

**After the Rain:
Rainfall Variability, Hydro-Meteorological Disasters, and Social Conflict in Africa**

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Water is a critical natural resource. In addition to fresh water for drinking and household use, water is a critical input for agriculture and industry. However, a significant share of the world's poor lacks access to clean water, and in many developing countries, irrigation, water transmission capacity, sanitation facilities, hydroelectric capacity, and so on, are lacking. This is especially true in Sub-Saharan Africa, where according to the United Nations World Water Development Report (United Nations Educational, Scientific, and Cultural Organization 2009), 340 million people lack access to clean drinking water, only 4 percent of annual renewable flows are stored (compared with 70-90 percent in developed countries), and for most countries, less than 5 percent of cultivated areas are equipped for irrigation. Thus, many countries depend on rainfall to supply water for crops, livestock, and human consumption; yet, this often means unreliable access to a vital resource. Flooding and extended droughts can destroy individual livelihoods, seriously undermine macroeconomic growth, and place strains on government revenues.

In this paper we examine the relationship between rainfall, water, and socio-political unrest in Africa. In particular, we are interested in how deviations from normal rainfall patterns, and extreme events such as flooding and drought, affect political behavior and the propensity for individuals and groups to engage in disruptive activities such as demonstrations, riots, strikes, communal conflict, and anti-government violence. Do extreme weather events exert a significant influence on political disturbances and social conflict? What forms of conflict are most likely and do they potentially threaten the stability of the government? This topic is especially pressing as the process of global climate change accelerates, potentially making

rainfall more erratic and severe weather events more likely (Intergovernmental Panel on Climate Change 2007).

Possible links between climate change and conflict have gained considerable attention, including at the United Nations.² Some observers have even blamed climatic conditions for particular civil wars such as Darfur (Faris 2009). While we eschew simple, direct causal pathways from water resources to civil war and avoid mono-causal explanations for political violence, we argue that water scarcity can lead to resource competition, poor macroeconomic outcomes, reduced state capacity, and ultimately, social conflict. However, as a departure from many studies on the topic, we do not necessarily expect full-blown civil wars to emerge as a result of water scarcity. Launching an insurgency entails significant start-up costs and planning, popular mobilization, funding, and organizational capacity. Government inability or unwillingness to accommodate opposition groups, or repress them, is also needed for armed rebellions to emerge. However, grievances and competition over water resources can generate significant social conflict in ways that do not require the level of organization and funding typically needed for sustaining an insurgency. Such events can be extremely disruptive, cost thousands of lives, and ultimately bring down regimes.

The next section of this paper develops a theory of how rainfall and water resources affect political stability and posits several hypotheses. Then, we describe a new dataset we compiled on social conflict in Africa and the methods we propose to test our hypotheses. Following this we discuss the results of our analysis.

² United Nations General Assembly. *Climate Change and its Possible Security Implications. Report of the Secretary General.* 64th Session, Item 114 of the Provisional Agenda. 11 September, 2009.

Theory: Hydro-Meteorological Disasters and Conflict

Over the last ten years or so, there has been a growing interest in the relationship between natural resources and civil conflict. One body of literature argues that the abundance of natural resources—particularly minerals and oil—can lead to political violence (Bannon and Collier 1999, de Soysa 2002, Collier and Hoeffler 2004, Ross 2004, Humphreys 2005; Lujala 2009). Such resources can be looted to fund rebel organizations, the discovery of new resources can lead to friction over their allocation, and dependence on primary commodities can weaken state capacity. Others scholars have argued that the scarcity of vital resources—particularly water and food—can lead to or aggravate conflict (Hauge and Ellingsen 1998, Homer-Dixon 2001, Le Billon 2001, Maxwell and Reuveny 2000, Percival and Homer-Dixon 1996). Resource scarcity is argued to generate grievances over the lack of basic necessities and fuels conflict over their distribution. These literatures do not necessarily contradict each other, as the former typically focuses on the availability of lucrative, though non-essential commodities such as gemstones and oil while the latter focuses on access to basic needs.

With growing concern over the human implications of climate change, many scholars have begun to employ quantitative methods to understand the link between environmental scarcity and civil war (see *Political Geography* special issue, 2007). For the most part, researchers have looked at land and water resources—and changes in their availability—to determine whether or not there is a direct link between scarcity and war (Hauge and Ellingsen 1998, Homer-Dixon 2001, Miguel, Satyanath and Sergenti 2004, Hendrix and Glaser 2007, Raleigh and Urdal 2007, Thiesen 2008). Yet there is hardly a consensus in the literature about causal relationships as findings have been weak and inconsistent (Salehyan 2008). In a related body of work, studies of international conflict find little interstate violence over water and

demonstrate that cooperative arrangements are more likely (Wolf 1998, Toset, Gleditsch, and Hegre 2000, Gleditsch et al. 2006). Rather than a simple, direct relationship between water and land scarcity and war, future research should explore how environmental conditions interact with political institutions and policies, existing social cleavages, and conflict mitigation strategies to foster or mitigate the likelihood of rebellion.

In this paper, we depart from previous studies by looking at other forms of conflict short of full-blown civil war and state failure. Much of the literature on civil war rightly argues that grievances—including over access to water and other resources—are not sufficient to explain armed conflict. While grievances are certainly important, mobilizing a rebellion is a costly and risky endeavor which requires long-term planning, leadership, organizational capacity, funding, and internal or external sanctuaries to evade government repression (Collier and Hoeffler 2004, Fearon and Laitin 2003, Salehyan 2007, Tilly 1978). The opportunity costs for individual insurgents are high as they forgo productive economic activity and risk death. For most aggrieved actors, most of the time, rebellion is not a viable option. Moreover, the resort to armed conflict requires that the government be unwilling or unable to reach a compromise with the opposition that is mutually preferred to war (Fearon 1995; Walter 2009). In the context of resource scarcity, armed conflict does nothing to increase the supply of resources and may indeed diminish them (Maxwell and Reuveny 2000). Therefore, conflicts arise over the *distribution* of resources rather than their absolute *level*, and distributional issues are inherently part of a political bargaining process. If the regime is sufficiently responsive to citizen demands there may be adequate alternatives to rebellion (Hegre et al 2001).

With this in mind, we argue that extreme deviations from normal rainfall patterns, droughts, and floods—which we collectively term hydro-meteorological disasters—may lead to

other forms of social and political disorder short of civil war. Some forms of politically-motivated violence, such as riots, do not require the high levels of organization or funding typical of armed rebellion. In addition, individuals and groups competing for resources may fight directly rather than engage the government, which is often far riskier given the state's preponderance of coercive force. Finally, mass demonstrations and strikes may seriously undermine government authority and disrupt the economy, without sustained violent campaigns. Thus, our analysis is in line with research that argues there may be distinct sets of variables that explain rebellion versus protests and other disturbances (Scarritt and McMillan 1995, Regan and Norton 2005). While under certain circumstances and in particular contexts, hydro-meteorological disasters may contribute to armed rebellion, we believe that unorganized dissent, mass demonstrations, and communal conflicts (not to mention inter-personal disputes) are more likely responses.

It should not be assumed however, that strikes, riots, communal conflicts, demonstrations, and so on are lower-order forms of conflict. Indeed, they can be quite disruptive. For instance, following elections in Kenya in 2007—in which land rights were a major campaign issue—thousands of people died during weeks of rioting and the government was forced to accept a power-sharing deal. In the early 1990's, mass demonstrations in Zambia forced the government of Kenneth Kaunda to accept multi-party elections. In Ghana in 1994, ethnic riots killing approximately 3,000 people and displacing tens of thousands more erupted after a price dispute in a local market. Clearly, these events have the potential to cost many more lives than low-level insurgencies, and can be far more disruptive to basic government functions.

We argue that there are at least five mechanisms through which hydro-meteorological disasters may lead to socio-political conflict. These causal pathways are not mutually exclusive

and may reinforce one another. Conflicts may include civil war, but we stress that other forms of disorder are more likely to occur since civil war is a rare event, the onset of which depends on other factors in addition to access to resources. Grievances and resource competition are more likely to translate into disorganized violence and conflicts that do not involve the state.

First, hydro-meteorological disasters may lead to conflict among consumers of water, including among those who depend on water as an input for their products. Water is necessary for human consumption, washing, cooking, and so on. As water stores decline, consumers may come into conflict with one another over access to wells, riverbeds, and the like. Importantly, water is a major input for agricultural producers and pastoralists as well as for manufacturing and mining. Thus, farmers, herders, manufacturers, and other producers, may come into conflict over water rights, which have a direct impact upon their livelihoods (Campbell et al 2000, Eriksen and Lind 2009). In addition, rainfall shortages exacerbate the encroachment of deserts into formerly productive land and can lead to increased competition over cropland and pastures.

Second, both the excess (i.e. flooding) and the shortage of water can lead to price disputes between rural producers and urban consumers. Droughts and damage to cropland after excess rain can lead to temporary food shortages and spikes in market prices. For instance, although weather-related conditions were one of many causal factors (Alexandratos 2008), the rising price of staple crops in 2008 led to massive protests and riots in dozens of countries, especially as urban consumers demanded relief from price inflation (Hendrix, Haggard, and Magaloni 2009). Food price inflation clearly has a negative impact on the welfare of urban dwellers. However, the net impact on rural welfare is ambiguous as small-scale farmers are often net purchasers of food, and some farmers may see a decline in living standards (Barrett and Dorosh 1996).

