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From Armed Conflict to Disaster Vulnerability

Marcus Marktanner, Edward Mienie, and Luc Noiset
Kennesaw State University
www.kennesaw.edu/icat

1. INTRODUCTION

There is a long literature focusing on the interrelationships between natural hazards, disasters and political and economic development. Natural hazards such as droughts, floods, or earthquakes can destroy livelihoods, cause social misery, and create humanitarian disasters when appropriate mitigation and adaptation mechanisms are lacking. One particular factor that can aggravate the negative effects of natural hazards is the presence of conflict. There are two ways that conflict can elevate the damage from natural hazards. Some natural hazards can be deliberately brought about by warring parties, like diversions of rivers or weather modifications (Davis, 1972). More generally, however, existing conflict can increase a society's vulnerability to natural hazards. This paper is concerned with this latter aspect, or as Wisner et al. (2004, p. 74) rightly call it, "war as a dynamic pressure" on natural hazards.

While there is a significant amount of qualitative research describing how conflict undermines societies' resilience to natural hazards, studies trying to quantify the degree to which conflict increases societies' vulnerability to natural hazards are less common. The purpose of this paper is to complement the rich literature of qualitative research by providing quantitative evidence from a macro perspective about the degree to which a prevailing environment of conflict increases vulnerability to humanitarian disasters induced by natural hazards.

In this paper we work with a dataset which includes all disaster deaths as reported by the Centre for Research on the Epidemiology of Disasters (CRED) between 1960 and 2010. For CRED to record a disaster event in a country, one of the following criteria must be met: At least ten disaster-resultant deaths, one hundred or more people affected, a state of emergency is declared, or a call for international assistance is issued.

It should be noted that while the CRED dataset is useful for empirical multi-country comparative research, it is not without criticism. Sharma (2010), for example, lists various definitional, accounting, modeling, inter-temporal, spatial, and socio-psychological issues that could be taken into account when

working with CRED data. Like all quantitative studies, the results of our paper are confined by the operational limits of the data we use. Of course, such limitations do not per se invalidate the useful insights derived from careful macro-empirical research. Macro-empirical studies are important to help tie together findings from micro case studies.

For our conflict data we rely on the Major Episodes of Political Violence (MEPV) dataset, specifically the "armed conflict total score" (ACTOTAL), which classifies ethnic and civil political violence on a scale from zero to ten. From this dataset we constructed a dummy variable "armed conflict" equal to one for any episode of political violence. This corresponds to any armed conflict episode with at least 500 directly related fatalities. There are a total of 1,495 such incidences.

Our dataset contains roughly five million disaster deaths, caused by 3,791 CRED-disaster incidences, which include droughts, earthquakes, epidemics, extreme temperature, floods, mass movements (wet and dry), storms, volcanoes, and wildfires. The greatest number of disaster fatalities is caused by droughts, floods, and storms. Disasters differ strongly with respect to their death tolls. While there were only 49 recorded droughts, their combined death toll is more than two million, making up more than 40 percent of all disaster deaths. On the other hand, there were 683 recorded floods with a combined fatality count of close to 300,000 (less than six percent). Lastly, there were 556 recorded storms, which caused almost one million fatalities (almost 20 percent).

We hypothesize that as armed conflict undermines a state's disaster risk management capacity, an armed conflict event increases the vulnerability to subsequent natural hazards, which in turn will be identifiable as excess disaster deaths. Although there have been a number of qualitative case studies that suggest this might be the case (e.g. Wisner et al, 2004; Keefer 2009),

to the best of our knowledge no in-depth empirical work on the global dimensions of this relationship has yet been conducted. Such a macro-empirical perspective has the advantage that it can provide policymakers and disaster risk management agencies with the best estimate of the additional disaster

deaths that might be expected in conflict areas susceptible to natural hazard induced disasters, thus supporting disaster relief and contingency planning.

We find that, after controlling for standard socioeconomic conditions, disasters emerging from natural hazards following armed conflict events lead to roughly forty percent more disaster deaths than would have occurred had the areas not previously experienced conflict. In other words, with respect to our sample's total death toll, which includes disasters in both conflict and non-conflict environments, roughly 14 percent of the deaths are statistically attributable to the presence of armed conflict at some point of time within the ten-year period prior to the disaster.

The remainder of this paper is organized as follows: Section two reviews the literature. The introduction of our data and methodology follows in section three. We present our empirical results in section four. Section five concludes with a summary of our main findings and outlook.

