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# Climate Change and Conflict: Avoiding Small Talk about the Weather[1]

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Will climate change cause conflict? Policymakers seem convinced that, at the very least, climate change will exacerbate groups' tendencies toward violence. Yet, climate change–conflict researchers have failed to uncover consistent linkages between environmental shifts and intrastate contention. This article examines recent research in the field in order to ascertain the reasons for this disconnect. It argues that, although climate change–conflict research has been characterized by significant methodological innovations, theoretical propositions have not kept pace. Rather than developing claims that are specific to climate change–conflict relationships, analysts tend to import arguments from the earlier environmental conflict and civil wars literatures, with little modification. As a result, it is often unclear whether the climate change–conflict relationship is actually being tested. The article offers three recommendations for further specification of theoretical arguments: explicit incorporation of agricultural variables into climate change–conflict models; maintenance of the recent emphasis on conditional effects, with greater attention to local institutions; and a shift in analytic focus from climate *change* to climate *uncertainty*.

Will climate change cause conflict? Recent statements by political leaders suggest that climate change is a significant security threat. UN Secretary General Ban Ki-Moon has issued numerous statements about the negative human security implications of climate change.[2] During his second week in office, American President Barack Obama claimed that "urgent dangers to our national and economic security are compounded by the long-term threat of climate change, which, if left unchecked, could result in violent conflict."[3] The issue has also attracted interest in academic circles; a robust research program has emerged, with special issues of *Political Geography* (2007) and the *Journal of Peace Research* (2012) devoted to the topic. Yet, after a half decade of work, scholars have failed to identify consistent relationships between climate change and conflict in systematic, cross-national analyses (for overviews, see Buhaug, Gleditsch, and Theisen 2008; Salehyan 2008; Bernauer, Böhmelt, and Koubi 2012; Gleditsch 2012; Scheffran, Brzoska, Kominek, Link, and Schilling 2012).

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[2]For example, at the 18th session of the Conference of the Parties to the UNFCCC, on December 4, 2012. Remarks available at http://www.un.org/sg/statements/index.asp?nid=6482 (Accessed December 13, 2012).

[3]Remarks by President Barack Obama on "Jobs, Energy Independence, and Climate Change," East Room of the White House, January 26, 2009. Cited in Nordås and Gleditsch (2009).

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This has led some researchers to question the existence of a climate change–conflict connection: or at least, the importance of climate change as a driver of conflict, relative to other factors (Turner 2004; Barnett and Adger 2007; Raleigh 2010; Benjaminsen, Alinon, Buhaug, and Buseth 2012; Gleditsch 2012; Slettebak 2012). However, it is also possible that linkages have not been identified because of shortcomings in present methodological and theoretical approaches to the topic. This article, while agnostic about the actual existence of climate change-conflict linkages, identifies some characteristics of recent quantitative research that may contribute to the inconsistency of empirical findings. It also offers suggestions for alternative approaches. By providing a tighter coupling between theory and analysis, these strategies are more likely to either demonstrate a clear connection between climate change and conflict or provide more compelling evidence that such a relationship does not exist, even under most likely conditions.

The article proceeds in five sections. The first reflects on the similarities between recent climate change–conflict research and previous work on environmental conflict, observing that the contemporary research agenda is repeating—and even exacerbating—errors of the past. The most prominent of these is the issue of extended causal chains; theoretical models of the relationships between climate change and conflict are extremely complex, involving many intervening variables and indirect effects. Yet, most quantitative analyses evaluate the direct effects of climatological variables on conflict, overlooking these nuances (Hendrix and Glaser 2007; Meier, Bond, and Bond 2007; Burke, Miguel, Satyanath, Dykema, and Lobell 2009; Theisen, Holtermann, and Buhaug 2011/12; Benjaminsen et al. 2012; Hendrix and Salehyan 2012; Raleigh and Kniveton 2012). The potential for model misspecification is therefore very high.

The second section identifies a number of recent methodological developments in climate change–conflict research, which help to rectify the mismatch between theory and models. The first is the production of data sets on smaller scale and nonstate conflicts: the types of contention that are most likely to be associated with environmental shifts. The second development is the use of geographically disaggregated data. By geo-locating conflicts and collecting environmental, economic, and social data at the subnational level, researchers can more accurately identify correlations between environmental changes and conflict events, avoiding false positives. A third development is the use of two-stage statistical analysis techniques. These enable researchers to model the indirect effects of climate change on conflict via an intermediate variable: often, economic growth. Although two-stage analyses still omit many portions of proposed theoretical linkages between climate change and conflict, they nonetheless represent a step forward in responding to the issue of extended causal chains.

While recent methodological developments have been very promising, the article's third section argues that their utility is compromised by the continuing underdevelopment of theories concerning climate change–conflict linkages. Instead of elaborating their own hypotheses that are specific to climate change, quantitative climate change–conflict researchers usually import arguments from earlier environmental conflict studies or from the civil wars literature. Although this is a reasonable preliminary strategy, these theories require further modification in order to be usefully employed to analyze climate change–conflict relationships. In adjusting these theories, or in developing new ones, researchers' primary goal should be greater specification of intermediate causal linkages between climate change and conflict. This article recommends a shift from the current emphasis on economic growth, in general, to a concentration on agriculture: the economic sector that is most likely to be influenced by climate change. This section also observes that, in order to further specify and test climate change–conflict relationships, it may be necessary to further disaggregate the causal chain, restricting analyses to single linkages.

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By disaggregating the causal chain, analysts can examine each linkage in greater detail. This will facilitate greater attention to the topic discussed in the article's fourth section: conditional effects. Researchers have already begun to address this issue by attempting to identify the circumstances in which climate change is most likely to encourage contention. Up to now, this work has focused on political marginalization; scholars propose that peripheral, politically irrelevant groups are more likely to respond to environmental shifts with violence (Raleigh 2010; Theisen et al. 2011/12). Other researchers have sought to identify institutional factors that have a moderating effect on climate change–conflict linkages, such as state-level democratic governance (Koubi, Bernauer, Kalbhenn, and Spilker 2012). This article advocates further research on conditional effects, with an increased emphasis on local institutions. Returning to the earlier focus on agriculture, it supports this stance by presenting several illustrative examples of how institutions can interrupt the causal chain between climate change, agricultural productivity, and conflict.

