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Natural Disasters and the Risk of Violent Civil Conflict

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Does the occurrence of a natural disaster such as an earthquake, volcanic eruption, tsunami, flood, hurricane, epidemic, heat wave, and/or plague increase the risk of violent civil conflict in a society? This study uses available data for 187 political units for the period 1950–2000 to systematically explore this question that has received remarkably little attention in the voluminous literature on civil war. We find that natural disasters significantly increase the risk of violent civil conflict both in the short and medium term, specifically in low- and middle-income countries that have intermediate to high levels of inequality, mixed political regimes, and sluggish economic growth. Rapid-onset disasters related to geology and climate pose the highest overall risk, but different dynamics apply to minor as compared to major conflicts. The findings are robust in terms of the use of different dependent and independent variables, and a variety of model specifications. Given the likelihood that rapid climate change will increase the incidence of some types of natural disasters, more attention should be given to mitigating the social and political risks posed by these cataclysmic events.

That natural disasters such as earthquakes, volcanic eruptions, tsunamis, hurricanes, epidemics, and floods can have major political consequences has been well known since at least 465/464 B.C. when a massive earthquake struck Sparta. Ancient historians such as Thucydides, Diodorus, and Plutarch recount how the decimation of twenty thousand Spartan citizens was the proximate cause of a violent revolt by the Messenian helots who were enslaved when Sparta conquered that part of the Peloponnesus in the eighth century B.C. Long aggrieved by their brutal suppression as state serfs, helot ''guerrillas'' exploited the chaos and oliganthropia resulting from the earthquake to set up a position at Ithome from where a major Messenian revolt unfolded over the subsequent half decade. This revolt drastically altered the strategic balance of power in the Peloponnesus, although the revolt was eventually squashed by the Spartans in 459 B.C.[1]

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[1] Thucydides discusses the helot revolt in Book One, paragraphs 101–103 of *The Peloponnesian War*, (Thucydides 1985, 94–96). For discussions of the Helot revolt based on Thucydides and other ancient sources, see Oliva (1971) and de Ste. Croix (1972). A modern interpretation of the political and social effects of the earthquake at Sparta is to be found in the eminently readable book by de Boer and Sanders (2005, 45–64).

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Since then, a number of major disasters have impacted on the political landscape of the affected countries. Examples include earthquakes in Lisbon (1755), Peru (1970), Nicaragua (1972), and Guatemala (1976); cyclones/hurricanes in the Dominican Republic (1930), Haiti (1954) and East Pakistan (1970); a volcanic eruption on the island of Martinique in 1902; the Indian Ocean Tsunami of 2004 (specifically in relation to Indonesia and Sri Lanka); and drought and desertification in the Sahel and sub-Sahel Africa. These events have variously been attributed with halting colonial expansion, fuelling resistance to corrupt or incompetent regimes, the entrenchment of dictatorships, the instigation or escalation of ongoing conflicts and/or insurgencies (including resource based conflicts), and creating an enabling environment for the cessation of long running hostilities.[2]

Despite the headline-grabbing nature of these events and their known consequences, there are surprisingly few studies that systematically explore how natural disasters affect the patterns of politics and/or conflict. The literature on natural disasters tends to focus on the attributes of countries and peoples that make them vulnerable to disasters, on the management of the material effects of disasters, and on the process of recovery (Brooks 2003; Brooks and Adger 2003a,b; Burton, Kates, and White 1993; Cutter 2006; Dore and Etkin 2003; Vincent 2004; Wisner, Blakie, Cannon, and Davis 2004). The political and/or conflict literature, on the other hand, has traditionally considered ''the environment'' as a ''prize'' in resource wars, or as ''the victim'' of conflict. Very few studies have considered how natural disasters could lead to resource depletion and through this mechanism cause social stress and conflict. Path-breaking cross-sectional studies focusing on the political effects of natural disasters were undertaken by A. Cooper Drury and Richard Stuart Olson in the late 1990s (Drury and Olson 1998; Olson and Drury 1997). These studies focused on political unrest in general, though; not on violent civil conflict as a distinct category. Although they found a statistically significant relationship between the occurrence of natural disasters and the incidence of political unrest, their sample sizes were too small and the time periods looked at too short to support generalization. More recent studies, also limited in terms of scope or time period covered, confirm a significant causal relationship between natural disasters and conflict (Bhavnani, 2006), and between earthquakes specifically and civil unrest (Brancati, 2007). Given the importance of the subject, there is need for a more comprehensive study covering all natural disasters over an extended period of time. This article aims at meeting this need.

Despite the absence of literature focusing on the civil-conflict risk posed by natural disasters, older writings on environmental security and more recent contributions to ''political ecology'' provide useful concepts for understanding how natural disasters may impact on social systems (Brown 2005; Homer-Dixon 1999; Kahl 2006; Miguel, Satyanath, and Sergenti 2004; Peluso and Watts 2001). The best known research projects in environmental security find that environmental change affects conflict through its impact on social variables such as migration, agricultural and economic decline, and through the weakening of institutions, in particular the state (Homer-Dixon and Blitt 1998; Kahl 2006). Authors in the emergent political ecology tradition emphasize the social and discursive contexts within which environmental dynamics and conflict relate, challenging the notion that conflict can be reduced to scarcity factors alone (Peluso and Watts 2001,

[2] On the Lisbon and Peruvian earthquakes see de Boer and Sanders (2005, 88-107; 194-220). The effects of the volcanic eruption on Martinique are discussed in de Boer and Sanders (2002, 186-208). On the Indian Ocean Tsunami, see International Crisis Group (2005) and Renner and Chafe (2007, 20-31). For one example on drought and desertification see UNEP (2007, 70-97). The authors are grateful to Dr Mark Pelling of King's College, London, for providing information on the Nicaraguan and Guatemalan earthquakes, the East Pakistan cyclone, and the hurricanes in the Dominican Republic and Haiti.

20–21). We remain agnostic about which of the two approaches should ultimately be preferred, and rather draw valuable insights from both, keeping in mind the need to develop a parsimonious theoretical model that can be tested empirically. As natural disasters per definition lead to conditions of concentrated resource scarcity, it is appropriate to pursue the societal dynamics that result from disaster-induced scarcity along the conceptual and empirical avenues suggested by the environmental security school.[3] By singling out natural disasters as an extreme form of environmental change, and by undertaking a large scale cross-sectional analysis, we aim at further extending understanding of how different types of environmental change may be related to, or interact with, social stress. At the same time, we appreciate that connections between the environment and conflict need to be placed within specific contexts of patterns of privilege and power if a fuller and sufficiently critical understanding of conflict is to be arrived at.

We focus in particular on events of violent civil conflict, which is taken to refer to violent actions involving contending groups aimed at challenging, altering, or maintaining a particular distribution of public power and/or control over territory within a political unit. As a coercive phenomenon, violent civil conflict is accompanied by attempts ''to destroy, injure, thwart, or otherwise control'' (Mack and Snyder 1957, 218)[4] opponents, their resources, and/or the order on which their position depends. Violent civil conflict can be instigated both by occupiers/supporters of the state/regime, or by their opponents.[5] Violent civil conflict is disturbingly widespread in today's world and has rightly been referred to as ''development in reverse'' (Collier, Elliott, Hegre, Hoeffler, Reynal-Querol, and Sambanis 2003).

It is both possible and necessary to explore the effects of natural disasters on violent civil conflict in a systematic manner. It is *possible* to undertake a cross-sectional analysis of this potential linkage because of the recent availability of good quality cross-sectional time-series data collected by the World Health Organisation Collaborating Cent for the Epidemiology of Disasters (CRED). CRED's EM-DAT database provides extensive coverage of natural disaster occurrence from 1900–2006 for almost all countries currently in the international system.[6] In addition, we have access to data for the onset of violent civil conflict in 187 political units for which natural disaster data are available, covering the period 1950–2000. It is also now more *necessary* than ever to explore the political effects of natural disasters, given the dramatic increase in their occurrence and destructive potential since the mid twentieth century, attributed in part to the exponential increase in population numbers, and the stress placed on vulnerable eco-systems. There are indications that global climate change will lead to increased occurrence and severity of climate-related disasters over the course of the twenty-first century (IPCC 2007, 18; Scholze, Knorr, Arnell, and Prentice 2006, 13116–13120). While human control over the occurrence of natural disasters is indeed limited, and will continue to be so for the foreseeable future, insight into the risk that natural disasters pose plus a deeper understanding of the mechanisms through which this occurs, will help in the design of better contingency and assistance programs.

[3] Obviously, by singling out scarcity as a trigger in the causal chain linking natural disasters and violent civil conflict, we are not implying that other environmental conditions, such as that of resource abundance, for instance, cannot also lead to conflict.

[4] See also Gurr (1980, 2).

[5] See also Harbom and Wallensteen (2005), Urdal (2006).

[6] EM-DAT: The OFDA/CRED International Disaster Database—http://www.em-dat.net—Université Catholique de Louvain. Brussels, Belgium. (Accessed December 2, 2006). The EM-DAT database is widely held to be the most comprehensive global natural disasters data set available, but see Quarantelli (2001) for a critical methodological review.

Our results suggest that the helot revolt against Sparta in the fifth century B.C. was not an isolated event. While there is no reason to believe that each and every natural disaster will give rise to incidents of violent civil conflict, there is evidence that natural disasters significantly increase the *risk* of violent civil conflict in the short and medium term, particularly in low-and middle-income countries that have intermediate to high levels of income inequality and that have mixed political regimes. We find that earthquakes and volcanic eruptions pose the highest risk, but climate-related disasters also significantly increase the risk of violent civil conflict. The article proceeds by first exploring the possible mechanisms through which natural disasters could affect violent civil conflict (Section 2). In Section 3, we discuss the data sources for our measures of natural disasters and violent civil conflict, and develop a set of specifications for the empirical tests of our main hypothesis. Section 4 discusses the empirical findings and their import, and Section 5 concludes.

The Risks Posed by Natural Disasters and the Occurrence of Violent Civil Conflict

Following the example of the World Health Organisation Collaborating Centre for the Epidemiology of Disasters (CRED), we define natural disasters as nature-induced cataclysmic events or situations which overwhelm local capacity, often (although not necessarily) resulting in a request for external assistance. Natural disasters can be classified as *hydro-meteorological* (droughts, extreme temperature, floods, slides, wave/surge, wild fires and wind storms), *geological* (volcanic eruptions, earthquakes), and ''*other*'' (famine, insect infestation, and epidemics).[7] Natural disasters can further be divided into rapid-onset and slow-onset subgroups, with drought and famine being the most important examples of the latter. Natural disasters can also be distinguished in terms of the immediacy of their impact on society: impacts such as widespread death, the destruction of infrastructure, and dislocation are immediate and directly observable. Other effects may be less directly observable and work themselves out over longer periods of time. We refer to the latter category as ''structural'' effects, in distinction from the more proximate effects mentioned above. Natural disasters affect the structures of society by disrupting economic development, increasing income and wealth inequality, marginalizing certain groups, and by leading to large-scale migrations. Crucially, natural disasters can also weaken state capacity and legitimacy, creating opportunities for the disgruntled to engage in violent resistance.

