Climate Shocks, Hydrometeorological Disasters and Conflict Duration

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Abstract

Do natural disasters and adverse climatic conditions provide windows of opportunity for ending civil conflicts? Theoretically, the relationships are ambiguous: natural disasters may undercut the resources available to rebels and disasters may facilitate cooperation around humanitarian response, suggesting they provide ripe moments for conflict resolution, but they may also pull government resources away from counterinsurgency efforts and destroy the infrastructure necessary for the projection of state power, suggesting a prolonging effect. Similarly, adverse climatic conditions may fuel anti-government grievances and reduce the opportunity costs associated with participation in rebellion, suggesting drier conditions would be more conflict-promoting, but undermine the resource base available for fighting, suggesting wetter periods would be associated with conflict continuation. Based on a replication of Cunningham, Gleditsch and Salehyan's (2009) dyadic model of conflict duration, we test jointly the effects of climatic shocks (Salehyan and Hendrix 2014) and discrete hydrometeorological/climatic (HMC) disasters (Eastin 2016) on conflict duration. Consistent with recent findings in the climate/natural disaster and conflict literature, we find that discrete HMC disasters, like floods and hurricanes, prolong conflict, while drier conditions, net of the effect of discrete disasters, shorten conflicts. Further quantitative tests and case study-based methodologies are proposed to parse these seemingly contradictory findings.

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1. Introduction

Do hydrometeorological/climatic (HMC) disasters and adverse climatic conditions provide windows of opportunity for ending civil conflicts? Theoretically, the relationships between HMC disasters, climate shocks and conflict duration are ambiguous: natural disasters may undercut the resources available to rebels and disasters may facilitate cooperation around humanitarian response, but they may also pull government resources away from counterinsurgency efforts and destroy the infrastructure – such as roads and railways – necessary for the projection of state military power, suggesting a prolonging effect.

While there is now a large literature on climate and natural disaster impacts on conflict initiation, less emphasis has been placed on conflict duration and termination. This oversight is puzzling in light of significant interest in "disaster diplomacy" in both scholarly and policy circles and with respect to both interstate and intrastate conflicts. Western development and disaster response agencies such as UKAID (Harris, Keen, and Mitchell 2013) and FEMA (Coppola N.d.) have commissioned reports on the links between natural disasters and conflict resolution, and hopeful news reports highlight the potential for India-Pakistan cooperation in the creation of a multilateral disaster response force (India Times 2015). While there is much hope that natural disasters and climate change might have a silver lining of conflict-reducing effects, there is a dearth of systematic evidence, at least at the intra-state level (Gartzke 2012).

Anecdotes, however, abound. The 2010-11 drought in Somalia did not end the conflict between the Somali Federal Government and Al-Shabaab, but it did significantly weaken the rebels by sapping their resource base and forced them to retreat from their positions in Mogadishu (Roble 2011). The 2005 Asian tsunami helped end the conflict in Aceh, but did little to abate fighting in Sri Lanka (Beardsley and McQuinn 2009). The 1972 Managua, Nicaragua earthquake and resultant mismanagement of relief supplies provided fuel for the Sandinista rebellion (Olson and Gawronski 2003). The historical record provides ample evidence for both conflict-mitigating and –amplifying effects of natural disasters.

Similarly, the 2014 Intergovernmental Panel on Climate Change report – which highlighted threats to human security due to climate change-induced conflict – and several prominent studies have renewed interest in and debate over the influence of climatic shocks on conflict, particularly conflict onset and incidence (Hsiang, Burke and Miguel 2013; Buhaug et al. 2014; O'Loughlin, Linke and Witmer 2014). Because these studies operationalize climatic shocks as deviations from "normal", longer-run conditions, rather than discrete disasters, anecdotal evidence is more difficult to come by. Nevertheless, this now considerable body of literature has informed major policy publications by the IPCC (Adger et al 2014), the G7 (Rüttinger, et al 2015), and military planning documents like the US *Quadrennial Defense Review* (US Department of Defense, 2014) and Australia's *Department of Defense 2016 White Paper* (Australian Department of Defense, 2016).

This manuscript analyzes whether discrete HMC shocks – in the form of natural disasters – and climate shocks – operationalized as deviations from longer term mean climatic conditions – either prolong or shorten intra-state conflict duration. Theoretically, the relationships are ambiguous: natural disasters may undercut the resources available to rebels and disasters may facilitate cooperation around humanitarian response, suggesting they provide ripe moments for conflict resolution, but they may also pull government resources away from counterinsurgency efforts and destroy the infrastructure necessary for the projection of state power, suggesting a prolonging effect. Similarly, adverse climatic conditions may fuel anti-government grievances and reduce the opportunity costs associated with participation in rebellion, suggesting drier conditions would be more conflict-promoting, but undermine the resource base available for fighting, suggesting more agro-climatically advantageous conditions would be associated with conflict continuation.

Based on a replication of Cunningham, Gleditsch and Salehyan's (2009) dyadic model of conflict duration, we test jointly the effects of climatic shocks (Salehyan and Hendrix 2014) and discrete HMC disasters (Eastin 2016) on conflict duration. Consistent with recent findings in the climate/natural disaster and conflict literature, we find that discrete, rapid onset HMC disasters, like floods and hurricanes, prolong conflict, while drier conditions, net of the effect of discrete disasters, shorten conflicts. That is, separate from the effects of discrete disasters, more agro-climatically advantageous conditions appear to prolong conflict. Though the analysis is relatively preliminary, we use it as a basis for proposing more quantitative tests and case study-based methodologies to parse these seemingly contradictory findings.

The remainder of the manuscript proceeds as follows. The next section reviews the now quite large literature on climate change, natural disasters and conflict, noting that most studies focus on onset and incidence rather than duration or termination. The theory section elaborates theoretical mechanisms linking discrete disasters and deviations from "normal" climatic conditions to both conflict prolongation and termination, indicating the theoretical expectations are ambiguous. The following section discusses data, model specification, and interprets results. The final section draws preliminary conclusions, discusses the application of specific causal mechanisms to particular cases, and suggests further empirical tests.

2. Literature review

As evidence started emerging on the overlapping vulnerability to climate change and conflict in developing countries, the topic of climate change-conflict nexus has been receiving growing attention in the social sciences literature. In particular, it has been suggested that environmental change can lead to armed conflict onset through several mechanisms, including migration, resource scarcity, and other mechanisms in situations of political and economic instability and reduced state capacity (See Adger et al. 2014), though questions remain regarding the strength, direction, and causal nature of these relationships (Gleditsch and Nordås 2014).

Natural disasters, in particular, have been studied as potential drivers of conflict. The research findings have so far been conflictual, with some finding positive relationships between natural disasters and conflict onset (Drury and Olson 1998; Bhavnani 2006; Brancati 2007; Nel and Righarts 2008), and the second one arguing that natural disasters have minimal effect on conflict onset patterns, once other regime-level and economic characteristics are properly modeled (Bergholt and Lujala 2012; Omelicheva 2011). No real consensus has been reached on the relationship between natural disasters and conflict onset. The studies primarily applied hypotheses from the environmental conflict – scarcity literature towards natural disasters research and tested for such contextual variables as levels of economic development (Bhavnani 2006; Drury and Olson 1998; Nel and Righarts 2008), repression and regime type (Bhavnani 2006; Drury and Olson 1998), past conflict and political/ethnic tensions (Bhavnani 2006), and institutional resilience and capacity (Omelicheva 2011). However, little is known about the causation mechanisms at play, and resulting correlations do not present a substantial basis for policy conclusions (Kelman 2012). Moreover, many of these studies do not distinguish between climate-related natural disasters, such as floods, heat waves, droughts, and cyclonic storms and geological disasters, like earthquakes. Thus, the use of these studies to inform climate change adaptation and mitigation policy is somewhat suspect.