The final section of the article returns to the relationship between environmental conflict studies and climate change–conflict studies. I observe that, as research on climate change–conflict relationships moves down to a more local level and pays greater attention to conditional effects, it will bear an increasing resemblance to earlier environmental conflict research, particularly if scholars begin to complement large-N statistical analyses with qualitative case studies. In order to distinguish climate change–conflict analysis, I argue, researchers should shift from a focus on climate *change* to a focus on climate *uncertainty*. Although scientists expect that climate change will generate gradual, long-term changes in temperature and precipitation, an increase in the variability of weather patterns is expected to be its most pronounced impact. Increases in climate uncertainty are likely to generate different types of social effects than gradual, persistent shifts. Climate change–conflict researchers have attempted to integrate this feature of climate change into their models with measures of rainfall variability (Ciccone 2011; Theisen et al. 2011/12; Benjaminsen et al. 2012; Hendrix and Salehyan 2012; Koubi et al. 2012; O'Loughlin, Witmera, Linke, Laing, Gettelmanc, and Dudhiab 2012; Raleigh and Kniveton 2012). However, they have not theorized the effects of uncertainty or the impacts of rapid negative shocks.

## Old Wine in New Bottles?

The environment was initially identified as a potential security concern in the late 1980s, as the Cold War was drawing to a close. Early proponents of environmental security research delineated a wide array of threats arising from environmental degradation (for examples of such work, see Ullman 1983; Mathews 1989). However, this expansive agenda rapidly narrowed to focus on environmental conflicts. Two representative research programs, Thomas Homer-Dixon's Project on Environment, Population, and Security (The Toronto Group), and the Swiss-based Environmental Conflict Project (ENCOP), examined how degradation of renewable natural resources could lead to violent, intrastate contention (Bächler 1998; Homer-Dixon 1999).[4] The logic underlying the projects' claims was broadly Malthusian; as the quality or quantity of resources such as water or arable land decline, competition between individuals and groups is expected to increase. Sometimes, this competition will result in violent conflict. The projects also incorporated relative deprivation theory into their arguments, asserting that maldistribution of resources could increase the likelihood of contention (see also Gurr 1985).

[4]Additional early research was conducted under the auspices of the GECHS (Global Environmental Change and Human Security) Project (Lonergan 2000). This article focuses on the work of Homer-Dixon's Toronto Group, due to its prominence.

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The two programs identified environment–conflict linkages in numerous historical cases, including contention in Haiti, the Philippines, South Africa, Pakistan, and Rwanda (Homer-Dixon and Blitt 1998; Bächler 1999). However, other researchers questioned the generalizability of these results, as well as the relative importance of environmental degradation as a cause of internal conflict. The Toronto Group's environmental conflict model, in particular, was critiqued for its complexity (Gleditsch 1998). Homer-Dixon's argument includes three types of scarcity—supply-induced, demand-induced, and structural—which collectively have multiple social effects, which, in turn, can encourage at least three types of violent conflict, via a variety of causal pathways. Each of these causal pathways can be interrupted in multiple places by institutions or other contextual socioeconomic factors. This conditionality reduces the model's determinism; Homer-Dixon was not arguing that environmental degradation automatically leads to violence. However, the inclusion of so many intervening factors made it difficult to determine when environmental scarcity should lead to conflict and when it should not. It was also virtually impossible to identify the importance of environmental degradation, relative to other factors, as a cause of conflict. As Levy observed: "By the time one arrives at the end of the chain (violent conflict), so many intervening variables have been added that it is difficult to see the independent contribution of environmental degradation" (1995:45).

This complexity led Gleditsch to describe Homer-Dixon's model as "untestable" (1998:390). During the 1990s, only two large-N analyses of the model were attempted. Hauge and Ellingsen (1998) identified a statistically significant relationship between conflict onset and degradation of soil, deforestation, and freshwater scarcity.[5] However, the second report of the State Failure Task Force found no direct relationship between environmental factors and state collapse (Esty, Goldstone, Gurr, Harff, Levy, Dabelko, Surko, and Unger 1998). Before these inconsistencies were resolved, the focal point of environmental conflict research shifted: from renewable resource scarcity to non-renewable resource abundance. In the wake of conflicts such as the Sierra Leonean civil war, researchers began to examine how extraction of valuable resources, such as diamonds and oil, could impact the likelihood of violent internal conflict (for examples, see de Soysa 2002; Ross 2004). Concerns about the security implications of environmental degradation languished further following the attacks of September 11; with the increased prominence of international terrorism, the environment was no longer regarded as a significant security threat.

However, in the last five years, there has been a resurgence of interest in environmental security, prompted by increasing popular concerns about the negative consequences of climate change. In the first wave of environmental security research, several authors, including Homer-Dixon (1991), identified climate change as a potential source of instability (see also Gleick 1989). However, Homer-Dixon dropped climate change in his subsequent work, because he anticipated that its effects on conflict would be limited over the next few decades, relative to the impacts of other environmental factors, like soil degradation, deforestation, and freshwater scarcity (1994). Yet, by 2007, Homer-Dixon had changed his message. In an op-ed for the *New York Times* (2007), he wrote that "Climate stress may well represent a challenge to international security just as dangerous—and more intractable—than the arms race between the United States and the Soviet Union during the cold war or the proliferation of nuclear weapons among rogue states today." Other researchers and policymakers shared this elevated sense of concern; numerous reports issued from 2007–2008 highlighted the national and human security threats posed by global climate change

[5]Theisen (2008) was unable to replicate these results, even using Hauge and Ellingsen's original data.

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(CNA 2007; Parry, Canziani, Palutikof, van der Linden, and Hanso 2007; WBGU 2008).

