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The contribution of armed conflict to vulnerability to disaster: Empirical evidence from 1989 to 2018

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ABSTRACT

Disasters and armed conflicts often occur together, leading to severe consequences for affected populations. While qualitative investigations have explored how conflict can influence vulnerability to disasters, there is still a lack of systematic quantitative studies that provide broader evidence on the contribution of conflict to vulnerability. Although existing qualitative work has made progress in understanding potential mechanisms, large-scale quantitative studies are crucial for comprehending the scope of this relationship and attempting to isolate associations between specific variables. This study presents a statistical model using extensive large-N, cross-country data to address this research gap and analyse the conflict-disaster relationship. Analysing data from 157 countries between 1989 and 2018, we found a strong positive correlation between armed conflict and disasters. The results remained consistent across various model specifications and robustness checks. In countries experiencing armed conflict, disaster occurrence was observed 5% more frequently, disaster-related mortality per year was 34% higher, and deaths per million inhabitants were 16% higher compared to countries without conflict. While there is evidence that conflict can occasionally intensify disaster hazards, there is a greater evidence suggesting that the relationship between conflict and disaster operates through mechanisms that negatively affect vulnerability and response capacity.

1. Introduction

For the past three decades, more than half (55%) of the deaths attributed to disasters related to natural hazards, such as earthquakes and floods, occurred in settings where armed conflict was also present.[1] This percentage is disproportionately high, considering that only one out of three disasters (31%) happened in those armed-conflict settings (see Fig. 1). This difference presents a worrying imbalance in that the largest proportion of deaths from disasters have occurred in settings of armed conflict.

The Horn of Africa provides a striking example of the imbalance between disaster occurrence and disaster-related deaths in armed-conflict settings. In 2010, the region experienced its worst drought in 60 years. The drought was especially severe in Kenya, Ethiopia, and Somalia. As the crisis unfolded, population displacement and cattle loss were seen in Ethiopia and Kenya, but Somalia suffered a famine that killed approximately 250,000 people. The long years of ongoing conflict in Somalia had made the population

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[1] This statistic uses information on disaster-related deaths as reported in the Center for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT) and draws on data on the presence of armed conflict as reported by the Uppsala Conflict Data Program/Peace Research Institute Oslo (UCDP/PRIO). We calculated the estimation of 55% using the CRED EM-DAT and the UCDP/PRIO Armed Conflict Dataset, Version 19.1.

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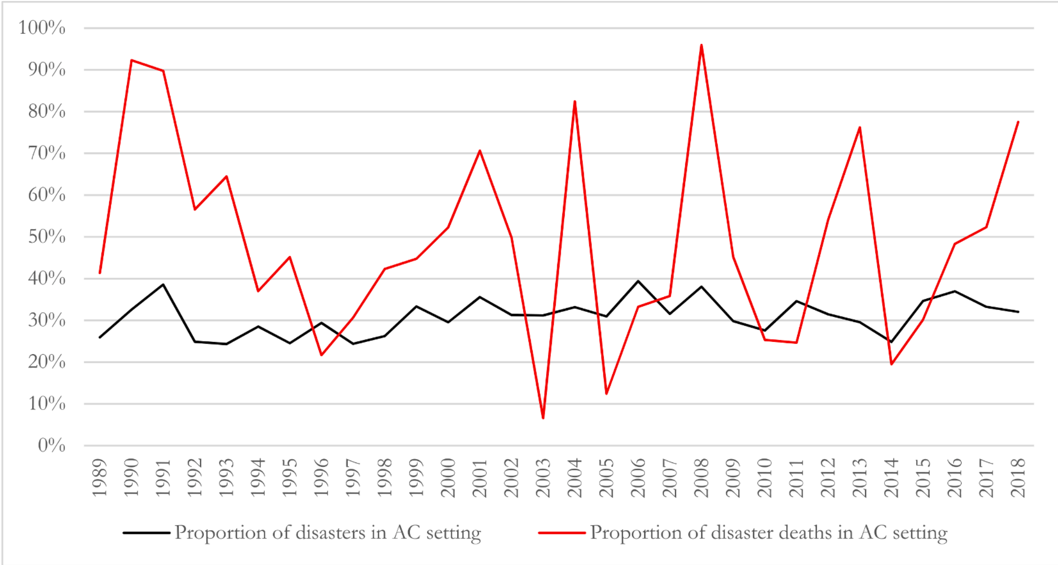

Fig. 1. Percentages of disasters and disaster-related deaths occurring in areas also experiencing armed conflict, 1989 to 2018. Source: Elaborated by the authors using data from the Epidemiology of Disasters Emergency Events Database and the Uppsala Conflict Data Program/Peace Research Institute Oslo. Notes: The average value between 1989 and 2018 was 55%, AC = armed-conflict.

vulnerable and eroded local institutions. An effective humanitarian operation was launched in neighbouring countries; however, in Somalia, the militant Islamist organization al-Shabaab prevented the entry of international aid, and international anti-terrorist legislation further kept aid from reaching the area [1].

While the above case is one of many examples illustrating how the effects of natural hazard-related disasters have been more drastic when they occur in conflict contexts, unfortunately, scholars and policymakers often examine conflict and disasters separately, devoting little effort to understanding how these two processes interact and enhance each other.

The work in the stream of research that has explored the nexus between disaster and conflict mostly consists of theory-driven qualitative studies and in-depth single case studies. Even though, several quantitative cross-country studies have examined the effects of disasters on conflict [2–5], to the best of our knowledge, only one study has conducted a quantitative analysis that examined the effects of conflict on disasters (see Ref. [6].

This research gap has become particularly relevant because there is strong qualitative evidence indicating how the chances of natural hazards resulting in disasters and causing more damage are increased in areas with recent political violence [7]. Both qualitative and quantitative studies on this topic are important because of the complementary strengths of different methodological approaches. The existing qualitative work has sought to understand potential mechanisms, whereas large-scale quantitative studies are necessary for assessing the breadth of this relationship and identifying the individual effects of specific variables. Therefore, it is of great interest for the disaster scholar's community but also to development and humanitarian institutions, practitioners, policymakers, and academics to count with research that answers the question:

"Does armed conflict contribute to disaster vulnerability?"

The aim of this study and the rest of the document is to present the mechanisms by which armed conflict can contribute to vulnerability to disasters and to estimate the strength of the relationship between armed conflict and occurrence of disasters and the number of deaths related to them. To do so, we assembled a data set that combines information on 157 countries between 1989 and 2018 in terms of occurrence of armed conflicts, occurrence of disasters, deaths due to disasters, as well as various socioeconomic, democratic, and geographic variables to control for different characteristics of each country.

We found a strong positive correlation between armed conflict and disaster occurrence, with disasters being 5% more likely to occur in contexts also facing conflicts. Beyond the high disaster–conflict co-occurrence, armed conflict is also associated with disaster-related deaths. According to our estimations, deaths related to disasters are between 16% and 34% higher in armed-conflict contexts than in contexts without armed conflict. These results were significant and consistent across several model specifications, after controlling for relevant socioeconomic variables (levels of development, democratic institution quality, population size and distribution, and country size), and when using different disaster, disaster-related death, and armed-conflict variables.