The theoretical literature on the specific impact of natural disasters on violent civil conflict is limited, and so our theoretical exposition has to rely on general explanations of violent civil conflict to begin with. There are three concepts around which the extensive macro-level literature can be made relevant for our current purpose, namely *motive*, *incentive*, and *opportunity*. All three concepts refer to strategic evaluations made and considerations entertained by actors, and thus serve as bridges between the extensively-researched macro-level and less well-understood micro-level of conflict. While we do not explore the bridge between the macro- and micro-level in any depth here, we employ this triadic distinction to analyze the mechanisms through which natural disasters can give rise to violent civil conflict. These mechanisms are summarized in Figure 1.

Under ''motive'' we consider how and when evaluations that an actor is not receiving her due can bring that actor to consider taking drastic action to alter the sources of her discontent. Widespread grievances and other forms of societal frustrations are said to be determined by relative deprivation, that is, the gap between individual expectations related to well-being and actual outcomes

[7] See Appendix A for a typology of natural disasters.

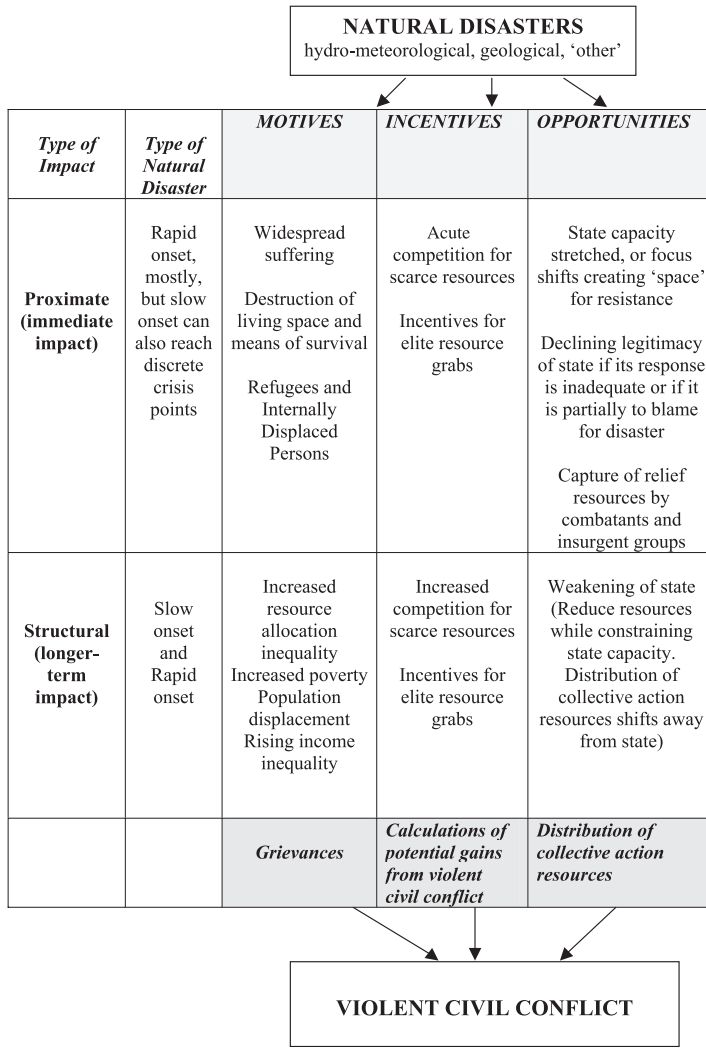

FIG. 1. Summary of Causal Argument Linking Natural Disasters and Violent Civil Conflict.

(Eckstein 1980, 144; Gurr 1970, 24; Thorbecke and Charumilind 2002). There are many grievances that could possibly induce actors to engage in civil violence to rectify the situations that gave birth to these grievances in the first place, but socio-economic grievances due to vertical (between individuals) and horizontal (between groups) income and wealth inequality have received considerable attention (Eckstein 1980; Huntington 1968; Østby 2003; Sigelman and Simpson 1977).[8] Ever since Aristotle in Book V of *The Politics* suggested that inequality is ''generally at the bottom of internal warfare in states'' (Aristotle 1974, 191) analysts of conflict have pinned much explanatory value on the distribution of wealth, and in particular on the distribution of income (Sigelman and Simpson 1977). However, there is a greater likelihood that perceived inequality will become a motive to act if there are structural impediments to mobility under conditions of modernization (Eckstein 1980; Huntington 1968; Zimmermann

[8] This literature is well-surveyed in Zimmermann (1980) and Lichbach (1989).

1980). Expectations of social mobility will be high in a society with a large cohort of young people and with a rapid rate of urbanization. If these expectations are thwarted by impediments to mobility related to social exclusion and/or ethnic discrimination—to mention but two possibilities—it is more likely that politically relevant grievances will arise (Nel 2006; Urdal 2006).

The concept of ''opportunity'' stems from the work of Tilly and others (Gamson 1975; Oberschall 1973; Tilly 1978). According to this approach, all societies have aggrieved citizens who feel that they are getting less than they deserve. However, political violence occurs only in a subset of societies, namely those that have conditions in which discontent can be organized, and in which violence is an attractive outlet for grievances. High levels of vertical and horizontal economic inequality and economic discrimination can induce resentment and grievances, but more inequality does not necessarily translate into more violent resistance. High levels of economic inequality are maintained by powerful elites whose preponderance of power produced the inequality in the first place. These elites can use their established power to suppress expressions of dissent, and it is hence possible that high inequality may be associated with less, not more violence (Lichbach 1989, 437). The disadvantaged have to overcome considerable collective action problems if they wish to express their grievances. Political dissent, violent or not, is dependent on access to some resources and mobilization opportunities relative to the power resources controlled by the elite. The concentration of collective action resources in a society could thus be an important determinant of whether violent civil conflict manifests itself. More precisely, ''opportunity'' relates to the strategic consideration that a motivated actor makes of the relative distribution of collective action resources in society. The existence of some uncertainty about this distribution can also act as an inducement to action.

The assessment of opportunities to act made by an aggrieved or otherwise motivated actor in itself can lead to violent resistance, but is probably not a sufficient condition. Some appreciation of the gains to be had from acting is also necessary. We classify such appreciations as *incentives*. Strategic evaluations that the actor will be better-off materially when engaging in violent civil conflict than when not are important inducements to civil violence, as recent literature argues. For example, it is suggested that resource-rich (specifically oil-exporting) countries in the developing world tend to have more violent and more protracted extreme political conflicts than do resource-poor countries (Collier and Hoeffler 2004; but see Fearon 2005). Rebels and other political opponents of the reigning elite may resort to extra-constitutional and violent means if (1) other avenues of gaining a stake in the riches of a country are systematically blocked (through a winner-takes-all political regime, for instance), and (2) if the political opponents calculate that their material gain will offset whatever personal or communal sacrifices they have to make in the process. A preponderance of exploitable resources could also affect the actor's strategic calculations of the relative availability of the means to pursue and sustain violent dissent.

In the absence of readily available information about the psychological environment to which actors respond (such as the exact nature of their motivations, assessments of opportunities, and the incentives that they face), we follow the example of the civil war literature in general by focusing on more readily available macro-societal indicators of potential grievances, the distribution of collective action resources, and of sources of potential incentives to get an empirical grip on conflict-inducing factors. We treat the concepts of motives, opportunities, and incentives as heuristic devices, and do not here explore the possibility that one or more can be subsumed under another in a more extended theoretical analysis.

The above-mentioned environmental security and political ecology literatures help us to link natural disasters to these general heuristic concepts. First,

environmental degradation leads to economic decline, migrations and increased competition for scare resources (Baechler 1998; Homer-Dixon and Blitt 1998). Second, it has been found that in the face of environmental change, elite actions help to create and maintain a situation of inequality through the processes of resource capture and ecological marginalization (Homer-Dixon and Blitt 1998:13), thus contributing to motives for violent reaction. Resource capture occurs when elites use their power and influence to make sure that they have a greater degree of control over increasingly scarce resources. Ecological marginalization occurs when elites faced with increasing resource competition exploit pre-existing structural scarcity[9] to push weak sections of society into marginal habitats. In addition, adverse environmental change can create opportunities for violent resistance by undermining state capacity and thus contributing to the redistribution of collective action resources away from the state. Societies where state capacity is noticeably weakening are more prone to violent civil conflict (Brown 2001, 3–25; Jackson 2001, 101–121). Adverse environmental change has been found to reduce state capacity through the dual actions of reducing state resources while increasing the demands placed upon it (Homer-Dixon 1997; Kahl 2006, 39–44). However, the exact nature of the state's response will have a great deal to do with whether scarcity reduces or enhances the opportunity for other groups to challenge its authority. The state is not a simple victim, incapable of responding to challenges. Increased ''scarcity'' can sometimes act to strengthen the state, particularly when the state taps into new revenue sources through foreign aid, for instance (Hartmann 2001, 55). There are reasons to believe that natural disasters will have results very similar to those of adverse environmental change, but that these effects may be even more pronounced and more immediate. We distinguish between structural and proximate effects.

Structural effects impinge on distributional patterns in society, including the distribution of resources, income, and wealth, and the distribution of collective action resources between society and the state. Structural effects have longer-term impacts, and can provide *motive, incentive*, and *opportunity. Motive* is affected through heightened grievances brought about by increased poverty, inequality, displacement and marginalization. *Incentive* to forego the opportunity cost of not engaging in conflict may be more acute in the context of increased competition for scarce resources, especially if the state is assessed to be weakening (*opportunity*) due to the mismatch between its available resources and the demands being made on it due to the disaster. The weakening of the state may also provide *opportunity* for groups with pre-established motives unrelated to the actual disaster to partake in conflict. In particular if the state is weakened or distracted by a new conflict, space could be opened for other dissident groups to challenge its hold on political power. Furthermore, the longer-term impacts of structural change are likely to correlate positively with the duration and intensity of conflict. By undermining state structures and by increasing grievance levels, severe impacts may add to the pressures which extend and even exacerbate existing conflict. The structural effects of natural disasters are thus likely to be associated with larger scale organized armed challenges to the prevailing political and socio-economic regime.

