature or precipitation (Bollfrass & Shaver 2015) to quarterly changes (Maystadt et al. 2015) to monthly changes (Maystadt & Ecker 2014).

Finally, studies use different econometric techniques. In the last decade, the literature has made remarkable progress with respect to data availability and quality, adding data resources such as the Uppsala Conflict Data Program Georeferenced Event Dataset (UCDP GED), the Social Conflict Analysis Database (SCAD), and the Armed Conflict Location and Event Data (ACLED). There have also been advances in statistical sophistication, such as the instrumental-variable approach, structural equation models, and Boolean logit.

The review starts with a discussion of the proposed pathways, both direct and indirect, as well as the theoretical mechanisms linking climate change to conflict. The review of the empirical literature is structured along these direct and indirect pathways. The last section highlights some of the theoretical and analytical shortcomings in existing research and points to several avenues for further research.

CLIMATE AND CONFLICT: PATHWAYS AND THEORETICAL MECHANISMS

How is climate change linked to conflict? There exist two potential pathways. The first one views climate as affecting the likelihood of conflict via direct physiological and/or psychological factors and resource scarcity. The second postulates that climate indirectly leads to conflict by reducing economic output and agricultural incomes, raising food prices, and increasing migration flows. Whether climate directly or indirectly affects conflict, however, depends on socioeconomic and political factors that condition (intensify or weaken) the effect.

Direct Pathway: Physiological and/or Psychological Factors and Resource Scarcity

Climate change is said to affect the likelihood of interpersonal violence due to some underlying physiological and/or psychological factors. That is, warmer or colder temperatures, by elevating levels of discomfort and aggressiveness, increase hostility and violence (Anderson & Bushman 2002). However, whether the temperature–aggression nexus occurs via physiological or psychological factors remains an important area of future research.

Climate change affects the likelihood of intragroup violence via the scarcity of renewable resources such as freshwater, arable land, forests, and fisheries. Following a neo-Malthusian line of argument, it is assumed that adverse climatic conditions, e.g., high temperatures or low rainfall, coupled with overpopulation reduce the resources needed to sustain human livelihood. Reduced resources increase competition, which leads to conflict (Homer-Dixon 2001). At the national level, for instance, less rainfall or high temperatures could lead to conflict among consumers of water, e.g., farmers and herders, as well as urban unrest, insurrections, and other forms of civil violence, especially in the developing world. Some scholars suggest that scarcity, especially around shared resources such as transboundary water resources, can also lead to interstate conflict (Gleditsch et al. 2006).

However, this line of argument has been heavily challenged. Scholars in the Cornucopian tradition, i.e., economic optimists including neoclassical economists, stress that absolute scarcity rarely occurs because efficient markets and functioning institutions effectively steer conservation, substitution, technological innovation, investment, and international trade to overcome scarcity (Lomborg 2001). In addition, political ecologists identify other factors such as poor governance, corruption, institutional instability, and other location-specific and structural conditions as important confounding factors in the relationship between resource scarcity and conflict (Barnett & Adger 2007). Consequently, they criticize the neo-Malthusian argument as being overly deterministic, since it removes violent conflict from its local social and political contexts (Raleigh et al. 2014).

Indirect Pathways: Economic Outcomes and Migration

The indirect pathways focus on the effect of climate change on conflict via economic impacts and migration. There are several possible causal mechanisms underlying these relationships, which are mainly drawn from the conflict literature.

Economic output. According to economic theory, the rate of crime is expected to increase when wages and employment decline because rational individuals, taking into account the relative returns, costs, and risks, decide to prey rather than produce. The same logic has been applied to rebellion: An individual's incentive to rebel rises as individual/household income and economic opportunities decline (Chassang & Padró i Miquel 2009). Consequently, since adverse climatic conditions, e.g., higher temperature, lower precipitation, or extreme weather events, depress output (Burke et al. 2015, Dell et al. 2012; for a review of the literature see Dell et al. 2014), many scholars predict an inverse relationship between climate-depressed economic output and conflict (e.g., Miguel et al. 2004).