The focus on conflict onset in natural disaster research has largely stemmed from broader environmental conflict literature and has resulted in omission of alternative approaches towards analyzing conflict and disasters (Gleditsch 2012). Conflict resolution perspectives, in particular, have been largely ignored in the environmental conflict literature (Mislan and Streich 2014). Recent studies, however, suggest that natural disasters can be analyzed from the perspective of conflict resolution and ongoing conflict. Growing evidence and research demonstrates the positive impacts of natural disasters on conflict development and the conflict resolution opportunities that they provide.

The bulk of research in the positive consequences of natural disasters in general has been made by disaster politics and disaster diplomacy literature, which sheds light onto non-scarcity mechanisms, which could drive both conflict and reconciliation following a natural disaster. Broadly defined, this subset of studies looks at political and social pathways of change after a disaster, considering a wide range of dependent variables, among which is violent conflict. Dill and Peeling (2006) argue that disasters create a window of opportunity for "novel socio-political action", which is not limited to violent conflict, but affects a wide range of settings, such as elections, ethnic tensions, peace negotiations, and others. Similarly, Goldstone (2001) argues the effects of natural disasters on regime support are actually contingent on the quality of post-disaster response. When disaster response is poorly managed, developing country governments face an increased risk of political unrest; when disaster response is effective, it can result in increased support for the incumbent government. Evidence suggests this tendency is mirrored in US politics, so much so that US politicians may strategically underinvest in disaster prevention so as to reap the benefits of effective disaster response (Healy and Malhotra 2009).

Multiple authors have considered this notion of a window of opportunity within the context of violent conflict, in particular, arguing that natural disasters have a potential to both promote peace and exacerbate violence depending on local dynamics unraveling following natural disaster onset and disaster response. Within this literature, which developed largely independently from environmental conflict studies, a disaster, rather than conflict, is the primary starting point of analysis. Hence, greater attention is paid to the nature of disaster consequences, such as mass destruction, and necessity for humanitarian relief and reconstruction. Within this context, authors have analyzed such dynamics as a decrease in the relative fighting capacity of conflict parties based on the geographic and spatial impact of the disaster (Le Billon and Waizenegger 2007), emergence of a power vacuum and repositioning of political actors (Dill and Peeling 2006), change in the legitimacy of conflict actors based on their disaster response (Dill and Peeling 2006; Dill and Peeling 2008; Gawronski and Olson 2010; Goldstone 2001; Mandel

2002), increase in societal trust and level of compassion towards the "other" (Mandel 2002; Skidmore and Toya 2014; Slettebak 2012), aid and resource distribution (Rajasingham-Senanayake 2009) and scarcity (Brancati 2007), past conflict dynamics (Akcinaroglu, DiCicco, and Radziszewski 2011; Kelman 2012), and rebel group characteristics (Beardsley and McQuinn 2009).

An analysis from the vantage point of the disaster itself also allows for the consideration of temporal elements of its impact. An important aspect of the aforementioned mechanisms is the distinction between short-term and long-term disaster consequences: de-escalatory dynamics, such as fighting capacity reduction, widespread compassion and focus on the disaster in the stage of initial relief, can eventually be replaced by a reemergence of previous tensions and buildup of conflict activity (Dynes and Quarantelly 1976; Kelman and Koukis 2000). However, Kelman (2006) notes that this is not an inevitable escalation. In case of pre-existing tendencies towards cooperation, "disaster diplomacy" can lead to reconciliation between the parties. In addition to the distinction between short-term and long-term disaster effects, the duration of the disaster itself plays a critical role. Fast-onset, rather than slow-onset disasters tend to produce a greater sense of emergency (Mandel 2002) and hence have a greater initial tendency to promote de-escalation.

Developing in parallel to the literature on discrete disasters and conflict, there is now a large body of literature investigating the links between climate shocks – or deviations from long-term precipitation and temperature means for a given region or country – on conflict. This literature is now quite large (for a recent review, see Salehyan 2014), especially with respect to the question of whether climate shocks – operationalized as deviations from long-term climatic means – are causally related to human conflict at a variety of temporal and spatial scales (Hsiang, Burke and Miguel 2013; Buhaug et al. 2014; O'Loughlin, Linke and Witmer 2014).

Within this literature, there are three primary interpretations of correlations between climatic conditions, particularly precipitation levels relative to long-term means, and armed conflict. First, the Neo-Malthusian hypothesis holds that climate shocks generate grievances and fuel conflict over resource distribution as people fight directly over control of resources needed for survival (Raleigh and Urdal 2007; Hendrix and Salehyan 2012; Hsiang, Burke and Miguel 2013). Second, the opportunity cost model linking environmental factors and conflict (Maystadt et al. 2013; Miguel et al. 2004) links better climatic conditions – such as more abundant precipitation – with economic prosperity, and in turn, better wage-earning opportunities and higher opportunity costs to participating in fighting. Both arguments predict that violent mobilization will increase during periods of acute environmental scarcity. Finally, the resource mobilization hypothesis suggests that while scarcity stemming from climatic shocks might generate grievances and lower opportunity costs to participating in violence, the same scarcity saps the resource base necessary for the pursuit of political aims (Devlin and Hendrix 2014; Salehyan and Hendrix 2014).

All of these hypotheses have found support (and contradictory evidence) in the literature. Salehyan (2014) notes that differences in findings are largely a function of differences in temporal, spatial and social scales across studies, while O'Loughlin, Linke and Witmer (2014) argue differences in conclusions are driven by differences in econometric modeling choices.

Whatever the origins of these differences, the debate has become rancorous, if not at times openly hostile. For the moment, we simply note that while all these mechanisms are plausible, empirical tests of the climate-conflict link have thus far focused primarily on conflict onset and incidence, and thus tell us relatively little about whether natural disasters or climatic conditions might either prolong conflict or provide opportunities for conflict resolution.

3. Incorporating Conflict Theory: Natural Disasters, Climatic Conditions, and Ripeness

Even though multiple studies look into the conflict resolution potential of natural disasters, conflict theory does not prominently feature in the aforementioned research. However, this synthesis is an important part of moving forward in conflict-natural disaster modeling and can help understand the place of individually analyzed mechanisms of conflict-natural disaster interaction as a part of the overall conflict process, interrupted by a natural disaster event or climatic shock. The theory of conflict ripeness provides a good basis for such analysis.