However, while the locus of perceived insecurity has shifted to climate change, the older environmental conflict models have remained surprisingly intact. In spite of the extensive critiques directed at Homer-Dixon's model, climate change–conflict researchers have often used it as a starting point for analysis. In these studies, climate change is simply attached to the front end of the Toronto Group model; it becomes the cause of the various environmental scarcities that lead to competition and conflict (for examples, see Buhaug et al. 2008; WBGU 2008). There are, however, at least three problems with this approach. First, it replicates the testing difficulties associated with Homer-Dixon's original arguments, as the model retains its original complexity. Second, climate change-conflict research exacerbates these analytic challenges by attaching an additional, preliminary linkage to the causal chain connecting environmental factors to conflict (Tetrais 2011). To demonstrate a relationship between climate change and conflict, scholars must now establish that climate change leads to environmental scarcity and maldistribution, in addition to demonstrating that environmental scarcity drives competition and conflict. And, like the scarcity–conflict relationship, the climate change–scarcity relationship is conditioned by social, economic, and political factors. Third, the model's complexity is further increased because climate change—the increased concentration of carbon dioxide and other greenhouse gases in the earth's atmosphere—does not only lead to environmental scarcity. Climate change is also expected to generate accelerated sea level rise and impact the frequency and intensity of natural disasters, such as floods, hurricanes, droughts, and wildfires (Solomon 2007). Introducing these additional intermediate components into environmental conflict models multiplies the causal pathways from climate change to violent contention, making an already unwieldy model even less amenable to statistical testing.

Given the complexity of the relationships being evaluated in quantitative climate change–conflict research, it is hardly surprising that analysts have failed to identify many statistically significant direct or indirect relationships between climate change and conflict (Salehyan 2008).[6] These results could, of course, simply be reflecting reality; there may be no linkage between climate change and conflict. However, they could also arise from data problems or model misspecification. The article's next section examines researchers' recent efforts to address these issues, highlighting the most compelling work as well as continuing limitations.

## Recent Methodological Developments

Early on in environmental conflict research, scholars recognized that, if environmental factors encouraged contention, many of these conflicts would occur at the substate level and entail a limited number of casualties. Renewable resource scarcity, in particular, was associated with inter-communal conflict: two groups

[6]Exceptions include recent studies of pre-industrial China and Europe, which find correlations between climatic shifts and conflict (Zhang, Brecke, Lee, He, and Zhang 2007; Tol and Wagner 2010; Zhang, Lee, Wang, Lie, Pei, Zhang, and Anc 2011) and a study by Hsiang, Meng, and Cane (2011), which finds that shifts in El Niño–Southern Oscillation (ENSO) patters are associated with conflict. A limitation of these studies is that they rarely include control variables in their models, so they run a high risk of omitted variable bias. A study of Sub-Saharan Africa by Burke et al. (2009) included controls and did find a relationship between climate change and conflict; however, a subsequent study by Buhaug (2010) revealed the frailty of these results. Thus far, the strongest relationship that has been found in quantitative climate change–conflict analyses was largely unexpected; unusually wet periods are associated with more conflict, while unusually dry ones are not (Hendrix and Glaser 2007; Meier et al. 2007; Theisen et al. 2011/12; Adano, Dietz, Witsenburg, and Zaal 2012; Hendrix and Salehyan 2012). However, O'Loughlin et al. (2012) find the opposite; wetter years are less conflict-prone.

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contesting local resource access, with little or no state involvement. This specification was not an obstacle for qualitative analyses of environmental conflict, such as those conducted by ENCOP and the Toronto Group. However, it has been a significant impediment to quantitative environmental conflict and climate change–conflict research, due to limitations in data availability. Quantitative environmental conflict research emerged from civil war studies. The data sets initially employed in these analyses only recognized conflicts as civil wars once they resulted in one thousand battle deaths: an extremely high threshold for environmentally induced contention. The UCDP/PRIO Armed Conflict Dataset reduced the fatality threshold to twenty-five (Gleditsch, Wallensteen, Eriksson, Sollenberg, and Strand 2002). However, it maintained the requirement that the central government be a participant in each conflict. It is only in the last few years that researchers have begun to employ data on substate or nonstate conflicts—those that do not involve government actors—and on conflicts and other forms of political mobilization that generate fewer than twenty-five deaths. These new data sets, such as the Social Conflict in Africa Database (Salehyan, Hendrix, Hamner, Case, Linebarger, Stull, and Williams 2012) and the UCDP Non-State Conflict Dataset (Sundberg, Eck, and Kreutz 2012), as well as country-specific conflict data collection efforts (such as those employed by Meier et al. 2007; Raleigh 2010; Slettebak and Theisen 2011; Theisen et al. 2011/12; Raleigh and Kniveton 2012), offer a promising avenue for future quantitative analyses of climate change–conflict linkages, as they will enable researchers to focus on the forms of contention that are most likely to be linked to environmental change.[7]

Another recent methodological innovation, which also brings climate change-conflict analyses closer to climate change–conflict theory, is the use of geographically disaggregated research designs. Many of the causal pathways proposed to lead from environmental events to violent contention require a geographic overlap between environmental conditions and conflict locations. Yet, environmental conditions within countries vary, as do the locations of internal conflicts. If a flood occurs in one part of a country, but a conflict takes place in another, it is unlikely that the two events are connected. Yet, if data were collected at the national level, they would appear to be correlated. By reducing the scale of analyses and geo-locating environmental conditions and conflict events, these false positives can be avoided, creating a more accurate assessment of environment-conflict linkages (Jensen and Gleditsch 2009). Researchers have implemented this strategy by collecting conflict, environmental, and social, political, and economic data at the level of local administrative units (Meier et al. 2007; Benjaminsen et al. 2012; Raleigh and Kniveton 2012) or based on geometric grids, dividing countries into 50 × 50 km or 100 × 100 km units (Raleigh and Urdal 2007; Theisen et al. 2011/12; Busby, Smith, White, and Strange 2012; O'Loughlin et al. 2012). This disaggregated approach is not appropriate for analyzing all causal pathways from environmental change to conflict, especially those that pass through state institutions (Hendrix and Salehyan 2012). However, it offers a much more accurate assessment of causal mechanisms that emphasize local resource scarcity or the impacts of localized physical phenomena such as natural disasters and sea level rise.[8] The greatest methodological obstacle to this approach is the limited availability of subnational data for socioeconomic conditions and sociopolitical institutions (Raleigh and Kniveton 2012).

New conflict data sets and geographically disaggregated research designs permit analysts to conduct quantitative tests that are a closer match with theorized

[7]Additional new data sets that may be helpful in climate change–conflict research are presented in a recent special issue of *International Interactions* (Vol. 38, No. 4, 2012).