By definition, proximate effects are more immediate than structural effects. Proximate effects of natural disasters come in the form of large scale loss of life over a short period, rapid population displacement, pressing hunger, outbreak

[9] The term ''structural scarcity'' comes from the work of Thomas Homer-Dixon and the Toronto group. It refers to a pre-existing situation of resource distribution inequality. This inequality causes a situation of scarcity for the majority of the population even though the resource itself is relatively abundant. For more information, see Homer-Dixon and Blitt (1998, 6).

of disease, and the general breakdown of social systems. All of these may increase the acuteness of grievances and hence provide powerful motives for action. Acute hunger, the spread of disease, and a sense of helplessness are likely to increase the incentives to engage in violent behavior, especially if the perception exists that the state is incapable of mitigating the effects of the disaster or of effectively policing scarce resources. Furthermore, motive to resist will increase if the state is considered to be in some way responsible for a hazard turning into a disaster, for instance when a drought gives way to famine, while the resultant declining legitimacy of the state provides the opportunity to act. Similarly, when the immediate effects of a disaster force the state to concentrate its repressive resources (police and military) in one part of the country, the opportunity may arise in another part for violent resistance.[10] *Opportunity* could also be affected by the pilfering of humanitarian resources, particularly in situations where there are inadequate mechanisms to monitor and control the dispersion of emergency aid. It is possible that the proximate effects of natural disasters will be associated with ad hoc outbursts of violence in the short term, but if these effects persist, larger scale organized armed conflict can also ensue.[11] Based on the preceding, we propose:

Hypothesis 1: *Natural disasters increase the risk of violent civil conflict either by triggering ad hoc outbursts of civil/political violence or by adversely affecting the structural conditions which inhibit the onset of organized armed conflict aimed at changing the regime or balance of political power in a society.*

In the next two sections, we submit this hypothesis to a series of empirical tests.

Empirical Design

Dependent Variables and Estimation Techniques

The test of Hypothesis 1 is based on a large *N* pooled cross-section research design, using the country-year as the unit of analysis. The analysis includes all independent states and dependent political units (with population larger than 150,000) in the international system from 1950 to 2000 inclusive, for which data on both violent civil conflict and the occurrence of natural disasters are available. A total of 8,203 observations, covering 187 political units, are analyzed. Data on the dependent variable —*violent civil conflict*—are derived from the UPPSALA/PRIO data set on the onset of domestic armed conflict, defined as a contested incompatibility involving armed force and concerning regime and/or territory between at least two parties, of which one is the occupier of the state apparatus (Gleditsch, Wallensteen, Eriksson, Sollenberg, and Strand 2002; Harbom and Wallensteen 2005, 634; Urdal 2006, 614). The onset of at least one incidence of domestic armed conflict per year or the absence of such an onset is recorded as a dichotomous variable. The Uppsala/PRIO data set is careful to focus only on politically motivated armed conflict, and also records a new onset only after 2 years of ''inactivity'' have passed. The major shortcoming that the Uppsala/PRIO onset data set shares with other cross-country violent civil conflict data sets is the absence of conflict information on the subnational level, on the date and duration (in days/months) of conflicts, and on

[10] We are grateful to an anonymous reviewer for suggesting these opportunity-enhancing consequences of the proximate effects of natural disasters.

[11] On the other hand, the proximate effects of natural disasters can also be salutary. Societies that undergo the devastation of natural disasters can rally around a common cause of dealing with its proximate effects, such as loss of life and livelihood and the outbreak of disease, thus creating what can be called a ''therapeutic community'' (Olson and Drury 1997).

the exact number of conflict deaths (Miguel et al. 2004).[12] These shortcomings set limits to the exactness of the following empirical analyses, in particular because the main explanatory variable is also in the form of discrete time-bound events. PRIO/Uppsala uses a threshold of 25 conflict-related deaths for all violent civil conflict, and 1,000 conflict-related deaths as a threshold for major violent civil conflicts. While the quantitative difference between minor (<1,000 deaths) and major violent civil conflict (>1,000 deaths) is clear, this quantitative measure does not help us to determine the qualitative differences between the two types of conflict precisely. Nevertheless, the PRIO/Uppsala data set is preferred because it captures more events of violent civil conflict than its competitors do. We focus on the data reflecting the onset of all violent civil conflicts, but also test for the effect of natural disasters on minor versus major violent civil conflicts. There are 225 observations of the onset of all violent civil conflict in the data set, which represent only 2.7% of the total number of observations. There are 81 observations of major violent civil conflict and 144 of minor violent civil conflict. We are thus clearly dealing with what King and Zeng (2001) call ''rare events.'' While a logit estimation of the log-likelihood that the onset of violent civil conflict will follow an occurrence of natural disasters is appropriate given the dichotomous nature of the dependent variable, the rarity of the onset of violent civil conflict could mean that the estimated event probabilities will be too small. To correct for potentially biased logit estimates of events that are rarer than 5% of total observations, we employ a procedure suggested by King and Zeng (2001) that generates approximately unbiased and lower-variance estimates of the logit coefficients and their variance–covariance matrix.[13]

Explanatory variables: natural disasters

The explanatory variables used are derived from the CRED EM-DAT database mentioned above.[14] An event or situation is classified as a disaster event by CRED if one or more of the following criteria are met: (1) Ten or more people reported killed, (2) one hundred people reported affected, (3) it leads to the declaration of a state of emergency, and/or (4) it leads to calls for international assistance. For the period that we are looking at (1950–2000) CRED repeated the per country count of an event for every country affected by that event. As previously noted, we distinguish between *hydro-meteorological, geological* and '*other*' types of natural disasters. We introduce a variable called *all natural disaster* comprising the sum of all three categories. In view of anecdotal evidence that climate-related disasters are increasing due to the effects of climate change, we created a category called *all climate* which includes all disasters that are likely to be impacted upon by climate change, broadly conceived. In effect this combines the categories of hydro-meteorological and ''other'' disasters. We also test for the effect of *rapid-onset natural disasters* which includes all natural disasters except famine and drought.[15] Recorded incidences of the explanatory variable relative to population size are used as primary predictors

[12] Both the Uppsala/PRIO and CRED EM-DAT data sets do not make provision, in the time period that we are looking at, for cross-border contagion of either natural disasters or violent civil conflict.

[13] We use their Relogit software to generate the corrected estimations. Available at http://gking.harvard.edu/stats.shtml. (Accessed November 18, 2006)

[14] See: EM-DAT: The OFDA/CRED International Disaster Database (http://www.em-dat.net) Université Catholique de Louvain. Brussels, Belgium. (Accessed December 2, 2006) Data for this study gratefully received by email October 2006 from EM-DAT.

[15] We do not test for the effect of famine because of the reverse causality that violent civil conflict (and other political events) could have on its occurrence (see Dreze and Sen 1989).

in the cases of *all natural disasters* and *all climate disasters*, although robustness checks also use a variable based on number of disasters relative to total territory covered by the affected political unit.[16] As there is no more than one *geological disaster* (volcanic eruptions and earthquakes) recorded per country year, this variable is in effect a dummy variable and we do not weigh for population or territory size when exploring the effects when exploring the effects of this category of disasters. Finally, robustness checks also consider the intensity of the number of natural disasters experienced by a country in one year, by interacting the number of natural disasters with the number of people affected, relative to the size of the population.[17]

Intervening and Control Variables

We expect that natural disasters will have a more pronounced impact on communities which already display many of the attributes typical of conflict-prone societies, namely high levels of income and asset inequality, lack of political robustness, and large youth bulges. These features are concentrated among low and middle-income countries.[18] Two-hundred and fifteen of the violent civil conflict onset observations are from these countries and only 10 from high-income countries (World Bank classification). Per capita income thus clearly is an important predictor of violent civil conflict onset, and we use the natural log of GDP per capita, weighted for purchasing power in robustness checks (Heston, Summers, and Aten 2003). GDP per capita serves as an approximation for a whole spectrum of development indicators and is therefore often included as a ''catch-all'' variable in civil war studies (Hegre and Sambanis 2006). As there is a close negative correlation between income inequality and national output per capita, and as observations on GDP per capita are numerous, the latter is sometimes seen as a useful alternative to the relatively scarce direct observations of income inequality. We are less convinced of its usefulness, though. Its linear association with the occurrence of violent civil conflict does not pick up the distinct inverted U-shape relationship between inequality and violent civil conflict to which a number of authors have pointed (Lichbach 1989; Nagel 1974; Nel 2006). As noted, income and wealth inequality has been singled out as an important motive factor in the literature on civil conflict. As can be deduced from the discussion of the interplay of motives, opportunities, and incentives in Section 2, the relationship between level of inequality and conflict may not be linear, however. Countries with very high and low inequality are less conflict prone than intermediate to high inequality countries, as the degree of inequality reflects the concentration of collective action resources and political power. Very high levels of income concentration result from the concentration of political power and collective action resources, and although motives based on grievances may abound, the opportunities to pose a challenge to the regime are severely curtailed in such societies. At intermediate to high levels of inequality, motives based on grievances may be as high, but collective action resources are likely to be somewhat less concentrated and

[16] The per capita version is probably more reliable than the per territory size version as an indicator of how widely disasters affect human relationships.

[17] We do not run fixed effect models. Following Beck and Katz (2001), we consider the use of fixed effect models to control for the influence of unit idiosyncrasies in binary outcome time-series cross-section data as pernicious. There are many units with no other outcome than zero, and to control for their presumed idiosyncratic effects on the parameter estimates does not make any sense.

[18] A recent World Bank study (Collier et al. 2002) has found that middle-income countries have a civil-war risk four times as high as OECD countries (down from five times as high in the 1960s), while the low-income countries have a typical risk fifteen times as high as the OECD group of countries.

more opportunities for collective action may therefore exist. On the other hand, low inequality is associated with the prevalence of democracy and redistributive mechanisms, resulting in lower grievance levels and less violent conflict.