According to Zartman (1995), a constant cost/benefit analysis by the parties on the merits of further confrontation defines the development of conflict. Therefore, the best moment for attempted resolution and negotiations is when parties realize that the costs of further conflict are higher than the benefits - a “ripe moment”. In particular, ripeness occurs when the parties are faced with a mutually hurting stalemate – a situation, when neither of them can achieve their goals by escalation at acceptable costs (Zartman 1991). This notion is very close to the “window of opportunity” term coined by Dill and Peeling (2006), discussed above and reflects an overall attention of both conflict resolution and disaster diplomacy theory to critical junctures and external shocks in conflict development (Druckman 2001; Mitchell 1995; Pruitt 2002). Climatic shocks, like drought (Salehyan and Hendrix 2014) may alter the calculations of the parties regarding the benefits and costs of further confrontation strategies, especially when one or more conflict actors is dependent on the natural resource base for the resources necessary to prosecute their war aims. Natural disasters profoundly reshape the strategic context in which the parties are operating, including resource mobilization strategies and availability (Salehyan and Hendrix 2014), humanitarian aid coordination necessities and new public opinion and legitimacy concerns (Dill and Peeling 2006; Dill and Peeling 2008; Gawronski and Olson 2010; Goldstone 2001; Mandel 2002; Rajasingham-Senanayake 2009).

Incorporating two theoretical perspectives, the concept of an external shock or critical juncture provides a useful tool for simultaneously analyzing temporal and causal aspects of the post-disaster environment outlined by various authors in the relevant studies. Generally put, natural disasters induce a mutually hurting stalemate on the conflict through two primary mechanisms: (1) decreased incentives towards escalation, and (2) increased incentives towards cooperation, which can vary in strength and duration based on both external conditions of original disaster impact or climatic shock, as well as preexisting trends in conflict and negotiations. This short-term de-escalation dynamic can either be carried out into long-term reconciliation or result in an eventual escalation of conflict to prior or greater levels.

Natural disasters increase the cost of further confrontation, thus reducing incentives for escalation. The primary asset of conflicting parties is their physical capacity for military action and ability to mobilize resource for continued action, which is often severely affected following a disaster or adverse shock to the local economy (Salehyan and Hendrix 2014; Le Billon and Waizenegger 2007). In a case of fast-onset disasters, infrastructure is destroyed and combatants are injured; in the case of slow-onset calamities, such as drought, basic livelihood resources, such as water, are less accessible, and continued recruitment can be a challenge (Roble 2011). Coupled with the reduced legitimacy of further fighting in the face of widespread destruction, natural disasters change the equilibrium of military power, thus creating a need for a change of strategy and recalculation of future moves. Even if military capacity is not significantly affected, time is needed to gather strategic intelligence on one's own and adversary's resources, and new decisions have to be made, which goes for both sides of the conflict, including the government. Overall, capacity losses and time needed for strategy recalculation increase conflict costs and reduce the probability of escalation.

While the incentives towards fighting decrease, the incentives towards cooperation increase. As the parties are locked in a mutually hurting stalemate, the only tool they can leverage in conflict is public opinion change by effective humanitarian response coordination. It becomes in the interest of the government to attempt some reconciliatory humanitarian moves in order to assert their influence in the rebel region and strengthen its position in the eyes of the affected population. The rebels are driven by the same logic, attempting to facilitate relief in order to boost their support. However, none of the parties can do so without the help of the other, as long as the rebels hold at least some territorial control in the affected areas. Therefore, the conditions for cooperation on disaster-related needs are created.

However, the initial mutually hurting stalemate and ripeness are not always sustained. The dynamics on the ground change as the short-term acute emergency conditions and response phase are replaced by long-term disaster recovery: pre-existing conditions and strategies come back into play as things get back to normality, resources are replenished, and new conflicts arise over humanitarian aid and resource misdistribution or capture (Kelman 2012; Dynes and Quarantelly 1976). Effective third-party interventions can stall return to conflict and encourage the parties to act on the existing opportunity for resolution (Zartman 2001) through external positive incentives towards negotiation as well as increased conflict costs in case of noncooperation (Mitchell 1995; Zartman 1991). However, escalation of conflict to prior of higher levels also becomes a distinct possibility as the parties can use disaster response levers to boost their support among their constituents and replenish resources. Overall, a natural disaster presents a critical juncture in conflict development, forcing the parties to reconsider their strategies.

Very few studies have systematically tested this model of disaster impact on ongoing conflict rather than conflict onset. The literature so far has focused on case studies, primarily the 2004 Indian Ocean tsunami and its impact on violent conflict in Sri Lanka and Indonesia (Le Billon and Waizenegger 2007; Rajasingham-Senanayake 2009; Beardsley and McQuinn 2009). While cases helped identify potential causal mechanisms affecting post-disaster conflict development, systematic quantitative analysis is needed in order to extrapolate these findings to a broader group of cases and understand the policy implications of these mechanisms.

One such study was carried out by Kreutz (2012) who tested for the peacebuilding potential of natural disasters by analyzing the incidence on cease-fires, peace negotiations and peace agreements within 12 months of a natural disaster in separatist conflicts. He finds a higher incidence of cease-fires and peace negotiations in comparison to pre-disaster peacebuilding activity. Kreutz (2012) attributes this correlation to a need for humanitarian relief coordination and public opinion concerns by the central government, which stimulates the government to grant concessions to the rebels. Parties are motivated to cooperate on issues of relief and reconstruction or at least cease fighting while these activities are in process.

Given the 12-month post-conflict period chosen by Kreutz (2012) for analysis, these results show that natural disasters have a peacebuilding potential in the short-term to medium-term time range. While Kreutz (2012) does not find evidence of an increased incidence of peace agreements within this period, a look at longer-term horizon is suggested by the theory. Natural disasters affect conflict in the long term and their influence ripples beyond the one-year mark, well into the reconstruction phase defined by previous disaster politics studies. The initial ripeness of the post-disaster period, which results in a higher number of cease-fires and peace negotiations, is either carried out into a long-term peace process or is not sustained and results in another round of escalation and potential resolution my military victory. In this article, we hypothesize that, through either mechanism, conflict duration is expected to decrease as a result of a disaster impact. The underlying logic is that, even though in the short-term a disaster results in a temporary slowdown of conflict activity, in the long-term it promotes faster conflict termination through greater engagement of the parties with the conflict agenda by bringing out all previous tendencies in conflict and creating new tensions as well as areas for cooperation and trust-building.

Hypothesis 1: Rapid-onset HMC disasters are negatively associated with conflict duration.

Alternately, rapid-onset HMC disasters may prolong conflict. As Eastin (2016) argues, HMC disasters may degrade the ability of state forces to project power and engage in counterinsurgency. HMC disasters typically degrade transportation infrastructure, such as roads, railways and vehicle fueling networks. The proportional effects of such degradation are typically larger for state forces, which are more likely to be mechanized and comparatively infrastructure-dependent than insurgents, who are typically more lightly armed and less dependent on heavy equipment (Lyall and Wilson III 2009). Moreover, disaster response typically reduces government revenues while increasing demands on state resources for disaster relief (Devlin and Hendrix 2014). To the extent both the infrastructure-destroying effects and resource mobilization effects are more sharply felt by the government, they amount to a reduction in its coercive capacity to either repress or accommodate rebels, suggesting a conflict-prolonging effect.

Hypothesis 2: Rapid-onset HMC disasters are positively associated with conflict duration.

Thus far, the theoretical discussion has revolved around the mechanisms linking discrete disasters to conflict duration. What about the effects of climatic shocks that take the form of annual deviations from longer-term climatic means, net of the effects of acute disasters? Again, the effects are theoretically ambiguous. The first expectation is that conflict will be prolonged by conditions of environmental scarcity – defined as periods of scarce precipitation – because of grievances, resource competition, and lower opportunity costs for fighting. Alternately, the resource mobilization hypothesis suggests conflict will be prolonged under conditions of abundance as mobilization opportunities become more favorable.[2] That is, this discussion suggests two competing notions of what might constitute a "ripe" moment for conflict resolution: times of scarcity or times of plenty.