[8]These data sets also reduce concerns about the varying effects of climate change in different geographic regions, as they make large-N analyses of single regions or single states more viable.

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climate change–conflict linkages. A final methodological innovation, the use of two-stage statistical analysis techniques, does the same. Although many researchers continue to test the direct impact of climate change on conflict, thereby subsuming the entire casual pathway into one relationship (Hendrix and Glaser 2007; Meier et al. 2007; Burke et al. 2009; Theisen et al. 2011/12; Benjaminsen et al. 2012; Hendrix and Salehyan 2012; Raleigh and Kniveton 2012), others have begun to examine the impacts of climate change on conflict, via the intermediate variable of economic growth. One of the first articles to employ this technique, using climatological variables, was by Miguel, Satyanath, and Sergenti (2004). This study was primarily interested in the connection between economic growth and internal conflict. However, its authors recognized that tests of this relationship would be subject to endogeneity issues; the dependent variable, conflict, was likely to impact economic growth, as well as being impacted by it. To overcome this concern, Miguel et al. employed precipitation data, a truly exogenous factor, to instrument economic growth. Using a two-stage approach, they predicted the effects of year-to-year shifts in precipitation on economic growth and then regressed those results on internal conflict. Although Miguel et al.'s measurements of both precipitation and conflict have come under fire (Jensen and Gleditsch 2009; Ciccone 2011), the two-stage technique has been increasingly widely adopted, including by researchers who are explicitly interested in the relationship between climate change and conflict (Bergholt and Lujala 2012; Koubi et al. 2012).

In addition to relieving endogeneity issues, two-stage modeling responds, in part, to the problem of extended causal chains discussed in section one. Instead of presuming an intermediate socioeconomic linkage between environmental conditions and conflict, this approach models it. The two-stage approach does not, of course, fully capture the extended climate change–conflict model proposed by studies such as Buhaug et al. (2008). Yet, it is an encouraging methodological development. The next section of the article nonetheless argues that, while the two-stage technique is promising, its utility for climate change–conflict studies is compromised by persistent underdevelopment of the theories being tested and inappropriate data choices for the intermediate step in two-stage models.

## Specifying Causal Chains

In their introduction to the special *Political Geography* issue on climate change and conflict in 2007, Nordås and Gleditsch argued that, for analysis to move forward, researchers would need to improve the theoretical foundations of environmental conflict studies, further specifying the relationships between climate change, environmental degradation, and violent contention. Unfortunately, this recommendation has not been widely heeded, especially within quantitative climate change–conflict studies (Raleigh and Kniveton 2012). Instead of developing and testing new claims or more detailed causal logics linking climate change to conflict, these analyses have tended either to reiterate Homer-Dixon's arguments or to import a suite of arguments from the civil wars literature, often with little modification. The latter arguments, which emphasize the economic causes of intrastate conflict, have been particularly prominent in work employing two-stage analytic techniques. These arguments are drawn primarily from the seminal civil war studies by Collier and Hoeffler (2004) and Fearon and Laitin (2003), which are presented in some detail here in order to evaluate their utility for climate change–conflict analysis.

Collier and Hoeffler's study aimed to compare the relative importance of traditional "grievance"-based explanations for civil war, such as social inequality, and "greed"-based arguments, which emphasized economic opportunity. Collier

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and Hoeffler argued that individuals are more likely to participate in rebellions when the benefits of doing so exceed the benefits of engaging in alternative, legal economic activities. These conditions were most likely, they hypothesized, in countries that are economically underdeveloped, have low economic growth rates, are highly dependent on natural resource extraction, and where males' access to education is limited. Climate change–conflict researchers import this argument by asserting that climate change can reduce economic growth, thereby decreasing the opportunity costs of participating in a rebellion (Mehlum, Miguel, and Torvik 2006; Buhaug et al. 2008; Theisen et al. 2011/12; Bergholt and Lujala 2012; Hendrix and Salehyan 2012).

Fearon and Laitin also noted the importance of opportunity in encouraging civil wars. However, their article placed greater emphasis on state weakness than rebel greed. Weak states experience more civil wars, they argued, because countries with limited resources or bureaucratic capacity have greater difficulty resisting rebel challenges. In Fearon and Laitin's formulation, state weakness can be induced by a variety of factors, including recent independence, a large population, and regime instability. Climate change–conflict researchers argue that state weakness can also arise from climatologically induced economic downturns. In this hypothesized trajectory, climatological shifts weaken economic performance, which reduces public tax revenue. This drop in income diminishes the state's capacity to finance social spending or resist internal challenges. At the same time, popular demands on the government increase, as reductions in personal income cause individuals to lean more heavily on the state's social safety net. Since the regime cannot keep pace with these popular demands, unrest is likely. State weakness therefore increases both the incentive and opportunity for rebels to challenge the government (Barnett and Adger 2007; Buhaug et al. 2008; Nel and Righarts 2008; Theisen et al. 2011/12; Bergholt and Lujala 2012; Hendrix and Salehyan 2012; Koubi et al. 2012).

These two economic logics—the rebel opportunity logic and the state capacity logic—constitute reasonable general arguments connecting economic performance to conflict outbreak. However, their utility in climate change–conflict studies would be increased through further modification and elaboration, particularly for the first linkage in the model, between climate change and economic growth. A number of tentative propositions have been offered to describe this relationship. Bergholt and Lujala (2012) observe that hydrometeorological disasters can destroy industries and infrastructure, which could undermine individual economic income as well as national productive capacity. Many studies emphasize the impact of climate change on agriculture, observing that shifts in precipitation and temperature can affect yields (Parry et al. 2007; Zhang et al. 2007, 2011; WBGU 2008). Mehlum et al. (2006) suggest that changes in agricultural productivity and food prices can impact the economic security of rural and urban populations. However, these mechanisms are not tested.