Third, as livelihoods in affected areas come under stress, many will opt to migrate to urban areas in search of alternative work. Migration—both within countries and across national boundaries—can lead to intensified competition over jobs, housing, and other resources; it can also lead to shifts in ethnic settlement patterns, which may intensify inter-communal conflict (Nordås, Gleditsch and Salehyan 2007, Reuveny 2007). The growth of urban slums—although they are often vibrant communities—has been associated with entrenched poverty, crime, substance abuse, and political conflict (Neuwirth 2005, Davis 2007). Urban growth also places strain upon governments as demand for basic services such as sanitation, electricity, police protection, roads, and so on, increase. Thus, migration can create friction between locals and new arrivals as well as place increased demands on providers of local services.

Fourth, states often intervene in markets in order to increase their revenues and expand patronage opportunities. In Africa, market distortions are often particularly high (van de Walle 2001). States intervene in the economy through taxation, subsidies, marketing boards, price controls, import and export controls, among other means, and such market interventions are designed by incumbents so as to maintain political stability and control (Bates 1989, Krueger 1996, Kasara 2007). Given the central importance of agriculture and other water-intensive sectors to African economies, extreme weather events can have particularly pronounced effects (Benson and Clay 1998). Hydro-meteorological disasters can place enormous strains on government revenues through the reduction of the tax base as well as increased demands for services and assistance by the hardest hit. Moreover, the ability of incumbents to maintain patronage networks and reward core supporters—either through direct transfers or through manipulating markets—can be undermined. For instance, Robert Bates (1989, Chapter 4) discusses how drought in Kenya led to increased demands on the Kenyan Maize Board, an

institution which worked primarily to influence food prices, and in turn, political stability. Planning failures caused episodic droughts to turn into major food crises in Kenya, which ultimately threatened the very survival of the regime.

Finally, natural disasters can have negative macroeconomic effects more generally (Kreimer and Arnold 2000). Hydro-meteorological disasters can present an enormous human and financial toll on developing economies and government resources. Displacement and loss can hurt overall economic productivity. In addition, food shortages and malnutrition can present long-term negative developmental effects and harm worker productivity in the short-term. Economic research has shown that, in general, adverse rainfall shocks have a negative effect on overall growth (Miguel, Satyanath, and Sergenti 2004, Jensen and Gleditsch 2009, Fiala 2009). General economic malaise may in turn lead to civil conflict and social disorder.

We note that many of these effects are far-reaching and impact economies and societies as a whole. A current wave of research has sought to find *local* patterns of conflict and natural disasters (Buhaug and Lujala 2005, Buhaug and Rød 2006, Raleigh and Urdal 2007). These studies have looked for correlations between local environmental conditions such as droughts, land degradation, water shortages, etc, and political conflict *in that locality*. While we believe these studies are useful and have the potential to reveal many interesting relationships, we argue that there is no reason to expect that the effect of local environmental conditions be limited to the immediate area. Indeed many of the most significant effects of hydro-meteorological disasters are likely to be felt across the country and beyond. For instance, droughts in agricultural regions may lead to migration to urban areas and increased prices for urban consumers. Thus, political conflict may not be confined to drought-stricken areas, but be felt in distant urban centers. In addition, declining state revenues can lead to strains on public finances and negatively affect

public-sector employees across the economy. For instance, declining crop yields can reduce government revenues, which then cause the state to be unable to make payrolls for teachers in state schools, in turn leading to a strike by teachers. Finally, disaster affected populations can take their protests and demands directly to the national capital rather than hold local demonstrations. Thus, causal pathways may be long and far-reaching; it would be misleading to only look for localized effects.

Hypotheses

The discussion above suggests several non-exclusive pathways to socio-political conflict. Although we believe them all to be plausible, data constraints prevent us from testing the mechanisms in great detail. However, take as a whole the discussion above suggests that hydro-meteorological disasters—which we define as 1) extreme deviations from normal rainfall patterns, 2) droughts, and 3) flooding—increase the likelihood of conflict. Stated formally:

Hypothesis 1: hydro-meteorological disasters will increase the frequency of socio-political disturbances.

In addition, given the large costs and risks associated with challenging the state, we expect inter-personal and inter-communal violence to be the norm, rather than direct opposition to governmental authorities. Disputes in peripheral regions often take place without the active involvement of the state. Moreover, conflicts over market prices, employment, access to water resources, and so on, often do not directly imply a challenge to the state itself but can manifest themselves through social unrest. Therefore, we posit:

Hypothesis 2: Hydro-meteorological disasters will increase the frequency of extra-governmental socio-political disturbances more than the frequency of government-directed disturbances.

Finally, given the inability or unwillingness of many African governments to respond to citizen demands and the weakness of many African institutions (Herbst 2000), we expect affected citizens to be more likely to resort to violence rather than nonviolent activities such as protests and strikes. For protests and strikes to be successful, people must believe that these tactics have a high likelihood of success. Given the failure of many African states to make appropriate adjustments in response to demands from below, violent outbursts of popular grievances are more likely. Moreover, when survival is at stake, groups may resort to violence to secure resources, as violence may be necessary in order to directly procure resources through raiding or land occupation. Thus we expect:

Hypothesis 3: Hydro-meteorological disasters will increase the frequency of violent socio-political disturbances more than the frequency of nonviolent disturbances.

Data and Methods

The Dependent Variable: Political Disturbance Events

We test for the effect of climatic factors on six different dependent variables: *civil conflict onset*, *total events*, *nonviolent events*, *violent events*, *government-targeted events*, and *non-governmental events*. *Civil conflict onset* is a dummy variable that takes on a value of 1 if the country-year contained the onset of an intrastate conflict characterized by 25+ annual battle

deaths, and zero otherwise. These data are from Strand's (2006) update and transformation of the Uppsala Conflict Data Project/Peace Research Institute of Oslo armed conflict dataset (Gleditsch et al. 2002). As stated above, however, we do not expect to find a very strong link between organized armed conflict and environmental conditions.

All the event variables are counts of the number of events in a given year. These data are from the Social Conflict in Africa Database³ (SCAD), which contains information on instances of contentious collective action such as *protests*, *riots*, and *strikes*; but includes also *intra-governmental violence*, such as coups or factional fighting within the military; violent *repression* by the government or its agents; *anti-government violence* that does not meet the conventional thresholds for civil conflict (as defined by the Uppsala University Armed Conflicts Dataset); and *extra-governmental violence*, or violence by a non-state, organized militant group against individuals, rival communal groups, or other social actors not involving the state. Every country in Africa (with a population greater than one million), including North Africa, is coded for the period 1990-2009. The data are compiled from *Associated Press* and *Agence France Presse* newswire reports, and contain detailed information about event duration, magnitude, the actors and targets involved, state repression of popular protest, issues, and location. For the specific coding methodology, see Appendix 2. A total of 6,222 events have been coded thus far. These events do not include, however, violent events that occur during periods of civil conflict as defined by the Uppsala Conflict Database that are directly related to the conflict dynamic. Individual battle events in states experiencing civil conflict are being coded in the ACLED database (Raleigh and Hegre 2005).

³ This analysis is on a preliminary version of the dataset. We are currently updating the data through 2009 for all 47 cases.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Civil Conflict Onset, 2-Year Intermittency Threshold ⁴	873	0.05	0.22	0	1
Total Events	901	6.91	11.55	0	95
Nonviolent Events	901	3.65	5.53	0	42
Violent Events	901	3.26	7.06	0	67
Government-Targeted Events	901	3.58	5.53	0	40
Non-Government-Targeted Events	901	3.32	7.43	0	74

Total events are all events for a country-year across event types. *Nonviolent events* are those events, such as protests and strikes, which are not violent in nature. *Violent events*, such as riots, government repression, anti-government violence, and both intra- and extra-governmental violence, are those in which the actor initiating the event acted in a violent manner. *Government-targeted events* are those where either the central and/or a regional government was a target. Finally, *non-government-targeted events* are those where the targets are nongovernmental entities. Descriptive statistics for our dependent variables are presented in Table 1. As can be seen from this table, civil conflict onsets are quite rare, involving only 5% of our observations, while the average country/year in our data experienced roughly seven social disturbance events.

Independent Variables: Climatic Shocks

We operationalize climatic shocks two ways. Our preferred measure of rainfall shock is the annual *standardized rainfall deviation* from the long-term (1979-2008) panel mean of rainfall for a given country. Our measure is based on the Global Precipitation Climatology Project (GPCP) database of monthly rainfall estimates, Version 2.1, aggregated to the yearly and country level. The data are available at a resolution of 2.5° latitude by 2.5° longitude and cover the time

⁴ Data are from 1990-2007.

period 1979-2008. Because the data combine measurements from a variety of remote-sensed sources and rain gauges, they are much more accurate, and their measurement less potentially affected by human factors, than rain gauge estimates alone. To generate our standardized *rainfall deviation* variable, we measure deviations from the long-term mean rainfall for a given country and dividing them by the panel's standard deviation.⁵ Values for standardized *rainfall deviation* range have a mean of 0.05, a standard deviation of 1, and range from -3.74 to 3.91. This measure more accurately accounts for cross-sectional differences in both mean values for rainfall, which range from 3.1 cm/yr (Egypt) to 233.3 cm/yr (Sierra Leone), and within-panel variance, measured by the variation coefficient, which ranges from 0.05 (Democratic Republic of Congo) to 0.27 (Botswana).⁶ We test for both linear and curvilinear relationships between the standardized *rainfall deviation* and disturbance events by running the analysis with both the linear measure and its squared term.