Climatic variability and extreme weather events, however, are unlikely to affect all individual/household incomes within a country equally. Such events are more likely to directly affect agricultural incomes due to their heavy dependence on weather conditions. This implies that the opportunity cost theory predicts the strongest inverse relationship between insurrection and agricultural incomes (Dal Bó & Dal Bó 2011). Therefore, the expectation should be that loss of agricultural income due to adverse climatic conditions could trigger the onset of conflict, while loss of national income due to climate would be associated with the duration and intensity of conflict. This is because during peacetime, the collective action problem inherent in instigating rebellion is more severe and harder to overcome, and governments are more resilient to economic shocks and better able to respond to challenges and avoid conflict. Yet, studies rarely make such distinctions between the causes and dynamics of conflict.

In addition, adverse climatic conditions can lead to higher food prices by dramatically reducing crop yields and the subsequent supply of crops. Temporary food price increases are likely to amplify the opportunity cost of rebellion, since they further reduce the short-term opportunity cost of fighting (Chassang & Padró i Miquel 2009). Moreover, since existing theories suggest that transitory shocks are sufficient to solve collective action problems and mobilize individuals for political ends (e.g., Acemoglu & Robinson 2001), higher food prices due to climatic changes should lead to onset of low-level political violence such as demonstrations, protests, and riots, especially in urban settings where residents lack access to cheap substitutes.

Output contractions due to adverse weather shocks could also shrink government coffers through a reduction in tax revenue. Limited resources curtail a leader's capacity to provide goods and services to the public, keep her political promises, maintain or build patronage networks, and buy off real and potential opposition, thus making it easier for opponents to organize political resistance, e.g., a coup or a revolution to remove the leader from office (Bueno de Mesquita & Smith

2017). In particular, the inability of a government to provide for its people after a natural disaster could ignite protests against the government. Natural disasters could also hamper a government's ability to wage a counterinsurgency due to reduced revenues and destruction of infrastructure, thus prolonging the duration of civil conflict.

Finally, climate-driven economic downturns are likely to exacerbate actual or perceived economic inequality in a society, which increases the likelihood of conflict. The key concept linking inequality to conflict is relative deprivation, which captures the extent to which people's expectations about what they should be achieving exceed their actual levels of achievement. Relative deprivation leads to frustration and aggression, which motivate individuals to participate in rebellion to redistribute wealth and political power. Grievances due to climate-induced adverse economic conditions could lead to low-level conflict, such as protests when food prices rise as well as to civil conflict when a certain (ethnic) group is particularly affected by such conditions and is excluded from political power (Cederman et al. 2013).

Migration. Climate change can cause a large number of people to flee from their homes (Koubi et al. 2016). The influx of large numbers of "environmental migrants" is likely to burden economic and resource bases in the receiving areas, thus promoting contests over scarce resources (Brzoska & Fröhlich 2015, Reuveny 2007). For instance, migrants and residents may compete over land, jobs, health care, education, and social services. In addition, environmental migration could lead to conflict by stirring ethnic tensions that arise when migrants and residents belong to different ethnocultural groups and the arrival of newcomers upsets an unstable ethnopolitical balance (Brzoska & Fröhlich 2015; see also Gaikwad & Nellis 2017).

Contextual Factors: Economic Development and Political Institutions

Climate can act as a threat multiplier (CNA Corp. 2007) in that it has the potential to exacerbate a wide range of existing and often interacting conflict drivers such as resource scarcity and unmanaged migration. Yet, its effects on conflict are likely to vary with contextual factors such as national and local economic development, political institutions, and administrative capacity of national and local governments to address climate-related problems. Countries with high levels of poverty and high dependence on renewable resources, e.g., agriculture, are more susceptible to climate-related adverse economic conditions, which in turn are often associated with higher likelihood of conflict (Ide et al. 2014). Climate-induced migration, especially in underdeveloped countries, might exacerbate the likelihood of conflict since these countries typically find it more difficult to absorb and manage an influx of migrants in urban settings (Reuveny 2007). In addition, political institutions and government capacity at multiple levels are important in addressing acute resource shortages and resolving these in a peaceful manner (Linke et al. 2017). For instance, regions or countries with high administrative capacity and low levels of corruption as well as inclusive political institutions experience less violent conflict because leaders have the incentive to provide economic support, infrastructure, and social services to their citizenry for alleviating climatic hardship in order to stay in power (Bueno de Mesquita & Smith 2017).