Instead, statistical analyses either skip intermediate variables, regressing climatological measures such as precipitation and temperature directly against conflict, or they employ broad measures of economic performance, such as changes in per capita income, as intermediate variables in two-stage models. These expansive economic measures were appropriate in civil war studies, since analysts were explicitly interested in the relationship between overall economic performance and conflict. However, they are a poor choice for climate change–conflict studies, which should be concerned only with the alterations in economic performance that are generated by climatological shifts. Although climate change has significant impacts on some sectors of states' economies, it has little effect on others. This variation must be reflected both in researchers' theoretical claims and in their empirical tests. Instead of employing broad operationalizations of

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economic performance as intermediate variables, analysts should focus on those aspects of the economy that are most clearly linked to climate change.[9]

One way to accomplish this would be to employ an economic factor that is more closely linked to climate change as an intermediate variable: for example, agricultural performance. Of all sectors in a state's economy, agriculture is the most strongly affected by climatological conditions: a status which, as noted above, has been already recognized in the climate change–conflict literature, even if it is not reflected in methodological practices. Agricultural mechanisms have not only been suggested for the first stage of the climate change–conflict relationship, linking climate change to economic performance. They have also been proposed for the latter stage, linking economic performance to conflict. Theisen et al. (2011/12) apply the weak state argument to agriculture, asserting that poor harvests reduce government income, thereby inducing a decline in states' capacities to respond to public needs, at the same time as demand for such services increases. Others apply Collier and Hoeffler's economic opportunity argument to agriculture, asserting that reductions in crop yields undermine farmers' livelihoods, making rebellion a more appealing activity (de Soysa, Gleditsch, Gibson, and Sollenberg 1999; Ohlsson 2000; Mehlum et al. 2006; Buhaug et al. 2008). Another argument draws from the human security literature, rather than civil war studies, to assert that agricultural downturns can lead to food shortages, which encourage internal conflict (Messer, Cohen, and D'Costa 1998; Johnstone and Mazo 2011) and criminal acts (Mehlum et al. 2006). Further arguments are more circuitous: suggesting, for example, that agricultural downturns prompt migration, which can then lead to conflict, via a variety of causal pathways (Reuveny 2007).

Like the first causal linkage, between climate change and agricultural performance, the linkage between agricultural performance and conflict has been subject to few systematic tests. In the environmental conflict literature, de Soysa (2002) found that a higher percentage of arable land in a country's total territory reduced the likelihood of internal conflict; he interpreted this as an anti-Malthusian finding. Urdal (2005) included a measure of cropland scarcity in his model of population pressures and armed conflict; the analysis produced mixed results, as did a later study of the linkages between agricultural yields, population density, and political violence in India (Urdal 2008). Mehlum et al. (2006) found that high rye prices in nineteenth-century Bavaria were associated with increases in property crime, but decreases in violent crime. Zhang et al. (2007, 2011) demonstrated that, in pre-industrial Europe and China, drops in temperature were correlated with reductions in agricultural yield and value, which were linked to increases in conflict. However, since the latter analyses employ no control variables, the validity of their results is questionable.

Of these studies, only the last group was specifically concerned with the issue of climate change. This overall paucity of analysis, along with the inconsistent findings, suggests that the relationship between climate change, agricultural performance, and conflict remains an important area for further study. One way to proceed would be to employ the two-stage analytic techniques already being used in climate change–conflict analysis, but replace the intermediate variable of economic growth with measures of agriculture. Time series data on agricultural yields, value, and producer prices are available from the FAO and are often employed for calculating the impacts of climate change on agricultural output, outside of climate change–conflict studies (for example, Lobell and Field 2007). Although the data are incomplete, this shortcoming may be a reasonable tradeoff in light of biases currently being incurred through model misspecification. Alternatively, if

[9]Dunning (2008) observes that, since changes in economic growth can be caused by factors other than climate change, using economic growth as an intermediate variable in climate change–conflict analyses can violate a key requirement for the use of instrumental variables.

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subnational agricultural data are available for a state, the climate change–conflict relationship could be quantitatively tested on a smaller scale. Urdal (2008) employed this approach in his study of India, which generated some of the strongest statistical support for environmental scarcity–conflict relationships.

In short, before rejecting claims that climate change and conflict are not associated, it is necessary to develop more precise causal claims and test them with appropriate data. Two-stage modeling, with alternative intermediate variables, represents one possible response. Yet, as with any two-stage model, this adjustment would still omit many components of the complex causal chain leading from climate change to conflict. In order to evaluate these linkages in greater detail, it may be necessary to disaggregate analyses further, examining single, intermediate stages in the climate change–conflict relationship, instead of the full model. These direct relationships would include the relationship between climate change and its environmental effects, including scarcity, natural disasters, and accelerated sea level rise; between specific environmental effects and agricultural performance; between agricultural downturns and social adjustments; or between changing social relations and conflict initiation.[10] Of course, statistical analyses of isolated linkages in the climate change–conflict causal chain would be subject to potential endogeneity problems and omitted variable bias. Yet, these concerns must be balanced against the loss in theoretical specificity required to commence analyses from the very beginning of the causal chain. Two possible methodological correctives are to lag independent variables or to complement statistical analyses with case studies, where causal mechanisms can be observed more easily. Neither is a perfect fix. Nonetheless, given the mismatch in theory and analysis incurred through the use of direct or two-stage statistical tests of climate change–conflict connections, such tradeoffs should be considered.

## Incorporating Conditional Effects

A shift to more disaggregated analyses would facilitate the development and evaluation of more nuanced theoretical claims for each stage of the climate change-conflict relationship. One such nuance would be greater consideration of the role of conditional effects. Although the paucity of empirical support for climate change–conflict relationships has led few scholars to infer that no such linkage exists, many suggest that climate change and conflict are linked, but only under certain conditions (Barnett and Adger 2007; Nordås and Gleditsch 2007; Deligiannis 2012; Hendrix and Salehyan 2012). Within the quantitative climate change–conflict literature, the issue of sociopolitical marginalization, in particular, has recently attracted increasing attention.[11] Researchers hypothesize that climate change is more likely to inspire conflict among groups that occupy a peripheral position in society, possessing limited access to political authority or economic opportunities (Theisen et al. 2011/12). These "politically irrelevant" groups are more exposed to negative environmental developments and have less access to government assistance after experiencing climatological disasters. Consequently, their only recourse, in the face of degrading environmental conditions, may be aggression (Raleigh 2010).