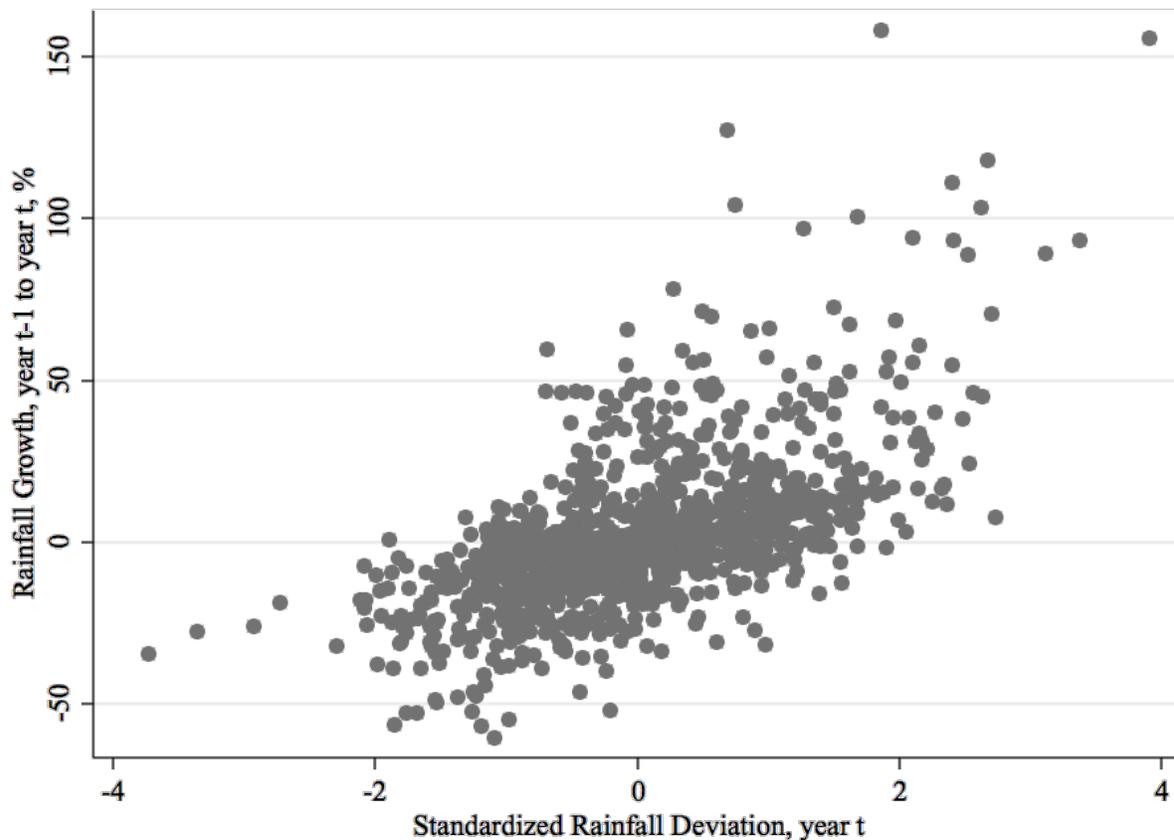
Previous studies of rainfall and conflict (Miguel, Satyanath, and Sergenti 2004, Hendrix and Glaser 2007, Jensen and Gleditsch 2009) operationalize rainfall shocks as the percent change in annual rainfall in country i in year t from the previous year. As a measure of whether or not a given country-year was a particularly wet or dry year, this measure can be misleading. Figure 1 shows a scatterplot of our *rainfall deviation* variable against the annual percent growth in rainfall. While the two variables are positively correlated ($r = 0.62$), it is clear that a year with zero growth following an unusually wet year would still be an unusually wet year, while a year of 50 percent growth following an unusually dry year might still be a less-than-average year. For

⁵ More formally, this is $(X_{it} - \bar{X}_i)/\sigma_i$, where \bar{X}_i is the panel mean for country i , X_{it} is the current rainfall in time t for country i , and σ_i is the standard deviation for country i .

⁶ The variation coefficient is the ratio of the standard deviation to the mean. Higher values indicate greater variance around the mean, i.e., Botswana's rainfall varies comparatively widely from year to year.

this reason, our *rainfall deviation* more accurately measures relative rainfall abundance, given the historical norm for that country.

Figure 1: Rainfall Growth vs. Standardized Rainfall Deviation from Long-Term Means



Our second measure of climatic shocks focuses on instances of droughts and flooding as discrete natural disasters. The World Health Organization's Collaborating Center for the Epidemiology of Disasters (CRED) EM-DAT database contains data on natural disasters from 1900-2007. Events meet the CRED definition of disaster if one or more of the following criteria are met: (1) Ten or more people were reported killed, (2) one hundred people were reported affected, (3) it led to the declaration of a state of emergency, and/or (4) it led to calls for international assistance (<http://www.emdat.be/criteria-and-definition>). Following Nel and Righarts (2008), we employ simple counts of events, *drought events* and *flood events*. Because

flooding is more episodic than drought, which is a sustained phenomenon, is it much more common; with the mean country year witnessing over three times more flood events than drought events. *Drought events* occur in 18.3 percent of country-year observations, while *flood events* occur in 33.5 percent of country years.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Rainfall Deviation	935	0.05	1.00	-3.73	3.91
Rainfall Deviation ²	935	1.00	1.53	0	15.27
Drought Events	935	0.18	0.39	0	1
Flood Events	935	0.50	0.89	0	7

Droughts and flooding are of course related to the volume of precipitation, but also a host of other factors, including higher temperatures (which are themselves related to precipitation, see Burke et al. 2009), the rate of evaporation, deforestation, and erosion (in the case of droughts), as well as the timing of precipitation, runoff, and storm surges (in the case of flooding). Thus, *rainfall deviation* does not correlate perfectly with instances of drought and flooding ($r = -0.11$ and $r = 0.22$, respectively).

We note that several measures of environmental degradation, such as deforestation or unclean water, may be endogenous to human activity and political processes. Rainfall, however, is independent of human activity, thus eliminating concerns of endogeneity among our independent and dependent variables. Moreover, this should mitigate the risk of omitted variable bias since it is unlikely that unmodeled social or political features of a country would both affect conflict behavior and precipitation. For this reason, we believe the rainfall data to be a superior measure of water-related stress. The CRED data on droughts and floods are somewhat more prone to human activity and the political incentives of elites. Fatalities resulting from natural

disasters, the declaration of a state of emergency, and calls for international assistance are not purely meteorological in nature and could be driven by other factors.

Controls

While omitted variables should not be of great concern in our models that use rainfall data, we include a number of additional variables for comparison purposes and as controls in our models that use CRED. We employ a battery of controls typical to the literatures on protest and civil conflict. First, we control for regime type. Many studies have found an inverted-U shaped relationship between regime type and contentious collective action of various types: political protest and violence is least common in highly repressive authoritarian regimes, more common in democracies, and most common in hybrid regimes or anocracies—those political systems in which democratic and authoritarian tendencies intermingle (Muller and Weede 1990, Hegre et al. 2001, Hendrix, Haggard and Magaloni 2009). To model the inverted-U hypothesis, we include both the revised combined Polity score, commonly referred to as *Polity2*, and its squared term. *Polity2* ranges from -10 (strong autocracies) to 10 (strong democracies).⁷

Second, we control for level of development and economic growth. The negative relationship between economic development and civil conflict is the most robust finding to emerge from the conflict literature (Hegre and Sambanis 2006). Moreover, various studies indicate that economic growth is associated with a decrease in political violence (Collier and Hoeffler 2004, Miguel, Satyanath and Sergenti, 2004, Hendrix, Haggard and Magaloni 2009).

Third, we control for population and population growth. For any given level of grievance, we would expect that more populous countries would see more political protest

⁷ As per the *Polity IV Dataset Users' Manual*, standardized authority scores are handled in the following manner: -66 (cases of foreign interruption) is treated as “system missing.” -77 (cases of interregnum) is treated as 0. -88 (cases of regime transition) is the difference between the beginning and ending Polity code, prorated for the duration of the transition (Marshall and Jaggers 2009).

(Fearon and Laitin 2003, Hendrix, Haggard and Magaloni 2009). Population growth is included to control for the possibility that countries undergoing rapid demographic transformation will be more prone to political disorder (Urdal 2005). Countries with large populations and large economies may also have greater news coverage, making these controls important to include.

Finally, we control for the incidence of civil conflict. Reporting on the conflict might “crowd out” reporting on other forms of contentious collective action, and under some circumstances the conflict itself may make the expression of popular grievance more risky. However, conflicts themselves are often the cause of large-scale protest (as in Rwanda in 1995 and Liberia in 2001 and 2003). Thus, the expected effect of civil conflict is indeterminate.

Estimation and Results

For modeling civil war/insurgency, we use standard logistic regression with errors clustered at the country level and a count of years since last conflict (peace years) along with three cubic splines, as per Beck, Katz, and Tucker (1998). Because the distribution of disturbance events is highly skewed, we use negative binomial regression. Negative binomial models are similar to other event count models, such as Poisson regression, but are more appropriate for over-dispersed data; theoretically, one would expect that a given social disturbance would make future disturbances more likely. The interpretation of coefficient estimates for negative binomial models is not intuitive: for a one unit change in the independent variable, the log of expected counts of the dependent variable is expected to change by the regression coefficient, given the other independent variables in the model are held constant. As with other maximum likelihood estimators, the magnitude of the marginal effect is contingent on the values of all independent variables of interest.