EMPIRICAL EVIDENCE

Direct Pathway

Numerous empirical studies report a direct, positive relationship between temperature and different forms of interpersonal violence, e.g., murder, assault, rape, burglary, interplayer violence during sporting events, and horn-honking while driving, in different time periods and geographical regions (e.g., Mares & Moffetti 2016, Ranson 2014). For example, Mares & Moffetti (2016) find that homicide rates increase as temperatures rise in a sample of 57 countries for the period 1995–2012. They also claim that this positive relationship will continue as global warming raises average temperatures around the world and predict that each degree Celsius increase in global temperature will increase homicide rates by 6%. Overall, these studies and the evidence provided suggest that temperature has an immediate effect on criminal activity.

The first wave of large-N quantitative research examining the link between climate-induced scarcity and intergroup conflict focuses mostly on Africa and Asia or regions/countries within these continents due to their vulnerability to climatic changes. Studies have correlated meteorological or climatological indicators such as extreme temperatures, storms, or droughts with different forms of conflict. This research, however, provides inconclusive evidence for a strong direct relationship between temperature and intergroup conflict (Gleditsch 2012, Bernauer et al. 2012). On the one hand, Hsiang et al. (2011) find that the probability of civil conflict onset in the tropics during El Niño Southern Oscillation years is twice as large as in La Niña years. Similarly, Burke et al. (2009) report that temperature increases had a significantly positive effect on civil war incidence in sub-Saharan Africa in the period 1981–2002 and conclude that current greenhouse gas emissions would increase the incidence of civil war by about 50% by 2030. In contrast, Buhaug (2010), using an expanded data set and different econometric models, shows that temperature does not predict civil conflict in Africa. Consequently, Buhaug (2010) criticized the Burke et al. (2009) result as being sensitive to (*a*) the operationalization of the dependent variable, (*b*) the time-period and country sample, and (*c*) the use of country fixed effects and the omission of other known determinants of conflict such as social and geopolitical factors. In response to these criticisms, Burke et al. (2010) revised their model and reported additional results confirming a weak relationship between temperature and conflict, which disappeared after 2002, conceivably due to international peacekeeping efforts, economic development, and improvements in domestic governance. While this debate clearly indicates different disciplinary modeling practices, additional research on temperature and conflict provides similarly contradictory results. Some studies report a positive effect of temperature on conflict onset or incidence at the global level (e.g., Landis 2014, Bollfrass & Shaver 2015) as well as on violent events in Africa (e.g., O'Loughlin et al. 2014), but others do not find an effect (e.g., Wischnath & Buhaug 2014a, Böhmelt et al. 2014). Higher temperature, though, seems to increase the likelihood of low-level conflicts such as urban riots (Yeeles 2015), as well as political instability in the form of irregular leader transitions (i.e., coups) (Dell et al. 2012) and incumbents' electoral losses potentially speeding democratic turnover (Obradovich 2017).

Research on precipitation and precipitation extremes, i.e., lower or higher than normal, has yielded similarly contradicting results. While several studies show that wetter years increase the incidence and intensity of civil conflict, especially in less developed countries (e.g., Salehyan & Hendrix 2014, Bollfrass & Shaver 2015), the majority of studies fail to uncover robust effects of precipitation on conflict (e.g., Wischnath & Buhaug 2014a, Böhmelt et al. 2014, Couttenier & Soubeyran 2013). Klomp & Bulte (2013) also do not find any evidence that El Niño is linked to civil conflict onset in sub-Saharan Africa, refuting Hsiang et al.'s (2011) result. Since both climate and conflict are unlikely to affect a whole country in a similar fashion, several studies employ spatially disaggregated data to examine the effect of extreme rainfall reduction, associated with drought, on conflict. For instance, researchers employing the UCDP GED data set have demonstrated that no direct and localized relationship exists between drought and civil conflict onset in Africa (Theisen et al. 2012) or Asia (Wischnath & Buhaug 2014a). They conclude that the primary causes of civil conflict are economic and sociopolitical rather than climatological.