Hypothesis 3: Precipitation levels will be negatively associated with conflict duration.
Hypothesis 4: Precipitation levels will be positively associated with conflict duration.

The theorized mechanisms assume that country-level climatic conditions are a significant determinant of both government and rebel resources. This assumption is most defensible in those cases where economic conditions – both national and household – are coupled to climatic conditions. For instance, Salehyan and Hendrix (2014) find the strongest substantive effects for climate shocks on political violence in samples including only African and Asian countries. Though urbanizing rapidly, Africa and Asia are still predominately rural (60 and 52 percent, respectively) and employment in agriculture still predominates (FAO 2012, UN DESA 2014). Thus, we expect that climatic conditions will be a more significant determinant of conflict duration in Africa and Asia than in the more industrialized and/or service-oriented economies of other world regions. Thus, we expect the relationships embodied in hypotheses 1-4 will, if evident at all, be amplified in Africa and Asia, i.e., the substantive effects will be larger.

4. Data, Methods and Results

We test our hypotheses regarding links between climatic shocks, natural disasters, and conflict duration via a re-analysis/extension of Cunningham, Gleditsch and Salehyan (henceforth CGS, 2009). They analyze 273 distinct civil conflicts at the dyad level (404 total dyads), allowing them to include data on the attributes not just of states but of non-state armed actors as well. Though included in their study to facilitate hypotheses tests, we treat them as controls (discussed below) that address otherwise unmodeled conflict heterogeneity in duration models that only include structural attributes of states and/or national economies or relatively sparse information on non-state combatants, such as ultimate goals (Kreutz 2012, Eastin 2016). A conflict is coded as having ended if violence ceases for a period of more than two calendar years or if the conflict ends due to a formal settlement process.

We draw our climatic and natural disaster data from Dell, Jones, and Olken (2012) and the Centre for Research on the Epidemiology of Disasters (2015), as transformed by Salehyan and Hendrix (2014) and Eastin (2016), respectively. The climatic variables, *precipitation anomaly* and *temperature anomaly*, represent the current year's difference from the 10-year moving average of the indicator for a given country panel (1950-2005) and divide it by the panel's standard deviation.[3] The resulting variables represent differences (in standard deviations) in the

[2] Future iterations of this paper will more fully nest this discussion in the bargaining model of conflict (Powell 2006), where exogenous, transitory shocks that have symmetric effects on conflict actors should not affect the prospects for conflict initiation or termination. Only when the effects are asymmetric do such models result in the expectation of altered conflict dynamics.

[3] The 10-year moving average is used because each of the climatic variables displays significant trending over time. This temporal trending complicates both regression and semi-parametric analysis, as the climatic variables are non-stationary (Imbens 1994). While one way to address this is with panel-specific time trends, this approach allows us to control for temporal trends in the climate variables without assuming a function form (linear, quadratic,

current year from historic trends; both are approximately normally distributed with a mean of ~0 and standard deviation of 1. Previous research finds evidence of a positive association between this measure of precipitation and conflict intensity, both at the intrastate and interstate levels of analysis (Salehyan and Hendrix 2014, Devlin and Hendrix 2014).

Because we are focused on the impact of HMC conditions on conflict duration, we restrict our analysis of discrete disasters to hydrological (floods, mud and landslides), meteorological (storms) and climatic (extreme temperature, droughts, and wildfires) events. We use the annual count of *HMC disaster onsets*, i.e., events that begin in a particular calendar year, to capture the overall magnitude of discrete disaster impacts.[4] While these data are subject to some measurement error, they are more reliable than estimates of numbers killed and/or affected and economic costs, as these are endogenous to a host of political-economic factors, including expectations of international assistance (Cohen and Werker 2008, Eastin 2016). As a robustness check, we decompose HMC disasters into total disasters and *slow onset disaster onsets*, which capture events like droughts and heat waves. Because they develop over comparatively longer periods of time, slow onset disasters are typically not experienced by local populations as "shocks", per se, but as challenges that develop over a period of months.

Given that both precipitation and temperature anomalies and both operationalizations of disasters capture elements of climatic conditions in a given country-year, we might expect they would be highly correlated. However, this is not the case. While precipitation and temperature anomalies are negatively correlated – higher temperatures are associated with less rainfall and vice versa – neither is strongly correlated with the count of HMC disasters; similarly, neither is highly correlated with the count of slow onset disasters ($r < 0.1$ in all instances; see table 1).

Table 1: Manifest Correlations between Counts of HMC Disasters, Slow Onset Disasters, Precipitation and Temperature Anomalies

	ln Count of HMC Disaster Onsets	ln Count Slow Onset Disaster Onsets	Precip. Anomaly	Temp. Anomaly
ln Count HMC Disaster Onsets	1.00			
ln Count Slow Onset Disaster Onsets	0.43	1.00		
Precip. Anomaly	0.05	-0.03	1.00	
Temp. Anomaly	0.02	0.08	-0.25	1.00

* $p < 0.05$. Data sources: Salehyan and Hendrix 2014, Eastin 2016.

A frequency plot of HMC disasters and precipitation anomalies confirms this: 80% of country-years with HMC disasters had precipitation anomaly values between -1.2 and 1.43. This is likely because as constructed, precipitation anomalies tell us nothing about the *distribution* of rainfall in a given year. A year with a "normal" (i.e., near mean) value for total rainfall, but in which all the of rain occurred in one or two days, precipitating mudslides and flooding, is observationally equivalent to one in which the rainfall was spread more uniformly throughout the year. For

sinusoidal) for the temporal trend and then applying it to all countries regardless of their specific climatic trends; see Salehyan and Hendrix (2014).

[4] We use the natural log transformation for statistical analysis because the data are highly skewed, though this choice does not materially alter the findings.

example, in 2001 India experienced precipitation levels that were close to the country adjusted mean (-0.12), but nevertheless experienced 17 HMC disasters. By modeling precipitation anomalies and HMC disasters jointly, we may thus separate the effects of general climatic conditions (anomalies variables) from discrete climatic shocks (HMC disasters).

