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Does disaster contribute to armed conflict? A quantitative analysis of disaster–conflict co-occurrence between 1990 and 2017

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Abstract

Purpose – Disasters and armed conflict often co-occur, but does that imply that disasters trigger or fuel conflict? In the small but growing body of literature attempting to answer this question, divergent findings indicate the complex and contextual nature of a potential answer to this question. The purpose of this study is to contribute a robust cross-country analysis of the co-occurrence of disaster and conflict, with a particular focus on the potential role played by disaster.

Design/methodology/approach – Grounded in a theoretical model of disaster–conflict co-occurrence, this study merges data from 163 countries between 1990 and 2017 on armed conflict, disasters and relevant control variables (low human development, weak democratic institutions, natural resource dependence and large population size/density).

Findings – The main results of this study show that, despite a sharp increase in the co-occurrence of disasters and armed conflict over time, disasters do not appear to have a direct statistically significant relation with the occurrence of armed conflict. This result contributes to the understanding of disasters and conflicts as indirectly related via co-creation mechanisms and other factors.

Originality/value – This study is a novel contribution, as it provides a fresh analysis with updated data and includes different control variables that allow for a significant contribution to the field.

Keywords Conflict, Disaster, Cross-country analysis, Vulnerability

Paper type Research paper

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1. Introduction

Armed conflict and disasters can both trigger extensive loss of human life as well as social and economic disruption in the affected communities. According to the World Bank (Corral *et al.*, 2020), by 2030, up to two-thirds of the world's extremely poor will live in fragile and conflict-affected situations, which threatens to reverse development gains and hinder progress toward the global goal of reducing worldwide poverty to below 3%. Alongside this trend, in 2019 alone, the livelihoods of more than 90 million people were impacted by disasters related to natural hazards, such as earthquakes or floods, with approximately 23,900 people losing their lives because of disaster-related causes (CRED, 2019).

Rather than being isolated events, disasters and violent conflicts often happen at the same time, resulting in severe consequences (Mena and Hilhorst, 2020; Peters, 2021). Since the early 1980s, the number of countries experiencing both armed conflict and disaster in the same year has systematically increased (Figure 1). From 1949 to 1958, an average of 18% of countries experiencing armed conflict also saw a disaster in the same year, whereas this number was 81% for 2009–2018.

This article quantitatively unpacks disaster–conflict co-occurrence and answers the question about the role of disasters in the occurrence of armed conflict and controlling for other variables that have been found to affect armed conflict occurrence. A small but growing body of literature attempts to answer questions linked to the contribution of disaster to conflict, but, to date, the results have been varied, contradictory or inconclusive (Salehyan, 2008; Scheffran *et al.*, 2012; Buhaug *et al.*, 2014; Mach *et al.*, 2019).

This study contributes an in-depth empirical statistical analysis to the emerging body of work examining the co-occurrence between disasters and conflict. This is especially important in view of the sharp increase in disaster–conflict co-occurrence demonstrated in Figure 1. To do so, we analyze data from a cross-country large-*N* data set, building a model of the co-occurrence of disaster and conflict that includes country- and year-specific controls suggested by previous work as potential preconditions for the disaster–conflict nexus.

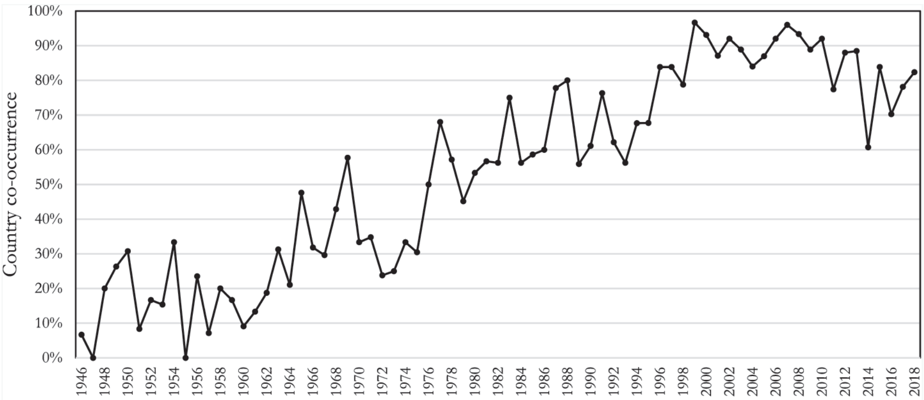

Figure 1. Country co-occurrence of armed conflict and disasters by year

Source: Authors own work. Elaborated 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 that experienced at least an armed conflict and a disaster within the same year

These control variables include the country's level of human development and the fragility/stability of its governance system.

This is not the first empirical analysis to quantitatively examine the relationship between disaster and conflict. However, in an extensive literature review, we identified the following four shortcomings in previous cross-country studies, which we address in the present study: incomplete representation of disasters, limited variation in conflict variables, outdated data sets and small sample size. As will be discussed in more detail below, these shortcomings were overcome by using comprehensive quantitative data on disasters and multiple dependent variables assessing different aspects of conflict. The combined data set comprised 4,073 observations on 163 countries from 1990 to 2017 [1].