Below, we summarize the related literature, describing previous findings on how disasters affect political violence and the likelihood of engaging in armed conflict, before moving on to discuss the relatively scant literature on the reverse effect, reviewing a conceptual framework and the state of existing evidence on how armed conflict can increase disaster occurrence and disaster-related deaths. We then describe the study methods and data used to fit the model, before presenting the empirical results. The concluding section reviews several mechanisms that may explain the persistent relationship between conflict and disaster outcomes and offers some reflections on our results and their implications for scholarly and applied fields.

2. Do conflicts worsen the effects of disasters?

Questions regarding whether disasters can trigger or prolong armed conflict have been the subject of several quantitative studies (e.g. Refs. [2,4,8–15[5]]. While there is an emerging body of work on this question, to date there is very little agreement among the academic community on whether and under what conditions disasters contribute to armed conflict [16].

In contrast, to the best of our knowledge, the question of whether armed conflict contributes to disaster risk has not been analysed statistically, with the one exception of [6]; whose work we discuss in this document and to which we propose a series of improvements that we implement as part of our research. This research gap is particularly interesting and relevant as there is strong qualitative evidence indicating how the chances of natural hazards becoming disasters and causing more damage are increased in areas with recent political violence [7]. Both qualitative and quantitative studies on this topic are important because of the complementary strengths of different methodological approaches. The existing qualitative work has sought to understand potential mechanisms, whereas large-scale quantitative studies are necessary for assessing the breadth of this relationship and identifying the individual effects of specific variables.

2.1. Understanding disaster risks

Disasters are a broad phenomenon that encompasses all the "serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts" [17]; n. p). In this article we focus on the so-called *natural hazards-related disasters*, which represent all the disasters that occur in relation to the occurrence of natural phenomena such as droughts, earthquakes, or storms, among others [18,19]. In contrast to the problematic concept of "*natural disaster*", a misnomer by multiple authors, this way of looking at disasters seeks to highlight the fact that although there are certain natural phenomena such as those mentioned above, their occurrence does not have to result in a disaster or have severe impacts on people too [19–24]. The main reason for this goes back to more than fifty years of expert disaster literature that understands that for a disaster to occur it is not enough to have an extreme natural phenomenon, but that this phenomenon needs to reach the human population that is vulnerable to that phenomenon, and that vulnerability is ultimately social and not natural [25–28]. In other words, although there are natural *hazards*,[2] disasters are not natural [18,19,23]; rather, disasters depend on social and political factors that make people vulnerable [21,29].

More than three decades ago, in the early 1990s [26], developed a framework for understanding disaster risks, seeing it as a function of a hazard multiplied by vulnerability conditions of exposed populations and reduced by mitigation measures to curb the hazard's impact. In addition, disaster risks may or may not be mitigated by policies and response capacities [18]. For example, the risk of high winds turning into a disaster with high levels of loss of life and property depends on vulnerabilities related to things such as the quality of housing and on response capacities, including early warning and evacuation mechanisms. Fig. 2 schematically represents the relations between hazards, vulnerabilities, capacities and disaster risks.

2.2. Qualitative studies on disaster risk and conflict

Since the start of the twenty-first century, growing attention has been dedicated to the role of conflict in the creation of disaster risk. Existing qualitative studies have suggested that armed conflict can increase people's vulnerability [18,21,26,31,32] and that conflict can have strong negative effects on all stages of disaster management, including mitigation, preparedness, response, and recovery [33,34]. [18] examined the effects of violent conflict on disaster risk reduction (DRR). He found that violent conflict often complicates, confuses, and/or obstructs DRR [18]; p. 68–72), amongst others by causing social vulnerability and institutional weakness, by obstructing effective disaster relief and recovery assistance, by increasing hazard frequency and intensity, and by impeding good DRR practice.

Violent conflict is a major cause of social vulnerability and creates political environments that can harm, diminish, and even destroy institutions for disaster governance, response, and risk reduction [18,33]. Many cases in which violent conflict has damaged institutions for DRR can be found in the existing literature. As one example, in the Indian region of Ladakh, disaster governance has been shaped by national security priorities because of the long-term presence of conflict in this zone [35]. Disaster governance led by the military with a hazard-centered approach has resulted in slow or absent disaster response (Ibid, 2018). Furthermore, the presence of conflict in Myanmar has made disaster response harder for international and national relief programmes [36]. In an overview report [37], found that long-term DRR initiatives tend to be prioritized lower than protection, peacebuilding, and stabilization in active conflict areas. The instability of the political system in Zimbabwe has eroded the ability of rural district councils to facilitate DRR [38], and '[i]n Colombia, Indonesia, Mozambique and South Africa, political competition and the quality of a country's institutions play a key role in determining the effectiveness of disaster risk reduction' [39]; p. 5). This institutional damage has been found to prevent forward movement on implementing good DRR practice in Afghanistan [33], and [40] has shown how armed conflict contributes to the spread of corruption in the government, increasing fatalities from earthquakes.

In addition to leading to institutional damage, armed conflict can cause the destruction of capital and infrastructure [41–44], which are needed to reduce disaster risk and to respond to disasters when they occur [18]. Armed conflict damages both the national and local economies [45] and prevents local communities from creating, developing, and maintaining low-risk livelihoods [46,47]. Armed conflict also shortens time horizons for people residing in zones in or near conflict areas, who are often unwilling to commit to

[2] The term 'natural' hazards have also been criticised and the naturalness of it questioned, as hazards are increasingly affected by human–nature interactions relating to land use, water management, and anthropogenic climate change [22].

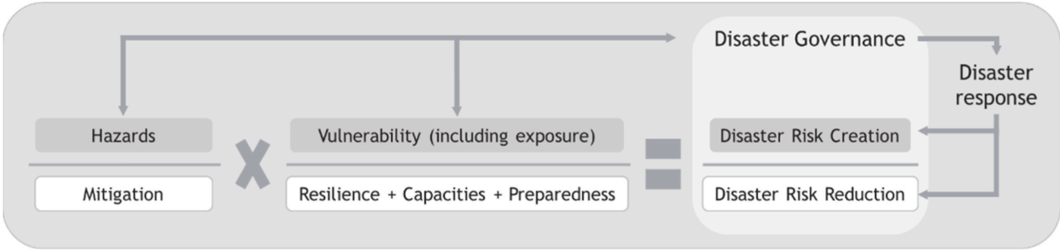

Fig. 2. Disaster governance, risk reduction, and risk creation. Source: Adapted from Ref. [30].

long-term planning because of the context of high insecurity [7]. Although these effects of conflict have not been linked to disaster production in existing studies, they are likely to contribute to disaster risk.

Conflict often results in forced displacement [30,48–50], which can further increase people's vulnerability to disasters. Examples of this include the cases of Afghanistan, where displacement to urban areas may increase residents' exposure and vulnerability [51]; Beirut, where displaced people face higher earthquake risk [52]; and Sri Lanka, where displaced people have significantly lower levels of resilience to flood disasters [53].