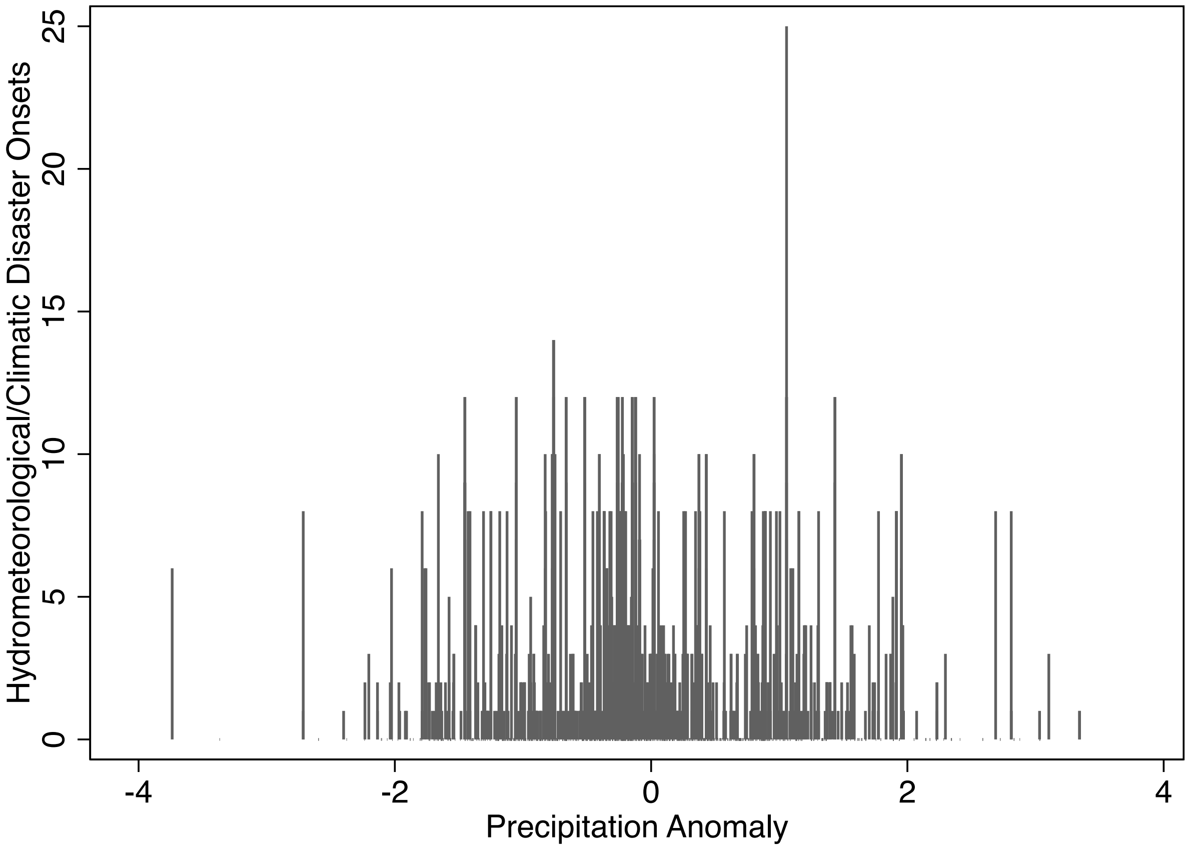

Figure 1: Yearly HMC Disaster Onsets and Precipitation Anomalies, 1966-2005. Despite an intuitive link between annual levels of precipitation and the frequency of HMC disasters (i.e., too little rain resulting in drought, too much resulting in flooding) the two variables are essentially uncorrelated with one another (r = 0.05), suggesting they capture different aspects of hydro-meteorological conditions.

Our control variables are taken directly from CGS (2009). They include several variables measured at the country-year level (GDP per capita, democracy, population, whether a coup d'etat occurred in a given year) and several variables that capture rebel capacity (ex., whether they control territory, rebel mobilization and arms-procurement capacity) and conflict dynamics (whether the war occurs on core or peripheral territory, the number of active dyads in the conflict). Following CGS, we employ the semi-parametric Cox proportional hazards model.

Tables 2 and 3 report the results of our re-analysis/extension of CGS's model on conflict duration. Table 2 contains estimates for models including disaggregated measures of rebel capacity while table 3 uses the aggregated measures.[5] In both cases, the first column replicates their original analysis while the second column restricts the analysis to conflict spells for which the climate variables are available. We note simply that the most substantively and statistically significant covariates of conflict duration from the CGS models (territorial control, coup d'etat, ethnolinguistic fractionalization, democracy, and two or more dyads involved) are unaffected by the sample restriction. The third column presents the results of the global analysis, while the fourth column presents the results of the analysis when restricted to conflict dyads in Africa and Asia, the world regions where we would expect climatic conditions to have the strongest substantive effects for conflict dynamics.

Across both model specifications, the coefficient on *HMC Disasters* is negative and highly statistically significant ($p < 0.01$), indicating that as the (ln) number of HMC disasters in a given year increases, the probability that the conflict will end in that year decreases; disasters are thus positively associated with conflict duration. The coefficients for the Africa and Asia sub-sample are 12 to 15 percent larger than the coefficient estimates for the global sample, indicating the proportional impact of natural disasters on conflict duration is somewhat larger for these regions. These findings are consistent with those reported by Eastin (2016), who finds that rapid-onset disasters (and HMC disasters specifically) significantly prolong conflict spells. They are substantively significant as well. Figure 2 plots the survival curves as a function of time for the 25^{th}, median and 75^{th} percentile values of *HMC Disasters* based on table 2, model 3. Holding all other variables constant, a one-unit increase in the *HMC Disasters* is associated with a roughly 40.1 percent decrease in the rate of conflict termination.

Further investigation suggests these effects are limited to rapid- rather than slow-onset HMC disasters like droughts or extreme temperature. Models estimated with the *ln slow onset disaster onsets* variable (table 2, models 5 & 6, table 3, models 11 & 12) never return statistically significant findings, and the sign on the coefficient switches from the full to the Africa and Asia sample. Notably, the coefficient on precipitation anomaly is negative and significant in all four of these specifications.

[5] Tables 2 and 3 in the present study correspond to tables 3 and 4 in CGS (2009).