The development of this analysis and the insights it provides present multiple contributions to research, practice and society. As mentioned earlier, given the limited number of quantitative analyses on disaster–conflict dynamics, this study advances conflict, disaster, development and environmental studies by refining theories and methodologies that deal with these two complex phenomena. Moreover, the findings can guide policymaking processes and intervention strategies. Understanding that disasters are indirectly linked to conflict allows for resources and strategies to be targeted more effectively to prevent or mitigate conflict. Conversely, in areas prone to conflict, disaster preparedness efforts can be enhanced. Additionally, this research can raise public awareness about the complex interconnections between environmental events and social issues, which is increasingly important in our interconnected and rapidly changing world.

In line with these observations, considering climate change and the increasing prevalence of disasters linked to it, as well as the growing number of humanitarian crises globally, our analysis and findings are crucial for long-term climate change adaptation and mitigation strategies and humanitarian early warning/early action strategies. By understanding how disasters can relate to conflicts, steps can be taken to strengthen social cohesion and conflict resolution mechanisms in these areas. For organizations involved in disaster response and relief, this link can help them better plan their operations, work more effectively in conflict-prone regions and potentially contribute to conflict prevention.

As for the remainder of the article, in Section 2, we introduce the main theoretical frameworks and constructs that inform and guide this study. Section 3 delves into the data we used and the methodologies applied in our analysis. We then present our results in Section 4. Finally, in Section 5, we discuss the findings and provide conclusions, emphasizing how these findings contribute to this field of study and outlining the potential implications.

2. The relationship between disasters and conflict

Much previous work on the relationship between disasters and conflict has defined disasters, including those related to natural hazards, such as droughts, earthquakes or floods, as social and political processes. Disasters occur when natural hazards impact communities that are *vulnerable* to them, resulting in severe consequences (Wisner *et al.*, 2004, 2012). Vulnerability, which is key in the study of disasters, develops over time through social, political and historical decisions such as where to live, building regulations or how much a society invests in preparedness (i.e. the ability to prevent, respond to and recover from disasters). Therefore, the concept of "natural disaster" is seen as a misnomer by disaster scholars, as it places the focus on the hazard rather than on the social vulnerability that creates disaster risk (Oliver-Smith, 1996; Bankoff *et al.*, 2004; Chmutina and von Meding, 2019).

In terms of the theoretical link between disasters and conflict, Quarantelli and Dynes (1976) argued that disasters could decrease a society's risk of violent conflict because people exhibit relatively high levels of agreement during crisis response. This notion has been strengthened in subsequent research providing evidence of cases where disasters have brought nations or regions together, thus reducing conflict risk (Le Billon and Waizenegger, 2007; Slettebak, 2012; Kelman, 2006, 2012; Toya and Skidmore, 2014). However, there has also been a body of research arguing the opposite. Homer-Dixon (1994) contended that disaster-induced resource scarcity might become a significant driver of conflict. Several authors (Drury and Olson, 1998; Brancati, 2007; Nel and Righarts, 2008) have supported Homer-Dixon's arguments that disasters or high climate variability (which overlaps with but differs from disasters; IPCC, 2012; Kelman, 2021) can cause a scarcity of resources. This resource scarcity, in turn, may lead to conflict or extend the duration of an ongoing conflict (Eastin, 2016). Moreover, theories associated with the development of armed conflicts have many elements in common with this understanding of the progression of vulnerability to disasters (Demmers, 2012; Gleditsch, 1998; Smith, 2004).

Research into the interplay between disasters and conflict, while still in an early stage, is quickly evolving generally, this body of work can be categorized into two main streams: The first stream concentrates on the role that primarily violent conflicts play in the instigation of disasters and the magnitude of their impacts. Within this stream, the examination of conflict's role in relation to disasters can be further categorized into two primary, interconnected groups: conflict creates and amplifies vulnerability to disasters or exacerbates hazards (Bankoff *et al.*, 2004; Wisner *et al.*, 2012; Blaikie *et al.*, 1994) and conflict triggers the occurrence of disasters (Desportes, 2019; Le Billon, 2003; Mena and Hilhorst, 2020, 2022). Conversely, the second stream postulates how disasters can precipitate conditions that give rise to, sustain or even resolve conflicts. In this paper, we choose to concentrate on this second one. While this topic has been broached in previous studies, its quantitative examination is even more scant. The following section will unpack the current knowledge base to establish the theoretical foundation that informs our methodological constructs and analysis.

2.1 Quantitative work on disasters and conflict

Most previous work on the co-occurrence of disasters and conflict has used qualitative methods, and studies including a quantitative examination of the relationship are relatively scarce. However, there is an emerging body of quantitative work on this topic that can be divided into two main categories: country-specific micro/meso-scale studies and cross-country macro-scale studies.