Depending on the level of economic development and whether the conflict takes place abroad or at home, armed conflicts may also result in serious damage to the environment [54,55], consequently increasing hazard frequency and intensity [18]. [18] discussed the aggravation of flood hazards in Southeast Asia by the United States' use of chemical defoliants during the Vietnam War and the aggravation of the effects of the floods in Pakistan in 2010 b y the 'timber mafia' deforestation in the country's mountain slopes as two examples of this phenomenon. Development, moreover, plays an important role in how hazards affect people and the potential for disaster risk reduction [56].

Disaster preparedness, mitigation, and response, as well as aid delivery, can be especially challenging in armed-conflict contexts. When aid providers must deal with multiple crises and prioritize aid delivery, areas where these actors have prior experience may be prioritized, leaving affected communities in other areas without assistance, even if their needs are greater [30].

In this context it is also relevant to understand how disasters and conflict are related spatially. Two terms present in the literature that address the spatial component of the relationship are "dual disasters" and "divided disasters". The term dual disasters refers to moments 'where a humanitarian crisis with human-made political roots overlaps with a humanitarian crisis induced by environmental disaster' [57]:1), therefore dual disasters focus on disasters and conflict occurring in the same location [57,58]; . The concept divided disasters focuses on disasters and conflict 'that occur in different locations within the same state' [59]:S266). Studies that have used this distinction to understand the relationship between disasters and conflict [57,59,60], show that although a violent conflict occurs in a different place than the disaster, when both occur in the same country there is an indirect influence of the conflict on the occurrence or impact of a disaster given the aforementioned conditions; since the conflict affects governance and social processes dynamics related to disaster occurrence in those countries.

2.3. *Quantitative studies on disaster risk and conflict*

Although there is an extensive body of qualitative literature focusing on how conflict contributes to the progression of vulnerability, studies that quantify this relationship are almost non-existent. As mentioned, to the best of our knowledge [6], work represents the only quantitative, cross-country study that examines the effects of armed conflict on vulnerability to disasters. In this study, we attempted to advance several aspects of this previous work in our statistical examination of the expectation that countries where armed conflict is taking place or has taken place in the preceding years have higher disaster risk because of a combination of effects on hazards, vulnerabilities, and response capacities, and that they therefore experience a higher rate of disasters and disaster-related deaths. More specifically, we identified three main areas for improvement in Marktanner et al.'s work that we have addressed in this study: First, Marktanner et al. used only the lagged value of armed conflict presence to estimate the effects on disasters, however it is also relevant to estimate the effects of disasters in armed conflict settings when they co-occur within the same year. Second, Marktanner et al. used a limited sample, consisting in some instances of only one observation for the time series per country; here, we constructed a balanced panel dataset for 157 countries with an average of 27 years of complete information per country. Third, Marktanner et al.'s work lacked the application of analyses with different dependent and explanatory variables to test the robustness and strength of their hypothesis. To address this limitation, we considered multiple variable forms for disaster-related deaths and armed conflict. Additionally, in this study, we incorporated a more complete set of control variables and used the Human Development Index (HDI) instead of gross domestic product (GDP) per capita as a proxy measure for development.

3. Data and methods

Based on our research question and our literature review, we adopted an empirical framework that considers the role of armed conflict in explaining the variation between countries in disaster occurrence and in disaster-related deaths. Our main interest was assessing the extent to which armed conflict is correlated with disaster occurrence and some of the consequences that follow (i.e. disaster deaths).

For our empirical analysis, we constructed a dataset containing information on 157[3] countries from 1989 to 2018, with a total of 4,242 country-year observations. The period of analysis was primarily determined by data availability for the main analytical variables. We maintained the same sample size across all the examined models for disaster occurrence and disaster-related deaths, allowing for reliable and straightforward comparisons across different model specifications.[4] This also helped to ensure that the estimated parameters were not sensitive to different sample sizes. Below, we describe each data source used to construct the dataset in the context of providing a detailed explanation of the dependent variables (disasters and disaster deaths), the explanatory variables (armed conflict), and the control variables included in our empirical specifications. Table 1 presents the descriptive statistics for all key variables included in our estimations.[5]

3.1. Dependent variables: disaster occurrence and disaster-related deaths

Our analysis aimed to estimate how armed conflict contributes to disaster risk and impact. We used information on disaster occurrence, deaths, and other related information from the Emergency Events Database (EM-DAT) from the Center for Research on the Epidemiology of Disasters [61].

We used this dataset because it provides the largest available coverage of reliable cross-country data on disasters, including essential information on the occurrence and consequences of over 14,874 ‘natural disasters’ (sic) (following CRED's nomenclature)[6] occurring worldwide since 1900.

For an event to be recorded as a disaster in the EM-DAT database, at least one of the following criteria must be met: 10 or more people reported killed, 100 or more people reported affected, state of emergency declared, and international assistance requested. These criteria help to standardize what counts as a ‘disaster’ and allow for comparison and analysis across regions and over time. Using these criteria to stablish what counts as a disaster, while valuable, also present some limitations (see Refs. [62,63], such as the fact that may not fully capture the severity of disasters, especially in instances where impacts are economically significant or long-term, or where small communities are disproportionately affected. The database's reliance on reported data might lead to under-reporting, either due to lack of resources or political reasons, with the requirement of official declarations or international aid requests potentially excluding some key events. Moreover, the potential for subjectivity and inconsistency in defining and counting ‘affected’ individuals can lead to disparities in data across different regions and disasters. Despite the limitations and constraints of this dataset it is the most extensive and reliable dataset available containing the data needed for our analysis.

Since our research is focused on the relationship between armed conflict and natural hazard-related disasters, we limited our analysis to this type of disaster, which is specified as ‘natural disasters’ in the EM-DAT dataset. The number of casualties resulting from a disaster, one of the most concerning consequences of disasters, is among the main disaster variables in the EM-DAT and often features prominently in disaster discourse, communication, and policy. Here, we focused our estimations on the aggregated occurrence of deaths, average deaths per disaster, and disaster-related deaths per million inhabitants per year in each country. Statistics on disaster-related deaths by disaster type and year, are presented in Table A1 in the Appendix.

Previous research examining the relationship between armed conflict and disaster has either focused on a specific location or compared the consequences of a single type of disaster across different scenarios. In contrast, we argue that a thorough analysis of how armed conflict contributes to disaster-related deaths should also include aggregate variables incorporating all disasters. As the United Nations Office for Disaster Risk Reduction recently acknowledged,

> The hazard community has shifted away from a focus on individual hazards and broadened its scope to examine more complex, real scenarios that acknowledge the likelihood of one hazard eventually leading to another (cascading hazard), or multiple hazards crossing in either time and/or space creating an even larger disaster. [64]; p. 82)

Thus, it is necessary to study the effects of the presence of armed conflict on aggregate disaster occurrence and consequences to account for the possibility of one disaster eventually leading to another, increasing the ultimate consequences.