2. LITERATURE REVIEW

One significant part of the literature focuses on how natural hazards can provoke social conflict, while another part examines how the interaction of natural hazards and conflict can often lead to humanitarian disasters. This section will focus first on the literature examining the link from natural hazards to conflict and then review the literature relevant to the causation from conflict to natural hazard based disaster vulnerability.

Cuny (1983) was one of the first to emphasize that "many governments destabilize in the years immediately following a disaster" (quoted in Drury and Olson, 1998, p. 153). Drury and Olson (1998) provide strong empirical evidence in support of the Cuny hypothesis. Cavallo & Noy (2010) show how the number of disasters has increased over the past twenty years and conclude that this trend will continue to jeopardize the stability of developing areas with limited capacities to either finance or organize disaster prevention policies. Nel and Righarts (2008) similarly argue that violent civil conflicts

increase after occurrences of natural hazard induced disasters and recommend that more attention be given to mitigating the political and social risks associated with the aftermath of disaster events.

One explanation for the political fallout after disasters is given by Homer-Dixon (1999), who finds that natural hazards trigger group grievances that translate into civil violence. Likewise, Bhavnani (2006, p. 32) concludes that the "greater the severity of the disaster, the greater the potential for conflict."

As opposed to the argument that natural hazards increase a country's conflict vulnerability, others argue that natural hazards can also have conflict mediating effects. One example of this is the case of Aceh, an Indonesian breakaway province. The conflict between the Indonesian government and the Aceh province already had left 125,000 persons dislocated when the region was hit by the 2004 tsunami (IOM, 2004; Mahdi, 2006), which claimed ten times more lives than had thirty years of breakaway political violence. Although fighting flared up shortly after the tsunami, secessionist violence came to a virtual halt within a year. Le Billon and Waizenegger (2007, p. 422), conclude that a "[r]apid and lasting transition to peace would have been less likely in Aceh without the tsunami." They contrast, however, the complex socio-political dynamics of Aceh with that of Sri Lanka, where the Tsunami led to an increase in violence. As the disaster diplomacy literature suggests, the exact turn of post-disaster events depends on complex spatial, political, and institutional structures (Kelman, 2003).

Among the triggers of political instability, the deterioration of people's livelihoods through climate change receives particular attention (Nel & Righarts, 2008; Besley & Persson, 2011; IISD, 2009). The effects of climate change are not yet fully understood, but severe weather conditions, drought, and disruptions of food supplies are possible scenarios. Although not necessarily attributable to climate change, world food prices have in fact dramatically increased in response to droughts.

Some have even suggested that the recent Arab uprisings can in part be attributed to these food price increases, which caused rapidly deteriorating livelihoods that ignited the long simmering anger towards authoritarian oppression (Werz and Conley, 2012). Similarly, Johnstone and Mazo (2011, p. 11)

state that a “proximate factor behind the unrest was a spike in global food crises, which in turn was due in part to the extreme weather throughout the globe over the past year.” Syria, in particular, was hit by severe droughts between 2006 and 2011 in its Northeastern region, pushing hundreds of thousands of people into extreme poverty, leading to a massive internal migration and a severe deterioration of the socio-economic fabric. While none of these events are definitively attributable to climate change, they hint at the potential political upheaval that can be anticipated if climate change does indeed lead to continued extreme weather changes throughout the globe. Effective national and international capacity building is widely needed in order to prevent the expected increases in natural hazards from becoming humanitarian disasters. O’Brien et al. (2006) discuss in detail the importance of capacity-building and resilience for managing climate change risks and mitigating the effects of those on vulnerable populations. Capacity-building, however, also carries risks. With respect to international capacity building efforts, Kent (2004, p. 852) argues that there “lingers a profound concern that the net result of these efforts has been to replace operational chaos with heavily institutionalized, self-absorbed and relatively insensitive systems that can rarely keep up with the perverse dynamics of humanitarian crises.”

Other authors have argued that natural hazards can reduce intra and inter-state state conflict. Bhavnani (2006) argues that natural hazards could reduce intra-state conflict because ensuing human suffering cuts across the political and civil divide. Similarly, Slettebak (2012) finds that the risk of armed conflict is reduced as climate change mandates cooperation over confrontation. Conca & Wallace (2009) view investments in disaster prevention as a peace-building formula. More generally, Bergholt & Lujala (2012) and Buhag (2012) do not find empirical evidence that more frequent and severe climate-related disasters lead to an increase in armed conflicts. As far as the effects on international disaster diplomacy are concerned, Kelman (2003, p. 121) suggests that “disasters can have a catalytic effect for major

changes in international affairs, but that disasters do not generate new outcomes on their own and may, in the end, achieve little."