Recent micro/meso-scale quantitative work has focused primarily on the effect of a single type of disaster in one country. Examples of such research include studies on the effects of the 2004 Indian Ocean Tsunami on intra-state violence in Sri Lanka (Kikuta, 2019), the impact of the 2015 earthquake on social conflict in Nepal (De Juan *et al.*, 2020) and the influence of earthquakes on social cohesion indicators in Chile (Dussaillant and Guzmán, 2014; Fleming *et al.*, 2014; Calo-Blanco *et al.*, 2017). This literature has yielded divergent findings, with analyses and conclusions that are highly dependent on the specific context in terms of conflict and disaster in the examined location.

The study of the effects of disaster on conflict requires reliable cross-context comparison including controls for country-level characteristics. This type of analysis would allow for the quantification of the relative effects of the occurrence of disaster on the occurrence of armed conflict. Empirical studies have already examined the effects of earthquakes, droughts and climate-related disasters in isolation; moving the debate forward will require a more holistic, macro, cross-country empirical framework that comparatively examines the effects of all types of disasters.

Recent large-sample, quantitative, cross-country studies analyzing the relationship between disasters and conflict can be categorized into three strands in terms of their conclusions. Work in the first strand argues that disasters promote conflict; specifically, this work asserts that disasters cause resource scarcity, which may lead to conflict (Drury and Olson, 1998; Brancati and Bhavnani, 2006; Nel and Righarts, 2008; Nelson, 2010) or increase its duration (Eastin, 2016). Similarly, other authors (Ide, 2015; Hendrix and Glaser, 2007) have emphasized that resource dependence, understood as the importance of natural resource rents in relation to overall economic activity, can be an additional factor increasing the likelihood of conflict. This is because contestable natural resources increase competition among groups vying for control of these resources, which intensifies when disasters result in abrupt resource scarcity. Studies in the second strand maintain that there is a negative relationship between disasters and conflict (a peace-promoting dimension of disasters) and argue that disasters can bring people in affected places together to address these crises (Le Billon and Waizenegger, 2007; Slettebak, 2012; Dussaillant and Guzmán, 2014; Toya and Skidmore, 2014).

Research in the third strand maintains that there is no statistically significant relationship between disasters and conflict (Omelicheva, 2011; Bergholt and Lujala, 2012; Schleussner *et al.*, 2016). Among authors espousing this view, some have focused on describing the co-occurrence of the two phenomena without examining the statistical link between them (Buchanan-Smith and Christoplos, 2004; Peters and Budimir, 2016), whereas others, such as Bergholt and Lujala (2012), have shown that, although climate-related disasters have a negative effect on gross domestic product (GDP) growth, they cannot be linked to an increased risk of armed conflict.

2.2 Quantitative work on conflict and disasters

To date, there is strong qualitative evidence indicating conflict might affect disasters. More specifically, recent research has shown how the chances of natural hazards becoming disasters and causing more damage increase when they happened in areas with recent political violence (Ide, 2019).

However, to the best of our knowledge, the question of whether armed conflicts contribute to disaster risk has not been approached quantitatively, with the sole exception of Marktanner *et al.* (2015) that argues that disaster deaths are 40% higher when they occur following armed conflicts. While the article is a major contribution to the non-existent quantitative literature examining the relationship from armed conflict to disasters, it could benefit of some improvements to allow the scholarly community gain a better understanding of the depth of the relationship between these two processes. Unfortunately, the study is based on a relatively limited sample, consisting in some cases of only one observation (year) per country and a maximum of seven years for some countries. The authors also only focus on analyses of the effects of disasters (their related deaths) rather than estimating how the probability of a natural hazard becoming a disaster is affected by scenarios of armed conflict. We believe that if these two gaps were addressed, then the literature on the relationship between conflict and disasters could greatly benefit. Based on the above and the Granger causality tests that we performed as part of this study, it is not possible to assert at this point the presence of an inverse direct causal relationship between these two variables, at least while the specification of the model proposed for the occurrence of the armed conflict in this article is followed.

2.3 Methodological limitations in existing literature

In reviewing existing quantitative studies on disasters and conflict, we identified another two important considerations. First, it is important to include country population size (Hendrix and Glaser, 2007; Slettebak, 2012; Bernauer *et al.*, 2012). Urdal (2005) and Raleigh and Urdal (2007), for example, found that land and water scarcity, in combination with high population density, increase the likelihood of violent conflict. These findings are consistent with the idea that substantial increases in population (and population density) can affect resource scarcity, environmental degradation and conflict. An additional reason it is necessary to control for country population size when studying the relationship between disasters and conflict is that the occurrence of disasters is often assessed using the number of human lives affected, as is the case in the EM-DAT data used in this analysis. Disasters occurring in more densely populated places can result in more fatalities than those occurring in areas with lower population density (Zhao *et al.*, 2017). Disaster-related fatalities are also perceived differently depending on the population density in the affected places (Asef, 2008).