3.2. Independent variables: armed conflict

To assess armed conflict, as the independent variable, we used the Uppsala Conflict Data Program/Peace Research Institute Oslo (UCDP/PRIO) Armed Conflict Dataset, Version 19.1, because it is one of the largest existing datasets available on organized violence and armed conflicts. The armed conflict unit from this dataset refers to state-based armed conflict, which is defined as ‘a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths in a calendar year’ [65]:4). Because we were interested in testing the effects of armed conflict on deaths related to disasters, we used the UCDP/PRIO dataset to create an armed conflict dummy variable capturing whether armed conflict occurred in a country each year. The UCDP/PRIO dataset includes information on a total of 1220 armed conflicts occurring from 1989 to 2018. These conflicts correspond to 179 ‘unique conflicts’ distributed across these three decades. Of these unique events, 12 had more than one country location registered in the dataset; in these cases, we used desk research to manually code which country was affected.

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[3] See Table A2 in the Appendix for a list of countries included in our analysis.

[4] The only exception was our analysis of the effects of armed conflict on the average deaths per disaster for which the sample size is less.

[5] See Table A3 in the Appendix for a correlation matrix for our key explanatory and control variables.

[6] The CRED EM-DAT categorizes disasters caused by the following hazards as ‘natural disasters’: earthquakes, dry mass movements, volcanic activity, extreme temperatures, fog, storms, floods, landslides, wave action, droughts, glacial lake outbursts, wildfires, epidemics, insect infestations, animal accidents, impacts with extraterrestrial objects, and space weather events. We include these in our analysis.

Table 1
Summary statistics for dependent, explanatory, and control variables in the sample (4242 country-year observations from 1989 to 2018).

Variable	Mean	Median	Std. Dev.	Min	Max
Dependent variables					
Disasters	2.32	1	3.96	0	43
Disaster deaths	417.99	3	5,837.09	0	229,549
Explanatory variables					
Armed conflicts	0.25	0	0.67	0	7
Control variables					
Population	42,100,000	9,820,311	144,000,000	381,850	1,390,000,000
HDI	0.65	0.67	0.17	0.10	0.95
Polity IV Index	3.70	6.00	6.37	−10.00	10.00
Pop. In rural areas (%)	0.44	0.44	0.23	0.00	0.95
Pop. Living at ≤ 5 m elevation (%)	0.05	0.02	0.08	0.00	0.59
Land area (km^2)	824,767	202,840	2,046,387	670	16,400,000

Note: HDI = Human Development Index.

3.3. Control variables

In assessing the strength of the relationships of armed conflict with both disaster occurrence and disaster-related deaths, we controlled for several variables that might affect vulnerability to natural hazards.

3.3.1. Population

In the EM-DAT, the outcome variables of interest (disaster occurrence, number of deaths, and number of people affected) all concern counts of people impacted by disaster and are therefore related to the population in an area. There could be three explanations for an observed increase in disaster occurrence or deaths: an increased disaster frequency or severity, an increased vulnerability to disasters, or an increased number of people exposed to disasters. It was therefore important to include a control for population in our analysis. To account for population size and variations across years and countries, we included the log of population as a control variable. Cross-country data on population size (counting all residents regardless of their legal status or citizenship) were drawn from the World Development Indicators [66].

3.3.2. Level of development

In contrast to most previous studies, which relied on GDP per capita [6,67], we used the HDI from the United Nations Development Programme [68] as a proxy for broader socioeconomic development. Compared with GDP per capita, the HDI, a composite index of three human welfare correlates – average level of income per capita, educational attainment, and health (proxied by life expectancy) – provides a more comprehensive account of overall socioeconomic development. Low levels of human development can increase vulnerability to natural hazards and therefore can be expected to be positively associated with disaster occurrence and disaster-related deaths [31]. As a robustness check, we replicated all estimations using GDP per capita instead of the HDI, which had little effect on the main findings in terms of the direction, size, or statistical significance of the associations with the disaster variables.[7]

3.3.3. Democratic institutions

Previous work suggests that countries with weaker democratic institutions may lack proper organization for disaster governance, response, and risk reduction. As a proxy for the extent of democratic accountability, we used data from the Center for Systemic Peace's Polity IV project [69]. Extensive data coverage allows Polity IV Index scores to continuously monitor regime changes in underlying modes of governance each year. The regime spectrum of the original Polity IV Index ranged from −10 (hereditary monarchy) to +10 (consolidated democracy). We use data from the Polity IV Index to control for the level of democracy since it is a widely used measure in similar studies [4].

3.3.4. Population living in urban areas

It was necessary to identify particularly dense human settlements instead of including population density as a linear variable because populations tend to cluster around seaports and fresh water sources, with half of the Earth's land mass consisting of areas that are inhospitable to human inhabitation. We therefore used estimates of the percentage of the population living in urban areas from the World Bank Development Indicators database [66]. Previous research has suggested that the accumulation of risk means that a country's greater urbanization may correspond to a greater propensity for disasters [70–73].

3.3.5. Population living ≤5 m above sea level

We used estimates of the percentage of the total population living in areas with elevations of ≤5 m above sea level derived from the Socioeconomic Data and Applications Center of NASA's Earth Observing System Data and Information System [74]. Data from this dataset is available per decade. We included available estimates for 1990, 2000, and 2010 for each one of the countries from our dataset. This variable allowed us to control for the lowland-dwelling population, which is important because previous research has demonstrated that people living in such areas are more prone to disasters [72,73,75].

[7] These results are available from the authors upon request.

3.3.6. Land area

We included a control for land area in square kilometres because, all else being equal, larger nations may be more likely to be exposed to natural hazards simply because of their larger surface area. We used land area estimates in square kilometres from the World Bank [66]. Land area is a country's total area, excluding area under inland water bodies, national claims to continental shelf, and exclusive economic zones. In most cases the definition of inland water bodies includes major rivers and lakes. Land area is particularly important for understanding an economy's agricultural capacity and the environmental effects of human activity. We included this variable in log form.

3.4. Model specification

To quantitatively examine the conflict–disaster nexus, we estimated several model specifications with alternative conflict and disaster variables. Our regressions can be formally summarized with the following equation:

$$DIS_{i,t} = \alpha + \beta_{AC}AC_{i,t} + \beta_{Z}Z_{i,t} + \varepsilon_{i,t} \tag{1}$$

Here, $DIS_{i,t}$ represents each disaster outcome variable – occurrence, for which we created a dummy variable that captures whether a disaster took place in a particular country and year; total deaths; deaths per million inhabitants; and average deaths per disaster – for country i in year t. $AC_{i,t}$ refers to a set of explanatory variables related to armed conflict occurrence (e.g. occurrence, occurrence in any of the last two years, total number of conflicts per year and if conflicts lasted more than two, three, four, or five years). $Z_{i,t}$ is a vector of the control variables presented in the previous section, and $\varepsilon_{i,t}$ is the time- and country-specific error term.

First, we estimated a logistic regression to assess the extent to which disaster occurrence is associated with armed conflict occurrence and other factors, as summarized in Equation (1). We present these results as the marginal effects of the explanatory and control variables. Next, we estimated linear random-effects models, with disaster-related deaths as the outcome variable and armed conflict occurrence as the key explanatory variable. As a complementary robustness check, we estimated our model specifications using Poisson regressions and assessed whether our results were still consistent across all specifications. As detailed below, the effects remained consistent also when using the Poisson regressions.