Level of inequality is thus an important intervening variable in considering both motives and opportunities for violent civil conflict. The risk that natural disasters pose to violent civil conflict is expected to be lowest at the two tails of the distribution of income inequality. The available income inequality data are plagued by numerous problems of compatibility across countries and of coverage (Knowles 2005), and even the best available inequality data set, the Estimated Household Income Inequality (EHII) data set produced by the University of Texas Inequality Project (Galbraith and Kum 2005) has numerous missing values and covers only the last four decades of the twentieth century. We prefer to use the readily available data on the fraction of live-born children who die before their first birthday (*infant mortality rate*)[19] as a proxy for economic inequality. Infant mortality is concentrated in the lower income deciles, and there is a very close positive correlation between infant mortality and available observations of income inequality. The lagged $(t - 1)$ infant mortality rate and its squared version are included[20] in the analysis to control for the potential nonlinear intervening effect of economic inequality.[21]

To control for political robustness, variables are constructed on the basis of the 21 value Polity2 combined regime indicator from the Polity IV data set (Marshall and Jaggers 2002). We use a dummy variable called *mixed regime* which is a combination of inconsistent/partial democracies (1 to 7) on the Polity2 scale and inconsistent/partial autocracies (−1 to −7 on the same scale). Some authors suggest that inconsistent/mixed regimes, that is regimes that cannot be regarded as fully autocratic or democratic, are the least robust in terms of surviving in general and suppressing the risk of civil conflict in particular (Gates, Havard, Jones, and Strand 2006). Partial or inconsistent democracies, for instance, provide a modicum of opportunities for voice, but are still so dominated by power and wealth elites that they fail to respond effectively to the grievances of the poor and marginalized (Hegre and Sambanis 2006; Merkel 2005; Reich 2002; Schatzman 2005).[22] To test whether this lack of robustness is unique to partial democracies only, we construct separate dummies for ''partial autocracies'' and ''partial democracies.'' We suggest that the identification of the ''partial'' features of mixed regimes accounts best for the curvilinear relationship that Hegre, Ellingsen, Gates, and Gleditsch (2001) and Urdal (2006) detect between Polity IV regime score and violent civil conflict. To construct the partial/mixed regime variable, the mean (=0) of the combined

[19] Data on infant mortality rate are constructed by Henrik Urdal (2006) from the UN's *World Population Prospects* and the UN *Demographic Yearbook*. Permission to use this data is gratefully acknowledged.

[20] The lagged version is preferred since infant mortality rate can be affected by the occurrence of both natural disasters and of violent civil conflict at *t*.

[21] The problem of multicollinearity looms large when using the GDP per capita measure of income level and the measure of infant mortality together, though, and in the regressions below we only enter one of these measures at a time. A measure of ethnic fractionalization is also not used, partly because we have only 2,722 observations of this measure, and partly because it is highly positively correlated (albeit probably spuriously) with infant mortality rate ($r = .57$).

[22] It is of course problematic to use what was intended as a continuous scale of democracy to arrive at a categorical distinction between types of democracy. Nevertheless, the Polity IV data set has so many advantages in terms of clarity of conceptualization and operationalization that researchers interested in the categorization of types of democracy prefer to use it instead of less transparent categorizations such as Reich (2003). The important question is where exactly to draw the line on this continuous scale between democracy and partial democracy, and the opinions differ on this (see Epstein, Bates, Goldstone, Kristensen, and O'Halloran 2006; Lee 2005; and Li and Reuveny 2006). We follow Epstein, Bates, Goldstone, Kristensen, and O'Halloran (2006) in believing that the cut-off used here, namely the score of seven, is sufficiently stringent in terms of the democracy and autocracy criteria used by Marshall and Jaggers (2002).

Polity2 is imputed to replace missing data, allowing us to use the full data set and to avoid the selection bias against authoritarian regimes that Ross (2006)[23] warns against. However, to control for this imputation we also estimate models without the imputation.

Using the same dependent variables as we do, Urdal (2006) finds that the existence of an exceptionally large cohort of 15–24 year olds relative to the total adult population of 15 years and older is a strong predictor of violent civil conflict in developing countries in particular. These so-called *youth bulges* tend to experience high levels of social frustration—low mobility prospects, high levels of unemployment, and overcrowding in urban centers. Natural disasters, we suggest, exacerbate these conditions and also provide incentives and opportunities for a violent resources grab as competition for scarce resources heat up and the capacity of the state to control the situation declines.[24]

In their sensitivity analysis of empirical results on civil war onset, Hegre and Sambanis (2006) identify *economic growth* as a significant and robust predictor of the onset of civil war. GDP growth reflects increased economic opportunities and may reduce grievances if its benefits are spread relatively evenly in a society (which may not be the case in highly unequal societies, though, which is another reason why it is important to control for the prevalence of economic inequality). Growth also raises the opportunity cost of engaging in violent civil conflict and can thus be deemed to be a disincentive factor. In general, we expect that the more robust a political unit's economy is, the less it will be adversely affected by natural disasters. We use 5-year averages of the Penn World Tables measure of growth in per capita GDP, weighted for purchasing power.[25]

The natural log of total population is often included as a control variable in civil war studies (see Fearon and Laitin 2003; and Hegre and Sambanis 2006). Since we normalize versions of the explanatory variables by taking the per capita versions of natural disasters, we do not enter total population as a control variable. As total population is simply a proxy for size, we take the direct route and instead control for the *total territory size of the political units*, expressed in square kilometers, where appropriate. We expect state capacity to be under more strain in larger countries that experience natural disasters, which could open up more opportunities for violent political resistance.

Dealing with Time

The data used here prescribe the country-year as the unit of analysis, and we assume that the causal arrow between the two sets of discrete events, if there is indeed one, runs from natural disasters to violent civil conflict. We use observations of both at *t*. However, case studies of the political effects of natural disasters have indicated that major civil conflicts do not always follow immediately after a disaster (Drury and Olson 1998; de Boer and Sanders 2002, 2005), and we thus also use a $t + 1$ version of the dependent variable to check for this possibility.

[23] Ross (2006) shows that authoritarian states are underrepresented in cross-sectional political studies, because they produce fewer observations of crucial data than do democracies. The imputation procedure followed here is a conservative correction of this bias, as it conserves all the available information, but does not overestimate the number of mixed regimes. If anything, the procedure increases the observations of the reference value in the mixed-regime dummy variable, and is thus a potential *undercount* of the incidence of partial/mixed regime types.

[24] However, there is a very high positive correlation ($r > .5$ in all cases) between the *infant mortality rate* and the size of the *youth bulge*, and we introduce these two variables only one at a time to avoid colinearity. The growth rate of urbanization is also highly positively correlated to the infant mortality rate and to 'youth bulges,' and is therefore not employed as a control variable here.

[25] As calculated by Urdal (2006) from Heston et al. (2003). Permission to use these data is gratefully acknowledged.

Following Hegre et al. (2001), Toset, Gleditsch, and Hegre (2000), and Urdal (2006) we introduce a control for time dependency in the form of a variable called *brevity of peace*. Time dependence is assumed to be a problem in the time-series PRIO/Upssala data as violent civil conflict is more likely in a political unit that has experienced civil conflict in recent years than it is in a unit where the incidence of violent conflict is few and far between. Hegre et al. (2001) and Urdal (2006) assume that the effect of a previous conflict declines geometrically[26] at a rate which halves the risk of conflict every 3 years. The *brevity of peace* variable has a value of 1 while a political unit is experiencing a conflict, and a value of close to 1 immediately after a unit-conflict has ceased. Over time, the value decreases to close to zero, provided there is no onset of a new armed civil conflict in the period that has lapsed.

Results and Discussion

Tables 1–3 report the results achieved by running logit analyses corrected for rare event data on the total sample of the onset of all violent civil conflict, and for the two subsets of which it is composed, namely minor violent civil conflict (<1,000 deaths) and major violent civil conflict (>1,000 deaths). Table 1 focuses on the effect on the onset of all types of violent civil conflict by the annual number of all types of natural disasters per country, weighted for that country's population size. Geological disasters (volcanic eruptions and earthquakes) are covered by Table 2. As noted, there is no more than one observation of geological natural disasters per country year in the data set, and the explanatory variable in Table 2 thus acts as a dummy. In Table 3, the attention turns to the number of climate-related disasters per country year, again weighted for relevant population size.

The findings reported in Table 1 confirm that natural disasters, as a rule, increase the risk of the onset of violent civil conflict at both t and at $t + 1$ to a degree that is statistically significant. This conclusion holds for both the smaller sample (with missing Polity IV values) and the larger sample (with missing values imputed), and for both the minor and major subsets of violent civil conflict (not shown). The statistically significant risk-increasing effect of natural disasters is evident not only when this explanatory variable is weighted for population size (Models 1–5), but also when it is weighted for territory size (not shown). Importantly, alternative specifications of the control variables, in particular the inclusion of a GDP per capita measure (in Model 3) and the youth bulge measure (Model 4), do not alter these results.[27] The risk that natural disasters pose is not only significant, but also reasonably powerful. An increase of one standard deviation in the per capita version of the *all natural disasters* variable at t increases the odds of the onset of any violent civil conflict by 23% (Model 2), and by 17% at $t + 1$ (Model 5). By using a dummy version of the *all natural disasters* variable (1 = experienced at least one natural disaster in a year), we determine that a political unit that experiences at least one natural disaster is 30% more likely to experience violent civil conflict compared to a unit that experiences no natural disaster. We are confident that these results are robust and confirm the findings of Drury and Olson (1998) and Bhavnani (2006), which were based on limited samples and/or time periods, that natural disasters pose a significant risk to the political health of societies. Our specification allows us to proceed beyond these

[26] Calculated as exp((−years in peace)/X), where X indicates the rate at which the effect of the preceding conflict diminishes over time.

[27] The effect of the intensity level of the total number of disasters (multiplied by number of people affected, and weighted by population size) is not statistically significant.

TABLE 1. Natural Disasters and the Risk of Violent Civil Conflict, 1950–2000

	1	*2*	*3*	*4*	*5*
Dependent	*All violent civil conflict (Smaller sample)*†	*All violent civil conflict*	*All violent civil conflict*	*All violent civil conflict*	*All violent civil conflict* $t+1$
No. natural disasters per capita	1.075** (0.280)	1.186** (0.268)	0.913** (0.287)	0.089** (0.279)	0.950** (0.306)
Infant mortality rate $t-1$	0.023** (0.007)	0.023** (0.006)			0.024** (0.006)
Infant mortality rate squared $t-1$	−0.000* (0.000)	−0.000** (0.000)			−0.000** (0.000)
GDP per capita			−0.428** (0.083)		
Mixed regime	0.422** (0.164)	0.524** (0.155)	0.583** (0.149)	0.568** (0.155)	0.375* (0.160)
GDP growth	−0.060** (0.020)	−0.068** (0.020)	−0.058** (0.019)	−0.070** (0.019)	−0.048* (0.020)
"Youth bulge"				0.052** (0.015)	
Brevity of peace	0.863** (0.181)	0.872** (0.164)	0.908** (0.168)	0.978** (0.161)	0.877** (0.165)
Constant	−4.992** (0.273)	−5.187** (0.255)	−0.505 (0.682)	−5.507** (0.467)	−5.172** (0.257)
N	5893	7840	8203	7928	7663

Relogit regression coefficients with robust standard errors in parentheses.
*$p < .05$, **$p < .01$.
†Sample with missing values on regime and GDP growth variables.
Note: All violent civil conflict = onset of violent civil conflict with minimum of 25 deaths.