These hypotheses, while intriguing, have found little support in recent empirical analyses (Slettebak and Theisen 2011; Theisen et al. 2011/12). This lack of support, even in most likely conflict scenarios, could arise because there is no actual linkage between climate change and contention. Alternatively, it could reflect the presence of other conditional factors, which counteract the negative

[10]Other plausible causal linkages could bypass agricultural performance: for example, passing through migration instead.

[11]For a similar trend in the qualitative literature, see Benjaminsen (2008).

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consequences of climate change. One such factor could be institutions. Thus far, quantitative climate change–conflict analyses have focused on state-level institutional characteristics. Koubi et al. (2012), for example, include a measure of regime type in the latter half of their two-stage model, asserting that democracy should mitigate the negative effects of climate change-induced economic downturns, as a democratic public can express political interests through actions short of conflict and governments must be more accountable to popular demands. Their analysis finds partial support for this claim; the relationship between declining economic performance and conflict is weaker for democratic states. However, the study finds no relationship between climate change and economic performance in the first stage of the model, which casts doubt on the salience of democracy in climate change–conflict linkages.

The institutions that are most likely to condition climate change–conflict relationships are, in any case, not those that exist at the state level. Rather, the most influential are likely to be the mechanisms that individuals and communities employ to manage local environmental degradation and maldistribution (Barnett and Adger 2007; Meier et al. 2007). These institutions include formal organizations, such as local courts and other conflict resolution devices, as well as agreements such as contracts and treaties. Institutions also include social norms and customary practice. If conceptualized broadly, institutions may even encompass the embedded "coping strategies" that individuals or communities adopt in the face of deteriorating environmental conditions. These local institutional mechanisms have only recently begun to be discussed systematically in the climate change–conflict literature (Raleigh 2010; Busby et al. 2012; Deligiannis 2012). Yet they are a long-standing analytic concern in development studies, political ecology, and climate change adaptation research. These fields observe that the negative impacts of climate change are conditioned on groups' "exposure," "vulnerability," and "resilience" to environmental hazards. While exposure is a physical measure, which refers to the likelihood that a household or community will experience environmental degradation or a hydrometeorological disaster, levels of vulnerability and resilience are conditioned by a wide range of social, economic, and political factors (Barnett 2001).[12]

These factors include wealth and technological capacity. However, vulnerability and resilience also depend on institutions. As climate change–conflict research moves forward, further efforts should be made to integrate these observations, testing whether communities that possess robust and cooperative coping strategies, social norms, and formal local institutions are less likely to experience conflict in the aftermath of negative environmental changes. To maintain the focus on agriculture, analysts could examine coping strategies such as intensifying production, changing crops, shifting field locations, and adjusting the timing of agricultural activities. They could also consider labor movements into off-farm activities and temporary migration (Ellis 1998; Raleigh, Jordan, and Salehyan 2008; Tschakert, Sagoe, Ofori-Darko, and Codjoe 2010). Such adjustments may be facilitated by the actions of more formal institutions, such as lending agencies and farm boards, which can supply capital and equipment that permit communities to survive a temporary downturn or adopt long-term, adaptive strategies. Together, robust institutions and coping strategies may enable communities to sever the first linkage in the climate change–agricultural performance–conflict causal chain.

They may also mediate the second linkage in the causal chain, between downturns in agricultural performance and conflict. Of particular significance in this relationship is another institution: the market. Although crop yields are an

[12]"Vulnerability" refers to a community's susceptibility to damage as a result of ecological shifts or climatological events. "Resilience" refers to its capacity to maintain its previous status when confronted with such events. A resilient community is a less vulnerable one.

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important component of agricultural performance, the socioeconomic impacts of agricultural downturns also depend on the prices that farmers receive for their crops.[13] Following the basic principle of supply and demand, if a downturn in crop yields is geographically coterminous with the crop's market, then the reduction in output—and consequent scarcity—will cause prices to rise. Under these circumstances, farmers will collect the same amount of revenue from a lower volume of production, so they will not suffer a loss of livelihood. In contrast, if the market for a crop extends beyond the geographic reach of the agricultural downturn, then a drop in yields will not result in local shortages, because staples can be purchased from outside of the region experiencing the agricultural decline. Consequently, prices will not increase and farmers' livelihoods will be undermined. This variation is significant theoretically. When applied to Collier and Hoeffler's rebel opportunity logic, it becomes clear that the appeal of participating in a rebellion, relative to engaging in other economic activities, depends not only on environmental factors, but also on institutions, such as the size of agriculture markets. If market size and dynamics compensate for drops in agricultural production, then livelihoods are not undermined. The appeal of legal economic activities remains steady. Under these conditions, environmental shifts do not increase the pool of potential rebel recruits.

A similar conditionality applies to the weak state logic. Weak state arguments emphasize both the increasing public demands on the government that arise as a result of climate change-induced environmental shifts, and the government's restricted capacity to respond. If climate change does not generate a loss of livelihoods, as in the scenario above, then popular demands will not increase. Moreover, the impact of climate change on government income is ambiguous. In the case of agriculture, the hypothesized climate change-state income linkage requires, first, that a government collect significant revenue from taxing farm outputs; if this is not the case, a downturn in agricultural productivity will have little effect on government receipts. Second, it requires that the state fails to adjust its taxation policies in response to declining yields, in order to sustain previous income levels. Neither of these assumptions is sustainable; state policies in response to agricultural downturns are likely to vary considerably. And if governments make adjustments that maintain prior revenue levels, the weak state argument ceases to be viable; agricultural downturns will not generate either the increased demands or the reduction in government capacity that are expected to lead to conflict.[14]

Local sociopolitical institutions and norms can also interrupt the linkage between agricultural performance and conflict. A number of recent climate change–conflict analyses have observed that, in times of scarcity, conflict behaviors decline, as groups cooperate in order to survive. Adano et al. (2012) find that pastoral groups in Kenya share wells during periods of drought, rather than increase contestation. Slettebak (2012) produces an analogous finding in a quantitative analysis of natural disaster–conflict linkages. Observing that disasters have no statistically significant impact on armed conflict, he draws on the disaster sociology literature to argue that, in the wake of a natural disaster, people pull together, rather than compete. A study with Theisen (2011) reports similar results for smaller-scale conflicts in Indonesia. These findings underline the importance both of conditional, institutional effects and of further theorization of the individual linkages that contribute to the climate change–conflict causal

[13]For subsistence farmers, this point is moot; since they are not selling their crops, they are concerned exclusively with yield, not price.