Second, it is also important to develop a model that avoids replicating limitations of previous quantitative studies of this topic. As mentioned before, earlier studies rely on data sets with a small sample size, that are outdated or have an incomplete disaster representation. Many also present a limited variation in the dimensions of conflict selected as dependent variables. For the shortcoming of incomplete disaster representation, for example, Von Uexkull *et al.* (2016) focused only on the effects of droughts in Asia and Africa; Schleussner *et al.* (2016) studied only climate-related disasters; and Drury and Olson (1998) analyzed only disasters exceeding 1,500 fatalities. In terms of limited variation in the dimensions of conflict included, Eastin (2016) assessed the effects of disasters only on conflict duration, and Slettebak (2012) analyzed only the effect of climate-related hazards that turn into disasters on conflict onset. When looking at different types of disasters separately, this allows one to examine (potentially large) differences in the correlation coefficients per type of disaster. However, if one focuses on individual types of disasters and given that these take place rather infrequently (e.g. in the case of landslides or earthquakes), then most countries will appear in the sample as not experiencing a disaster; if, however, one looks at all types of disasters simultaneously, then the probability that the country experiences a disaster of any type will be higher. In other words, while a country may experience a landslide or an earthquake only every 20 or 30 years, the frequency of experiencing a major disaster of any type is likely to be higher (e.g. every 5 or 10 years). As for using outdated data sets, Eastin's (2016) analysis included information on only the 86 countries with data coverage on conflict extending until 2005. As an example of small sample size, Drury and Olson (1998) focused on only 12 countries and exclusively analyzed disasters exceeding 1,500 fatalities.

3. Data and methods

We developed a model to quantitatively study the significance of disaster along with other variables that have been theorized to affect the co-occurrence of disaster and conflict. This model allowed us to explore how several variables that are potentially important in the study of the relationship between disasters and conflict interact, with a special focus on clarifying the role played by disasters.

The model brings together disasters, conflict and five additional variables that may play an important role in explaining the co-occurrence of disaster and conflict. Drawing on the previous work cited above, especially existing quantitative studies (to facilitate comparability), we selected the following country-level control variables for inclusion in our analysis:

- level of development;
- level of democracy;
- population size;
- dependence on natural resources; and
- population density.

Notably, these explanatory variables play different roles in the model, following the theoretical background on the disaster–conflict nexus.

Adding to the information abovementioned, other reasons also support the inclusion of these variables. First, several studies have presented empirical evidence that middle- and higher-income countries are less likely to experience conflict, compared with lower-income countries (Miguel *et al.*, 2004; Hegre and Sambanis, 2006; Dixon, 2009; Collier *et al.*, 2009; Murshed and Tadjoeddin, 2009; Hoeffler, 2011; Gleditsch, 2012; Slettebak, 2012; Ide *et al.*, 2014; Ide, 2015; Owain and Maslin, 2018). This may be because higher economic development translates into higher gains through economic activities relative to the gains of engaging in conflict. Alternatively, it may be that countries that are more developed suffer less resource scarcity. As Urdal (2005) pointed out, a significant number of quantitative studies have found that development level is strongly associated with conflict and should, therefore, be included in any model seeking to determine the roles of other variables in explaining conflict.

Economic development variables are also expected to be related to disasters through the mechanisms of vulnerability, resilience and adaptive capacity. The idea, generally, is that higher levels of development in a country correspond to more resilience because of a higher capacity to adapt. Although poverty is not the same as vulnerability (Adger, 2006), previous studies have found a strong correlation between adaptive capacity and economic development (Cutter and Hewitt, 1984; Watts and Bohle, 1993; Adger, 2006).

Quality of institutions and political stability are two additional independent variables that have been widely examined in terms of their relationship to conflict as a dependent variable (Koubi, 2019). There are multiple mechanisms by which these variables could moderate the relationship between disasters and conflict. First, a country that has institutions prepared to reduce disaster risks and orchestrate a response can better cope with and address potential disasters. Second, higher levels of political stability in a country correspond to greater likelihoods of resolving resource shortages peacefully (Linke *et al.*, 2017 in Koubi, 2019).

Population size and density are crucial control variables in any model that analyses the relationship between conflict and disasters. The occurrence of both disasters and armed conflict might be affected by a country's population size and its population density. Because the variables assessing conflict and disasters used in this study take into account population impact, it is necessary to control for country population size. To do this, our econometric model controls for the log of country population (size and density) per year. There are additional reasons to include population variables; for example, Urdal (2005) reported that, in contexts where land scarcity is combined with high population growth rates, the likelihood of violent conflict increases.

3.1 Model variables

3.1.1 Armed conflict. Data on armed conflict, the outcome variable, were obtained from the UCDP/PRIO [2] Armed Conflict Data set, Version 19.1, which provides excellent time/

country coverage for armed conflict. The UCDP/PRIO data set also provides information on conflict intensity level, which was necessary to estimate the effects of disasters on different armed conflict outcomes.