We estimate the event count models with a lagged dependent variable and country-level fixed effects. A fixed effects model converts observed values for the dependent and independent variables into deviations from their mean values within each unit. By allowing for intercept differences, fixed effects models eliminate the cross-sectional elements from the data and the estimated coefficients report only longitudinal changes within countries. This also accounts for unmodeled attributes of the country as a whole, and for the possibility that some countries may have greater news coverage than others. We also use year dummies and a time trend to control for factors that might affect levels of disturbances across all countries in a given year, and to account for any general linear trend in the number of events over time. Because of the availability of control variables, all analyses are run on a sample of 46 countries for the years 1991-2007.⁸

Table 3 reports logit coefficient estimates of the effects of our various climatic shock variables on civil conflict onset. Model 1 includes the both the linear and squared *rainfall deviation* measures, the lag of the rainfall measures, and a battery of controls. Model 2 includes both the present and lagged counts of *drought events* and *flood events*. The present effect of *rainfall deviation* is positive in model 1. We find no relationship between our measure of *drought events* and onset, though we do find a weakly significant, negative relationship between lagged *flood events* and conflict onset.

⁸ Somalia is excluded from the analysis for two reasons. First, the dynamics addressed in our theoretical argument presume at least a minimally functioning state, which Somalia lacks. Second, patterns of violence in Somalia have been driven largely by interactions with intervening third parties (the US and UN forces in the early 90s, Ethiopia in more recent years). In the interest of full disclosure, the inclusion of Somalia significantly diminishes the explanatory power of our various models.

Table 3: Civil Conflict Onset, Rainfall Deviations, and Droughts and Floods		
	(1)	(2)
Lagged DV	-2.057**	-1.953**
	(0.828)	(0.784)
Polity2	-0.044	-0.036
	(0.037)	(0.037)
Polity2 ²	-0.016	-0.016
	(0.012)	(0.013)
(log) Population	0.061	0.115
	(0.130)	(0.133)
Population growth, %	0.223***	0.207**
	(0.085)	(0.086)
(log) Real GDP per capita	-0.261	-0.274
	(0.335)	(0.357)
Real GDP growth, %	-0.036	-0.026
	(0.023)	(0.021)
Rainfall deviation	0.377***	
	(0.143)	
Rainfall deviation ²	0.003	
	(0.091)	
Rainfall deviation, lagged	0.017	
	(0.203)	
Rainfall deviation ² , lagged	-0.101	
	(0.191)	
Drought events		-0.324
		(0.651)
Drought events, lagged		0.152
		(0.624)
Flood events		-0.010
		(0.272)
Flood events, lagged		-0.411*
		(0.224)
Constant	-0.425	-0.665
	(2.157)	(2.424)
Controls for Temporal Dependence	Yes	Yes
Observations	765	765
Countries	46	46
Robust standard errors in parentheses		
* significant at 10%; ** significant at 5%; *** significant at 1%		

While the positive, linear effect of present *rainfall deviation* is strongly statistically significant ($p < 0.01$) and the marginal effect is large in percentage terms, the absolute effect on conflict onset is relatively small. Holding all the control variables at their mean, a one standard

deviation increase from mean rainfall increases the probability of onset from 0.033 to 0.046, an increase of 39.4 percent; a two standard deviation increase from mean rainfall increases the probability of onset to 0.066, or 100 percent. No combination of observed variables, however, results in a predicted probability of conflict onset in a given country-year of greater than 0.5. Contrary to arguments in the literature, increased rainfall, rather than water scarcity, is more likely to lead to conflict. Moreover, we find no evidence of a curvilinear effect. Perhaps more striking than the results regarding the hydro-meteorological variables is the fact that none of the standard controls in the civil conflict literature are significant in the model, including level of economic development and rates of economic growth (Fearon and Laitin 2003, Miguel, Satyanath, and Sergenti 2004, Hegre and Sambanis 2006). Models run with lagged indicators, a typical method of addressing endogeneity, returned results similar to those presented here.

Turning to our event data, tables 4 and 5 reports coefficient estimates of the effects of *rainfall deviation* on our five dependent variables. As *rainfall deviation* is both statistically and theoretically orthogonal to our dependent variables and other social, political, and economic variables that might be associated with social conflict, table 4 includes only a lagged dependent variable, present and lagged indicators of rainfall deviation, and time trends and period dummies. The findings indicate a positive, curvilinear relationship between contemporaneous *rainfall deviation* and four of our five dependent variables: *total events*, *nonviolent events*, *violent events*, and *government-targeted events*. Both wetter and drier years than average are associated with an increase in these types of events. Only *non-government-targeted events* are not significantly correlated with *rainfall deviation*. Lastly, lagged *rainfall deviation* is negatively associated with *government-targeted events*, indicating fewer government-targeted events as rainfall increases in the previous year.

	(1)	(2)	(3)	(4)	(5)
	Total Events	Nonviolent Events	Violent Events	Government-Targeted Events	Non-Government-Targeted Events
Lagged DV	0.025*** (0.003)	0.039*** (0.007)	0.047*** (0.007)	0.041*** (0.007)	0.041*** (0.006)
Rainfall deviation	-0.006 (0.030)	-0.026 (0.033)	0.031 (0.041)	-0.013 (0.034)	0.023 (0.038)
Rainfall deviation ²	0.052*** (0.019)	0.042** (0.021)	0.065** (0.026)	0.052** (0.022)	0.031 (0.024)
Rainfall deviation, lagged	-0.039 (0.030)	-0.042 (0.033)	-0.023 (0.041)	-0.078** (0.034)	0.051 (0.038)
Rainfall deviation ² , lagged	0.018 (0.020)	0.004 (0.022)	0.041 (0.026)	0.004 (0.023)	0.024 (0.025)
Constant	142.231 (167.628)	89.079 (186.792)	159.348 (234.260)	72.114 (192.315)	254.842 (215.598)
Time Trend	Yes	Yes	Yes	Yes	Yes
Period Dummies	Yes	Yes	Yes	Yes	Yes
Observations	826	826	826	826	826
Countries	46	46	46	46	46
Standard errors in parentheses					
* significant at 10%; ** significant at 5%; *** significant at 1%					

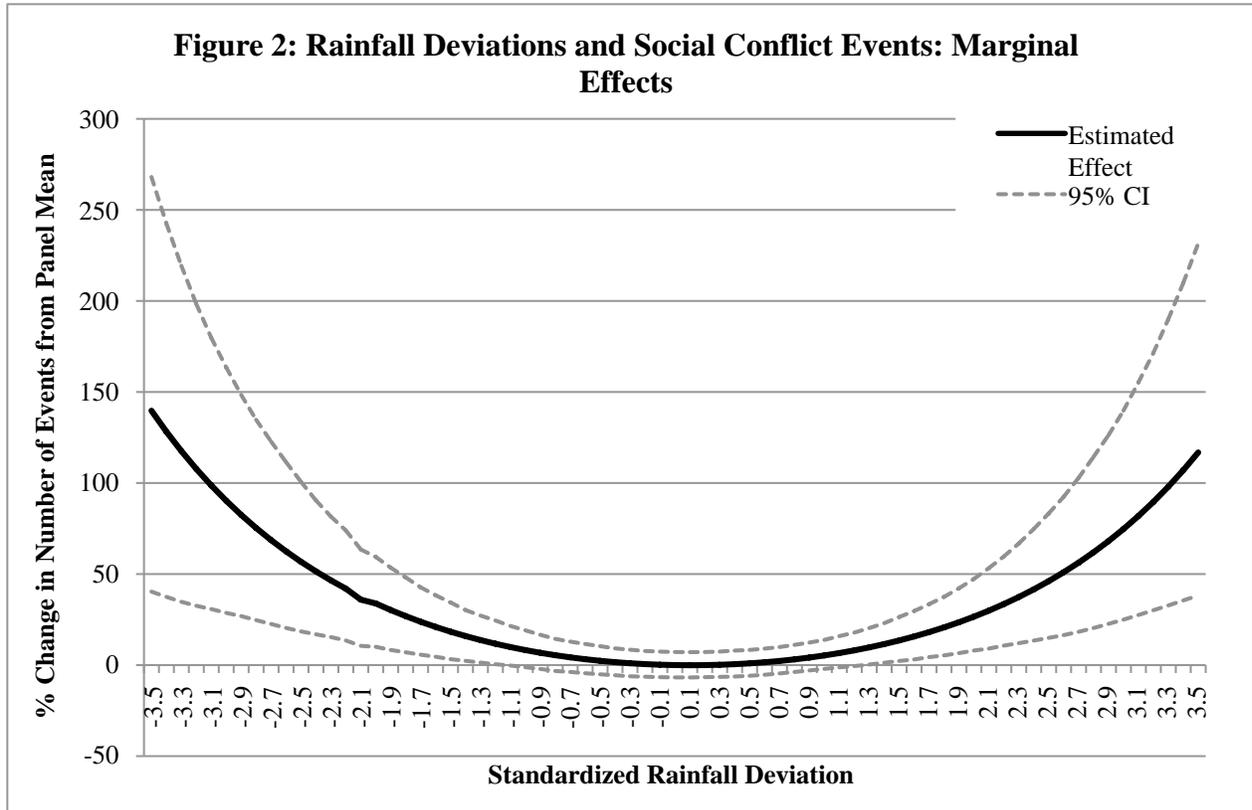
Table 5 includes the full battery of control variables. The findings indicate a curvilinear relationship between contemporaneous *rainfall deviation* and all five dependent variables: all five coefficient estimates are statistically significant (in joint tests) and positive. In terms of magnitude and strength of effect, the largest is on *violent events*, with a one-unit increase in *rainfall deviation* from the panel mean associated with a 0.085 increase in the difference in the log of expected counts (significant at $p < .01$, followed by *total events* (0.065, $p < 0.01$) and *government-targeted events* (0.063, $p < 0.01$). The magnitude and strength of effect is less for *nonviolent events* (0.052, $p < 0.05$) and *non-government-targeted events* (0.046, $p < 0.10$). Lagged *rainfall deviation* is only weakly associated with *violent events*, with the linear and square terms failing a joint significance test.