As advocated by Ref. [67] and in contrast to Ref. [6]; we used country-random effects for these estimations because short-term year-to-year shifts in the socioeconomic variables (such as HDI and the Polity IV Index) do not happen frequently, and their effects take time to appear. The control variables related to the geographic distribution of the population and our main explanatory variable also do not tend to change significantly on a yearly basis. Random-effects estimation ensures more efficient parameter estimates for variables exhibiting limited time variation because macro-scale variables that exhibit limited time variation typically have inflated standard errors and become statistically insignificant in cross-country regressions with fixed effects (for a discussion of these methodological aspects, see Refs. [76,77]. Both existing (ongoing) armed conflicts and their co-occurrence with disasters have shown increasing trends over the last several decades (see Fig. 3); therefore, we used year-fixed effects to capture the influence of the aggregated (time-series) trend and we included region-fixed effects in some model specifications to account for regional geographical characteristics. Finally, we also checked for multicollinearity on our model specifications by estimating the variance inflation factor (VIF) after our regressions and no further modifications on the model specifications were suggested because of this. We also did a unit root test for our main disaster variables, which resulted to be stationary, meaning that no further modifications were necessary.

4. Results

To answer our research question: "Does armed conflict contribute to disaster vulnerability?" we follow a series of steps that allow us to reach a conclusion by evaluating the strength of this relationship stage by stage.

We begin by examining the strength of the relationship between disasters and armed conflicts occurring in the same year (AC_t), in the previous year (AC_{t-1}), and long-term armed conflict that lasted for two ($AC_{t,t-1}$), three ($AC_{t,t-1,t-2}$), four ($AC_{t,t-1,t-2,t-3}$), or five ($AC_{t,t-1,t-2,t-3,t-4}$) consecutive years. Table 2 depicts the results of this analysis, including the control variables. Regardless of the specification, long-lasting armed conflict showed a strong positive correlation with disaster occurrence. The results of the logistic regressions suggest that disaster has been more likely to occur in contexts that have experienced armed conflict lasting for at least two consecutive years (see results for model specifications (3) to (6) in Table 2). With each additional consecutive year of armed conflict, we observe higher levels of disaster occurrence. This effect is positive and indicates the accumulated effects of long-term conflict on disaster occurrence.

The first stage of our analysis suggested then that armed conflict and disaster occurrence are indeed correlated but this effect is only observable once a country had engaged in armed conflict for two or more consecutive years.

Once assessed the relationship between armed conflict and disaster occurrence we focused our analysis on the effects of disasters in armed conflict settings. For the analysis of the relationships between disaster deaths (presented in log form)[8] and armed conflict in the current year, in either year, and in both years, as well as engagement in armed conflict lasting for three consecutive years, we ran all estimations with robust standard errors and analysed changes in the estimates when including region- and time-fixed effects. Table 3 presents the results of this analysis without controls. Regardless of the model specification, armed conflict was found to be strongly and positively correlated with disaster deaths, with a coefficient of the armed conflict variable that varied from 0.20 to 0.40. Since our dependent variable is expressed in natural log form, coefficients can be transformed and interpreted as elasticities, meaning that

[8] We transform our dependent variable of disaster related deaths to its logarithm because if skewed distribution to the right.

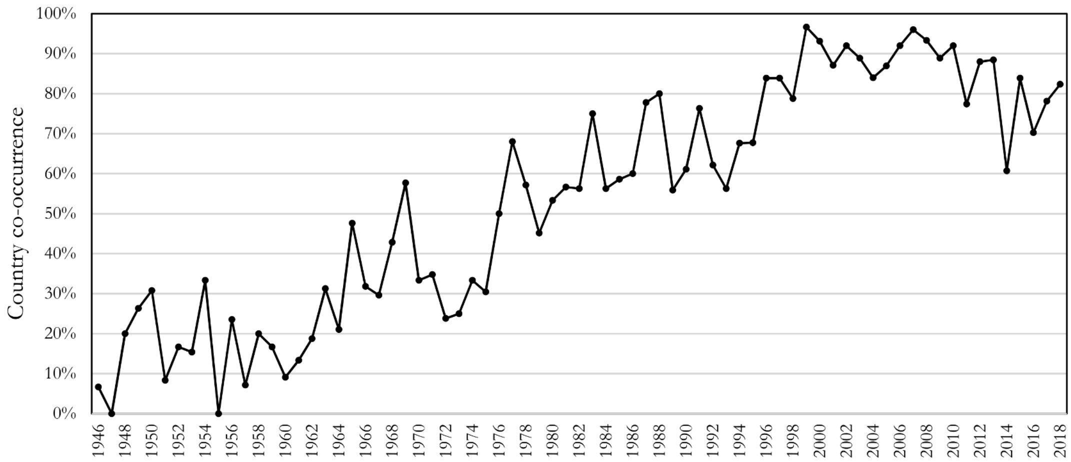

Fig. 3. Co-occurrence of armed conflict and disasters in countries in conflict Source: Elaborated by the authors based on the Emergency Events Database (EM-DAT) and the Armed Conflict Dataset, Version 19.1, from the Uppsala Data Conflict Program and the Peace Research Institute Oslo. Points on this graph are calculated as the percentage of countries in conflict that experienced at least an armed conflict and a disaster within the same year.

Table 2
Marginal effects based on logistic regression on disaster occurrence.

	(1)	(2)	(3)	(4)	(5)	(6)
	Disaster dummy	Disaster dummy	Disaster dummy	Disaster dummy	Disaster dummy	Disaster dummy
Explanatory variable						
Armed Conflict in current year *(t)*	0.03					
	(0.02)					
Armed Conflict in previous year, (*t-1)*		0.03				
		(0.02)				
Armed Conflict in t, t-1			0.05*			
			(0.03)			
Armed Conflict in t, t-1, t-2				0.05*		
				(0.03)		
Armed Conflict in t, t-1, t-2, t-3					0.06*	
					(0.03)	
Armed Conflict in t, t-1, t-2, t-3, t-4						0.06*
						(0.03)
Control Variables						
Population (Log)	0.12***	0.12***	0.12***	0.12***	0.12***	0.12***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
HDI	−0.16	−0.16	−0.15	−0.15	−0.15	−0.15
	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
Polity IV	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Pop. In urban areas (%)	−0.07	−0.07	−0.07	−0.07	−0.07	−0.07
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Pop. Below 5 m (%)	−0.12	−0.12	−0.12	−0.12	−0.12	−0.12
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Land area (Log)	0.02	0.02	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
pseudo R^2	0.11	0.11	0.11	0.11	0.11	0.11
Observations	4,184	4,184	4,184	4,184	4,184	4,184

Notes: Robust standard errors in parentheses. *p < .1; **p < .05; ***p < .01.

the existence of armed conflict coefficients of 0.20–0.40 are associated with a 22%–49% increase in the disaster-related death toll. Including the region- and year-fixed effects did not affect the significance of the estimates and usually increased the size of the estimated effect.

The second stage of our analysis suggested that armed conflict has a significant effect on disaster deaths as it can increase the disaster-related toll between 22% and 49%.