[14]Miguel et al. (2004) support this point by failing to identify a correlation between changes in rainfall and national tax revenues.

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chain: in particular, the expected linkage between economic downturns and competition and violence.

Interestingly, the recent shifts toward subnational analysis and greater incorporation of concepts from political ecology and development studies, as well as increasing concern with politically marginal groups, have brought climate change–conflict research closer to the original environmental conflict literature, which emphasized local context, conditionality, marginalization, and inter-communal conflict (Homer-Dixon 1994; Bächler 1998). Although this is in many ways a positive development—the environment–conflict relationship still being poorly understood—it raises questions about the validity of sustaining an analytic focus on climate change. In order to justify continuing research, it will be necessary to distinguish climate change from other forms of environmental degradation. The next section discusses one means of accomplishing this: emphasizing climate uncertainty.

## Distinguishing Climate Change: The Importance of Uncertainty

The phrase "climate change" is often interpreted very literally; people are concerned with how climatic characteristics are *changing*, usually through slow moving, long-term processes like shifts in temperature or rainfall. However, the most recent assessment report of the IPCC's Working Group 1 (Solomon 2007) emphasized that climate change's most pronounced physical impacts are not going to occur through slow moving, gradual adjustment. Rather, climate change will often take the form of sudden, nonlinear shocks. Climatic conditions are becoming more variable and hence more uncertain. This variability is one of the primary features distinguishing climate change from the forms of environmental degradation that were emphasized in the original environmental conflict literature. These other types of degradation—including water scarcity, soil degradation, and deforestation—were presumed to progress in a linear way. Conditions would deteriorate, but populations with the capacity to innovate would be able to adjust to the changes (Homer-Dixon 1999). In contrast, climate change will be characterized by sudden, unpredictable events. It is the behavioral consequences of these novel conditions that should be emphasized in future climate change–conflict research.

Conflict researchers have made some progress toward integrating variability into their empirical analyses. Initial studies of environmental scarcity–conflict relationships often lacked dynamic measures of environmental conditions. Hauge and Ellingsen (1998), for example, employed static data for two of their three environmental scarcity variables; only their deforestation data measured a year-to-year change in environmental conditions. As a result, although they aimed to test Homer-Dixon's theory about the effects of *increasing* environmental scarcity on conflict, most of their analysis assessed the impact of *absolute* levels of resource availability. In spite of the theory–data mismatch, static environmental measures are still employed in some conflict models (Hendrix and Glaser 2007; Raleigh and Urdal 2007; Theisen 2008). However, researchers have also introduced more dynamic measures of climate conditions into their analyses, particularly through the use of precipitation and temperature data.

Miguel et al. (2004) initiated this trend by employing a measure of year-to-year percentage changes in rainfall in their conflict model. Their goal was to capture the effect of positive and negative shocks on social behavior. However, this measure drew criticism for mean reversion problems (Ciccone 2011; Hendrix and Salehyan 2012). If a country experiences one extremely dry year, followed by a moderately dry year, a measure of year-to-year difference would show a positive change in precipitation from year 1 to year 2, in spite of the fact that rainfall in year 2 remained well below normal. Consequently, many years of drought would

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be coded as positive changes in rainfall, while many wet years would be coded as drops in precipitation. Thus, while year-to-year changes may be an important component of climate change–conflict relationships, an effective measure of variability must also indicate how each year's rainfall relates to average levels.

To eliminate the mean reversion problem, Hendrix and Salehyan (2012) instead employ a measure of annual rainfall deviation from the national mean, for the period they are studying (1979–2008). This measure is effective in capturing positive and negative differences from the national average; unusually wet or dry years are observed in the data. However, the tradeoff is that year-to-year changes, which may be dramatic, are truncated; only a portion of the shift from an extremely dry year to an extremely wet year, or vice versa, will be captured by a measure of deviation from the mean. Moreover, while the authors claim that their measure is capturing precipitation shocks, it is easy to identify circumstances in which this will not occur. For example, if there are five years with similarly below-average precipitation, only year 1 was truly a shock. The subsequent years constitute an emerging pattern. By years 4 and 5, drought has become the norm. Although these subsequent years of water scarcity can have devastating effects, conflicts that arise in year 5 cannot be described as the result of a climatological "shock." These would arise, instead, because of consistently negative environmental conditions.

Koubi et al. (2012) make some progress on this issue by measuring annual precipitation deviations from a thirty-year moving average of past values. This measure controls for gradual within-country changes. However, the workaround continues to misrepresent medium-term deviations. To fully capture the hypothesized relationship between rainfall variability and conflict in quantitative analyses, it would be preferable to devise an environmental measure that captures both the intensity of rainfall deviations from a long-term norm and year-to-year precipitation shocks. This article makes several recommendations for moving in this direction. The first is to shorten the time period included in the moving average to five years. By reducing the time frame, the measure will capture a larger portion of year-to-year variation, while still avoiding mean reversion problems. The shortened time frame will also place greater emphasis on recent experience, which is likely to be foremost in people's minds as they evaluate precipitation levels in the current year. A second recommendation, which would have similar effects, is to continue using a longer moving average, but weight more recent years more heavily. A third option is to literally merge the two measures by creating an index variable: scoring the intensities of year-to-year changes and of deviations from a moving average separately and then combining the scores.[15] The same strategies could also be employed with temperature and agricultural data.

In addition to developing alternative measurements of climate variability, an evolving climate change–conflict research agenda should devote greater attention to theorizing the impact of variability and uncertainty on conflict dynamics. In doing so, it seems like the existing literature on natural disasters and conflict would be a fruitful place to begin. Natural disasters are inherently uncertain events. They are episodic and unpredictable, both in timing and intensity. Many of them have very rapid onsets. They are therefore a reasonable analogue to the types of sudden shocks that are expected to arise from climate change and should be a useful starting point for predicting social responses to such events. Unfortunately, much of the conflict literature has failed to theorize the uncertainty associated with natural disasters. Instead, disasters have been treated as largely equivalent to other forms of environmental degradation (for an

[15]Year-to-year changes could be transformed into a dummy variable, for instance, where the threshold for registering a "change" was set relatively high; this would moderate the mean reversion problem.