Our analysis relied on UCDP/PRIO data capturing the incidence of state-based armed conflict, 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 (Pettersson, 2019: 1).

Because we were interested in assessing the links between disaster events and the occurrence of armed conflict, we used this data set to create an armed conflict dummy variable capturing whether a country experienced armed conflict in each year. For armed conflicts involving more than one country, our conflict dummy variable was assigned a value of 1 for all involved parties (countries).

3.1.2 Disasters. For data on disasters, we used the CRED EM-DAT, which divides disasters into two main groups: "natural disasters" (sic) and "technological disasters." The latter category captures human-made disasters primarily caused by human errors, misjudgments or negligence (e.g. a nuclear accident or a fire at an oil refinery). As this research explicitly focused on the relationship between armed conflict and natural hazard-related disasters, we defined "disasters" as including only events intrinsically linked to natural hazards ("natural disasters" in the EM-DAT).

The EM-DAT (CRED, 2019) provides reliable cross-country data and has the largest coverage of disasters available. It contains essential information on the occurrence (and effects) of over 14,874 "natural disasters" (using CRED's nomenclature) [3]. For a disaster to be entered into the database, at least one of the following criteria must be met:

- $\geq$ 10 people reported killed;
- $\geq$ 100 people reported affected;
- state of emergency declared; and
- international assistance requested.

This study also estimated several model specifications using alternative disaster variables available in the data set (i.e. disaster occurrence dummy variables disaggregated into geophysical or climate-related events, the number of disasters occurring within one year, the number of individuals whose livelihoods were negatively affected and the number of associated deaths).

3.1.3 Level of development. The United Nations Development Program's Human Development Index (HDI) was used as a proxy for broader socioeconomic development, in contrast to most previous studies, which used GDP per capita for this purpose. Compared with GDP per capita, the HDI (a composite index of three human-welfare indices – average level of income per capita, educational attainment and health [assessed using life expectancy]) offers a more comprehensive account of overall socioeconomic development. We expected a low level of human development to act as a precondition for conflict, given that lower HDI level likely corresponds to higher overall citizen dissatisfaction with the status quo and the associated demands for change. As a robustness check, all estimations were replicated using GDP per capita instead of the HDI, which had little effect on the main findings or on the direction, size or statistical significance of the effects of the disaster variables [4]. HDI data were drawn from the United Nations Development Program's Human Development Database [United Nations Development Program (UNDP), 2020].

3.1.4 Democratic institutions. As a proxy for the extent of democratic accountability, we used data from the Polity IV project of the Center for Systemic Peace (Marshall and Jaggers, 2019). With extensive data coverage on regime changes, Polity IV scores reflect shifts in underlying modes of governance each year. The regime spectrum of the index ranges from −10 (hereditary monarchy) to +10 (consolidated democracy).

3.1.5 Population size/density. Cross-country data on population size (counting all residents regardless of their legal status or citizenship) and density (number of people per square kilometer) were drawn from the World Development Indicators database (The World Bank, World Development Indicators, 2020). As discussed earlier, we expected positive correlations between population size/density and the conflict outcome variables. To control for population size, we included the log of country population per year.

3.1.6 Natural resource dependence. In addition to disaster events, we were also interested in testing the role of resource dependence as a conflict trigger. Previous research has indicated that countries with low levels of economic development and high dependence on renewable resources (for agriculture, for example) are more vulnerable to disasters, as well as complex economic conditions, which may increase the likelihood of conflict (Ide, 2015). Resource dependence was assessed with the proxy measure of the share of overall economic activity made up by natural resource rents, using data from the World Development Indicators database (The World Bank, World Development Indicators, 2020). This variable was included because contestable natural resources are likely to increase competition among groups vying for control of these resources, and this process may intensify when disasters cause abrupt resource scarcity (and possibly inequality in the distribution of the benefits accrued from these resources).

3.2 Model specification

Combining information from the databases described above, the final data set contained information on 163 countries from 1990 to 2017, with a total of 4,073 country-year observations. While for most of the countries included in our study, we count with all necessary information to run our regressions, we have also included countries for which we do not have information for the full range between 1990 and 2017. Nonetheless, the average number of observations (years) per country included in the sample is 25, which shows that these cases do not unbalance our panel significantly. We limited the sample to countries with data available for all estimated specifications to maintain the same sample size throughout the analysis, which facilitated comparison across different model specifications and avoided variation in the estimated parameters because of sample-size differences. Table 1 presents descriptive statistics for all key variables (dependent variables, explanatory variables of interest and control variables) included in our estimations [5].