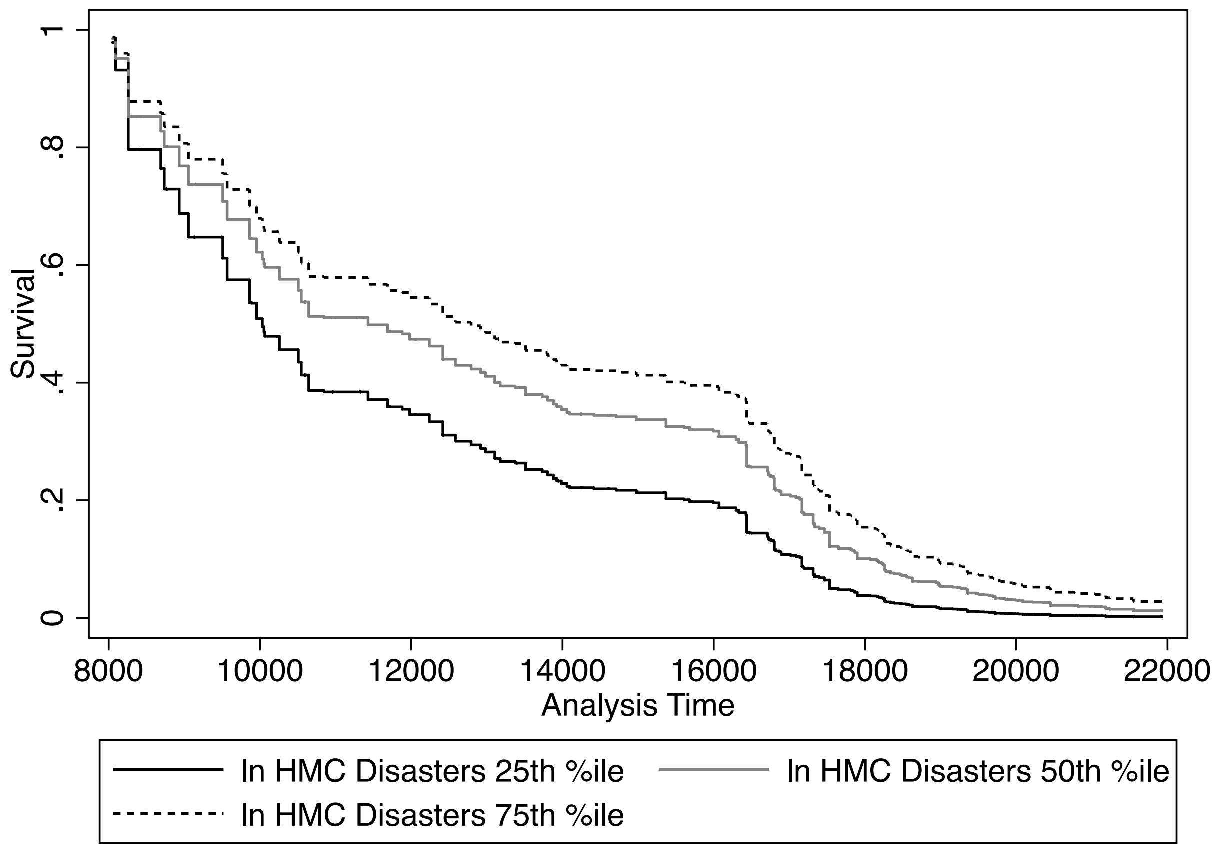

Figure 2: Survival Curves for Conflict Spells at Varying Values for Hydro-Meteorological/Climatic Disasters. Curves calculated based on table 2, model 3.

Table 2: Climate Anomalies, HMC Disasters, and Civil Conflict Duration: Disaggregated Rebel Capacity Measures

VARIABLES	(1) Global	(2) Global	(3) Global	(4) Africa & Asia	(5) Global	(6) Africa & Asia
Territorial Control	-0.344**	-0.409*	-0.448**	-0.521**	-0.428**	-0.510**
	(0.168)	(0.218)	(0.214)	(0.217)	(0.218)	(0.212)
Strong Central Command	0.217	0.182	0.123	-0.049	0.195	-0.006
	(0.190)	(0.243)	(0.248)	(0.287)	(0.247)	(0.282)
High Mob. Capacity	0.341	0.503	0.586*	0.295	0.510	0.088
	(0.211)	(0.314)	(0.310)	(0.372)	(0.320)	(0.384)
High Arms Proc. Capacity	1.941***	1.021	1.533	1.638	1.207	1.336
	(0.685)	(0.973)	(0.970)	(1.044)	(0.949)	(1.031)
High Fighting Capacity	0.262	-0.022	-0.100	0.058	-0.198	0.026
	(0.412)	(0.565)	(0.588)	(0.680)	(0.582)	(0.656)
Legal Political Wing	0.536**	0.154	0.143	-0.039	0.134	-0.080
	(0.228)	(0.283)	(0.284)	(0.297)	(0.283)	(0.297)
War on Core Territory	-0.136					
	(0.296)					
Coup d'Etat Attempt	3.332***	3.856***	4.163***	4.245***	4.010***	3.860***
	(0.323)	(0.468)	(0.439)	(0.514)	(0.449)	(0.525)
ELF Index	0.715**	0.949**	0.861**	0.949**	0.842*	1.144***
	(0.321)	(0.411)	(0.424)	(0.429)	(0.435)	(0.434)
Ethnic Conflict	0.153	0.032	-0.044	-0.227	0.032	-0.176
	(0.194)	(0.227)	(0.231)	(0.225)	(0.224)	(0.214)
ln GDP per capita	0.213**	0.055	0.040	-0.133	0.049	-0.157
	(0.098)	(0.129)	(0.128)	(0.127)	(0.133)	(0.123)
Democracy	-1.206***	-1.425***	-1.265***	-1.076**	-1.468***	-1.234***
	(0.229)	(0.344)	(0.359)	(0.449)	(0.348)	(0.432)
Two or More Dyads	-0.387***	-0.354**	-0.366**	-0.291*	-0.379**	-0.247
	(0.132)	(0.157)	(0.162)	(0.166)	(0.170)	(0.172)
ln Population	-0.167***	-0.168*	0.007	0.051	-0.178*	-0.115
	(0.059)	(0.088)	(0.098)	(0.101)	(0.094)	(0.093)
Precipitation Anomaly			-0.142*	-0.216**	-0.160*	-0.244***
			(0.084)	(0.094)	(0.083)	(0.089)
Temperature Anomaly			-0.146	-0.039	-0.134	-0.045
			(0.119)	(0.114)	(0.118)	(0.120)
ln HMC Disasters			-0.509***	-0.584***		
			(0.151)	(0.163)		
ln Slow Onset Disasters					0.235	-0.338
					(0.448)	(0.444)
Observations	2,446	1,714	1,714	1,389	1,714	1,389

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Net of the effect of these discrete HMC disasters, we find some evidence that precipitation abundance is associated with longer conflicts, especially in the Africa and Asia sub-sample. Across the two tables, the coefficients on *precipitation anomaly* are uniformly negative and statistically significant ($p < 0.1$) in three of the four models (table 2, models 3 and 4, table 3, model 8; p value for *precipitation anomaly* in table 3, model 7 is 0.11). That is, higher levels of rainfall are associated with longer conflicts. In the Africa and Asia sub-sample, a one standard deviation increase in rainfall from the panel moving mean is associated with a 19.5 percent decrease in the rate of conflict termination. Substantive effects are plotted in figure 3.

Evidence regarding *temperature anomaly* is indeterminate: though all of the estimated coefficients are negative, none approach statistical significance. Thus, we conclude that net of the effect of precipitation and HMC disasters, temperature levels are not associated with conflict duration, and thus the effects of climate shocks operate through precipitation and water availability, rather than through temperature.

Table 3: Climate Anomalies, Hydro-Meteorological/Climatic Disasters, and Civil Conflict Duration: Aggregated Rebel Capacity Measures

VARIABLES	(7) Global	(8) Global	(9) Global	(10) Africa & Asia	(11) Global	(12) Africa & Asia
Territorial Control	-0.406**	-0.454**	-0.490**	-0.574***	-0.468**	-0.549***
	(0.179)	(0.220)	(0.216)	(0.210)	(0.220)	(0.207)
Rebels Stronger	1.104***	0.810**	0.880**	0.699	0.751*	0.600
	(0.357)	(0.387)	(0.414)	(0.428)	(0.387)	(0.370)
War on Core Territory	-0.263					
	(0.291)					
Rebels at Parity	0.354*	0.496*	0.508**	0.295	0.515**	0.195
	(0.213)	(0.254)	(0.236)	(0.264)	(0.259)	(0.259)
Legal Political Wing	0.541**	0.176	0.172	-0.026	0.163	-0.070
	(0.238)	(0.286)	(0.287)	(0.300)	(0.288)	(0.300)
Coup d'Etat Attempt	3.377***	3.906***	4.197***	4.244***	4.063***	3.880***
	(0.320)	(0.456)	(0.424)	(0.501)	(0.441)	(0.515)
ELF Index	0.714**	0.951**	0.889**	0.995**	0.843**	1.172***
	(0.326)	(0.398)	(0.407)	(0.420)	(0.423)	(0.427)
Ethnic Conflict	0.173	0.055	-0.026	-0.206	0.054	-0.170
	(0.197)	(0.232)	(0.235)	(0.236)	(0.230)	(0.224)
ln GDP per capita	0.232**	0.090	0.073	-0.125	0.088	-0.156
	(0.095)	(0.126)	(0.125)	(0.124)	(0.131)	(0.121)
Democracy	-1.228***	-1.463***	-1.294***	-1.066**	-1.514***	-1.219***
	(0.233)	(0.349)	(0.367)	(0.452)	(0.355)	(0.435)
Two or More Dyads	-0.402***	-0.359**	-0.367**	-0.306*	-0.384**	-0.263
	(0.132)	(0.157)	(0.163)	(0.166)	(0.168)	(0.170)
ln Population	-0.144**	-0.155*	0.017	0.041	-0.167*	-0.113
	(0.062)	(0.088)	(0.097)	(0.100)	(0.094)	(0.093)
Precipitation Anomaly			-0.129	-0.207**	-0.150*	-0.235***
			(0.081)	(0.090)	(0.080)	(0.086)
Temperature Anomaly			-0.139	-0.049	-0.127	-0.051
			(0.117)	(0.114)	(0.116)	(0.120)
ln HMC Disasters			-0.495***	-0.555***		
			(0.152)	(0.161)		
ln Slow Onset Disasters					0.270	-0.333
					(0.448)	(0.446)
Observations	2,446	1,714	1,714	1,389	1,714	1,389