Finally, Keefer (2009) finds that different types of natural hazards have differing effects on conflicts. He argues that a rapid-onset hazard like an earthquake prolongs conflicts, especially those which involve a government and a rebel group. An earthquake redirects government's focus away from fighting the rebel group towards disaster relief; as a result an existing conflict is often paused but does not end and eventually returns to previous levels of intensity. Alternatively, he argues that a slow-onset hazard like a drought is more likely to trigger a conflict. A slow-onset hazard tends to generate redistributive demands. If government fails to respond to these demands because of insufficient political institutions and social safety nets, the willingness to resort to fighting increases.

Although there exists already a considerable literature examining the transmission mechanism from disaster to conflict, the reverse direction is equally important. It has become widely accepted that natural hazards are more likely to turn into humanitarian disasters in areas that have weak social institutions, which is particularly characteristic of those areas that have experienced conflict. Insightfully, Stallings (1991, p. 583) recommended "that social scientists treat natural disasters as both products of as well as contributors to ongoing social arrangements rather than assuming that they are politically neutral 'acts of nature.'"

The link between conflict and disaster vulnerability is of particular importance to the United Nations and its various international organizations and programs. For example, the United Nations Report of the Secretary-General on the Work of the Organization states that "the term 'natural disaster' has become an increasingly anachronistic misnomer. In reality, human behavior transforms natural hazards into what should really be called unnatural disasters" (United Nations, 1999, p. 2). Dasgupta (2007, p.1) similarly writes that "a flood or an earthquake is not a disaster in and of itself" and that, among other factors, "[h]umans have created their own disasters by engaging in armed conflict" (ibid, p.99). Lewis

and Kelman (2010) provide an exhaustive discussion of the human dimensions and causes of societal vulnerability to natural hazards.

There are several transmission mechanisms from conflict to disaster vulnerability that are worth noting. Five channels are of particular importance. First, armed conflict can lead to forced migration of large segments of the population to areas with greater hazards. Second, it can delay and disrupt access to humanitarian aid. Third, it can dismantle public disaster risk management capacities. Fourth, it can undermine the individual's resilience to natural hazards. And fifth, disaster vulnerability can become a tactic of warfare. The following five paragraphs briefly elaborate on these channels.

The International Federation of the Red Cross and Red Crescent Societies' World Disaster Report: Focus on Forced Migration and Displacement (2012, p. 15) reports that conflict accounts for more than 43 million refugees and internally displaced people in 2011. Many of these refugees are driven into camps where they are more vulnerable to natural hazards. Drought-affected refugees in Sudan may be a case in point in this regard. One of the effects of the armed conflict in Sudan is the displacement of persons, and especially of women and children. It has been estimated that by 2005 around 4.3 million people had been displaced and forced to live in barren and remote areas around Khartoum due to the civil war at the Sudanese border (Abdelmoneium, 2005).

The presence of rival warring parties in a disaster zone may block access to urgently needed humanitarian aid. Truck hijackings, anti-aircraft attacks, and the killing of aid workers have occurred in conflict areas such as Afghanistan, Angola, the Democratic Republic of Congo (DRC), Iraq, Somalia, and Sudan, just to name a few (see, for example, Dungel, 2004; UN, 2011, 2012). In the case of the DRC, sleeping sickness or Human African Trypanosomiasis (HAT) often affects people in regions afflicted by violent conflict and treatment of HAT is especially difficult in insecure settings. Sustained instability and armed conflict have huge impacts on the health of affected populations. According to Tong et al. (2011, p.3) more people in the DRC die from treatable diseases than from conflict related injuries because it is

"difficult to reach afflicted areas due to violent conflict or political instability." In other words, the very presence of armed conflict undermines the capacity of the state and the local economy to provide effective disaster risk management (USAID, 2012). Disaster risk management is by nature a public service while humanitarian disasters are often indicative of ineffective public administrations. The provision of an effective public service, however, requires a cooperative political decision-making environment, which societies in conflict cannot provide.

For example, many at-risk HAT areas in the DRC lack overall capacity to offer treatment to patients, let alone locate them in conflict areas, due to remoteness, poverty, insecurity and instability (Tong et al., 2011). In early 2008, the HAT treatment center in Bokoyo was closed due to conflict-related incapacity to offer medical treatment. In March 2009, the town of Banda was attacked by insurgents and medical supplies were stolen and the treatment center looted, which interrupted desperately needed medical treatment (Tong et al., 2011).