To empirically examine the disaster–conflict nexus, several model specifications were estimated with alternative conflict and disaster variables. The regression models follow the following generic specification:

$$AC_{i,t} = \alpha + \beta_{DIS}DIS_{i,t} + \beta_{AC}AC_{i,t-1} + \beta_{LLAC}LLAC_{i,t} + \beta_{Z}Z_{i,t} + \varepsilon_{i,t} \quad (1)$$

Here, $AC_{i,t}$ corresponds to each conflict outcome variable (e.g. occurrence of conflict or total number of simultaneous conflict events) for country i in year t. $DIS_{i,t}$ refers to a set of different explanatory variables related to disaster occurrence. $AC_{i,t-1}$ is a dummy variable for the occurrence of armed conflict in the previous year (hence capturing the effect of conflict in any year on conflict in the subsequent year). $LLAC_{i,t}$ is a conflict dummy taking the value of 1 if a country had engaged continuously in conflict in at least three consecutive

Table 1.
Summary statistics for variables used in the analysis (4,073 country-year observations, 1990–2017)

Variable	Mean	Median	SD	Minimum	Maximum
Dependent variables					
Armed conflict occurrence dummy	0.17	0	0.38	0	1
Total number of armed conflicts	0.24	0	0.65	0	7
Armed conflict onset	0.02	0	0.13	0	1
Number of minor conflicts	0.20	0	0.60	0	7
Number of wars	0.05	0	0.21	0	2
Explanatory variables					
Natural disaster occurrence dummy	0.67	1	0.47	0	1
Total number of natural disasters	2.37	1	4.13	0	48
Number of climate-related disasters	1.90	1	3.594755	0	37
Number of geophysical disasters	0.32	0	1.029433	0	14
Number of deaths	432	3	5,956	0	229,549
Number of affected people	1,391,126	500	13,700,000	0	346,502,337
Control variables					
Human development index	0.65	0.67	0.17	0.1	0.95
Polity IV index	3.65	6	6.38	−10	10
Population (in millions)	42	9.79	144	0.38	1,390.00
Natural resource dependence (rents as % of GDP)	8.17%	2.94%	11.41%	0%	84.24%
Population density (per square kilometer)	386.41	78.81	1804.78	0.14	21,388.60

Source: Authors' own work

years, capturing the persistence of conflict [6]. $Z_{i,t}$ is a vector of other control variables that measure the influence of the preconditions for conflict (level of development, democratic institutions and population size/density), as well as the importance of natural resource dependence as a trigger of conflict. $\varepsilon_{i,t}$ is the time- and country-variant error term.

For the main analysis, logistic regression models were estimated to assess how the probability of armed conflict occurrence is related to disaster occurrence and other factors, as defined in equation (1); the marginal effects of all explanatory and control variables are presented in the following section. Year dummies were included in all regression models to capture the influence of aggregate time-series trends, which was especially important given the increased rate of co-occurrence of disasters and conflict in recent decades (Figure 1). We opted for random effects estimation because this ensures efficient parameter estimates for variables exhibiting limited time variation (as is the case for most of the explanatory variables, including the HDI, the Polity IV Index, population size/density, resource dependence and lagged conflict occurrence). Macro-scale variables that exhibit limited time variation typically suffer from inflated standard errors and become statistically insignificant in cross-country regression models with fixed effects (for a discussion of these methodological aspects; Ali *et al.*, 2020; Wooldridge, 2010).

4. Results

Considering the importance of the co-occurrence of disaster and armed conflict, we began the analysis with a focus on the role of the occurrence of disaster in the occurrence of armed conflict. We then progressively tested the strength of the relationship between disasters and conflict by including the other explanatory (control) variables and the alternative disaster variables. Tables 2 and 3 present empirical estimations for all regression models, where the

Table 2. Marginal effects based on logistic regression with armed conflict occurrence (dummy variable) as the dependent variable (1990–2017)

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Disaster occurrence dummy	0.40** (0.17)	0.39* (0.20)	0.40** (0.20)	0.16 (0.20)	0.08 (0.20)	0.13 (0.20)	0.14 (0.20)	0.14 (0.20)
Armed conflict occurrence in previous year dummy		2.99*** (0.31)	2.79*** (0.31)	2.78*** (0.30)	2.73*** (0.29)	2.71*** (0.29)	2.73*** (0.29)	2.73*** (0.29)
Long-lasting conflict dummy			1.16*** (0.19)	1.12*** (0.19)	1.05*** (0.19)	1.03*** (0.19)	1.06*** (0.19)	1.05*** (0.19)
Log of population size				0.71*** (0.14)	0.75*** (0.13)	0.75*** (0.13)	0.75*** (0.13)	0.74*** (0.13)
Human development index					−5.82*** (1.08)	−5.28*** (1.08)	−4.95*** (1.06)	−4.97*** (1.06)
Polity IV index						−0.05** (0.02)	−0.04* (0.02)	−0.04* (0.02)
Natural resource dependence							1.72* (1.04)	1.81* (1.06)
Log of population density								(0.04) (0.13)
Pseudo R^2	0.02	0.19	0.21	0.23	0.25	0.25	0.25	0.25
Observations	4,073	4,073	4,073	4,073	4,073	4,073	4,073	4,073

Notes: Robust standard errors in parentheses. Year dummies are included in all regression models. $^{*}p < 0.1$; $^{**}p < 0.05$; and $^{***}p < 0.01$
Source: Authors' own work

outcome conflict variable was a dummy taking the value of 1 if the country experienced a conflict event with at least 25 battle-related deaths during that year.