Finally, and after examining the relationship between disaster-related deaths and several lengths of long-lasting armed conflict, we proceeded to include the proposed control variables. Table 4 presents the results of the models including six control variables and an additional group of dummy variables for conflict type to account for the occurrence of disasters with high average deaths (see Appendix Table A1). Even when including the selected control variables, the dummy variable for armed conflict occurrence was statisti-

Table 3
Linear random-effects results of armed conflict on disaster-related deaths (natural logarithm).

	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Deaths from disasters (ln, +1)	Deaths from disasters (ln, +1)	Deaths from disasters (ln, +1)	Deaths from disasters (ln, +1)	Deaths from disasters (ln, +1)	Deaths from disasters (ln, +1)	Deaths from disasters (ln, +1)	Deaths from disasters (ln, +1)
Armed conflict in the current year	0.35*** (0.13)	0.4*** (0.13)						
Armed conflict in the current or previous year			0.2* (0.12)	0.25** (0.12)				
Armed conflict in both the current year and the previous year					0.34** (0.14)	0.34** (0.15)		
Armed conflict in each of the preceding three consecutive years							0.34** (0.17)	0.33* (0.18)
Year-fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Region-fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Pseudo R^2	0.11	0.25	0.11	0.24	0.11	0.24	0.1	0.24
Observations	4,242	4,242	4,242	4,242	4,242	4,242	4,242	4,242

Notes: Robust standard errors in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

Table 4
Effects of armed conflict on different disaster-related outcomes, including controls.

	(15)	(16)	(17)	(18)
	Deaths from disasters (ln, +1)	Average deaths per disaster (ln, +1)	Deaths from disasters per million population (ln, +1)	Deaths from disasters (ln, +1)
Armed conflict in the current year	0.29** (0.13)	0.23** (0.12)	0.15** (0.07)	0.18* (0.11)
Population (log)	0.82*** (0.06)	0.47*** (0.05)	0.08** (0.03)	0.43*** (0.05)
Human Development Index	−2.29*** (0.87)	−2.53*** (0.69)	−1.79*** (0.49)	−0.99* (0.60)
Polity IV	0.03*** (0.01)	0.01 (0.01)	0.01* (0.01)	0.01 (0.01)
Population living in urban areas (%)	0.67 (0.46)	−0.51 (0.33)	−0.24 (0.24)	−0.63** (0.32)
Population living ≤5 m above sea level (%)	0.84 (0.9)	−0.12 (0.49)	−0.2 (0.3)	0.62 (0.57)
Land area (log)	0.01 (0.05)	−0.03 (0.04)	0.02 (0.02)	0 (0.03)
Earthquake				0.84*** (0.12)
Storm				0.83*** (0.09)
Flood				1.06*** (0.08)
Extreme temperature				1.38*** (0.15)
Epidemic				2.03*** (0.12)
Pseudo R^2	0.49	0.32	0.18	0.66
Observations	4,242	2,839	4,242	4,242

Notes: Robust standard errors in parentheses. *$p < .1$; **$p < .05$; ***$p < .01$.

cally significant across the four different model specifications (see specifications 15 and 16). The occurrence of armed conflict was associated with 34% more disaster-related deaths each year (specification 15), a 26% higher average number of deaths per disaster per year (specification 16), and a 16% higher number of deaths per million inhabitants (specification 17).

For all specifications, the population size, level of development, and democratic strength control variables remained significant. In our final model (18), we tested the effect of including variables for disaster types that tend to have high death tolls (see Appendix Table A1). After including dummy variables for earthquake, storm, flood, extreme temperature, and epidemic, the effect of armed conflict remained significant and with a coefficient of 0.18 that can be transformed and interpreted[9] as a 20% increase in disaster-

[9] As our dependent variable is in logarithm form, the coefficients can be transformed to be interpreted as percentage increases.

related deaths. The effects of the disaster type dummies were significant and high; the coefficient for epidemic was 2.03, which means that, when an epidemic occurs in a setting also experiencing armed conflict, the death toll is six times higher (661%) than would have been in a non-armed-conflict setting (Table 3).

As indicated, we also ran a Poisson regressions as a robustness check on our three main dependent variables (called the total number of disasters per year, the number of disaster deaths, and the number of disaster deaths per million inhabitants) with region and time fixed effects. The result was that all coefficients and IRRs (Incidence rate ratios) were positive and statistically significant for our independent variables armed conflict (dummy) and long-term armed conflict (conflict in t, t-1 and t-2). We opt to present the results of our logistic and OLS regressions in this article, to facilitate the interpretation of the results of our study.

5. Discussion

Over the last seven decades, the number of countries experiencing both armed conflict and disaster in the same year has increased systematically (see Fig. 3). While between 1949 and 1958, an average of 18% of countries experiencing armed conflict also experienced a disaster within the same year, this number increased up to an 81% for the decade between 2009 and 2018. Moreover, more than half of the deaths (55%) due to disasters between 1989 and 2018 occurred in situations of armed conflict, despite only one in three disasters (31%) occurring in such contexts. The high co-occurrence of both events, as well as the disproportionately high level of deaths due to disasters in settings of armed conflict, raises a relevant research question about whether armed conflict contributes to vulnerability to disaster.

Qualitative investigations have explored how conflict may influence vulnerability to disaster. However, systematic quantitative studies providing broader evidence on the contribution of conflict to vulnerability to disaster are lacking. Our quantitative study and this article provide evidence that the high occurrence of disasters in conflict-affected areas is more than a co-incidence.

First and based on the existent literature we provide a systematic summary of the potential mechanisms by which armed conflict can contribute to vulnerability to explain and sustain the results of our analysis. We identify at least seven different mechanisms by which armed conflict can contribute to vulnerability. First, armed conflict can damage institutions for disaster risk reduction. Second, armed conflict can cause the destruction of capital and infrastructure that make both people more vulnerable to natural hazards but also that are needed to respond to disaster when they strike. Third, armed conflict damages both the national and local economies and prevents local communities from creating, developing, and maintaining low-risk livelihoods. Fourth, armed conflict shortens time horizons for people residing in zones in or near conflict areas, who are often unwilling to commit to long-term planning because of the context of high insecurity, this can led to the establishment of vulnerable livelihoods. Fifth, conflict often results in forced displacement, which can further increase people's vulnerability to disasters. Sixth, conflicts may also result in serious damage to the environment increasing hazard frequency and intensity. Finally, disaster preparedness, mitigation, and response, as well as aid delivery, can be especially challenging in armed-conflict contexts. When aid providers must deal with multiple crises and prioritize aid delivery, areas where these actors have prior experience may be prioritized, leaving affected communities in other areas without assistance, even if their needs are greater. Even though this constitutes a comprehensive list of potential mechanisms, there might be more mechanisms yet to be found on how armed conflict can increase disaster risk.

Although the existing qualitative work has made progress in understanding these seven potential mechanisms, large-scale quantitative studies that study the strength of the relationship between armed conflict and disaster are lacking. These studies are important for understanding the breadth of this relationship and for attempting to isolate associations between specific variables. This study constructed a statistical model using large-*N*, cross-country data to contribute to this research gap, unpacking the conflict–disaster relationship.