	(1)	(2)	(3)	(4)	(5)
	Total Events	Nonviolent Events	Violent Events	Government-Targeted Events	Non-Government-Targeted Events
Lagged DV	0.024*** (0.004)	0.036*** (0.007)	0.043*** (0.007)	0.037*** (0.007)	0.035*** (0.006)
Polity2	-0.012 (0.011)	-0.016 (0.012)	0.003 (0.015)	-0.020 (0.012)	0.019 (0.015)
Polity2 ²	-0.004* (0.002)	-0.001 (0.002)	-0.009*** (0.003)	-0.003 (0.002)	-0.008*** (0.003)
(log) Population	-0.982 (0.756)	-0.985 (0.869)	-0.894 (1.063)	-0.992 (0.904)	0.017 (0.980)
Population growth, %	-0.035 (0.027)	-0.032 (0.033)	-0.035 (0.035)	-0.004 (0.037)	-0.066** (0.031)
(log) Real GDP per capita	0.077 (0.182)	0.178 (0.206)	-0.014 (0.241)	0.018 (0.212)	0.119 (0.213)
Real GDP growth, %	-0.008** (0.004)	-0.005 (0.004)	-0.014** (0.005)	-0.006 (0.005)	-0.010** (0.005)
Rainfall deviation	-0.012 (0.030)	-0.031 (0.034)	0.023 (0.041)	-0.017 (0.035)	0.013 (0.038)
Rainfall deviation ²	0.065*** (0.019)	0.052** (0.021)	0.085*** (0.026)	0.063*** (0.022)	0.046* (0.024)
Rainfall deviation, lagged	-0.014 (0.033)	-0.025 (0.037)	0.011 (0.044)	-0.051 (0.038)	0.072* (0.041)
Rainfall deviation ² , lagged	0.026 (0.023)	0.012 (0.026)	0.051* (0.030)	0.007 (0.027)	0.036 (0.027)
Civil conflict incidence	0.074 (0.105)	0.202* (0.119)	-0.078 (0.142)	0.085 (0.123)	0.023 (0.129)
Constant	442.514 (335.497)	596.101 (379.723)	195.274 (460.460)	553.667 (395.786)	446.428 (412.119)
Time Trend	Yes	Yes	Yes	Yes	Yes
Period Dummies	Yes	Yes	Yes	Yes	Yes
Observations	766	766	766	766	766
Countries	46	46	46	46	46
Standard errors in parentheses					
* significant at 10%; ** significant at 5%; *** significant at 1%					

Aside from the lagged dependent variable, the performance of our control variables was inconsistent. Our findings lend partial support to the inverted-U relationship between regime type and social conflict: *Polity2*² is negatively associated with all five dependent variables, though the relationship is not statistically significant with respect to *nonviolent events* and *government-targeted events*. The relationship is strongest with respect to *violent events* and *non-*

government-targeted events. The latter could be a somewhat spurious correlation, as *non-government-targeted events* are likely to also be *violent events*. Thus, the findings suggest that political institutional coherence matters more for deterring violence than nonviolent mobilization, a finding consistent with the literature (Muller and Weede 1990, Hegre et al. 2001). *GDP growth* is strongly and negatively associated with *total events*, *violent events*, and *non-government-targeted events*, though our estimation strategy is not designed to rule out simultaneity, which is highly plausible, as violence is tantamount to economic development in reverse (Collier et al. 2003).

We use CLARIFY (King, Tomz, and Wittenberg 2000) to estimate the effect of changes in *rainfall deviation* on the quantities of interest: expected counts of events. Holding all control variables at their mean values, a one standard deviation increase in *rainfall deviation* is associated with a 5.30 percent increase in expected *total events* from the panel mean, while a one standard deviation decrease in rainfall deviation is associated with a 8.24 percent increase in expected *total events* from the panel mean. A two standard deviation increase in *rainfall deviation* is associated with an 26.59 percent increase in expected *total events* from the panel mean, while a two standard deviation decrease in rainfall deviation is associated with a 33.85 percent increase in expected *total events* from the panel mean. Finally, a three standard deviation increase in *rainfall deviation* is associated with a 74.71 percent increase in expected *total events* from the panel mean, while a three standard deviation decrease in *rainfall deviation* is associated with an 90.27 percent increase in expected *total events* from the panel mean. Thus, *total events* are more sensitive to negative rainfall deviations than positive ones. This curvilinear relationship is depicted graphically in Figure 2.



However, not all event types are more responsive to rainfall scarcity than rainfall abundance. Table 6 reports marginal effects of *rainfall deviation* on percent changes in expected events from the panel mean value for the five event types. While *nonviolent events* and *government-targeted events* are more responsive to rainfall scarcity than abundance, *violent events* and *non-government-targeted events* are more responsive to rainfall abundance. The effect on violent events is the strongest, with a two standard deviation increase in rainfall deviation associated with an almost 50 percent increase in the expected number of *violent events*. This finding, taken with our positive, linear finding with respect to rainfall and *civil conflict onset*, stand in contrast to the body of findings relating environmental scarcity more strongly to political violence (Hauge and Ellingsen 1998, Miguel, Satyanath and Sergenti 2004, Hendrix and Glaser 2007).

	Total Events	Nonviolent Events	Violent Events	Government-Targeted Events	Non-Government-Targeted Events
- 2 Standard Deviations	33.85%	32.24%	35.38%	34.15%	17.28%
- 1 Standard Deviation	8.24%	8.87%	6.44%	8.40%	3.32%
Panel Mean	0	0.00%	0.00%	0.00%	0.00%
+ 1 Standard Deviation	5.30%	2.13%	11.71%	4.93%	5.93%
+ 2 Standard Deviations	26.59%	16.25%	48.93%	25.48%	23.11%

Table 7 reports coefficient estimates of the effect of the CRED hydro-meteorological disasters, *drought events* and *flood events*, on our five dependent variables. Neither present nor lagged measures of *drought events* and *flood events* are significantly associated with our dependent variables.⁹ None of the coefficients approaches conventional levels of statistical significance and the signs on the variables are not consistent across the various measures, save for contemporaneous *drought events*, which has a negative sign for all event types save for *non-government-targeted events*. The effects of the control variables are similar to those reported in table 5.

⁹ No statistically significant relationships between *drought* or *flood events* appeared in reduced-form equations without control variables. Controls are more appropriate in the case of the CRED variables, however, because the CRED data are more reliant on reporting of droughts and flooding, as well as calls for international assistance or declarations of state of emergency.

	(1)	(2)	(3)	(4)	(5)
	Total Events	Nonviolent Events	Violent Events	Government-Targeted Events	Non-Government-Targeted Events
Lagged DV	0.023*** (0.004)	0.034*** (0.007)	0.043*** (0.007)	0.035*** (0.007)	0.036*** (0.006)
Polity2	-0.011 (0.011)	-0.016 (0.013)	0.003 (0.016)	-0.022* (0.013)	0.024 (0.016)
Polity2 ²	-0.004* (0.002)	-0.001 (0.002)	-0.009*** (0.003)	-0.003 (0.002)	-0.007*** (0.003)
(log) Population	-0.726 (0.765)	-0.766 (0.876)	-0.492 (1.072)	-0.739 (0.916)	0.115 (0.982)
Population growth, %	-0.038 (0.027)	-0.035 (0.033)	-0.037 (0.035)	-0.008 (0.037)	-0.072** (0.031)
(log) Real GDP per capita	0.091 (0.184)	0.181 (0.208)	0.005 (0.244)	0.006 (0.215)	0.143 (0.216)
Real GDP growth, %	-0.007** (0.004)	-0.005 (0.004)	-0.013** (0.005)	-0.005 (0.005)	-0.009* (0.005)
Drought events	-0.003 (0.088)	-0.024 (0.099)	-0.033 (0.123)	-0.035 (0.103)	0.066 (0.112)
Drought events, lagged	0.013 (0.087)	-0.000 (0.098)	0.020 (0.122)	-0.031 (0.102)	0.087 (0.110)
Flood events	0.023 (0.038)	0.019 (0.041)	0.062 (0.052)	0.020 (0.044)	0.014 (0.044)
Flood events, lagged	-0.011 (0.038)	0.020 (0.042)	-0.029 (0.051)	0.032 (0.043)	-0.062 (0.045)
Civil conflict incidence	0.089 (0.105)	0.204* (0.118)	-0.065 (0.144)	0.118 (0.123)	0.030 (0.131)
Constant	337.415 (332.348)	587.124 (374.825)	5.990 (451.370)	659.032* (392.950)	45.078 (404.094)
Time Trend	0.023***	0.034***	0.043***	0.035***	0.036***
Period Dummies	(0.004)	(0.007)	(0.007)	(0.007)	(0.006)
Observations	-0.011	-0.016	0.003	-0.022*	0.024
Countries	(0.011)	(0.013)	(0.016)	(0.013)	(0.016)
Standard errors in parentheses					
* significant at 10%; ** significant at 5%; *** significant at 1%					

Though the absence of significant findings regarding the CRED disaster data is puzzling, we broach two initial explanations. As noted earlier, the CRED data are not highly correlated with our *rainfall deviation* measure. Moreover, the somewhat political criteria for inclusion in the CRED dataset suggest that these CRED-based variables may be endogenous to other control variables in the model. For instance, democracies may be more willing to acknowledge drought

and request external assistance, while more closed, autocratic systems may not allow reporting of localized hydro-meteorological disasters to enter the public domain. Whatever the case, the lack of significant findings linking CRED disasters to either civil conflict onset or our social conflict events suggests that further investigation of the CRED data is warranted.