TABLE 2. Geological Disasters and the Risk of Violent Civil Conflict, 1950–2000

	6	*7*	*8*	*9*	*10*
Dependent	*All violent civil conflict*	*All violent civil conflict*	*Minor violent civil conflict*	*Major violent civil conflict*	*Major violent civil conflict t + 1*
Incidence of geological disaster	0.743** (0.213)	0.432* (0.197)	0.822** (0.268)	0.608 (0.333)	0.725* (0.314)
Infant mortality rate $t - 1$	0.023** (0.006)		0.029** (0.007)	0.010 (0.010)	(0.013) (0.010)
Infant mortality rate squared $t - 1$	−0.000** (0.000)		−0.000** (0.000)	−0.000 (0.000)	−0.000 (0.000)
Mixed regime	0.523** (0.155)	0.527** (0.154)	0.598** (0.189)	0.368 (0.264)	0.150 (0.277)
GDP growth	−0.068** (0.020)	−0.067** (0.019)	−0.063** (0.023)	−0.075* (0.034)	−0.052 (0.036)
"Youth bulge"		0.056** (0.016)			
Brevity of peace	0.929** (0.167)	0.789** (0.166)	−0.242 (0.230)	2.538** (0.297)	2.481** (0.293)
Size		0.204** (0.033)			
Constant	−5.112** (0.256)	−8.061** (0.669)	−5.552** (0.321)	−6.225** (0.421)	−6.361 (0.441)
N	7840	7928	7840	7840	7663

Relogit regression coefficients with robust standard errors in parentheses.
*$p < .05$, **$p < .01$.
Notes: All violent civil conflict = onset of violent civil conflict with minimum of 25 deaths; minor violent civil conflict = onset of violent civil conflict <1,000 deaths; major violent civil conflict = onset of violent civil conflict >1,000 deaths.

TABLE 3. Climate-related Disasters and the Risk of Violent Civil Conflict, 1950–2000

	11	*12*	*13*	*14*
Dependent	*All violent civil conflict*	*Minor violent civil conflict*	*Major violent civil conflict*	*All violent civil conflict t + 1*
No. climate-related natural disasters per capita	1.112** (0.310)	0.811 (0.448)	1.372** (0.415)	1.148** (0.311)
Infant mortality rate $t - 1$	0.023** (0.006)	0.028** (0.007)	0.010 (0.010)	0.026** (0.006)
Infant mortality rate squared $t - 1$	−0.000** (0.000)	−0.000** (0.000)	−0.000 (0.000)	−0.000** (0.000)
Mixed regime	0.524** (0.155)	0.602** (0.189)	0.382 (0.261)	0.388** (0.160)
GDP growth	−0.067** (0.020)	−0.060* (0.024)	−0.080* (0.034)	−0.051* (0.020)
Brevity of peace	0.903** (0.162)	−0.212 (0.228)	2.446** (0.284)	0.570** (0.164)
Constant	−5.140** (0.251)	−5.523** (0.313)	−6.322** (0.412)	−5.163** (0.256)
N	7840	7840	7840	7663

Relogit regression coefficients with robust standard errors in parentheses.
*$p < .05$, **$p < .01$.
Notes: All violent civil conflict = onset of violent civil conflict with minimum of 25 deaths; minor violent civil conflict = onset of violent civil conflict <1,000 deaths; major violent civil conflict = onset of violent civil conflict >1,000 deaths.

earlier findings in that we can also explore the effects of different types of natural disasters and different types of violent civil conflict.

What Table 1 does not reveal is that there are important differences between the effects of different types of natural disasters and between the effects experienced by the two subsets of violent civil conflict. Rapid-onset disasters pose a higher and more significant risk than slow-onset disasters. A country that experiences one rapid-onset disaster is 50% more prone to violent civil conflict than one that does not (significant at the .01 level), while the effect of slow-onset disasters is lower and significant only at the .1 level (results not shown). Furthermore, of the rapid-onset disasters, a single geological disaster is a much more powerful conflict risk factor than a single climate-related disaster, most likely because of the larger degree of destruction normally associated with volcanic eruptions and earthquakes. A unit that experiences an earthquake or volcanic eruption faces twice the net risk of a violent civil conflict incident occurring than a unit that is spared these cataclysmic events (Model 6). This result confirms the findings of Brancati (2007) that earthquakes increase the risk of civil conflict significantly. In contrast, a single climate-related disaster adds only 18% more risk to a country's profile, and this risk is statistically not significant (result not shown). However, the coefficient for the number of all climate-related disasters weighted for population size is statistically highly significant (Model 11), which suggests that the risk posed by climate-related disasters may become higher as the number of disasters affecting a country in a single year increases. This positive relationship between number of climate-related disasters and violent civil conflict risk turns out to be nonlinear, as revealed by a polynomial investigation that shows that the violent civil conflict risk posed by climate-related natural disasters is at its highest, both at t and at $t + 1$, when a country experiences between five and eight such disasters in a year. However, the risk drops off significantly in units that experience more disasters in a single year. While the motive to engage in armed action may be equally present in societies that experience a single or many climate-related disasters, the extent of the destruction caused by a large number of disasters clearly diminishes the

opportunities and the incentives in the latter for agents to engage in the kind of collective action necessary to stage violent civil conflict. There is no indication that the category of *other disasters* (insect infestations and epidemics) poses any significant risk.[28]

Tables 2 and 3 provide evidence that there are also different dynamics at play with respect to minor compared to major violent conflict, that is, conflict with a battle-related death toll of at least 1,000. Although there is no difference between the effect that the total number of natural disasters weighted for population size have on minor and major violent civil conflict in general, some differences emerge when we look at the effects of geological and climate-related disasters separately, and also when we distinguish between the effects at t and at $t + 1$. One has to be careful not to make too much of the differences between minor and major violent civil conflict, as the distinguishing factor in some cases could simply be a few deaths more or less. However, it is noticeable that the coefficient for geological disaster when considering major violent civil conflict at t is not statistically significant (Model 9), but that it is at $t + 1$ (Model 10). In contrast, the same coefficient in the case of minor violent civil conflict is not significant at $t + 1$ (not shown), but is at t (Model 8). When considering the number of climate-related disasters per capita, we find that the coefficient of the number of disasters per capita is not significant for minor violent civil conflict at t (Model 12), but that it is significant in the case of major violent civil conflict (Model 13). At $t + 1$, climate-disasters increase the risk of both types of conflict significantly. A further difference between the two subsets, to which we shall return, is that some of the control variables behave significantly different in the case of major violent civil conflict compared to minor violent civil conflict. How can we account for these differences?

The distinguishing feature of earthquakes and volcanic eruptions is the large degree of destruction and upheaval that they cause, upsetting not only the collective action resources of the power-holders, but also of their challengers. It takes more collective action resources to stage a major rather than a minor event of civil conflict, and the general disruption and destruction caused by geological disasters makes large-scale organized resistance difficult in the short term. If we assume that violent civil conflict that leads to lower number of deaths demands less mobilization of especially political resources, it is clear why these incidents would be more prevalent in the short term. Incidences of minor violent civil conflict are most probably ad hoc violent reactions that, while still political (otherwise, they would not be included in the PRIO/Uppsala data set), are precipitated by the proximate effects of the destruction caused by geological natural disasters, and would be vents for frustration or be aimed at grasping opportunities to alter the distribution of valued scarce resources. In the medium term, though, major violent civil conflict would have time to gestate. We surmise that larger-scale violent civil conflict is, as a rule, related to attempts at altering the basic distribution of political power in a society, something that takes longer to put together than the ad hoc and opportunistic minor violent civil conflict. It is also possible that major violent civil conflict is a response to the structural effects of natural disasters as discussed in Section 2 above. These structural effects take longer to manifest themselves, and the opposition precipitating the major violent civil conflict in the wake of a volcanic eruption or earthquake would also need more time to organize an effective political challenge. The major disruption caused by volcanic eruptions and earthquakes thus precipitate smaller scale and ad hoc violence immediately, but through the sheer magnitude of the destruction caused may also undermine the ability of disgruntled groups in society to effectively stage major resistance in

[28] The coefficients for 'other' disasters (epidemics, insect infestation) are not statistically significant, and are not included here.

the short term. Gradually, the structural effects of geological disasters may increase the risk of politically motivated violent civil conflict, as disgruntled groups get their collective-action ducks in a row and as doubts grow about the ability of the ruling elite to ride out the disaster. In the medium term, at $t + 1$, a country that has suffered a single geological disaster is as likely to experience major politically-motivated violent conflict as it is to experience incidences of minor ad hoc violence immediately after the disaster struck. In the case of climate-related disasters the destruction and disruption caused is less pronounced than in the case of geological disasters, and major violent civil conflict emerges more readily in the aftermath of the former than the latter, for the reasons already explored. The relative absence of minor violent civil conflict in the immediate wake of climate disasters (Model 12) is an indication that climate-disasters probably create more incentives and opportunities for larger-scale challenges of the status quo in the shorter term. In the medium term, minor violent civil conflict is as likely as major violent civil conflict to follow climate-related disasters (Model 14).

Of importance in exploring the differences between minor and major violent civil conflict is also the behavior of some of the socio-economic, political, and time-dependence control variables. The results achieved for the control variables are as expected and are mostly significant in the case of all incidences of violent civil conflict and, with the exception of the *brevity of peace* variable, are also as expected for the subset of minor violent civil conflict. Our 5-year average measure of economic growth behaves as expected, always deflating the odds for the onset of violent conflict and significantly so, except in the case of geological disasters considering major violent civil conflict at $t + 1$ (Model 10). This coefficient is highly significant, however, in the case of all violent civil conflict and minor violent civil conflict at $t + 1$. A 3% increase in the economic growth rate decreases the risk of violent civil conflict by as much as 20%. Model 3 shows that income level is a significant ''catch-all'' predictor of the onset of violent civil conflict, but the generality of this measure—and the fact that it is closely correlated with so many more specific measures—is more of a curse than a boon. We therefore use it only as a robustness-check variable. Territory size (log transformed) is also highly significant in our robustness-check specification in Model 7, but as we use a per capita version of the explanatory variables in the models reported in Tables 1 and 3, it is here employed only in the case of geological disasters.[29] The coefficients for income level and territory are all statistically significant with respect to both minor and major violent civil conflict, and at both time periods that we look at.