Conflict affects an individual's resilience to natural hazards and makes coping strategies more expensive. Conflict typically disrupts productive activity and brings about a reduction of income, which undermines individuals' abilities to protect themselves from natural hazards. One famous case, of course, for this pattern was the Irish potato famine in the mid-19th century when the Irish, suppressed by the English, were denied the right to buy and sell food (that was still sufficiently available despite the blight) because it was sold by the British and Anglo-Irish landowners outside of Ireland (O'Boyle, 1996).

Conflict restricts the capabilities of individuals to provide for basic necessities. Assets are often sold off, food stocks become depleted and difficult to replenish, and access to health care becomes more difficult and costly. Keefer (2009, p. 22), for example, notes that "where conflict creates high risks of dislocation, households face a high risk of losing immobile investments in mitigation. Many effective disaster mitigation investments that are within reach of households and communities are immobile, however, and would be lost if they had to flee."

Warring parties may even deliberately use disaster vulnerability as a means of warfare. A highly relevant case is interstate conflict between two countries sharing a river, in which the upstream country deprives the downstream country from accessing water, therefore destabilizing the downstream country by provoking a drought or migration. There is even a long history of using weather modifications as a means of warfare. Gilbert (2004, online), for example, notes that while environmental warfare may sound new to some, it "has been researched extensively in military circles for years [and during the Vietnam war] the Pentagon revealed a seven-year cloud seeding effort in Vietnam and Cambodia, costing $21.6 million. The objective was to increase rainfall in target areas, thereby causing landslides and making unpaved roads muddy, hindering the movement of supplies." While Gilbert references weather modifications as an issue in real world military strategy, academic discussions about the legal implications of weather modifications have a much longer history (Taubenfeld and Taubenfeld, 1969).

Despite the increased interest by academics and international organizations into the link between conflict and disaster, to our knowledge there has been no comprehensive multi-country study which attempts to quantify the effect of conflict on disaster vulnerability. In the 2011 United Nations Development Report "Disaster-Conflict Interface-Comparative Experiences" it is noted that it "makes intuitive sense to assume that the geographical overlap of both disaster and conflict worsens the impact of crises, but evidence for this is limited. Analyses of concrete case study observations are also limited, and those that do exist come from different unconnected disciplines" (UNDP, 2011, p. 7).

The goal of this paper is to provide empirical evidence that natural hazards following episodes of conflict lead to greater vulnerability to natural hazards. In addition to verifying this relationship from a deductive perspective, our quantitative results provide an estimate of the additional human costs that can be expected from natural hazards in areas with prior episodes of violent conflict. Such information can be of critical importance for disaster vulnerability mapping and disaster relief planning.

3. DATA & METHODOLOGY

This study is interested in determining how many deaths can be attributed to armed conflict preceding a disaster. A first step is to synchronize CRED's country observations with the countries included in the 2011 World Bank Development Indicator Database. We build a panel dataset using ten five-year summary observations for each country present at the end of 2010. This means that countries that no longer existed in 2010 were not included in the analysis. Countries that came into existence after 1961 are included in the data from the date of their inclusion in the data set. The first five-year observation is the period 1961-1965, the last period is 2006-2010. Condensing observations into five-year periods helps obtain a more balanced panel dataset by reducing the bias in favor of developed countries, which generally collect and report data more frequently. While using five-year periods may appear arbitrary, they are frequently used in empirical studies using large panel data in which missing observations would otherwise create an estimation bias (see, for example, Li and Zou, 1998). The variables in our dataset are armed conflict events, disaster events, and standard socio-economic control variables. Our final dataset contains 11,016 observations. Table 1 summarizes the variables, abbreviations, descriptions, and sources.

Missing data was mostly a problem for the socioeconomic variables income inequality and natural resource rents. For these variables, we filled missing observations for a given five-year interval with the average of available data for a country. Since these variables are relatively stable over time, replacing missing observations by an average is not expected to affect the general results of the analysis.

Our dataset is a panel. Because our focus is on how armed conflict that precedes a natural hazard affects the death toll of a subsequent natural hazard, it is important to control for all other factors that may explain the dependent variable as well. Many of these factors can often only be captured by a dummy for the country, which is why a fixed-effect panel model is the most effective. We run three models. Model one runs the variable disaster deaths on per capita income and the lagged armed conflict

dummy. Model two additionally controls for the kinds of disaster, namely droughts, earthquakes, storms and floods, which, respectively, have the highest death toll record. Model three incorporates further socioeconomic controls, namely income inequality, natural resource rents, urban population (% of total), percentage of population living in areas where elevation is below five meters, and a measure of democracy.