The results of our analysis on 157 countries from 1989 to 2018 suggest that the presence of armed conflict and the occurrence of disasters are strongly and positively correlated and that disasters occur 5% more often in contexts where there is or has been conflict than in non-conflict settings. Moreover, for long-lasting armed conflict, in our logistic regression results, we observed a 1% increase in disaster occurrence for two additional years of conflict, pointing to the cumulative effects of prolonged conflict. This also points to conflict leading to the deterioration of livelihoods over time, making people more vulnerable and less able to prevent, respond to, and recover from a disaster.

In terms of the relationship between armed conflict and disaster-related deaths, we found that yearly disaster-related deaths were 34% higher and that deaths per one million inhabitants are 16% higher in armed conflict settings than in situations without conflict, after including the control variables. These results were consistent across several model specifications, including those with time- and region-fixed effects.

6. Consideration and reflections on data

We are mindful of certain considerations and limitations that should be taken into account in our study. Of utmost importance is the reliance on the quality of the dataset utilized to capture information about disasters. While the extensive disaster database incorporates data from various reliable sources, such as UN agencies, NGOs, insurance companies, research institutes, and press agencies, it is important to acknowledge that the dataset's construction may result in some missing data as recent publications have highlighted this potential limitation [78,79]. Even though we focus our study in the disaster deaths indicator, which is the one that is likely to have the lower amount of missing data [79], we still acknowledge and presume that localities, regions and countries with lower media freedom, human development or democratic regimes are likely to have underreported figures for their disaster occurrence and associated deaths. It remains a challenge for future research to account for these limitations and included higher quality data.

It is also important to acknowledged that analysing the strength of a potential statistical causal relationship between armed conflict and disasters is highly complex as both processes are likely to be cofounded. We acknowledge that at least two of our control variables (level of development measured with the HDI and democratic institutions measured with Polity IV) are strongly correlated with both armed conflict and disasters and therefore do not allow our analysis to make causal inference claims.

It is also important to acknowledge the inherent complexity involved in analysing the strength of a potential statistical causal relationship between armed conflict and disasters, as both processes are likely to be confounded. We recognize that at least two of our control variables (level of development measured with the HDI and democratic institutions measured with Polity IV) exhibit strong correlations with both armed conflict and disasters. As a result, our analysis limited us to make causal inference claims. Moreover, the data used in this study is likely to be heteroscedastic which can lead to biased results in our model. As our results refer mainly to the effects around the mean or expectation of the disaster frequency and deaths, this can result in a biased average effect of armed conflict existence on disaster frequency and deaths. The effects of armed conflict could be different for in cases far from the mean, making extremely severe disaster events more likely and more harmful. Furthermore, it is worth acknowledging the possibility of heteroscedasticity in the data used for this study, which may introduce certain predispositions into our model's results. In that sense, given that our findings primarily pertain to the effects centered around the mean or expectation of disaster frequency and deaths, there is a possibility of a biased average effect of armed conflict on these variables. To address this, multiple techniques were implemented to mitigate the impact of heteroscedasticity on the study's findings, as described above.

Another relevant consideration and possible limitation of our study corresponds to the unit of analysis. We conducted our study at the country level and this unit of analysis implies several complexities. In several countries, armed conflict can occur far away from where disasters strike, therefore in some cases making conclusions on the results at the country level might be misleading. We suggest that future research on this topic should be based on georeferenced data to account for the previously mentioned complexity. Future research should also account for the exact date of the beginning of each armed conflict, as well as for the occurrence of the disaster, to allow specifying the effect of armed conflicts that begin in a year where disasters also occur. Even though we acknowledge this large limitation in our study we also present several mechanisms by which armed conflict can contribute to the vulnerability to disaster that do not have to occur in the same geographical space. For example, a country that is ongoing an armed conflict might experience a deterioration of its country disaster preparedness and response institutions which can increase the vulnerability to natural hazards at different regions, or localities. As this analysis is at the macro scale, the findings should not be taken to suggest a unified approach that should be applied across contexts. Specific disasters and conflicts have their own unique characteristics, and the relationship between these phenomena may be highly contextual.

Finally, as our analysis focused on and found a strong and significant correlation between the two variables -and did not seek to prove or demonstrate causality between conflict and disasters- (see point two on this limitations section), future research should explore the possible existence of reverse causality between both variables. Similarly, we recognize that more research is needed to understand further nuances in the interaction dynamics of both variables, specially at the meso level of analysis. Analysing the relationship between armed conflict and disasters using updated geo referenced data can potentially lead to more refined results. Further analysis is also necessary to reach a deeper understanding of the different forces by which violent conflict increases vulnerability. Such an understanding is required for fully grasping which of these forces have stronger effects and how they interact. Future research should also aim to understand the specific time and regional dynamics of the relationship between conflict and disaster to provide better forecasting information and methods for those involved in scholarly work or practice related to development and humanitarian assistance. This will certainly contribute to reducing avoidable human losses where disasters and armed conflict co-occur.

7. Conclusion

Studying the co-occurrence of conflicts and disasters is important for development and humanitarian institutions, practitioners, policymakers, and academics because understanding the links between these phenomena can enable more effective forecasting, planning, and interventions to minimize the impacts of crises. However, empirical studies focusing on the nexus between how armed conflict affect disasters using quantitative methods are scarce. Existing quantitative research has mainly been interested in the question of how disasters affect conflict, rather than seeking to understand the role of conflict in determining disaster risk. This article contributes to the existing literature on the conflict–disaster nexus by providing a quantitative model that reveals the relationships of armed conflict with both disaster occurrence and disaster-related deaths. Armed conflict can be seen to affect the progression and creation of vulnerability in societies by acting as a dynamic pressure creating unsafe conditions. As our study shows, compared with countries without conflict, disaster occurrence was observed 5% more often, disaster-related mortality per year was 34% higher, and deaths per million inhabitants were 16% higher in cases where armed conflict was also present.

The results provide robust evidence aligning with theoretical arguments and confirming qualitative findings suggesting that countries affected by armed conflict have higher levels of vulnerability to natural hazards and are therefore more affected by disasters when they occur. Disaster events in countries facing conflict result in higher death tolls than would be the case in the absence of conflict. These findings have important policy relevance, as they suggest that the expected human losses in relation to disasters are much higher in armed-conflict settings than in non-conflict settings (partially because it is not natural hazards themselves that kill people, but rather their impact in the form of, for example, collapsing buildings). This adds to the urgency of pursuing conflict resolution and peace building in conversation with DRR programmes. Moreover, humanitarian responses focusing on conflict should be aware of potential unintended effects of their programmes on disaster risks. Finally, it brings urgency to systematically consider and refine diplomacy with governments engaged in conflict at moments when disaster occurs. Forging cease fires and lifting sanctions may be imperative to enable rescue, medical support, shelter, and maintenance to communities affected by the disaster.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendices

Table A1
Disaster-related deaths by disaster type and year.