Of greater significance is the fact that three important control variables lose their statistical significance when the subset of major violent civil conflict is considered alone (both at t and at $t + 1$), namely (1) the measure used to trace the effect of economic inequality, (2) the control for the presence of mixed (inconsistent) regimes, and (3) the measure of the presence of a 'youth bulge.' The measure for the infant mortality rate and its squared version are highly significant in all models where all violent civil conflict and minor violent civil conflict are considered. Recall that this measure is used here to capture the presence of income inequality—one of the motive sources for engaging in violent civil conflict. We find that an increase of one standard deviation in the infant mortality rate makes a country that experiences one natural disaster two-and-a-half times more likely to suffer any form of violent civil conflict, but also that this effect tapers off at very high levels of infant mortality/inequality. These results confirm the suggestions by Lichbach (1989) and Nagel (1974) that the relationship between income inequality and violent civil conflict is significant and that it

[29] We find no difference between the statistical significance when using log transformed or ''straight'' values of the total size of territory variable, but a curvilinear tapering off of the effects of this variable on the risk of violent civil conflict is suggested by the negative coefficient sign of the squared version of territory size (not shown).

traces an inverted U curve, with violent civil conflict most prevalent at intermediate to relatively high levels of income inequality.[30] However, we are surprised by the fact that the coefficients for infant mortality rate are not also highly significant in the case of major violent civil conflict. This result stays the same when we replace infant mortality with the EHII measure developed by Galbraith and Kum (2005) which was discussed above (results not shown).[31] The curvilinear effect related to vertical inequality between individuals/households (measured by both the infant mortality rate and by the EHII measure) is present also in the case of major violent civil conflict, but its significance has now dropped to the 10% range which is not insignificant, but which does not meet strict significance requirements. Clearly, measures of vertical economic inequality do not capture the motive factor with respect to major violent civil conflict as well as our theoretical exposition suggests. There may be other dimensions of inequality, such as horizontal inequality between societal groups for instance (Østby 2003), which are more significant predictors of major violent civil conflict, but we had no comprehensive data to control for this.

Secondly, our inconsistent (mixed) regime variable also drops out of the statistically significant range in the case of major violent civil conflict, but is highly significant in the case of all violent civil conflict and minor violent civil conflict.[32] A political unit that has a mixed regime is about 66% more likely to experience the onset of a violent civil conflict coterminous with or after the occurrence of a single natural disaster, but the risk is higher in the case of minor violent civil conflict (80%) than in the case of major violent civil conflict (40%). The fact that the coefficient for *mixed regime* is not statistically highly significant in the case of major violent civil conflict provides some reason to believe that this measure does not capture the regime features relevant to the onset of major violent civil conflict adequately. Findings by Hegre et al. (2001), Merkel (2005), Reich (2003), Schatzman (2005), Gates et al. (2006), and Hegre and Sambanis (2006) that partial or inconsistent regimes are most conflict prone are thus partly confirmed by these findings. As discussed below, there may be other important structural features that can better account for the onset of major violent civil conflict than the measure of inconsistent (mixed) regime-type.[33]

Finally, the presence of large numbers of disgruntled and unemployed youth (*youth bulge*) is significant with respect to all violent civil conflict (Model 4 and 7) but only when we avoid the multicollinearity this measure suffers with respect to the infant mortality rate and level of income. It remains significant when used as a predictor of minor violent civil conflict, which taken together with the above partially confirms Urdal's (2006) findings. However, we find that the youth bulge effect is less pronounced and not statistically significant in the case of major violent civil conflict.[34] Again, there is reason to believe that our specification,

[30] The infant mortality rate is also a useful proxy for a number of important socio-economic factors such as level of development achieved, the capacity of the state to deliver health services to the population, amongst others (Sen 1998; Ranis, Stewart, and Samman 2006; Urdal 2006). However, the curvilinear effect is more difficult to explain in the case of these other empirical correlates. We find that infant mortality rate is a much stronger predictor of violent civil conflict than income level, with an increase of one standard deviation in the former accounting for twice as much violent civil conflict risk as does an increase of one standard deviation in the measure of GDP per capita (weighted for purchasing power).

[31] In their study of the political effects of natural disasters, Drury and Olson (1998) also found that income inequality is not significant but they did not check for a curvilinear effect.

[32] It does not make a difference to these results whether a mixed regime is an inconsistent democracy or an inconsistent autocracy for it to lower the political robustness of the regime in the face of natural disasters (results for separate tests of these two inconsistent regimes not shown).

[33] Other regime measures based on the Polity IV data set do not fare better in predicting the onset of major violent civil conflict.

[34] Admittedly, we use a specification that differs significantly from that used by Urdal as we are interested in the net effects of natural disasters, while his study focused on the net effects of youth bulges as such.

while adequate to capture the significant factors increasing the risk of violent civil conflict per se, may not be sensitive enough to the factors leading to major violent civil conflict in particular.

The results achieved for the *brevity of peace* variable, which measures the conflict proneness of a society over time, also differ across the various types of violent civil conflict. The coefficients for this variable are positive and highly significant throughout the models focusing on all types of violent civil conflict and major violent civil conflict, but not in the case of minor violent civil conflict, indicating that societies that were conflict prone in the recent past are highly likely to experience major conflicts when natural disasters strike. What is less obvious is why the coefficient of *brevity of peace* is constantly negative and insignificant in the case of the models focusing on minor violent civil conflict (Model 8 and 12). One possible answer lies in the sudden and unexpected nature of natural disasters, whose proximate effects may increase the risk of minor violent civil conflict incidents *independent*ly of other factors that over time make a society more or less prone to violent political conflict. Ad hoc minor conflict, accompanied by some loss of life, can be unleashed by the destruction of livelihood and the breakdown of law and order following a rapid-onset natural disaster such as an earthquake, no matter how politically stable a society tends to be. In other risk assessments of the onset of all violent civil conflict in which the contingency of natural events are not considered, such as that offered by Urdal (2006) using youth bulges as the main explanatory variable, the *brevity of peace* variable will act differently than here, taking on a significant positive value also in the case of minor violent civil conflict.

The political and social-economic specifications used in this study are thus more than adequate to capture the dynamics of the combined category of the onset of all violent civil conflict, and of the onset of minor violent civil conflict. They behave less well when it comes to predicting major violent civil conflict, though. By default, the larger part of the explanatory weight in the case of major violent civil conflict is carried by the *brevity of peace* variable. The fact that this control variable for conflict proneness is so powerful suggests that there may be structural features at play in the case of major violent civil conflict that remain unaccounted for in our specifications. We have already mentioned horizontal inequality as one such feature. Other structural features that may also be important, but for which we also had no time-series data, include the ecological fragility (or environmental stress level) of a society. In his case studies of environmental factors that induced political conflicts in Kenya and the Philippines, Kahl (2006) singles this out as an important factor. Another important feature may be the quality and the robustness of the public authorities, local and national, to deal with the type of systemic shocks posed by natural disasters. This latter feature may even be more important than regime type, but this hypothesis must await its test until we find time-series data on the service-delivery quality of public authorities.

Conclusions

In light of the significant insights produced by the literature on the effects of environmental transformation on civil war, it is surprising that so few analysts have systematically explored the links between natural disasters and violent civil conflict in detail. The lack of large *N* cross-section time-series data is partly to blame, but so is the tendency by political scientists and other conflict specialists to underestimate the importance of geography and environmental factors. Given the growing importance of environmental factors as climate change kicks in and as natural ecologies are stretched to the limit, it becomes all the more important to correct this oversight. This paper contributes to the violent civil conflict

literature by looking at the net risks posed by the number and type of natural disasters, weighted for population and territory size, for the onset of both minor and major violent civil conflict. On explicit theoretical grounds, we expect natural disasters to increase the risk of violent civil conflict through their proximate and structural macro-social effects, increasing the motive, incentive, and opportunity for conflict. By increasing grievances and increasing the incentive for resource grabs, while reducing state ability to respond (therefore redistributing collective action resources), natural disasters have powerful social impacts which can act to destabilize society.

Using a comprehensive data set that covers 187 political units and the whole second half of the twentieth century, we find robust evidence that rapid-onset natural disasters significantly increase the risk of violent civil conflict in the short to medium term. As a rule, earthquakes and volcanoes hold somewhat higher civil-conflict risks than do climate-related disasters, but the conflict effects of the latter are also quite significant. Epidemics and insect infestations are the least likely to result in violent civil conflict. The relationship between the number of climate-related natural disasters experienced by a political unit and the risk of violent civil conflict is curvilinear, tracing an inverted U, with an upper turning point between five and eight climate-related disasters. Looking at all incidences of violent civil conflict, we find that income inequality, proxied by infant mortality rate, is an important intervening factor that determines when and where rapid-onset natural disasters give rise to conflict. In addition, the conflict risk posed by natural disasters is higher in political units with mixed regimes than in autocracies or consolidated democracies. Autocracies are less conflict prone given the preponderance of state repressive capacity but also because some autocracies are quite successful in addressing grievance issues such as income inequality (pre-democratic Indonesia and South Korea being prime examples). Consolidated democracies provide legitimate channels for voicing dissent, and the incentives to engage in violence are less than in a partial, incomplete democracy.[35] Disaster intensity seems to be relatively unimportant, and does not explain the difference between minor and major incidences of violent civil conflict. These findings are robust to the use of different versions of the dependent variable, and to a range of alternative specifications of the explanatory and control variables. Rapid-onset natural disasters are significant predictors of the risk of civil war in societies with mixed regimes, low economic growth rates, and intermediate to relatively high levels of income inequality, whether we weigh for population size or not, whether we control for the size of the total area covered by a political unit or not, whether we control for income level or not, and whether we systematically remove outliers or not.