Studies also examine the relationship between precipitation extremes and conflict at the communal level in Africa using mostly disaggregated data (e.g., ACLED, SCAD). These studies show that precipitation extremes affect conflict, but they disagree on the nature of the extremes. On the one hand, exceptionally dry conditions increase the risk of communal conflict in Sudan (Maystadt et al. 2015) and sub-Saharan Africa (Fjelde & von Uexkull 2012), as well as livestock-related violence in Kenya (Ember et al. 2014). On the other hand, unusually wet periods increase communal violence in Ethiopia, Kenya, and Uganda (Raleigh & Kniveton 2012; for Kenya, see also Theisen 2012). At first glance, the latter finding is a surprising one, given that climate change is predicted to create scarcity rather than abundance [abundance is expected to lead to conflict in the case of nonrenewable resources such as oil and diamonds (Koubi et al. 2014)]. It seems, however, that pastoralist violence occurs during periods of higher rainfall because it gives pastoralists a strategic advantage: higher rainfall makes it easier for raiders to escape by washing away the tracks of stolen animals, and thick vegetation provides opportunities to hide (Raleigh & Kniveton 2012). While this finding places the scarcity argument on its head, still it captures logistical considerations that are unique to the livestock raiding in East Africa, and hence it might be difficult to generalize beyond this area. Finally, other studies show that drier-than-normal conditions do not affect conflict but wetter-than-normal conditions seem to decrease the risk of violence in East Africa (O'Loughlin et al. 2012, 2014).

Less precipitation, by reducing the supply of water in transboundary river basins, can increase the probability of interstate conflict. Research indicates that water scarcity increases the risk of conflict in river-sharing dyads relative to other pairs of countries (Gleditsch et al. 2006) and that this risk is more pronounced in upstream/downstream configurations (Brochmann & Gleditsch 2012). The most recent study on this topic (Devlin & Hendrix 2014), however, finds that joint precipitation scarcity, i.e., when both members of a dyad experience drier-than-average conditions, reduces the likelihood of an interstate militarized dispute. Other studies report that water scarcity enhances the incentives of riparian states to cooperate rather than to fight (Dinar et al. 2015). In addition, the existence of transboundary treaties, the specific design of international water agreements, and effective international frameworks for water allocation further mitigate the risk of conflict (Dinar et al. 2015). Link et al. (2016), though, note that successful management of shared river basins in times of climatic changes should not be based on water allocation schemes alone; it should also consider other socioeconomic and political factors that connect water availability, e.g., adaptive capacity and construction of dams, with cooperation or conflict (see also De Stefano et al. 2017).

Climate change is predicted to increase both the frequency and intensity of extreme weather events such as storms, floods, landslides, and droughts. With the exception of drought, most natural disasters occur relatively abruptly and do not last for an extended period. Yet, by damaging public and private infrastructure, destroying crops, and killing livestock, they can cause or worsen scarcity that can lead to conflict. While the existing empirical literature does not provide strong evidence that natural disasters affect the onset of conflict, it seems that natural disasters increase the duration of civil conflict (Ghimire & Ferreira 2016). Natural disasters also increase state-sponsored repression (Wood & Wright 2016), the incidence and severity of insurgent and government attacks (Eastin 2018), and transnational terrorism (Paul & Bagchi 2016). Nardulli et al. (2015) compare the pre- and post-disaster levels of civil unrest, measured as the number of demonstrations and strikes as well as political attacks initiated by nonstate actors. They show that post-disaster periods have significantly higher levels of unrest, but this result is driven by only one in six disasters. They also find that while a higher number of fatalities increases unrest, a higher proportion of a country's population affected by the disaster decreases unrest. A possible explanation for the latter finding is that widespread disasters generate solidarity and cooperation (see also Theisen 2012).

While the inconclusiveness of the empirical results might be due to the differences in data sets (e.g., temporal and spatial domains and the operationalization of both dependent and independent variables) and model specification (e.g., fixed effects and inclusion of control variables), heterogeneity also plays an important role. That is, studies examining the direct effect of climate on conflict (with the exception of the very few that use disaggregated data) assume that the effect is the same within a country and across different types of countries or regions. However, given that neither climatic shocks nor conflict risk affects all the territory of a state in the same way, it seems unlikely that a given climatic shock would have the same effect across different countries and socioeconomic and political contexts. Climatic shocks usually do not lead to conflicts in wealthy and politically stable countries. Consequently, criticism has arisen that the direct connections between climate and civil conflict are a type of environmental determinism that "reduces conflict to an immediate and unmediated function of physical, biological and physical–geographical signals" and should thus be avoided (Raleigh et al. 2014, p. 76). Several scholars indeed note that other factors, e.g., population pressure, nondemocratic political regime, low economic development, and ethnopolitical exclusion, are likely either to condition this relationship (Buhaug 2015, Ide et al. 2014, Gleditsch 2012) or to have a stronger impact on conflict risk than adverse climatic conditions (O'Loughlin et al. 2014, Böhmelt et al. 2014).