Table 1:

Variables and Sources

Variable	Abbrev.	Description	Source
Disaster Deaths	dd	Persons confirmed as dead and persons missing and presumed dead per 1,000,000 of the population from the following disasters: droughts, earthquakes, epidemics, extreme temperature, floods, mass movements (wet and dry), storms, volcanoes, and wildfires	Centre for Research on the Epidemiology of Disasters (CRED)
Drought Dummy	Drought	1 if CRED recorded respective event during period of interest, zero otherwise.	
Earthquake Dummy	Earthqu	1 if CRED recorded respective event during period of interest, zero otherwise.	
Storm Dummy	Storm	1 if CRED recorded respective event during period of interest, zero otherwise.	
Flood Dummy	Flood	1 if CRED recorded respective event during period of interest, zero otherwise.	
Armed Conflict Dummy	ACLag	1 if MEPV recorded at least one armed conflict total score of greater than zero during a given period, zero otherwise, lagged by one period.	Major Episodes of Political Violence Dataset (MEPV), 1946-2008, available at www.systemicpeace.org
Per capita income	Y	GDP per capita, PPP (constant 2005 international $)	2011 World Bank Development Indicator Database
Gini Index	Gini	Gini index.	
Natural Resource Rent	nrr	Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents. (Rent captures the profit associated with the production and sale of a natural resource).	
Urban Population	urban	Urban population (% of total)	
Lowland	lowland	Population living in area where elevation is below 5 meters (% of total population)	
Democracy	Polity2	Polity2 score	Polity IV Project: Political Regime Characteristics and Transitions, 1800-2010 available at http://www.systemicpeace.org/polity/polity4.htm

The rationale for selecting income inequality as a control variable stems from the idea that inequality coincides with social exclusion and therefore greater vulnerability (Cramer, 2003). Natural resource rents are hypothesized to be influential on disaster vulnerability because the economically active labor force has a greater exposure to the elements as, for example, in agrarian or mining communities. Similarly, holding all else constant, a natural hazard in a concentrated population area is likely to lead to a greater humanitarian disaster, which is a hypothesized relationship that we proxy with the urbanization rate. Likewise, again holding everything else constant, the percentage of population living in areas below an elevation of five meters aggravates the effects of storms and floods. Our final control variable is the Polity2 score, which is used to represent the strength of democratic institutions in each country. We hypothesize that stronger democratic institutions imply a government that is more responsive to the needs of the public and which will therefore be more prepared in the face of natural hazards.

Using socioeconomic control variables in a comprehensive panel-study like the one proposed in this paper must necessarily neglect the complex interaction of social and physical processes in the transmission mechanism from a natural hazard to a humanitarian disaster. Nevertheless, such control variables are important from two perspectives. First, they are necessary to test the robustness of the main hypothesis, which is the relationship between conflict and disaster deaths. Secondly, significant control variables provide hints at complex interactions between natural hazards and disasters at place, which can motivate and complement additional avenues of inquiry.

Formally, our model can be written as

$$dd_{i,j} = \beta_X X_{i,j} + \beta_C AC_{i,j-1} + \alpha_i + \varepsilon_{i,\mathrm{j}} \qquad (1)$$

where i = represents the unit observations (countries), j = the observation period, $X_{i,j}$ = vector of socioeconomic and kind of disaster control variables, β_x the corresponding regression coefficients of the control variables, AC the armed conflict variable, β_C = the coefficient associated with AC, α_i = country

dummies, and ⍰ the error term. The panel regression is run with the natural log of the dependent variable, which allows us to interpret the coefficient as elasticities and semi- elasticities.

Table 2 summarizes descriptive statistics of the variables, which shows that no variable meets the required normality assumptions necessary to obtain efficient estimators. All variables are skewed to the right, which is why we employ natural log transformations to improve the distributional characteristics. While these transformations have made the distributions more normal, no variable passed the ⍰^{2} test for normality. In order to address potential biases from this data imperfection, including possible, outliers, we present both regular and heteroskedasticity corrected panel estimates.