While our main results are robust, we are less confident that we have exhausted the factors that determine when and where natural disasters increase the risk of major violent civil conflict. The analysis reveals significant differences between the minor and major subsets of violent civil conflict, but we are hesitant to overemphasize these differences given the imprecision of the criterion used to distinguish between the two subsets in the PRIO/Uppsala data set. Nevertheless, the detected differences point to the conclusion that the destruction caused by geological disasters inhibit the development of major conflict in the short term. We also find that youth bulges are more of a threat for the onset of minor than for major violent civil conflict. In addition, the conflict history of a society is significant in accounting for the outbreak of major incidences of violent civil conflict, but less so in the case of minor conflicts where the contingency of natural disasters seems to be an overriding factor. There is clearly different dynamics

[35] Gates et al. (2006) find a systematic pattern of self-enforcing equilibria in the case of autocracies and consolidated democracies which are absent in the case of mixed regimes. See also Epstein et al. (2006).

at play in the case of major compared to minor violent civil conflict, although natural disasters in both cases significantly increase the risk of violent civil conflict. More research is called for to identify those structural features of conflict-prone societies that the *brevity of peace* variable nicely reflects in the case of major violent civil conflict, but which remain largely unaccounted for in our specifications. We also believe that finer time-calibrated onset data can assist in drawing clearer causal conclusions, while further research is also necessary to test for the cross border impacts of natural disasters and how international responses to natural disasters affect social outcomes. One further important factor which we had to ignore due to absence of systematically collected data is the effect that disaster refugees could have. Does the presence of large numbers of displaced persons increase or decrease the risk of civil conflict? Data restrictions also prevented us from testing for the impact of natural disasters on conflict duration or termination.

However, the empirical results registered above confirm the hypothesis that sudden, cataclysmic environmental change significantly increases the risk of civil conflict. Now that we know which disaster-prone countries face the higher risk of violent civil conflict, we can combine this information with analytic tools such as *Disaster Hotspots* (Dilley, Chen, Deichmann, Lerner-Lam, Arnold, Agwe, Buys, Kjekstad, Lyon, and Yetman 2005) and the IPCCs regional predictions of future ''extreme climatic events''[36] to provide socially sensitive early-warning and disaster-monitoring systems. Given the dire predictions that natural disasters are set to become more frequent in the near future, conflict reduction and management strategies in the twenty-first century simply have to be more attuned to the effects of natural disasters than they have been up to now.

References

Aristotle. 1974. *The Politics*. Trans. T. A Sinclair Harmondsworth: Penguin Books.

Baechler, Gunther. 1998. ''Why Environmental Transformation Causes Violence: A Synthesis.'' *Environmental Change and Security Project Report* 4: 24–44. Available at http://www.wilsoncenter.org/topics/pubs/ACF1497.pdf

Bhavnani, Rakhi 2006. *Natural Disaster Conflicts*. Available at http://www.disasterdiplomacy.org/bhavnanisummary.pdf. (Accessed July 25 2007).

Beck, Nathaniel, and Jonathan N. Katz. 2001. ''Throwing Out the Baby with the Bath Water: A Comment on Green, Kim, and Yoon.'' *International Organization* 55(2): 487–495.

de Boer, Jelle Zeilinga, and Donald Theodore Sanders. 2002. *Volcanoes in Human History: The Far-reaching Effects of Major Eruptions*. Princeton: Princeton University Press.

de Boer, Jelle Zeilinga, and Donald Theodore Sanders. 2005. *Earthquakes in Human History: The Far-Reaching Effects of Seismic Disruptions*. Princeton: Princeton University Press.

Brancati, Dawn 2007. ''Political Aftershocks: The Impact of Earthquakes on Intrastate Conflict.'' *Journal of Conflict Resolution* 51: 715–743.

Brooks, Nick. 2003. Vulnerability, Risk and Adaptation: A Conceptual Framework. Tyndall Centre for Climate Change Research Working Paper No.38. Available at http://www.tyndall.ac.uk/publications/working_papers/wp38.pdf

Brooks, Nick, and W. Neil Adger. 2003a. Country Level Risk Measures of Climate-related Natural Disasters and Implications for Adaptation to Climate Change. Tyndall Centre for Climate Change Research Working Paper No.26. Available at http://www.tyndall.ac.uk/publications/working_papers/wp26.pdf. (Accessed November 11, 2005)

Brooks, Nick, and W. Neil Adger. 2003b. ''Does Global Environmental Change Cause Vulnerability to Disaster?'' In *Natural Disasters and Development in a Globalizing World*, ed. Mark Pelling. London and New York: Routledge.

Brown, Michael E. 2001. ''The Causes of Internal Conflict.'' In *Nationalism and Ethnic Conflict* – Rev. edition, ed. Michael E. Brown. Cambridge, MA: The MIT Press.

[36] As included in the Inter-governmental Panel on Climate Change (IPCC) *Assessment Reports*.

BROWN, OLI. 2005. The Environment and Our Security: How Our Understanding of the Links Has Changed. Proceedings of the International Conference on Environment, Peace and Dialogue among Civilizations, May 9–10, 2005. Available at http://www.iisd.org/pdf/2005/security_env_peace_iran.pdf

BURTON, IAN, ROBERT W. KATES, AND GILBERT F. WHITE. 1993. *The Environment as Hazard*. New York: The Guilford Press.

COLLIER, PAUL, AND ANKE HOEFFLER. 2004. ''Greed and Grievance in Civil War.'' *Oxford Economic Papers* 56: 563–595.

COLLIER, PAUL, LANI ELLIOTT, HAVARD HEGRE, ANKE HOEFFLER, MARTA REYNAL-QUEROL, AND NICHOLAS SAMBANIS. 2003. *Breaking the Conflict Trap: Civil War and Development Policy*. New York: World Bank and Oxford University Press.

CUTTER, SUSAN L. 2006. *Hazards, Vulnerability and Environmental Justice*. London: Earthscan.

DILLEY, MAXX, ROBERT S. CHEN, UWE DEICHMANN, ARTHUR L. LERNER-LAM, MARGARET ARNOLD, JONATHAN AGWE, PIET BUYS, ODDVAR KJEKSTAD, BRADFIELD LYON, AND GREGORY YETMAN. 2005. *Natural Disasters Hotspots – A Global Risk Analysis*. Washington: The International Bank for Reconstruction and Development/The World Bank and Columbia University.

DORE, MOHAMMED H.I., AND DAVID ETKIN. 2003. ''Natural Disasters, Adaptive Capacity and Development in the Twenty-first Century.'' In *Natural Disasters and Development in a Globalizing World*, ed. Mark Pelling. London and New York: Routledge.

DREZE, JEAN, AND AMARTYA SEN. 1989. *Hunger and Public Action*. Oxford: Oxford University Press.

DRURY, A. COOPER, AND RICHARD STUART OLSON. 1998. ''Disasters and Political Unrest: An Empirical Investigation.'' *Journal of Contingencies and Crisis Management* 6(3): 153–161.

ECKSTEIN, HARRY. 1980. ''Theoretical Approaches to Explaining Collective Political Violence.'' In *Handbook of Political Conflict: Theory and Research*, ed. Ted Robert Gurr. New York: The Free Press.

EPSTEIN, DAVID L., ROBERT BATES, JACK GOLDSTONE, IDA KRISTENSEN, AND SHARYN O'HALLORAN. 2006. ''Democratic Transitions.'' *American Journal of Political Science* 50(3): 551–569.

FEARON, JAMES D. 2005. ''Primary Commodity Exports and Civil War.'' *Journal of Conflict Resolution* 49(4): 483–507.

FEARON, JAMES D, AND DAVID D. LAITIN. 2003. ''Ethnicity, Insurgency, and Civil War.'' *American Political Science Review* 97(1): 75–90.

GALBRAITH, JAMES K., AND HUYUNSUB KUM. 2005. ''Estimating the Inequality of Household Income: A Statistical Approach to the Creation of a Dense and Consistent Data Set.'' *Review of Income and Wealth* 51(1): 115–143.

GAMSON, WILLIAM A. 1975. *The Strategy of Social Protest*. Homewood, IL: Dorsey.

GATES, SCOTT, HEGRE HAVARD, MARK P. JONES, AND HAVARD STRAND. 2006. ''Institutional Inconsistency and Political Instability: Polity Duration.'' *American Journal of Political Science* 50(4): 893–908.

GLEDITSCH, NILS PETTER, PETTER WALLENSTEEN, MIKAEL ERIKSSON, MARGARETTA SOLLENBERG, AND HAVARD STRAND. 2002. ''Armed Conflict 1946-2001: A New Dataset.'' *Journal of Peace Research* 39(5): 615–637.

GURR, TED ROBERT. 1970. *Why Men Rebel*. Princeton: Princeton University Press.

GURR, TED ROBERT. 1980. ''Introduction.'' In *Handbook of Political Conflict: Theory and Research*, ed. Ted Robert Gurr. New York: The Free Press.

HARBOM, LOTTA, AND PETER WALLENSTEEN. 2005. ''Armed Conflict and its International Dimensions, 1946-2004.'' *Journal of Peace Research* 42(5): 623–625.

HARTMANN, BETSY. 2001. ''Will the Circle be Unbroken? A Critique of the Project on Environment, Population and Security.'' In *Violent Environments*, ed. Nancy Peluso and Michael Watts. Ithaca: Cornell University Press.

HEGRE, HAVARD, AND NICHOLAS SAMBANIS. 2006. ''Sensitivity Analysis of Empirical Results on Civil War Onset.'' *Journal of Conflict Resolution* 50(4): 508–535.

HEGRE, HAVARD, TANJA ELLINGSEN, 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.

HESTON, ALAN, ROBERT SUMMERS, AND BETTINA ATEN. 2003. Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP). Available at http://datacentre2.chass.utoronto.ca/pwt/docs/pwt61.html (Accessed June 12, 2005).

HOMER-DIXON, THOMAS F. 1997. 'Key Findings', The Project on Environmental Scarcities, State Capacity, and Civil Violence. Available at http://www.library.utoronto.ca/pcs/state/keyfind.htm. (Accessed June 8, 2006).

Homer-Dixon, Thomas F. 1999. *Environment, Scarcity and Violence*. Princeton and Oxford: Princeton University Press.

Homer-Dixon, Thomas F., and Jessica Blitt, eds. 1998. *Ecoviolence: Links among Environment, Population and Security*. Lanham: Rowman and Littlefield Publishers Inc.

Huntington, Samuel P. 1968. *Political Order in Changing Societies*. New Haven: Yale University Press.

Intergovernmental Panel on Climate Change. 2007. ''Summary for Policymakers.'' In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson, pp. 7–22. Cambridge, UK: Cambridge University Press. Available at http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf. (Accessed December 6, 2007)

International Crisis Group. 2005. Aceh a New Chance for Peace. Asia Briefing No. 40. 15 August. Available at http://www.crisisgroup.org/library/documents/asia/indonesia/b040_aceh__a_new_chance_for_peace.pdf. (Accessed October 27, 2006)

Jackson, Richard. 2001. ''Understanding the Causes of Civil Conflict.'' In *Turning the Tide: A New Approach to Conflict Resolution*, ed. Peter Greener. Wellington: Auckland University of Technology and the British Council, New Zealand.