Indirect Pathways

Existing empirical research on the indirect effects of climatic changes on conflict concentrates on economic outcomes, such as income, agricultural production and food prices, and migration.

Adverse economic outcomes. Adverse climatic conditions can lead to intergroup violence by hindering economic growth, reducing agricultural production, and triggering food scarcity and/or price volatility for staple commodities (Dell et al. 2012; for a review of the literature see Dell et al. 2014). The existing empirical literature, however, provides quite ambiguous results, particularly for precipitation. In an influential study, not directly related to the climate–conflict nexus, Miguel et al. (2004) examine the effects of income on civil war in Africa. Recognizing that income is endogenous to conflict, they employ an instrument for income. Given that income in Africa depends largely on agriculture, that agricultural income varies with rainfall patterns since only a very small percentage of the land is irrigated, and that rainfall is exogenous to conflict (i.e., there is no plausible mechanism through which the weather is influenced by conflict), Miguel et al. (2004) use rainfall as an instrumental variable for income growth. Specifically, they regress the incidence of civil war on rainfall growth (and lagged rainfall growth) for 41 sub-Saharan African countries for the period 1981–1999, arguing that negative rainfall growth represents an unfavorable agricultural productivity shock that can lead to civil war. They find that lower rainfall growth leads to more conflict and state that their findings provide evidence for the opportunity cost mechanism.

Ciccone (2011), however, claims that rainfall growth rates are not an appropriate measure of a rainfall shock due to the mean-reverting nature of rainfall. That is, positive or negative rainfall shocks are likely to be followed by a reversal to average values. This means that positive growth in year-on-year rainfall may reflect either a positive rainfall shock or a reversal to normal conditions following a negative shock. He then re-evaluates the Miguel et al. (2004) analysis after extending the time period beyond 2000 and replacing rainfall growth rates with overall rainfall levels and finds that conflict is unrelated to rainfall. In a reply, Miguel & Satyanath (2011) note that the relationship between rainfall shocks and economic growth does not appear to hold in the period 2000–2009 because of Africa's unprecedented economic growth in nonagricultural sectors and, perhaps, the spread of democratization. Once again, the conclusions regarding the climate–conflict relationship are heavily influenced by data and modeling choices.

Miguel et al.'s (2004) work has since been extended to other regions and other forms of conflict. Recent studies at the national level in Africa or globally, however, fail to find a robust link from precipitation and/or temperature deviations (Van Weezel 2015, Koubi et al. 2012) or natural disasters (Bergholt & Lujala 2012) to civil conflict onset. Mixed evidence is also provided by studies that employ disaggregated data sets. For instance, while Hodler & Raschky (2014) report that economic shocks, measured by nighttime light intensity and instrumented by lagged rainfall levels and droughts, increase the probability of civil conflict in Africa, Wischnath & Buhaug (2014a), using rainfall and temperature anomalies as instruments for economic growth, fail to reveal a robust connection between climate and civil conflict onset in Asia.

Although studies using the instrumental-variable approach claim to have uncovered a strong causal relationship between economic decline due to adverse climate and conflict (e.g., Miguel et al. 2004), the validity of any climatic variable as an instrument is disputed, as it is difficult to prove that climate satisfies the exclusion restriction that an instrumental variable must meet. If climate *only* affects conflict through economic growth or economic conditions in general, then it satisfies the restriction. However, climate could influence conflict through other channels, such as migration or tactical considerations by rebels. For instance, one could argue that during periods of heavy rainfall, fighters are less willing to fight (Gawande et al. 2017) and/or roads become flooded or damaged, making it more difficult for rebel groups to organize (Miguel et al. 2004). Raleigh & Kniveton (2012) find evidence that rebel violence is more common in dry periods when movements are easier and conflict logistics require less effort as there are fewer diseases and the harvest period allows for subsistence. It is thus not evident that climatic variables satisfy the exclusion restriction required of instrumental variables.