Conclusions

Despite the preliminary nature of our analysis, our results suggest three main findings. First, rainfall variability has a significant effect on both large-scale and smaller-scale instances of political conflict. We find some evidence that rainfall is correlated with civil war and insurgency, although wetter years are *more* likely to suffer from violent events. This may be due to tactical considerations of rebel groups; insurgents may be less likely to launch violent campaigns when there are severe water shortages, or may be more prone to attack when ample foliage provides cover (Meier, Bond and Bond 2007). Nonetheless, we find that very high and very low rainfall years increase the likelihood of all other types of political and social conflict, confirming our main hypothesis.

Second, our analysis does not support the conjecture that discrete hydro-meteorological disasters are associated robustly with either civil conflict or social conflict. However, extremes in rainfall have large effects across the board on all types of political conflict, though the relationship is strongest with respect to violent events, which are more responsive to abundant than scarce rainfall.

Third, and somewhat surprisingly, our control variables by-and-large failed to perform as expected in explaining the incidence of disturbance events. Our interpretation of these non-findings is that fixed effects models remove all the cross-sectional variation from the dataset, and as such there is simply not enough variation in regime type, economic development and growth,

and population and population growth at the country-level to explain within-country variation in the incidence of disturbance events. It bears noting that though these variables do not themselves explain much variation in social conflict, our strategy is not designed to answer the question of whether political, economic, and demographic variables mediate the relationships between rainfall deviations, hydro-meteorological disasters, and social conflict. Our findings establish clear, positive correlations between extreme rainfall and various types of social conflict in Africa. However, these correlations are much stronger in some countries (in particular, Tanzania, Zimbabwe, Swaziland, Mauritania and Mozambique) than in others, suggesting that local environmental, political, economic, and socio-demographic factors mediate the relationship between rainfall and social conflict. Future work will explore these relationships.

Lastly, our research demonstrates the utility of using more refined indicators of conflict—beyond conventional analyses of civil war. We have shown that hydro-meteorological disasters have a pronounced effect on social disturbances in Africa. Thus, climate change and shifting rainfall patterns have the potential to unleash serious problems for Africa in particular, but also across the globe.

References

- Alexandratos, Nikos. 2008. "Food Price Surges: Possible Causes, Past Experience, and Longer Term Relevance." *Population and Development Review*. 34(4): 663-697.
- Bannon, Ian, and Paul Collier. 1999. "Natural Resources and Conflict: What Can We Do?" In *Natural Resources and Violent Conflict: Options and Actions*, Ian Bannon and Paul Collier eds. Washington, DC: World Bank.
- Barrett, Christopher and Paul Dorosh. 1996. "Farmers' Welfare and Changing Food Prices: Nonparametric Evidence from Rice in Madagascar." *American Journal of Agricultural Economics*. 78 (3): 656-669.
- Bates, Robert H. 1989. *Beyond the Miracle of the Market: The Political Economy of Agrarian Development in Kenya*. Cambridge: Cambridge University Press.
- Beck, Nathaniel, Jonathan N. Katz, and Richard Tucker. 1998. "Taking Time Seriously: Time-Series-Cross-Section Analysis with a Binary Dependent Variable." *American Journal of Political Science* 42 (4): 1260-1288.
- Benson, Charlotte and Edward Clay. 1998. *The Impact of Drought on Sub-Saharan African Economies: A Preliminary Examination*. World Bank Technical Paper No. 401. Washington D.C: World Bank.
- Buhaug, Halvard, and Jan Ketil Rød. 2006. "Local Determinants of African Civil Wars, 1970-2001." *Political Geography* 25 (3): 315-335.
- Buhaug, Halvard, and Päivi Lujala. 2005. "Accounting for Scale: Measuring Geography in Quantitative Studies of Civil War." *Political Geography* 24 (4): 399-418.
- Burke, Marshall B., Edward Miguel, Shanker Satyanath, John A. Dykema, and David Lobell. 2009. "Warming Increases the Risk of Civil War in Africa." *Proceedings of the National Academy of Sciences* 106 (49): 20670-20674.
- Campbell, David, Helen Gichohi, Albert Mwangi, and Lucy Chege. 2000. "Land Use Conflict In Kajiado District, Kenya." *Land Use Policy* 17: 337-348.
- Collier, Paul, and Anke Hoeffler. 2004. "Greed and Grievance in Civil War." *Oxford Economic Papers* 56: 563-595.
- Collier, Paul, Lani Elliot, Håvard Hegre, Anke Hoeffler, Nicholas Sambanis, and Marta Reynal-Querol. 2003. *Breaking the Conflict Trap: Civil War and Development Policy*. Oxford, UK: Oxford University Press.
- Davis, Mike. 2007. *Planet of Slums*. London, UK: Verson
- de Soysa, Indra. 2002. "Paradise is a Bazaar? Greed, Creed, and Governance in Civil War, 1989-99." *Journal of Peace Research* 39 (4): 395-416.
- Eriksen, Siri and Jeremy Lind. 2009. "Adaptation as a Political Process: Adjusting to Drought and Conflict in Kenya's Drylands." *Environmental Management*. 43: 817-835
- Faris, Stephan. 2009. *Forecast: The Surprising—and Immediate—Consequences of Climate Change*. New York: Holt and Company.
- Fearon, James D., and David D. Laitin. 2003. "Ethnicity, Insurgency, and Civil War." *American Political Science Review* 97 (1): 75-90.
- Fiala, Nathan. 2009. "When More is Too Much: The Effect of Rainfall Shocks on Economic Growth and Civil Conflict." Typescript.
- Gleditsch, Nils Petter, Kathryn Furlong, Håvard Hegre, Bethany Lacina, and Taylor Owen. 2006. "Conflicts over Shared Rivers: Resource Scarcity or Fuzzy Boundaries?" *Political Geography* 25 (4): 361-382.

- Gleditsch, Nils Petter, Peter Wallensteen, Mikael Eriksson, Margareta Sollenberg, and Håvard Strand. 2002. "Armed conflict 1946-2001: A new dataset." *Journal of Peace Research* 39 (5): 615-37.
- Hauge, Wenche, and Tanja Ellingsen. 1998. "Beyond Environmental Scarcity: Causal Pathways to Conflict." *Journal of Peace Research* 35 (3): 299-317.
- Hegre, Håvard, and Nicholas Sambanis. 2006. "Sensitivity Analysis of the Empirical Literature on Civil War Onset." *Journal of Conflict Resolution* 50(6): 937-961.
- Hegre, Håvard, Scott Gates, and Nils Petter Gleditsch. 2001. "Toward a Democratic Civil Peace? Democracy, Political Change, and Civil War, 1816-1992." *American Political Science Review* 95 (1): 33-48.
- Hendrix, Cullen S., and Sarah M. Glaser. 2007. "Trends and Triggers: Climate, Climate Change, and Civil Conflict in Sub-Saharan Africa." *Political Geography* 26 (6): 695-715.
- Hendrix, Cullen S., Stephan Haggard, and Beatriz Magaloni. 2009. "Grievance and Opportunity: Food Prices, Political Regimes, and Protest." Presented at the annual meeting of the International Studies Association, New York, NY, February 15-18.
- Homer-Dixon, Thomas. 2001. *Environment, Scarcity, and Violence*. Princeton, NJ: Princeton University Press.
- Humphreys, Macartan. 2005. "Natural Resources, Conflict, and Conflict Resolution: Uncovering the Mechanisms." *Journal of Conflict Resolution* 49 (4): 508-537.
- Intergovernmental Panel on Climate Change. 2007. *Climate Change 2007 - Impacts, Adaptation and Vulnerability*. Cambridge: Cambridge University Press.
- Jensen, Peter Sandholt, and Kristian Skrede Gleditsch. 2009. "Rain, Growth, and Civil War: The Importance of Location." *Defence & Peace Economics* 20 (5): 359-372.
- Kasara, Kimuli. 2007. "Tax Me if You Can: Ethnic Geography, Democracy, and the Taxation of Agriculture in Africa." *American Political Science Review* 101 (1): 159-172.
- King, Gary, Michael Tomz, and Jason Wittenberg. 2000. "Making the Most of Statistical Analyses: Improving Interpretation and Presentation." *American Journal of Political Science* 44(2): 347-361.
- Kreimer, Alcira and Margaret Arnold, eds. 2000. *Managing Disaster Risk in Emerging Economies*. Washington, D.C.: World Bank.
- Krueger, Anne O. 1996. "Political Economy of Agricultural Policy." *Public Choice* (87): 163-175.
- Le Billon, Philippe. 2001. "The Political Ecology of War: Natural Resources and Armed Conflicts." *Political Geography* 20 (5): 561-584.
- Lujala, Päivi. 2009. "Deadly Combat over Natural Resources." *Journal of Conflict Resolution* 53 (1): 50-71.
- Marshall, Monty J., & Keith Jaggers, 2009. *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2008*. Version p4v2009e. College Park, MD: University of Maryland. URL: <http://www.cidcm.umd.edu/inscr/polity/index.htm>.
- Maxwell, John and Rafael Reuveny. 2000. "Resource Scarcity and Conflict in Developing Countries." *Journal of Peace Research*. 37(3): 301-322.
- Meier, Patrick, Doug Bond, and Joe Bond. 2007. "Environmental Influences on Pastoral Conflict in the Horn of Africa." *Political Geography* 26 (6): 716-735.
- Miguel, Edward, Shanker Satyanath, and Ernest Sergenti. 2004. "Economic Shocks and Civil Conflict: An Instrumental Variables Approach." *Journal of Political Economy* 112(4): 725-753.