4.1 Initial findings

Specification 1 in Table 2 shows that the likelihood of armed conflict was 40% higher in countries experiencing a disaster event than in those not experiencing a disaster event, and this effect was statistically significant at the 5% level. This high disaster–conflict co-occurrence is consistent with previous research and with the trends from 1990 to 2017 shown in Figure 1. However, as we progressively expanded the model by incorporating additional preconditioning and triggering factors, the marginal effect of the disasters dummy gradually decreased in magnitude, ultimately losing its statistical significance. In the richest model (Specification 8, which includes controls for past conflict occurrence, population size, level of human development, extent of democratic accountability, natural resource dependence and population density), the relationship between disasters and conflict was no longer statistically significant in this macro, national-level analysis. Why is this, and how significant are the other variables in the model?

The coefficient of disasters was generally found to be statistically nonsignificant after adding the control variables (with the exception of the less complete models – Specifications 1–3), and the marginal effects of all included control variables were observed to be statistically significant and to have the expected sign, in line with the theoretical insight and previous empirical findings discussed above. Considering the coefficients of all regressors as they appear in the fullest model (Specification 8) in Table 2, we see that a country's history of armed conflict was related to the country's likelihood of engaging in conflict. In fact, in this model, experiencing conflict in the previous year increased the probability of engaging in conflict by approximately 2.7 times, and countries experiencing long-lasting conflict in the past (for at least three consecutive years) were 1.06 times more likely to engage in conflict.

Population size, weak democratic institutions and low levels of human development all showed strong associations with armed conflict, supporting previous findings on the role of these variables as preconditions for conflict (statistically significant at the 1%, 10% and 1% levels, respectively). The coefficient of population density was positive but statistically insignificant. A 1% increase in population size was associated with a 0.75% increase in the probability of conflict. Further, higher levels of development were associated with lower likelihood of a country experiencing conflict: a 0.1-point increase in the HDI was associated with a reduction in the probability of conflict by almost one-half. The model also shows that more authoritarian regimes were more likely to experience conflict: A one-unit increase in the Polity IV Index (which ranged from −10 to +10, with higher values indicating more extensive democratic rights) was linked to a 4% reduction in the likelihood of armed conflict (statistically significant at the 10% level). This is consistent with the theoretical literature, which indicates that these variables influence disaster occurrence and impact. Moreover, the

Table 3. Marginal effects per type of disaster on armed conflict occurrence

Disaster type	Earthquake	Flood	Drought	Wildfire	Storm	Volcanic activity	Landslide
	−0.07	−0.02	0.07	0.15	−0.02	−0.04	0.01
	(0.09)	(0.07)	(0.24)	(0.18)	(0.06)	(0.28)	(0.10)

Notes: Robust standard errors in parentheses. Year dummies and additional explanatory variables (lagged armed conflict, population size, HDI, Polity IV, natural resource dependence and population density) are included in all regression models
Source: Authors' own work

(lack of) governance in a particular context also influences disaster occurrence throughout the process, from disaster prevention to disaster response and recovery (Tierney, 2012; Mena and Hilhorst, 2022; Peters, 2021).

Finally, we found empirical support for a positive link between resource dependence on conflict: A 1% increase in the share of GDP made up by natural resource rents corresponded to a 1.72% rise in the likelihood of armed conflict (statistically significant at the 10% level). However, despite the effect of disaster occurrence on conflict occurrence and the theoretical framework supporting the relationship between these variables, after controlling for other variables, disaster occurrence was not found to be statistically significantly linked to the occurrence of armed conflict in this macro-level analysis [7].