Hsiang et al. (2013), seeking to systematically examine the climate–conflict relationship, conduct a meta-analysis based on 60 quantitative studies. To be included in the analysis, a study should employ or could be specified as fixed-effect panel regression of a reduced form equation, i.e., it should regress climatic (contemporaneous and lagged) variables on conflict, and also include time- and location-specific fixed effects in favor of specific economic and political variables. In defense of their modeling choice, Hsiang et al. argue that socioeconomic and political variables such as gross domestic product are "bad controls" because they are endogenously determined and may themselves be affected by climatic conditions. Furthermore, the authors combine studies with different temporal and geographical scales as well as measures of conflict and climate. For instance, they include a study on violence in baseball games, along with studies on communal violence, civil conflict, and wars fought centuries ago. Hsiang et al. conclude that deviations from mild temperatures and normal precipitation systematically increase conflict risk, often substantially, and estimate that on average, a one-standard-deviation change in weather variables increases intergroup conflict by 14%. Buhaug et al. (2014) criticize this study with respect to sample selection, selection of indicators, and interpretation of results and point out that the conclusion is misleading and at odds with recent empirical evidence. The UN IPCC's Fifth Assessment Report (IPCC 2014) supports Buhaug et al.'s critique, stating that climatic changes *indirectly* increase the risk of conflict by amplifying well-documented drivers of conflict such as poverty and economic shocks.

Given the natural relationship between weather and agricultural production, agriculture has been the focus of much of the recent empirical literature on climate and conflict. Several studies provide evidence for a relationship between climate-induced reduction in agricultural production and conflict across many centuries. However, they disagree on which particular type of climatic change is the most influential. On the one hand, Zhang et al. (2011), using data stretching back 1,000 years, show that by reducing agricultural production, cooler temperatures caused conflict in the northern hemisphere. Similarly, Anderson et al. (2015) employ panel data from 1100 to 1800 and show that colder growing seasons led to greater expulsion of the Jewish population from European cities during the fourteenth to sixteenth centuries, and that the effect was stronger in societies with lower state capacity. Jia (2014), on the other hand, using panel analysis for the period between 1470 and 1900, shows that drought triggered peasant rebellions in China, and that technological innovation in the form of the introduction of drought-resistant sweet potatoes mitigated the drought's effect on rebellion.

Studies using recent data focus on areas where agriculture based on rain-fed crops represents a large share of the national income, such as sub-Saharan Africa and Asia. These studies use the instrumental-variable approach and, with the exception of Buhaug et al. (2015) and Wischnath & Buhaug (2014b), report that adverse climatic conditions affect various types and dynamics of conflict via their negative effect on agricultural production, livestock prices, and incomes. The low opportunity cost is the main mechanism that leads to conflict. In particular, Gawande et al. (2017) find that rainfall shocks by reducing agricultural output increase the intensity of conflict, measured as number of killings, in the Maoist belt in India. Maystadt & Ecker (2014) report that drought by decreasing livestock prices increases the incidence of communal conflict in Somalia. Studies focusing on climate-depressed agricultural incomes show that drought increases the incidence of most crimes, including burglary, banditry, rape, riot, and murder in India (Blakeslee & Fishman 2018). Rainfall extremes increase the probability and intensity of land invasion in Brazil (Hidalgo et al. 2010); the intensity of guerrilla and paramilitary attacks, as well as the numbers of clashes and casualties, in coffee-producing municipalities in Colombia (Dube & Vargas 2013); and the number of Hindu–Muslim riots in India (Sarsons 2015). Sarsons (2015), however, finds that rainfall shortages and riots continue to occur together in districts with dams that supply irrigation, which should make agricultural production less sensitive to rain shocks. This suggests that agricultural income is unlikely to be the only channel that links climate to conflict in this context. Hence, by presenting evidence of violation of the exclusion restriction, Sarsons undermines the validity of rainfall and temperature as valid instruments for economic conditions and casts serious doubt on the reliability of the results of the relevant studies.

Furthermore, a few studies seeking to construct a better measure of agricultural production exploit the within-year variation in the timing of climate shocks that occur during the growing season of the main crop(s) cultivated in an area (country or grid). For example, such studies find that lower or higher temperatures during the core month of the rice-growing season in Indonesia (Caruso et al. 2016) or the maize-growing season in sub-Saharan Africa (Jun 2017) reduce the crops' yield, and the reductions in turn increase the incidence of civil conflict. Similarly, Harari & La Ferrara (2018) show that weather shocks such as above-average temperatures or below-average rainfall during the growing season of several types of crops in 39 African countries have a larger impact on conflict-related incidents than weather shocks outside of the growing season.