Year	Earthquake	Mass mov. (dry)	Volcanic activity	Extreme Temp.	Storm	Flood	Landslide	Drought	Wildfire	Epidemic	Year total
1989	650	55	0	381	4,256	4,716	445	237	1	1,870	12,611
1990	42,845	73	33	979	4,604	2,251	141	0	0	2207	53,133
1991	2,454	86	683	835	146,297	5,852	728	2,000	90	30,682	189,707
1992	4,033	323	1	388	1,344	5,315	712	0	122	6,675	18,913
1993	10,088	181	99	106	2,965	6,150	1578	0	3	651	21,821
1994	1,242	0	101	341	4,239	6,771	307	0	84	2,505	15,590
1995	7,739	0	0	1,730	3,763	7,956	1,521	0	29	4,428	27,166
1996	576	0	4	300	4,581	8,047	1,155	0	45	16,887	31,595
1997	3,159	0	53	604	6,150	7,685	801	732	266	10,674	30,124
1998	9,573	0	0	3,269	24,935	10,653	1,141	20	150	12,931	62,672
1999	21,869	0	0	771	12,270	34,807	445	361	70	6,293	76,886
2000	217	11	0	934	1,354	6,025	1,012	80	47	6,980	16,660
2001	21,348	0	0	1,787	1,911	5,014	786	99	33	8,515	39,493
2002	1,639	60	200	3,369	1,382	4,236	1,100	588	6	8,762	21,342
2003	29,617	0	0	74,698	1,049	3,910	706	9	47	3,522	113,558
2004	227,290	44	2	255	6,547	6,982	313	80	14	3,245	244,772
2005	76,241	0	3	1,550	5,251	5,754	664	149	45	3,909	93,566
2006	6,692	11	5	4,826	4,329	5,843	1,638	134	13	6,402	29,893
2007	780	0	11	1,086	6,035	8,607	271	0	148	5,484	22,422
2008	87,918	120	16	1,688	140,985	4,007	504	8	86	6,904	242,236
2009	1,893	36	0	1,386	3,287	3,627	723	0	190	4,895	16,037
2010	226,733	0	323	57,188	1,564	8,356	3,427	20,000	166	12,143	329,900
2011	20,946	0	3	435	3,103	6,163	309	0	10	3,174	34,143
2012	711	16	0	1,834	3,105	3,544	501	0	21	1,887	11,619
2013	1,120	46	0	1,821	8,598	9,836	235	0	35	534	22,225
2014	774	0	102	1,168	1,432	3,494	960	0	16	12,911	20,869
2015	9,550	13	0	7,425	1,279	3,502	1,006	35	67	1,445	24,322
2016	1,311	0	0	490	1,754	4,397	361	0	39	2,354	10,706
2017	1,012	8	0	359	2,516	3,331	2,312	0	165	2,140	11,843
2018	5,264	17	878	536	1,712	2,881	275	0	221	2,601	14,385
1989–2018 average:											62,007

Table A2
Countries included in the sample.

Continent	Region	Country	Years	Continent	Region	Country	Years
Asia	Central Asia	Kyrgyz Republic	28	Africa	Eastern Africa	Burundi	29
		Tajikistan	28			Comoros	15
	Eastern Asia	China	29			Djibouti	24
		Japan	29			Eritrea	7
		Korea, Rep.	29			Ethiopia	19
		Mongolia	29			Kenya	29
	South-Eastern Asia	Cambodia	29			Madagascar	19
		Indonesia	29			Malawi	29
		Lao PDR	29			Mauritius	29
		Malaysia	29			Mozambique	29
		Myanmar	29			Rwanda	29
		Philippines	29			Tanzania	29
		Singapore	29			Uganda	29
		Thailand	29			Zambia	29
		Timor-Leste	17			Zimbabwe	29
		Vietnam	29		Middle Africa	Angola	20
	Southern Asia	Afghanistan	16			Cameroon	29
		Bangladesh	29			Central African Republic	29
		Bhutan	14			Chad	19
		India	29			Congo, Dem. Rep.	28
		Iran	29			Congo, Rep.	29
		Nepal	29			Equatorial Guinea	19
		Pakistan	29			Gabon	29
		Sri Lanka	29		Northern Africa	Algeria	29
	Western Asia	Armenia	28			Egypt, Arab Rep.	29
		Azerbaijan	24			Libya	29
		Bahrain	29			Morocco	29
		Cyprus	29			Sudan	29
		Georgia	19			Tunisia	29
		Iraq	22		Southern Africa	Botswana	29
		Israel	29			Eswatini	29
		Jordan	29			Lesotho	29
		Kuwait	25			Namibia	29
		Lebanon	14			South Africa	29
		Oman	19		Western Africa	Benin	29
		Qatar	29			Burkina Faso	19
		Saudi Arabia	29			Cabo Verde	19
		Syria	28			Côte d'Ivoire	29
		Turkey	29			Gambia, The	29
		UAE	29			Ghana	29
		Yemen, Rep.	29			Guinea	29
Europe	Eastern Europe	Belarus	24			Guinea-Bissau	14
		Bulgaria	29			Liberia	20
		Czech Republic	26			Mali	29
		Hungary	28			Mauritania	29
		Moldova	28			Niger	29
		Poland	29			Nigeria	16
		Romania	29			Senegal	29
		Russian Federation	27			Sierra Leone	29
		Slovak Republic	26			Togo	29
		Ukraine	28	Americas	Caribbean	Cuba	29
	Northern Europe	Denmark	29			Dominican Republic	29
		Estonia	28			Haiti	29
		Finland	29			Jamaica	29
		Ireland	29			Trinidad and Tobago	29
		Latvia	28		Central America	Costa Rica	29
		Lithuania	28			El Salvador	29
		Norway	29			Guatemala	29
		Sweden	29			Honduras	29
		United Kingdom	29			Mexico	29
	Southern Europe	Albania	29			Nicaragua	29
		Croatia	28			Panama	29
		Greece	29		Northern America	Canada	29

(*continued on next page*)

Table A2 (*continued*)

Continent	Region	Country	Years	Continent	Region	Country	Years
		Italy	29			United States	29
		North Macedonia	19		South America	Argentina	29
		Portugal	29			Bolivia	29
		Serbia	16			Brazil	29
		Slovenia	28			Chile	29
		Spain	29			Colombia	29
	Western Europe	Austria	29			Ecuador	29
		Belgium	29			Guyana	29
		France	29			Paraguay	29
		Germany	29			Peru	29
		Luxembourg	29			Suriname	15
		Netherlands	29			Uruguay	29
		Switzerland	29			Venezuela, RB	29
Oceania	Australia and New Zealand	Australia	29				
		New Zealand	29				
		Melanesia	77				
		Fiji	29				
		Papua New Guinea	29				
		Solomon Islands	19				

Table A3
Explanatory and control variables: correlation matrix.

	Armed conflict dummy	Population	Human Development Index	Polity IV Index	Urban population (%)	Population living at ≤ 5 m elevation (%)	Land area (km^2)
Armed conflict dummy	1						
Population	0.17	1					
Human Development Index	−0.26	−0.01	1				
Polity IV Index	−0.17	−0.03	0.41	1			
Urban population (%)	−0.23	−0.08	0.79	0.23	1		
Population living at ≤ 5 m elevation (%)	−0.11	0.00	0.13	−0.12	0.16	1	
Land area (km^2)	0.17	0.45	0.11	0.02	0.13	−0.08	1

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