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

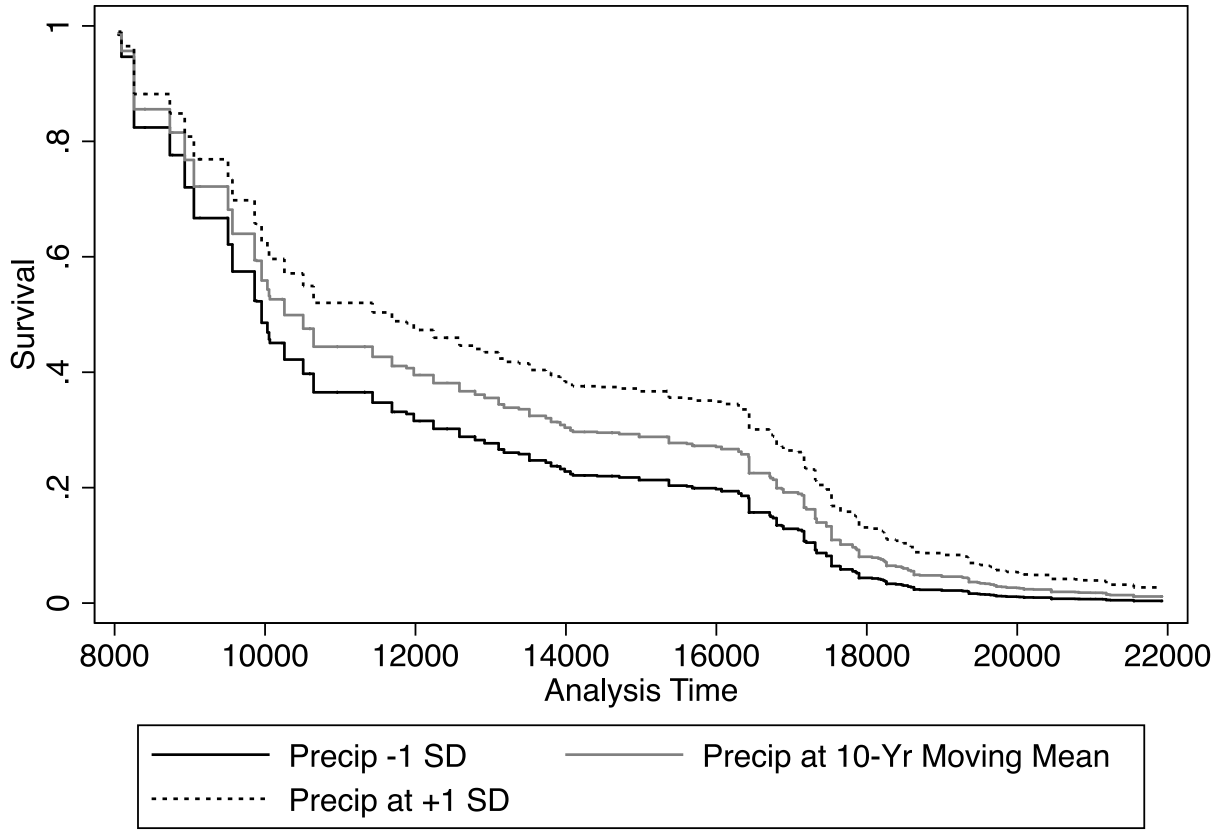

Figure 3: Survival Curves for Conflict Spells at Varying Values for Precipitation Anomalies for Africa and Asia Sub-Sample. Curves calculated based on table 2, model 4.

Our analysis supports two preliminary conclusions regarding the effects of water scarcity/availability and natural disasters on conflict duration. First, HMC disasters – discrete events that lead to loss of life and property, declarations of emergency, and/or calls for international assistance – do not appear in the main to provide propitious moments for conflict resolution. In contrast, HMC disasters are correlated with longer conflicts. These findings confirm those of Eastin (2016), and demonstrate that the finding is robust to alternative modeling choices both in terms of estimator (semi-parametric Cox proportional hazards vs. parametric Weibull regression) and choices of control variables.

Second, net of the effect of these discrete disasters, more advantageous agro-climatic conditions are associated with longer conflicts, particularly in Africa and Asia, where the correlation is both substantively and statistically more significant. This finding is consistent with those reported by Salehyan and Hendrix (2014), who interpret the effect as operating through the resource mobilization channel: as resources become comparatively less constrained, both dissidents and states have more resources to invest in prolonging the conflict. However, these correlations are far too aggregated to give us direct purchase on this causal mechanism. In order to investigate whether this channel is plausible, we present a mini-case study of conflict dynamics in Somalia, a country where climatic conditions are significant determinants of both household and national income. Agriculture provides over 70 percent of employment, with herding, rather than sedentary horticulture, contributing the larger share. Irrigated cropland is scarce, making agricultural activities dependent on rainfall.

Table 4: Contribution of Agriculture to GDP and Employment and Share of Irrigated Cropland for Somalia, Sudan

Country	Agriculture, % GDP	Agriculture, % Employment	Irrig. Cropland, % of Total
Somalia	60.2	71.0	6.2

Data sources: CIA World Factbook 2016, FAO 2003.

Anecdotal evidence suggests the 2010-11 drought in the Horn of Africa – the worst since the early 1990s – led to a decrease in the capacity of al-Shabaab, an Islamist insurgent group that has fought against the Somali federal government since its formation in 2006. Up until the drought, al-Shabaab had been on the offensive, exploiting the power vacuum created by Ethiopia's withdrawal of troops from Somalia in 2009. This offensive coincided with a bumper crop, reportedly one of the best seen in Somalia in several years, for which al-Shabaab received credit and political support (Al Jazeera 2010).

However, fortunes took an abrupt turn. In July 2010 the United Nations declared a famine in Somalia. The disaster was exacerbated by the weakness of the Somali government and ongoing military conflict on the ground. The drought and the famine came amidst armed conflict waged by al-Shabaab on the territory of the country and has significantly contributed to the dynamics of the conflict. Most importantly, it has undermined the human and natural resource base of al-Shabaab in famine-affected regions and consequently lead to a decrease in its fighting capacity.