Kahl, Colin. 2006. *States, Scarcity, and Civil Strife in the Developing World*. Princeton: Princeton University Press.

King, Gary. 1999. Software. Available at http://gking.harvard.edu/stats.shtml. (Accessed November 15, 2006).

King, Gary, and Langche Zeng. 2001. ''Explaining Rare Events in International Relations.'' *International Organization* 55(3): 693–715.

Knowles, Stephen. 2005. ''Inequality and Economic Growth: The Empirical Relationship Reconsidered in the Light of Comparable Data.'' *Journal of Development Studies* 41(1): 135–159.

Lee, Cheol-Sung. 2005. ''Income Inequality, Democracy, and Public Sector Size.'' *American Sociological Review* 70(1): 158–181.

Li, Quan, and Rafael Reuveny. 2006. ''Democracy and Environmental Degradation.'' *International Studies Quarterly* 50(4): 935–956.

Lichbach, Mark Irving. 1989. ''An Evaluation of 'Does Economic Inequality Breed Political Conflict' Studies.'' *World Politics* 41(4): 431–470.

Mack, Raymond W., and Richard C. Snyder. 1957. ''The Analysis of Social Conflict: Towards an Overview and and Synthesis.'' *Journal of Conflict Resolution* 1(2): 212–248.

Marshall, Monty G., and Keith Jaggers. 2002. *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2002*. University of Maryland, Centre for International Development and Conflict Management. Available at http://www.bsos.umd.edu/cidcm/inscr/polity. (Accessed June 12, 2004)

Merkel, Wolfgang. 2005. ''Embedded and Defective Democracies.'' *Democratization* 11(5): 33–58.

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.

Nagel, Jack. 1974. ''Inequality and Discontent: A Nonlinear Hypothesis.'' *World Politics* 26(4): 453–472.

Nel, Philip. 2006. ''Globalization and Violent Political Dissent in Developing Countries.'' In *Globalization and Conflict: National Security in a 'New' Strategic Era*, ed. Robert G. Patman. London: Routledge.

Oberschall, Anthony. 1973. *Social Conflict and Social Movements*. Englewood Cliffs, NJ: Prentice-Hall.

Oliva, Pavel. 1971. *Sparta and Her Social Problems*. Prague: Academia.

Olson, Richard Stuart, and Alfred Cooper Drury. 1997. ''Un-therapeutic Communities: A Cross-National Analysis of Post-Disaster Political Conflict.'' *International Journal of Mass Emergencies and Disasters* 15(2): 221–238.

Østby, G. 2003. ''Horizontal Inequalities and Civil War: Do Ethnic Group Inequalities Influence the Risk of Domestic Armed Conflict?'' Candidate Political Thesis, Department of Sociology and Political Science, Norwegian University of Science and Technology.

Peluso, Nancy, and Michael Watts. 2001. ''Violent Environments.'' In *Violent Environments*, ed. Nancy Peluso and Micheal Watts. Ithaca and London: Cornell University Press.

Quarantelli, Enrico L. 2001. ''Statistical and Conceptual Problems in the Study of Disasters.'' *Disaster Prevention and Management* 10(5): 325–338.

Ranis, Gustav, Fraces Stewart, and Emma Samman. 2006. ''Human Development: Beyond the Human Development Index.'' *Journal of Human Development* 7(3): 323–358.

REICH, GARY. 2002. ''Categorizing Political Regimes: New Data for Old Problems.'' *Democratization* 9(4): 1–24.

RENNER, MICHAEL, AND ZOE CHAFE. 2007. *Beyond Disasters: Creating Opportunities for Peace*. WorldWatch Institute, Washington, DC.

ROSS, MICHAEL. 2006. ''Is Democracy Good for the Poor?'' *American Journal of Political Science* 50(4): 860–874.

SCHATZMAN, CHRISTINA. 2005. ''Political Challenge in Latin America: Rebellion andCollective Protest in an Era of Democratization.'' *Journal of Peace Research* 42(3): 291–310.

SCHOLZE, MARCKO, WOLFGANG KNORR, NIGEL W. ARNELL, AND COLIN PRENTICE. 2006. ''A Climate-change Risk Analysis for World Ecosystems.'' *Proceedings of the National Academy of Sciences* 103(35): 13116–13120.

SEN, AMARTYA. 1998. ''Mortality as an Indicator of Economic Success and Failure.'' *Economic Journal* 108(446): 1–25.

SIGELMAN, LEE, AND MILES SIMPSON. 1977. ''A Cross-national Test of the Linkage Between Economic Inequality and Political Violence.'' *Journal of Conflict Resolution* 21(1): 105–128.

DE STE. CROIX, AND GEOFFREY E.M. 1972. *The Origins of the Peloponnesian War*. Ithaca: Cornel University Press.

THORBECKE, ERIK, AND CHUTATONG CHARUMILIND. 2002. ''Economic Inequality and Its Socioeconomic Impact.'' *World Development* 30(9): 1477–1495.

THUCYDIDES. 1985. *The Pelopponnesian War*. Harmondsworth: Penguin Books.

TILLY, CHARLES. 1978. *From Mobilization to Revolution*. Reading, MA: Addison-Wesley.

UNITED NATIONS ENVIRONMENT PROGRAMME. 2007. *Sudan Post Conflict Environmental Assessment*. United Nations Environment Programme, Nairobi. Available at http://postconflict.unep.ch/publications/UNEP_Sudan.pdf (Accessed August 27 2007).

TOSET, HANS PETTER WOLLENBAEK, NILS PETTER GLEDITSCH, AND HAVARD HEGRE. 2000. ''Shared Rivers and Interstate Conflict.'' *Political Geography* 19(8): 971–996.

URDAL, HENRIK. 2006. ''A Clash of Generations? Youth Bulges and Political Violence.'' *International Studies Quarterly* 50(3): 607–629.

VINCENT, KATHARINE. 2004. Creating an Index of Social Vulnerability to Climate Change for Africa. Tyndall Centre for Climate Change Research, Working Paper 56. Available at http://www.tyndall.ac.uk/publications/working_papers/wp56.pdf. (Accessed November 15, 2005).

WISNER, BEN, PIERS BLAKIE, TERRY CANNON, AND IAN DAVIS. 2004. *At Risk: Natural Hazards, Peoples Vulnerability and Disasters*, 2nd edition. London: Routledge.

ZIMMERMANN, EKKART. 1980. *Political Violence, Crises, and Revolutions*. Cambridge: Schenkman.

Appendix A. Natural Disaster Types and Subtypes

Natural disaster category	*Natural disaster type*	*Natural disaster subtype*	*Onset category*
Geological	Earthquake		Rapid onset
	Volcano		
Hydro-meteorological	Extreme temperature	Cold wave	
		Heat Wave	
	Flood	Coastal/lake flood	
		Flash floods	
		Plain flood	
		Valley flood	
	Slide	Avalanche	
		Landslide	
		Mudflow	
		Rockfall	
	Wave/surge	Tsunami	
		Tidal wave	
	Wildfire	Forest	
		Peat	
		Scrub	
		Steppe	
	Windstorm	Cyclone	
		Hurricane	
		Tornado	
		Tropical storm	
		Storm	
		Typhoon	
		Winter storm	
	Drought		*Slow onset*
Other	*Famine*		
	Insect infestation	Grasshopper	Rapid onset
		Locust	
		Other	
	Epidemic	Anthrax	
		Arbovirus	
		Diarrheal	
		Diphtheria	
		Intestinal Protozoal	
		Leptosporisis	
		Malaria	
		Measles	
		Meningitis	
		Plague	
		Rabies Respiratory	
		Rickettsial	
		Small pox	
		Viral Hepatitis	

Adapted from: Guidelines: Table 1. List of disaster types as recorded in EM-DAT. Available at http://www.em-dat.net/guidelin.htm.

Appendix B. Descriptive Statistics for Variables Used in Table 1

Variable	*N*	*Mean*	*SD*	*Min*	*Max*
Dependent variables					
Onset of all violent civil conflict	8203	0.027	0.163	0.000	1.000
Onset of minor violent civil conflict	8203	0.018	0.131	0.000	1.000
Onset of major violent civil conflict	8203	0.010	0.099	0.000	1.000
Natural disasters variables					
Number of all natural disasters	8203	0.810	2.010	0.000	35.000
Number of all natural disasters per capita	8203	0.082	0.175	0.000	2.810
Volcanic eruptions and earthquakes (geological natural disasters)	8203	0.070	0.255	0.000	1.000
Number of all climate-related natural disasters	8203	0.703	1.806	0.000	34.000
Number of all climate-related natural disasters per capita	8203	0.072	0.159	0.000	2.730
''Other'' natural disasters	8203	0.097	0.414	0.000	8.000
Control variables					
Infant mortality rate	8026	79.226	57.867	4.000	263.000
Mixed (inconsistent) regimes	8203	0.186	0.389	0.000	1.000
GDP per capita (PPP) log transformed	8203	8.267	0.923	5.620	10.575
GDP per capita growth (5-year averages)	8203	2.047	3.266	−23.000	50.000
''Youth bulge'' (as % of adult population)	7928	29.960	6.192	12.900	45.000
Brevity of peace	8203	0.157	0.327	0.000	1.000
Size of total territory (log transformed)	8203	11.499	2.579	3.332	16.925

Appendix C. Correlation Matrix for Explanatory Variables, Pearson's *r*, Two Tailed

	No. natural disasters per capita	*Geological disaster*	*No. climate disasters per capita*	*Infant mortality rate*	*Mixed regime*	*Growth of GDP per capita*	*Youth bulge*	*GDP per capita*	*Territory size*
Geological disaster	0.450*								
No. climate disasters per capita	0.969*	0.259*							
Infant mortality rate	−0.133*	−0.052*	−0.130*						
Mixed regime	0.611*	0.046*	0.060*	0.088*					
Growth of GDP per capita	−0.018	0.015	−0.028	−0.080	−0.012				
Youth bulge	−0.020	−0.009	−0.029*	0.521*	0.176*	−0.096*			
GDP per capita	−0.012	0.002	−0.010	−0.623*	−0.209*	0.178*	−0.594*		
Territory size	0.244*	0.202*	0.219*	0.216*	0.154*	−0.044*	0.029*	−0.211*	
Brevity of peace	0.189*	0.134*	0.179*	0.179*	0.119*	−0.099*	0.199*	−0.270*	0.265*

*Statistically significant up to 5% level.