- Muller, Edward N., and Erich Weede. 1990. "Cross-National Variation in Political Violence: A Rational Action Approach." *Journal of Conflict Resolution* 34 (4): 624-651.
- Nel, Philip, and Marjolein Righarts. 2008. "Natural Disasters and the Risk of Violent Civil Conflict." *International Studies Quarterly* 52 (1): 159-185.
- Neuwirth, Robert. 2005. *Shadow Cities: A Billion Squatters, a New Urban World*. New York: Routledge.
- Nordås, Ragnhild, and Nils Petter Gleditsch. 2007. "Climate Change and Conflict." *Political Geography* 26 (6): 627-638.
- Percival, Val and Thomas-Homer Dixon. 1996. "Environmental Scarcity and Violent Conflict: The Case of Rwanda." *Journal of Environment and Development*. 5(3): 270-291.
- Raleigh, Clionadh, and Håvard Hegre. 2005. "Introducing ACLED: An Armed Conflict Location and Event Dataset." Paper presented to the Conference on "Disaggregating the Study of Civil War and Transnational Violence", University of California Institute of Global Conflict and Cooperation, San Diego, CA, March 7-8.
- Raleigh, Clionadh, and Henrik Urdal. 2007. "Climate Change, Environmental Degradation, and Armed Conflict." *Political Geography* 26 (6): 674-694.
- Regan, Patrick M., and Daniel Norton. 2005. "Greed, Grievance, and Mobilization in Civil Wars." *Journal of Conflict Resolution* 49 (3): 319-336.
- Reuveny, Rafael. 2007. "Climate Change-Induced Migration and Violent Conflict." *Political Geography* 26 (6): 656-673.
- Ross, Michael L. 2004. "What Do We Know about Natural Resources and Civil War?" *Journal of Peace Research* 41 (3): 337-356.
- Salehyan, Idean. 2007. "Transnational Rebels: Neighboring States as Sanctuary for Rebel Groups." *World Politics* 59 (2): 217-242.
- Salehyan, Idean. 2008. "From Climate Change to Conflict? No Consensus Yet." *Journal of Peace Research* 45 (3): 315-326.
- Scarritt, James R., and Susan McMillan. 1995. "Protest and Rebellion in Africa: Explaining Conflicts between Ethnic Minorities and the State in the 1980s." *Comparative Political Studies* 28 (3): 323-349.
- Strand, Håvard. 2006. "Onset of Armed Conflict: A New List for the Period 1946-2004, with Applications." Typescript.
- Thiesen, Ole Magnus. 2008. "Blood and Soil? Resource Scarcity and Internal Armed Conflict Revisited." *Journal of Peace Research* 45 (6): 801-818.
- Tilly, Charles. 1978. *From Mobilization to Revolution*. Reading, MA: Addison-Wesley.
- Toset, Hans Petter Wollebæk, Nils Petter Gleditsch, and Håvard Hegre. 2000. "Shared Rivers and Interstate Conflict." *Political Geography* 19 (5): 971-996.
- United Nations Educational, Scientific and Cultural, Organization. 2009. *United Nations World Water Development Report 3: Water In a Changing World*. London, UK: UNESCO.
- Urdal, Henrik. 2005. "People versus Malthus: Population Pressure, Environmental Degradation, and Armed Conflict Revisited." *Journal of Peace Research* 42 (4): 417-434.
- van de Walle, Nicholas. 2001. *African Economies and the Politics of Permanent Crisis, 1979-1999*. Cambridge: Cambridge University Press.
- Walter, Barbara F. 2009. "Bargaining Failure and Civil War." *Annual Review of Political Science* 12: 243-261.
- Wolf, Aaron. 1998. "Conflict and Cooperation Along International Waterways." *Water Policy* 1(2): 251-265.

Appendix 1: List of Countries

The following countries were included in our analysis.

Country	Total Events, 1990-2008	Country	Total Events, 1990-2008
Algeria	190	Madagascar	42
Angola	50	Malawi	112
Benin	57	Mali	38
Botswana	14	Mauritania	66
Burkina Faso	54	Mauritius	8
Burundi	98	Morocco	86
Cameroon	77	Mozambique	42
Central African Republic	115	Namibia	21
Chad	46	Niger	148
Cote D'Ivoire	228	Nigeria	823
Democratic Republic of Congo	323	Republic of Congo	33
Egypt	278	Rwanda	57
Eritrea	8	Senegal	66
Ethiopia	55	Sierra Leone	79
Gabon	43	Somalia	408
Gambia	11	South Africa	775
Ghana	73	Sudan	207
Guinea	42	Swaziland	57
Guinea-Bissau	44	Tanzania	77
Kenya	295	Togo	69
Lesotho	53	Tunisia	28
Liberia	98	Uganda	63
Libya	50	Zambia	115

Appendix 2: Political Disorder in Africa Codebook

Political disorder in Africa: Coding methods and procedures.

This dataset will contain information on protests, riots, strikes, and other social disturbances in Africa. Whereas conflict data is generally available for large-scale events such as civil war, the purpose of this dataset is to compile information on other types of political disorder.

Every country in Africa (with a population greater than 1 million) will be covered from, 1990-2008. The primary source of information for this dataset will consist of searches of major world publications, as found in Lexis-Nexis. This information may be supplemented by other sources, as needed.

Search methodology

The Lexis-Nexis news archive can be accessed from the UNT Library's Electronic Resources. Within the Lexis-Nexis academic search engine, select the news tab. You will see a screen such as the one displayed below:

LexisNexis® Academic: News - Windows Internet Explorer

http://www.lexisnexis.com/us/academic/search/newssubmitForm.do

LexisNexis® Academic

Search Sources

General News Legal Business People

News Help

How do I...?

Find a specific news story?

Find out if a publication is included in LexisNexis® Academic?

Narrow my search to retrieve only relevant articles?

View additional News search form topics?

View tutorials

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Search terms Terms and Connectors Natural Language

Nigeria

In Headline & Lead Paragraphs And

protest

Anywhere in the document Or

riot

Anywhere in the document Or

strike

Anywhere in the document Or

violence

Anywhere in the document Less...

Search terms

Add index terms Show

Sources

Wire Service Stories

Associated Press Financial Wire

Associated Press Online

The Associated Press State & Local Wire

Associated Press Worldstream

Specify date Date is between... Jan 1 1999 and Dec 31 1999

Clear form

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Start Sent Items - Microsoft O... LexisNexis® Academi... C:\Documents and Sett... EST_terrorism_June24-M... EST_terrorism_June5.do... Internet 100% 1:58 PM

Search Procedure

1. In the first field, search for the country name and select the option that allows you to search in the “In Headline & Lead Paragraphs” field.
2. Use Boolean options to select additional terms. In the example given above, “Nigeria” is selected as the country AND “protest” OR “strike” OR “riot” OR “violence” are chosen as additional terms. For each country, be sure to search for the terms, “protest,” “strike,” “riot”, and “violence” in the “anywhere in the document” field.
3. In the “sources” field, choose, “Wire Service Stories”.
4. Within the list of wire services, choose “Agence France Presse – English”, “The Associated Press”, “Associated Press Online”, and “Associated Press Worldstream”.
5. In the date field, select an entire calendar year (i.e. Jan 1 to Dec 31). You may choose to select less than a full calendar year if the search produces too many hits.

Your search will produce results such as this:

The screenshot shows a web browser window displaying the LexisNexis Academic search results page. The search criteria are set to "Nigeria" with 560 results. The results are sorted by "Publication Date" and show a list of 14 news items. The first item is "Nigerian labour seeks apology over use of teargas to disperse demo" from Agence France Presse. The second item is "Protesters burn down four churches in northern Nigeria" from Agence France Presse. The third item is "Rights group: Nigerian soldiers commit killings, rapes in Delta" from Associated Press Worldstream. The fourth item is "Long queues for fuel in Nigerian capital" from Agence France Presse. The fifth item is "Nigerian police use teargas to disperse demo in Abuja" from Agence France Presse. The sixth item is "Lagos governor attacked in militants' 'civil war'" from Agence France Presse. The seventh item is "Lagos governor escapes death in attack, four killed: reports" from Agence France Presse. The eighth item is "Two more Nigerian states take steps to adopt Sharia" from Agence France Presse. The ninth item is "Govt plans to rebuild Lagos slum, dwellers protest" from Agence France Presse. The tenth item is "15 die, two villages razed in Nigerian communal clashes: report" from Agence France Presse. The eleventh item is "Nigerian lawmaker admonishes U.S. delegation on trade visit" from Associated Press Worldstream. The twelfth item is "Nigerian Senate enacts Niger Delta development law" from Agence France Presse. The thirteenth item is "Shoot-at-sight order 'irreconcilable with democracy' in Nigeria" from Agence France Presse. The fourteenth item is "Death toll mounts in Lagos ethnic clashes" from The Associated Press.

Sorting procedure

1. Begin with the oldest listed story and proceed chronologically. For each story, determine if this information is relevant to the data project. For instance, in one story on Nigeria, there is a reference to a strike which occurred in the Ivory Coast, making this an irrelevant story. However, there is a story regarding violent student protests in Kwara, which is relevant.
2. Sometimes, many articles will cover a single news story or event. Group these articles together as a single event. Avoid double or triple counting a single event if there are multiple articles chronicling a story.
3. Sometimes, a single article will cover multiple events. Determine if the main actor(s) and target(s) are different, and if so, code these as distinct events.
4. You may find that a long-running event began prior to the current calendar year, or persists after the calendar year. If this is the case, proceed to find earlier (or later) articles pertinent to the event.