A year into the famine, al-Shabaab banned most humanitarian aid agencies delivering aid to famine-affected populations, such as UNICEF, WHO, UNHCR, and others (Al Jazeera 2011). Such a decision, which was made on the grounds of humanitarian organizations' alleged political agendas in al-Shabaab-controlled territories, contributed to a waning of organization's support among the population. Al-Shabaab's withdrawal from Mogadishu in August 2011 is attributed "to its increasing unpopularity with local Somalis after the group banned foreign aid to alleviate the famine that ravaged Somalia in the summer of 2011" (Mapping Militant Organizations Project 2016). In addition to the blocking of humanitarian aid, al-Shabaab enforced tax collection in famine-affected regions (BBC News 2012), which further eroded the trust of the population in al-Shabaab as a grantor of their religious freedom and overall prosperity.

Famine also undermined the support for the organization within its own ranks and was a contributing factor in a wave of defections that occurred in 2011-2012. Defectors from al-Shabaab mentioned that, among other factors, the inability of al-Shabaab to pay salaries and to provide food during the famine years contributed to their decision to leave the organization: "Joining them was a surefire way to get money during their first years. But now they can't even get meals for their fighters" (The Star 2012). Thus, decreasing agricultural output and lack of alternative livelihood opportunities within al-Shabaab motivated fighters to defect and seek opportunities elsewhere, for example, in the DDR process. The inability of al-Shabaab to collect taxes from the famine-ravaged population, which had nothing to give, also contributed to the shrinking of the resource base available to the organization and its fighters, as did outmigration from al-Shabaab-held territory (Roble 2011). By 2011, al-Shabaab had begun seeking increased cooperation with criminal gangs and pirates in order to make up for resource shortfalls stemming from the drought (Reuters 2011).

In addition to waning support and a wave of defections, the end of 2011 was also characterized by an increase in fragmentation within al-Shabaab's leadership (Mapping Militant Organizations Project 2016). The divisions were caused reportedly by diverging visions of the organization's future and its links to al-Qaeda (Mapping Militant Organizations Project 2016). However, a strain on organization's resources caused by the famine and disagreements over humanitarian organizations' operations in al-Shabaab regions might have also contributed to the internal fragmentation of the leadership and decrease in the efficiency of its overall command and control structure.

Interestingly, these dynamics were not reflected in battle death figures for the drought-affected years: battle death totals for 2010-11 were relatively similar to those observed in the pre- and post-drought years (2009 and 2011; see table 5). However, the similarity in death tolls masks the dynamics discussed earlier, which included loss of territorial control and out-migration from al-Shabaab held territory.

Table 5: Battle Death Estimates for Somalia, 2008-2014

		Battle Death Estimates		
Year	Intensity	Low	Best	High
2014	War	894	1140	2271
2013	Minor	744	917	1746
2012	War	2445	2620	2919
2011	War	1559	1938	2269
2010	War	1547	2158	2307
2009	War	1350	1539	1755
2008	War	656	1483	2165

Source: UCDP 2016.

How does this discussion relate to our quantitative findings? At first blush, it may seem ambiguous: the time period under discussion (2010-11) was characterized both by scarce precipitation (i.e., low scores on the precipitation anomaly variable) but also by an HMC disaster (the drought). Moreover, though the discussion is consistent with the resource mobilization hypothesis, the conflict did not actually end and is ongoing as of March 2016. Still, this discussion provides some *prima facie* evidence for the purported resource mobilization mechanism discussed earlier. Future iterations of this paper will include other additional case studies that probe the face validity of the findings.

5. Conclusions

In brief, our preliminary findings are as follows. Consistent with recent findings in the climate/natural disaster and conflict literature, we find that discrete HMC disasters, like floods and hurricanes, prolong conflict, while drier conditions, net of the effect of discrete disasters, shorten rather than prolong conflicts. These findings are generally consistent with some recent findings from the natural disaster and conflict (Eastin 2016) and climate change and conflict literatures (Salehyan and Hendrix 2014), though the findings are as yet too preliminary to be considered conclusive. The present analysis does not, in the main, provide support for the disaster diplomacy hypothesis.

Consistent with Eastin (2016), we find HMC disasters are associated with longer conflicts. However, there are at least two important caveats to this finding. First, the estimated effect is the average effect across all conflict types. To the extent our samples are stratified, they are only stratified according to world region (Africa and Asia) and whether the disasters are slow- or rapid-onset. It is entirely possible that for some subset of disasters and conflict cases – or both – the effect of the disaster could be conflict-dampening. Further investigation and sample stratification, not only by treatment (HMC disasters) but also by contextual, country-, conflict- or armed actor-level factors that might mediate their effects, is warranted. Kreutz (2012), for instance, finds disasters to be associated with increased propensity for negotiations in separatist conflicts.

Second, there is the lingering issue of endogeneity and omitted variable bias. Attributes of states that may affect conflict duration may also affect the frequency of reported natural disasters. For an event to count as a natural disaster in the EM-DAT database, one of the following criteria must be met: 1) 10 or more people dead; 2) 100 or more people affected; 3) declaration of a state of emergency; or 4) a call for international assistance (CRED 2015). Thus, EM-DAT codings are susceptible to both reporting bias in the detection of disaster-related deaths and affected individuals and strategic calculations, on the part of leaders, regarding states of emergency declarations and calls for international assistance. Given the strong correlation between media freedoms and democracy (Whitten-Woodring 2009) and the relative absence of domestic political opposition that might highlight disaster-related damage in attempts to win office (Hendrix and Wong 2013; Quiroz-Flores and Smith 2013) it is likely that natural disasters in non-democracies are significantly underreported. Moreover, income should mediate the relationship between disaster magnitude, with higher income countries being less likely to call for international assistance following a disaster. Taken together, these two expectations suggest lower-income democracies – the types of regimes previous analysis suggests should be involved in longer conflicts – are more likely to report disasters. And while both regime type and level of development are controlled for in the various models, this does not entirely remedy this problem.

Though the sample is restricted to countries that experienced conflict spells, Eastin's data indicate democracies experience rapid onset disasters at almost three times the rate of non-democracies (mean rapid onset disasters per year, non-democracies = 1.11; mean rapid onset disasters per year, democracies = 2.99, $p < 0.01$). When the sample is stratified to look at low-income countries, the gap is slightly wider (mean rapid onset disasters per year, non-democracies with GDPpc < sample median = 0.90; mean rapid onset disasters per year, democracies with GDPpc < sample median = 2.93, $p < 0.01$). This pattern is evident when we look within-countries as well, pre- and post-democratic transition. The Philippines reported an average of 5.3 rapid onset disasters per year under non-democratic rule, but 10.3 per year once it transitioned to democracy ($p < 0.01$); for Indonesia, the values are 4.7 and 11.4, respectively ($p < 0.01$). To the extent that disasters have both random and non-random components, further investigation of the non-random determinants of disaster propensity is warranted.

In closing, we think the present analysis provides strong support for analyzing climate shocks and discrete disasters as complements, rather than substitutes. Earlier contributions to the literature have often treated these indicators interchangeably, as if a high (low) score on the precipitation anomaly variable were a suitable operationalization of flooding (drought). The descriptive statistics presented here suggest this is not the case and that the two measures, even when restricted to HMC disasters, capture different aspects of climate impacts on conflict processes.

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