Table 2:

Summary Statistics of Variables

Variable	**N**	**Mean**	**Median**	**Std. Dev.**	**⍰^{2} test against normality**
Per Capita Income	1,176	10,005	5,135	12,479	<0.01
Disaster Deaths	2,160	75.0	0.118	644	<0.01
Gini	1,530	40.8	39.8	9.7	<0.01
Natural resources Rent	2,030	8.2	2.1	15.7	<0.01
Urban Population	2,100	49.0	48.2	25.2	<0.01
Land area below 5 meters	2,090	13.3	5.3	21.3	<0.01
Polity 2	1,416	0.5	0.0	7.3	<0.01

4. EMPIRICAL RESULTS

We begin our empirical discussion by presenting descriptive characteristics of the nexus between armed conflict and subsequent human disaster vulnerability. Table 3 presents the disaster profile per region. It shows that floods, storms, and extreme temperatures top the list of disasters in most regions. The exception is Sub Saharan Africa (SSA), where epidemics rank before floods and storms by considerable margins.

Table 3:

Disaster Incidences by Region (Total 1960-2010)

	Droughts	Earthquakes	Epidemics	Ext. Temp.	Flood	Mass Move Dry	Mass Move Wet	Storm	Volcano	Wildfire	Total
EAP	12	120	83	16	325	12	112	359	22	24	1,085
WE	0	55	14	58	120	4	41	133	1	29	455
CEE	1	30	11	71	100	3	23	45	0	13	297
LAC	4	113	82	43	341	8	104	249	15	7	966
MENA	1	52	22	5	122	4	10	33	1	4	254
NAM	0	13	8	21	42	2	2	65	1	16	170
SA	6	62	79	64	190	4	63	119	0	3	590
SSA	28	30	427	4	303	2	24	102	8	15	943
Total	52	475	726	282	1,543	39	379	1,105	48	111	4,760

Legend: EAP=East Asia and the Pacific, WE=Western Europe, CEE=Central and Eastern Europe, LAC=Latin America and the Caribbean, MENA=Middle East and North Africa, NAM=North America, SA=South Asia, SSA=Sub Saharan Africa.

Looking at disaster deaths, depicted in Table 4, the picture is less homogeneous. Storms cause the most deaths in East Asia and the Pacific (EAP). The death toll of storms and earthquakes stand out in Latin America and the Caribbean (LAC). In Sub-Saharan Africa (SSA), droughts and epidemics cause the greatest loss of human lives. Table 4 also shows that the risk of dying in a natural hazard is biggest in the southern hemisphere.

Table 4:

Sum of Total Deaths per Million by Region and Hazard (Total 1960-2010)

	Droughts	Earthquakes	Epidemics	Ext. Temp.	Flood	Mass Move Dry	Mass Move Wet	Storm	Volcano	Wildfire	Total
EAP	148.4	5,366.0	1,088.9	23.8	1,163.1	32.3	354.5	13,896.8	58.1	34.7	22,166.6
WE	0.0	788.3	21.6	2,507.5	149.8	5.9	305.8	72.0	0.2	18.6	3,869.7
CEE	0.5	152.4	47.7	1,051.8	415.1	2.6	145.5	33.8	0.0	7.7	1,857.1
LAC	6.6	37,324.1	1,564.2	77.3	3,599.9	210.0	1,505.9	15,211.6	812.6	3.8	60,316.0
MENA	0.4	4,601.1	533.6	6.2	1,105.6	10.1	18.3	207.2	0.3	7.0	6,489.9
NAM	0.0	1.9	3.8	15.1	8.3	2.8	2.0	119.6	0.4	0.4	154.3
SA	3,081.1	3,201.9	2,138.4	112.9	1,867.6	19.9	146.7	8,244.0	0.0	4.1	18,816.7
SSA	31,782.5	162.5	16,515.7	1.8	1,330.3	22.6	167.7	736.6	181.5	12.0	50,913.2
Total	35,019.5	51,598.3	21,913.9	3,796.4	9,639.8	306.2	2,646.3	38,521.7	1,053.0	88.3	164,583.5

Moving to the regression analysis estimating the impact of conflict events on subsequent disaster deaths, Table 5 shows the results of the panel fixed effects regression with regular and robust standard errors.

Table 5:

Panel Fixed Effects Regression

DV = Disaster Death (natural log+1)	Model I	Model II	Model II
	-2.366	-1.984	-36.013
Const	(1.562)	(1.420)	(36.374)
	[1.674]	[1.441]	[34.444]
	0.491	0.329	0.193
Per capita income (natural log)	(0.182)***	(0.165)**	(0.228)
	[0.195]**	[0.169]*	[0.239]
	0.672	0.420	0.412
Armed Conflict Event Dummy (ACLag)	(0.167)***	(0.153)***	(0.159)***
	[0.176]***	[0.152]***	[0.162]**
		0.957	0.868
Drought dummy		(0.277)***	(0.277)***
		[0.384]**	[0.339]**
		1.006	1.030
Flood Dummy		(0.123)***	(0.136)***
		[0.126]***	[0.142]***
		1.029	0.750
Earthquake Dummy		(0.165)***	(0.176)***
		[0.193]***	[0.177]***
		1.029	0.499
Storm Dummy		(0.124)***	(0.138)***
		[0.161]***	[0.133]***
			0.867
Gini (natural log+1)			(3.378)
			[2.856]
			0.027
Natural Resources Rents (natural log+1)			(0.147)
			[0.191]
			0.009
Urban (natural log+1)			(0.012)
			[0.016]
			22.327
Lowland (natural log+1)			(23.345)
			[21.125]
			0.013
Polity2			(0.014)
			[0.015]
N	1,176	1,176	870
Cross-sectional Units	184	184	140
Minimum time-series length	2	2	1
Maximum time-series length	7	7	7
Adj. R^2	32.5%	44.5%	42.4%
F-Stat	4.1	6.0	5.3

Standard errors in parentheses and robust standard errors in brackets: *** significant at 1%, ** significant at 5%, * significant at 10%.

A comparison of the regular fixed-effects estimates and the ones with robust standard errors shows that the adverse consequences from the violations of the normality assumption are negligible. The results show that the presence of armed conflict prior to a disaster is highly significant and robust. Because the dependent variable disaster death is natural log transformed, the coefficient for the variable ACLag can be interpreted in model II and III as a semi elasticity, more precisely that the death toll from a disaster is, on average, roughly 40 percent greater whenever it is followed by an armed conflict event.

Of course, in some of our observations disasters and armed conflict occur simultaneously during the same five year period observation. We did not use simultaneous armed conflict events as explanatory variables, because the focus of our study is whether a legacy of armed conflict tends to increase disaster deaths and not whether disaster deaths tend to increase in the midst of an armed conflict. Our results therefore suggest that a history of armed conflict casts a long shadow over a country's ability to build resiliency against natural hazards. This means that even after a formal peace has been achieved, latent conflict remnants may still prevent the level of political cooperation and coordination needed to build necessary disaster risk management capacities.

The dummies for the major kinds of disasters in terms of occurrence and death toll are also very significant. The socioeconomic control variables, however, are not, which is most likely due to strong correlation with the country-fixed effects.

The human significance of the armed conflict variable is highly meaningful. In our dataset we have a total of 5.1 million disaster deaths. Not all disasters have occurred in areas with prior histories of armed conflict, but for those that have, in accordance with our rough regression coefficient, we attribute 40% of the deaths to a history of armed conflict. After doing this we arrive at close to 737,000 deaths in disasters attributable to a legacy of armed conflicted events. Table 6 provides a breakdown of these numbers by region. It shows that over the five decades between 1960 and 2010, the regions most

vulnerable to the nexus between armed conflict and disasters were Sub-Saharan Africa, Central and Eastern Europe, South Asia, and East Asia and the Pacific, respectively.

Table 6:

Disasters and Armed Conflict by Region (1960 to 2010 sum)

Region	Disaster Death	Disaster Death due to Armed Conflict	Percent Disaster Death Attributable to Armed Conflict
CEE	77,380	17,985	23.24
EAP	933,735	217,814	23.33
LAC	510,863	89,690	17.56
MENA	148,599	26,513	17.84
NAM	21,370	3,258	15.25
SA	2,418,753	154,411	6.38
SSA	854,563	217,196	25.42
WE	128,650	9,745	7.57
Total	5,093,913	736,612	14.46