In addition to causing income shocks to agricultural producers, adverse climate can also affect consumers by increasing the prices of the affected crops, and hence food prices. Higher food prices lead to various forms of social unrest, such as demonstrations, riots, and government crises. For instance, it is often stated that rising food prices played a role in fomenting the Arab Spring unrest across North Africa and the Middle East in 2011. Several studies emphasize grievances and report a positive relationship between higher food prices caused by decreased rainfall or natural disasters and the outbreak of urban unrest in African countries (Smith 2014) or the incidence of social unrest globally (Bellemare 2015). Higher food prices due to adverse climatic conditions can also affect civil conflict; for instance, Raleigh et al. (2015), using disaggregated data for 113 African markets from January 1997 to April 2010, find that decreased rainfall increases the incidence of violent conflict through its effect on food prices.

Despite their preliminary nature, these findings suggest collectively that adverse economic conditions due to climate do not lead to a higher risk of conflict, but rather they affect dynamics of conflict such as duration, severity, and intensity.

Migration. The migration channel through which changes in the climate could significantly increase the probability of conflict has been rarely explored systematically (Burke et al. 2015). The evidence provided by the limited large-N studies is inconclusive (e.g., Brzoska & Fröhlich 2015, Bernauer et al. 2012). For example, Reuveny (2007) examines 38 cases of recognized environmental migration episodes, about 50% of which coincided with conflict. He concludes that it is difficult to identify "purely environmental" clashes. Ghimire et al. (2015) report that displacement caused by catastrophic floods is likely to lengthen the duration of an existing civil conflict, but it does not affect the risk of new conflict outbreaks. Similarly, Bhavnani & Lacina (2015), using irregular rainfall patterns in migrant-sending Indian states as an instrument for migration, find that greater rates of internal migration are associated with a higher risk of riots. Finally, De Juan (2015) reports that violence, measured as number of villages attacked or destroyed, during the early years of the Darfur war was more prevalent in areas that experienced higher water availability and more vegetation. He attributes the increase in conflict incidents to resource competition resulting from high levels of immigration in these areas from areas with decreasing resource availability.

The lack of conclusive evidence linking climatic changes with migration and conflict is largely due to the inability of the existing research to model adequately the complexity of this relationship. For instance, most of the existing literature assumes that all types of climatic change, e.g., floods and droughts, lead to conflict and that all environmental migrants are equally prone to conflictive behavior. However, migration due to a short-term climatic event such as a flood is less likely to cause conflict than migration due to a long-term climatic event such as a drought. This is because migrants responding to short-term climatic events are unlikely to compete with locals in the receiving areas for jobs and public services, and the migrants tend to be welcomed, as they are perceived by the locals as having no other option than to flee the disaster-affected areas. Moreover, the distribution of humanitarian aid is likely to alleviate immediate scarcities. In addition, the extant research focuses on more aggregated levels of analysis, such as the country or region, and hence it risks drawing imprecise inferences due to the difficulties in separating the effect of climatic change from the many other determinants of conflict. Koubi et al. (2018) focus on the individual and argue that migrants who experience gradual, long-term climatic events such as droughts or desertification in their place of origin, relative to the ones who experience sudden, short-term climatic events such as floods and storms, are more likely to have developed grievances that lead to heightened conflict perceptions in their new location. Relying on individual-level survey data from five developing countries, the authors find that indeed migrants who had experienced long-term climatic changes show significantly higher levels of perceived conflict in their new location. This study shows that it is crucial to understand why migrants leave their homes and how residents in the host locations perceive them in order to be able to prevent conflict in the receiving areas. This is one of the most important priorities for future research on the security implications of climate change.