Coding procedure

Once you have identified a particular disturbance event, collect the following information and insert it into the spreadsheet provided.

Start Date

List the day, month, and year in DD/MM/YYYY format for when the event begins. If the exact day cannot be identified, provide your best approximation of the start date.

End Date

List the day, month, and year in DD/MM/YYYYY format for when the event ends. . If the exact day cannot be identified, provide your best approximation of the end date.

Etype (categorical)

Indicate the type of event according to the following coding scheme. This should identify the initial character of the action or event (see escalation coding, below).

1 = **Organized Demonstration.** Distinct, continuous, and largely peaceful action directed toward members of a distinct “other” group or government authorities. In this event, clear leadership or organization(s) can be identified.

2 = **Spontaneous Demonstration.** Distinct, continuous, and largely peaceful action directed toward members of a distinct “other” group or government authorities. In this event, clear leadership or organization cannot be identified.

3 = **Organized Violent Riot.** Distinct, continuous and violent action directed toward members of a distinct “other” group or government authorities. The participants intend to cause physical injury and/or property damage. In this event, clear leadership or organization(s) can be identified.

4 = **Spontaneous Violent Riot.** Distinct, continuous and violent action directed toward members of a distinct “other” group or government authorities. The participants intend to cause physical injury and/or property damage. In this event, clear leadership or organization(s) cannot be identified.

5 = **General Strike.** Members of an organization or union engage in a total abandonment of workplaces and public facilities.

6 = **Limited Strike.** Members of an organization or union engage in the abandonment of workplaces in limited sectors or industries.

7 = **Pro-Government Violence (Repression):** Distinct violent event waged primarily by government authorities, or by groups acting in explicit support of government authority, targeting individual, or “collective individual,” members of an alleged opposition group or movement. Note that this event is initiated by the government or pro-government actors. See code for repression, below.

8 = **Anti-Government Violence:** Distinct violent event waged primarily by a non-state group against government authorities or symbols of government authorities (e.g., transportation or other infrastructures). As distinguished from riots, the anti-government actor must have a semi-permanent or permanent militant wing or organization.

9 = **Extra-government Violence:** Distinct violent event waged primarily by a non-state group targeting individual, or “collective individual,” members of an alleged oppositional group or movement. As distinguished from riots, at least one actor must have a semi-permanent or permanent militant wing or organization. Government authorities are not listed as actors or targets.

10 = **Intra-government Violence:** Distinct violent event between two armed factions associated with different elements within the government. These include violence between two legally constituted armed units (e.g. clashes between police and military) or between unofficial militias associated with particular governmental leaders. This code includes events such as military coups.

Escalation (categorical)

Did the nature of the event change during its duration? If so, indicate the type of event last reported.

0 = **No Escalation.**

1 = **Organized Demonstration.** Distinct, continuous, and largely peaceful action directed toward members of a distinct “other” group or government authorities. In this event, clear leadership or organization(s) can be identified.

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Actor 1 (text)

Record the general political or identity group (i.e. actor) directly involved in the fighting, violence, or protest. (If the actor is only “allegedly” responsible for in an event, note the allegation in the “notes” field, below.)

Actor 2 (text)

Record the general political or identity group (i.e. actor) directly involved in the fighting, violence, or protest.

Actor 3 (text)

Record the general political or identity group (i.e. actor) directly involved in the fighting, violence, or protest.

Target 1 (text)

Record the general political or identity group directly targeted by the fighting, violence, or protest.

Target 2 (text)

Record the general political or identity group directly targeted by the fighting, violence, or protest.

Cgovtarget (dichotomous)

Was the central government the target of the fighting, violence, or protest?

Yes = 1, No=0

Rgovtarget (dichotomous)

Was a regional, provincial or local government the target of the fighting, violence, or protest?

Yes = 1, No = 0

Npart (categorical)

Total number of participants in the event.

1 = less than 10

2 = 10 to 100

3 = 101 to 1,000

4 = 1,001 to 10,000

5 = 10,001 to 100,000

6 = 100,001 to 1,000,000

7 = over 1,000,000

-99 = unknown

Ndeath (use cardinal numbers)

Record the best estimate of the number of persons killed in the event. If multiple estimates are given, use the mean number of reported deaths. If the exact number is not given, use the following codes:

- 99 = unknown
- 88 = unknown but probably small (less than 10)
- 77 = unknown but probably large (10 or more)

Repress (categorical)

Did the government use repression or violence against participants in the event?

- 0 = no repression used
- 1 = non-lethal repression used (e.g. tear gas, arrests, etc)
- 2 = lethal repression used

Elocal (text)

Identify the name of the locality where the event occurred.

Locnum (categorical)

Coding of the event locality

- 1 = Capital city
- 2 = Other major urban area (population greater than 100,000)
- 3 = Rural (including small towns, villages with population less than 100,000)
- 4 = Multiple urban areas
- 5 = Multiple rural areas
- 6 = Province/region listed, exact location unknown
- 7 = Nationwide. Effects several cities and rural areas
- 99 = location unknown

Issue 1 (categorical)

What was the first issue that was mentioned as the source of the tension/disorder?

- 1 = elections
- 2 = economy, jobs
- 3 = food, water, subsistence
- 4 = environmental degradation
- 5 = ethnic discrimination, ethnic issues
- 6 = religious discrimination, religious issues
- 7 = education
- 8 = foreign affairs/relations
- 9 = domestic war, violence, terrorism
- 10 = human rights, democracy
- 11 = pro-government
- 12 = economic resources/assets
- 13 = other
- 14 = unknown, not-specified

Issue 2 (categorical)

What was the second issue, if any, that was mentioned as the source of the tension/disorder

- 1 = elections
- 2 = economy, jobs
- 3 = food, water, subsistence
- 4 = environmental degradation
- 5 = ethnic discrimination, ethnic issues

- 6 = religious discrimination, religious issues
- 7 = education
- 8 = foreign affairs/relations
- 9 = domestic war, violence, terrorism
- 10 = human rights, democracy
- 11 = pro-government
- 12 = economic resources/assets
- 13 = other
- 14 = unknown, not-specified

Issue 3 (categorical)

What was the third issue, if any, that was mentioned as the source of the tension/disorder

- 1 = elections
- 2 = economy, jobs
- 3 = food, water, subsistence
- 4 = environmental degradation
- 5 = ethnic discrimination, ethnic issues
- 6 = religious discrimination, religious issues
- 7 = education
- 8 = foreign affairs/relations
- 9 = domestic war, violence, terrorism
- 10 = human rights, democracy
- 11 = pro-government
- 12 = economic resources/assets
- 13 = other
- 14 = unknown, not-specified

Issuenote (text)

Include a very brief description of the event.

Nsource (categorical)

Did more than one news article give information on the event?

1 = yes, 0 = no

Notes (text)

Include additional information you would like to report. Also take care to list any irregularities you noticed in this case, questions about the coding, discrepancies between sources, etc.

Appendix 2, Continued: Sample Event Codings

<u>cocode</u>	<u>year</u>	<u>startyear</u>	<u>startday</u>	<u>startmonth</u>	<u>endday</u>
501	2005	2005	10	11	10
501	2006	2006	11	11	11
551	2007	2007	20	6	30
565	1998	1998	15	10	31
565	1999	1999	2	8	2
<u>endmonth</u>	<u>endyear</u>	<u>countryname</u>	<u>startdate</u>	<u>enddate</u>	<u>eduration</u>
11	2005	Kenya	10-Nov-05	10-Nov-05	1
11	2006	Kenya	11-Nov-06	11-Nov-06	1
6	2007	Zambia	20-Jun-07	30-Jun-07	11
10	1998	Namibia	15-Oct-98	31-Oct-98	17
8	1999	Namibia	2-Aug-99	2-Aug-99	1
<u>etype</u>	<u>escalation</u>	<u>actor1</u>	<u>actor2</u>	<u>actor3</u>	<u>target1</u>
2	0	Environmental Activists			Government
1	0	Climate Network Africa			Industrialized Countries
6	2	Students			Zambian government
8	0	Caprivi separatists			Government
8	0	Caprivi separatists			Government
<u>target2</u>	<u>cgovtarget</u>	<u>rgovtarget</u>	<u>npart</u>	<u>ndeath</u>	<u>repress</u>
Thailand	1	0	2	0	0
	0	0	4	0	0
	1	0	-99	0	0
	1	1	3	-99	2
	1	1	-99	16	2
<u>elocal</u>	<u>locnum</u>	<u>issue1</u>	<u>issue2</u>	<u>issue3</u>	<u>issuenote</u>
Nairobi	1	4			Environmental activists protest plan to give Thailand 175 wild animals
Nairobi	1	4	8		Environmental activists call on wealthy countries to curb climate change
Lusaka	2	4			Students boycott class over poor sanitation conditions. Escalates to protests.
Caprivi strip	6	4			Secessionist unrest worsened at the end of October, and Mishake Muyongo, an opposition leader, had to flee to Botswana with several dozen supporters. He was joined by his first cousin, King Mamili, who is leader of the Mafwe tribe, the dominant
Katima Mulilo	3	4			Namibia Alleged secessionists try to seize control of this small town on the

					northeastern edge of Namibia's remote Caprivi Strip. At least 16 people are killed in the fighting.
<u>nsource</u>	<u>notes</u>				
1					
1					
1	End date is an estimate.				
0					
1					