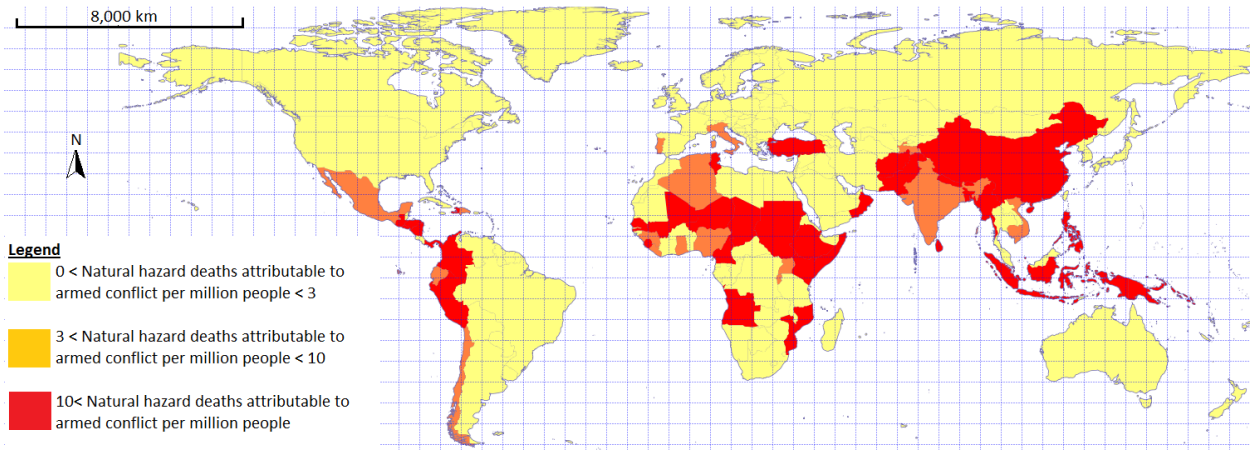
The map of Figure 1 below illustrates the nexus between armed conflict and vulnerability to natural hazards graphically. The armed conflict-natural hazard vulnerability is simply calculated as the sum of all disaster deaths per million of the population statistically attributable to armed conflict for the 1960-2010 time period. The map shows 101 countries with disaster deaths that are attributed to armed conflict events. This amounts to 40% of the 252 countries and territorial units depicted in the map of Figure 1.

The countries colored in red are those where between 1960 and 2010 on average more than ten disaster deaths per million of the population were statistically attributed to armed conflict. This represents approximately 15% of all observations. Countries colored in orange had on average between 3 and 10 disaster deaths per million of the population statistically attributed to armed conflict during the period. Another 10 percent of all countries fall in this range. Colored in yellow are those countries with on average of up to three disaster deaths per million of the population statistically attributed to armed conflict events.

Although no map can convey every complexity of the relationship between armed conflict and subsequent disaster vulnerabilities, this map is a useful illustration of the geographic clustering of the interaction between the two variables and is therefore useful to identify those countries that have the highest peace dividend in terms of disaster risk management.

Figure 1:

World Map of Natural Hazards-Armed Conflict Vulnerability (1960-2010 Sum)



Source: Authors' illustration.

Like any statistical analysis, the mapping of disaster vulnerabilities that follow armed conflicts is subject to data limitations. For example, the armed conflict variable in our data includes both domestic and inter-state conflicts, but not all inter-state conflicts involve fighting in each country. This can overstate the impact of armed conflict on disaster deaths inside countries that do not experience fighting within their territory. Since interstate conflicts have become the exception rather than the rule after World War II, this possible bias is at best small. On the other hand, not including interstate conflict would underestimate the effect of armed conflict on disaster deaths in countries where fighting occurred. There is also a tendency for extraordinary large disasters like the 2004 tsunami to overstate the true impact of armed conflict on disaster deaths.

Another concern is the definition of the armed conflict variable, which we have defined as a binary variable without distinguishing between levels of conflict. This specification, of course, overstates the effects of minor conflicts and understates the effects of major conflicts on countries' vulnerability to natural hazards.

5. CONCLUSION

The literature on the relationship between disasters and armed conflict is predominantly concerned with political violence as a consequence of natural hazards. Our paper adds to the literature which focuses on the reverse causation, from armed conflict to disaster deaths. We examine and estimate the legacy effects of armed conflict events that have occurred within a ten-year period prior to a disaster.

Our empirical results estimate the degree to which regions that have experienced an armed conflict event are more vulnerable to disaster deaths. In particular, we find that disaster deaths in these areas are on average forty percent higher compared to disasters that are chronologically detached from armed conflict events. With these results we are able to attribute around 14% of the approximately five million disaster deaths between 1961 and 2010 to legacies of armed conflict. In other words, controlling for socio-economic and geographic characteristics, as well as types of humanitarian disasters, more than 700,000 deaths would have been avoided if areas affected by a natural hazard had not had a legacy of conflict.

These findings identify the important link between armed conflict, natural hazards, and humanitarian disasters. Important qualitative research and especially case studies have pointed to the causal link from conflict to increases in disaster deaths and the empirical evidence presented in this paper complements these studies from a macro perspective.

We are aware of data limitations in our study which point to the need for more detailed information and further research. In terms of model and variable specification opportunities, avenues for future research

are far more complex than what could have been addressed in this paper. Eventually, the purpose of our paper is not so much to propagate one coefficient for the relationship between armed conflict and disaster vulnerability, but to show how such a macro approach could be important to identify policy priorities associated with disaster prevention and management.

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