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exception, see Slettebak 2012). Event counts of droughts and floods become robustness checks for models that do little more than assess Homer-Dixon's theoretical logic: that greater environmental scarcity increases the risk of contention (Theisen 2008; Theisen et al. 2011/12). Alternatively, natural disaster data serve as an instrumental variable for economic growth; disasters are expected to reduce economic productivity, which leads to popular grievances and institutional weakness (Bergholt and Lujala 2012).

In these analyses, authors do note that natural disasters' most distinguishing feature is the speed at which they occur. They also observe that quick changes in socioeconomic conditions are more significant drivers of conflict than gradual changes or persistent deprivation (Brancati 2007; Nel and Righarts 2008). Yet, the authors make little attempt to explain this variation. The same observation applies to research on environmental scarcity and livelihood loss (for example, Ohlsson 2000). Rapid negative transitions are expected to be more dangerous than gradual changes, but only a few people suggest why. Gurr (1985) offers one explanation; he argues that, when environmental degradation is slow, elites have more time to buttress themselves against internal challenges, which enables them to deter violent resistance. Examining climate change, Buhaug et al. claim that unpredictable events will be more dangerous than slow shifts in resource availability, because it is easier to develop efficient management strategies for slowly developing or chronic conditions than for periodic events (2008:6).

Similar theoretical lacunae are evident for the issue of variability. Many authors assert that increased climate variability will be a critical source of insecurity (Hendrix and Glaser 2007; Zhang et al. 2007; Raleigh 2010). As Buhaug et al. state: "…increasing resource *variability*, which is associated with higher levels of unpredictability, will constitute the greatest challenge to human livelihood" (2008:7, emphasis in original). However, they do not elaborate on this claim. In response, this article reiterates Barnett and Adger's observation that, in order to understand the linkages between climate change and conflict, we need a better understanding of why individuals choose violence (2007:650). To develop this understanding, it will be necessary to delve deeper into psychological and anthropological theories of conflict. The remainder of this section considers how climate variability might impact human behaviors, again through the intermediate issue of agriculture.

Discussions of climate variability frequently deploy the terms "unpredictability" and "uncertainty." In agricultural societies, some degree of unpredictability and uncertainty is normal. The precise timing of storms or heat waves is unknown. Crops are always vulnerable to disease and infestation. In response to these conditions, as noted in section four, farmers deploy coping strategies. They may also adopt long-term adaptive strategies for dealing with chronic scarcity or gradually degrading environmental conditions (Raleigh, Jordan, and Salehyan 2008). Thus, a baseline level of uncertainty is not automatically a source of insecurity; it is expected. It is also bounded. Although the precise timing of storms and heat waves is unknown, deviations are confined to certain seasons or certain intensities. Even if these outer bounds are exceeded, such an occurrence is regarded as an extremely rare event. However, as climate change increases a system's variability, prior definitions of "normal" will be called into question. Resource management systems that were resilient at low levels of uncertainty may fail in the face of increasingly inconsistent conditions. Coping strategies that worked in the past may be thwarted by the perception that circumstances are becoming increasingly unstable (Challinor, Wheeler, Garforth, Craufurd, and Kassam 2007).

Increasingly erratic timing of rainfall and temperature trends, combined with unpredictable flood or drought events, will lead to reductions in agricultural productivity and more frequent crop failures (Parry, Rosenzweig, Iglesias, Livermore, and Fischer 2004). Farmers will observe that patterns of behavior that

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were formerly effective now persistently fail to generate adequate and consistent agricultural yields. Given the novelty of the emerging conditions, appropriate responses may be unclear. At the beginning of each growing season, farmers will be increasingly uncertain of the outcome of their labor. Successive failures will exacerbate this sense of insecurity, particularly if state institutions reveal themselves to be incapable of or uninterested in managing negative shocks (Raleigh 2010). The more unpredictable the system becomes, the greater the perceived insecurity.

Perceptions that the causal connections between one's efforts and observed outcomes are becoming increasingly frayed can have psychological, as well as physical, effects (Barnett and Adger 2007). People could become more frustrated or more resigned. These sentiments might engender risk aversion, aggression, or apathy. But these behavioral pathways are not well understood, at least within the conflict literature. Ember and Ember (1992) offer one of the few studies to assess the impacts of threats of future scarcity on conflict activities. They observe that, while chronic scarcity has little effect on the likelihood of war, a sense of intensified future risk encourages preemptive attacks; groups seize resources from others in order to ensure their own survival. Yet, Ember and Ember's study was limited to pre-industrial societies. It is unclear whether the competitive, zero-sum dynamics they observe are equally characteristic of contemporary states. Although there are many anecdotal observations that people respond to uncertainty with aggression (de Soysa et al. 1999), these claims need to be rigorously tested.

To do so, it is necessary to identify historical situations that were characterized, not simply by uncertainty, but by *rising* uncertainty: when conditions were perceived as becoming increasingly arbitrary. To find appropriate analogues, it may be helpful to look beyond environmental issues. Although there have been plenty of historical cases of environmental degradation, situations of increasing environmental uncertainty are less evident. Nonetheless, one can easily identify incidences of increasing political uncertainty. Literatures examining popular responses to life under dictatorships or in war zones, or work on "states of exception" more generally, could enhance conflict analysts' understanding of how individuals and groups are likely to respond to escalating climate variability.

Incorporating variability and uncertainty will enable climate change–conflict scholars to make an independent contribution to conflict research, rather than reiterating claims about the impacts of linear environmental degradation on social contention. Yet, even if this adjustment or the other alterations recommended in this article are adopted, it is still possible that researchers will fail to unearth empirical associations between climate change and conflict. The negative effects of climate change may be counterbalanced by institutions. Alternatively, the impact of climate change may be washed out by other, more significant determinants of conflict, such as wealth, population size, or social divides. It is also possible that climate change will have positive effects, which reduce the likelihood of conflict (Gleditsch 2012). Nonetheless, even if the proposed theoretical developments do not result in the discovery of further climate change–conflict connections, they will move the research program forward by offering more compelling evidence that such a relationship does not exist.

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