Contextual Factors

Studies interact and/or combine climatic variables with socioeconomic and political factors to examine when and where conflict occurs. Overall, these studies reveal that adverse climatic conditions are more likely to lead to conflict in places that already experience conflict, and where institutions are ineffective, essential services are difficult to obtain, and people are vulnerable to these climatic conditions. In particular, climate-induced economic shocks are more likely to lead to civil conflict onset in autocratic regimes (Koubi et al. 2012) and to increase the number of land invasions in Brazilian municipalities that are highly unequal (Hidalgo et al. 2010). Drought increases the incidence of both civil conflict and communal violence in African regions lacking road infrastructure and access to improved water sources (Detges 2016, Jones et al. 2017). Drought also increases the likelihood of sustained violence in regions with agriculturally dependent (Von Uexkull et al. 2016) and politically excluded (Schleussner et al. 2016, Von Uexkull 2014) groups, as well as the incidence of rebel-perpetrated atrocities against civilians in agricultural areas of developing countries (Bagozzi et al. 2017). A recent study, however, shows that intercommunity dialogue between ethnic groups and certain natural resource use rules seem to moderate the effect of drought on individuals' support for violence (Linke et al. 2017). This finding recognizes the existence of factors that could counteract the effects of climatic changes on conflict while still admitting that climate change in itself constitutes an indirect conflict factor. Overall, this strand of research shows that while conflicts cannot be attributed solely to climate change, this does not mean that climate change is not among the important contributors to conflict.

CONCLUSION

In this article, I review and summarize the recent literature on the links between climate change and conflict. Results from this growing body of rigorous quantitative research in political science as well as in economics and other disciplines indicate that climate change acts as a threat multiplier in several of the world's regions. Four avenues for future research seem particularly promising (and badly needed).

First, scholars should continue to investigate how climatic changes interact with and/or are conditioned by socioeconomic, political, and demographic settings to cause conflict. In other words, scholars must peruse when and where climatic conditions are more likely to lead to conflict. The civil conflict in Syria is a case in point. Many academics and policy makers attribute the civil conflict in Syria to the drought that occurred in late 2000. However, the same drought also affected neighboring countries such as Israel, Jordan, and Lebanon, where civil conflict did not occur. Consequently, one could argue that government policies such as the mismanagement of natural resources or the cancellation of important subsidies forced people to migrate to urban settings, where high youth unemployment and state repression helped trigger the Syrian popular uprising, and the subsequent violent response by the Syrian government led to civil war. Had the Syrian government implemented better economic and social policies, and properly responded to the humanitarian crisis caused by the drought, the conflict most likely would not have occurred. Recent research aiming at forecasting conflict confirms that policies that improve good governance and uphold political rights reduce projected conflict risks (Hegre et al. 2016, Witmer et al. 2017).

Second, scholarly work on the climate–conflict nexus should look beyond African countries formerly under British colonial rule, e.g., Kenya. While the attention to these countries has led to an improved understanding of the complex relationship between climatic conditions and conflict, the focus on countries that experience conflict (i.e., selection on the dependent variable) and are convenient to conduct research in induces a "streetlight effect" (Adams et al. 2018) that limits our ability to make any strong inferences regarding this relationship. Scholars should examine countries that regularly experience adverse climatic conditions but not conflict in order to properly understand how climatic conditions and conflict are connected.

Third, although there is increasing evidence that climatic conditions are associated with conflicts, still scholars need to provide clear explanations as to how and why the association exists. The interpretation of many studies also contains considerable confusion of correlation and causation regarding the linkages between climate change and conflict because authors tend to present and push more detailed theories than they can actually test with quantitative data. Consequently, scholars should study the causal mechanisms that link climate change to conflict. This is not an easy task, as multiple mechanisms could contribute to conflict in one setting and different mechanisms could dominate in different contexts. Nevertheless, this is of utmost importance, since only if we understand why conflict arises in the presence of adverse climatic conditions can we design appropriate policies and institutions to avoid conflict. Micro-level case studies along the lines of Koubi et al. (2018), Linke et al. (2017), and Dube & Vargas (2013) may be a fruitful way forward.

Finally, scholars should examine the effects of abundance. With the exception of a few studies which claim that climate-induced abundance can contribute to civil conflict (e.g., Salehyan & Hendrix 2014), the literature so far has focused exclusively on scarcity. However, climate change could contribute to the sort of abundances that could contribute to conflict. For instance, higher temperatures, by causing the melting of the polar ice cap in the Arctic, will improve accessibility to Arctic ports, reduce costs of oil and mineral exploration and exploitation, and open up new shipping lanes. Under these circumstances, competition and conflict could become the Arctic reality if cooperative mechanisms cannot keep pace with developments or otherwise prove inadequate to settle international disputes in the region. Future research could examine whether climate change could act as a threat multiplier also for interstate conflict in the Arctic.

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