One should be careful when interpreting empirical results and make a distinction between causality and correlation. Indeed, causality can in principle run in both directions; that is, disasters can cause conflict, as well as conflicts can cause disasters. To evaluate a possible causal direction, we first regressed current conflict occurrence on the three- and six-year lags of disaster occurrence (which given the long lag-length makes them more likely to be exogenous) and on the other control variables appearing in the fuller specification (8) of Table 2. Second, we regressed current disaster occurrence on the three- and six-year lags of conflict occurrence (which, the latter, for similar reasons, are likely to be rather exogenous). In both cases, we did not find support for a statistically significant effect running in either direction. In addition, we also run a series of Granger causality tests to provide support to the aforementioned observation. We generated two new variables based on the fuller specification (8) of Table 2. We first run regressions where Conflict and Disaster Occurrence become solely regressed on the control variables of vector Z (i.e. population size, HDI, Polity IV, natural resource dependence and population density) and correspondingly saved the residuals as two new variables that now capture the unexplained components of Conflict and Disaster (i.e. the remaining parts of Conflict and Disaster that are not explained by these control factors, but which could still be explained by Disaster and Conflict, respectively). We can call these Conflict(rest) and Disaster(rest). Then we run a series of Granger causality tests, where we regressed Conflict(rest) on the lagged values of itself and Disaster: as an example, for one and four lags, the corresponding F-statistics and probabilities were (1.04 and 30.90%) and (0.82 and 51.18%) without, hence, supporting Granger-causality running from Disaster toward unexplained Conflict occurrence. Similarly, we run a series of Granger causality tests, where we regressed Disaster(rest) on the lagged values of itself and Conflict: for one and four lags, the corresponding F-statistics and probabilities were (1.19 and 27.51%) and (1.58 and 17.72%) without again supporting Granger-causality running from Conflict toward unexplained Disaster occurrence.

An additional important factor to consider here is that conflict and disaster are each treated as a singular phenomenon in this model, although, in reality, both can manifest in different ways and can have long or short manifestation periods (Demmers, 2012; Wisner *et al.*, 2004). Therefore, we next specified a model testing different indicators of disasters. Specifically, we separated out climate- and geophysical-related disasters. In an exercise to assess how robust these results are and to understand whether different types or measures of disaster might have a different association with armed conflict, we replicate the richest specification presented in Table 2 (Specification 8) with alternative disaster measures as the outcome variable. We assessed the correlations between conflict occurrence and: total number of disasters in the same year; a climate-related disaster dummy, a total number of climate-related disasters; a geophysical disasters dummy, total number of geophysical disasters; total number of individuals whose livelihoods were negatively affected; and total number of people who died or were otherwise affected as a result of disasters. In line with the findings presented above, none of these disaster variables was significantly correlated with the occurrence of armed conflict, and the results for all other control variables remained robust in terms of sign and statistical significance. This can also be seen in Table 3, where we present the correlation coefficients per disaster type once replicating the full specification (8) of Table 2.

5. Discussion and conclusion

Natural hazard-related disasters and armed conflict present a high level of co-occurrence, resulting in severe consequences for millions worldwide. Although the link between disasters and armed conflict has been researched in past decades, few quantitative studies have examined this co-occurrence, and existing quantitative work has largely been beset by shortcomings. We aimed to contribute to this line of research by conducting an in-depth quantitative analysis of the co-occurrence of disasters and conflict, assessing multiple aspects of disasters and including several operationalizations of conflict in a large country-level sample with data collected over a recent three-decade period. With a focus on the role of disasters in the manifestation of conflict, this approach allowed us to present a more robust case than has generally been seen in the past in quantitative work on this topic. Although existing qualitative studies have described how disasters may be associated with conflict in specific contexts (Heijmans, 2012; Mena and Hilhorst, 2020, 2022; Peters, 2021), the present study contributes a large cross-country econometric model that allows the analysis and comparison of data from 163 countries over the three-decade period from 1990 to 2017.

The model was built using the UCDP/PRIO Armed Conflict Database and the Centre for Research CRED EM-DAT, along with data sets including information on each country's level of development, level of democracy, population size/density and natural resources dependence as relevant control variables.

The analysis of the findings indicates that, despite the observed rise in the co-occurrence of disasters and armed conflicts, there is no statistically significant evidence to suggest that disasters are associated with a higher probability of armed conflicts – at least directly – at the macro (country) level. Instead, we find that, within the limits of this co-occurrence model, cross-country variation in armed conflict is largely explained by other preconditioning factors – namely, low levels of development, low democratic accountability and large population size, as well as by past conflict experience and resource dependence (as an additional conflict trigger). The macro-level association between disasters and armed conflict becomes statistically nonsignificant after controlling for these variables.

Understanding that there is no direct statistically significant evidence linking disasters to a higher probability of armed conflicts at the macro level has several research and societal contributions. First, together with expanding our knowledge on the topic, this study challenges previous assumptions and provides a more nuanced understanding of the complex relationship between disasters and conflicts. By identifying other preconditioning factors as major contributors to cross-country variation in armed conflict, such as development levels, democratic accountability, population size, past conflict experience and resource dependence, the research has important policy implications. It emphasizes the need for comprehensive approaches addressing underlying factors and enables more effective resource allocation for conflict prevention and resolution. The findings also contribute to a deeper understanding of the underlying dynamics driving armed conflicts and vulnerability. This study informs efforts to design interventions that address not only the immediate impacts of disasters but also the socioeconomic and political factors that contribute to conflict. It has the potential to enhance conflict prevention strategies and build resilience in disaster-prone regions.

Two reflections should be considered in the interpretation of these results. First, the findings show the importance of including additional variables in disaster–conflict models. This indicates that, instead of being directly related, disaster and conflict are related through other processes and phenomena. These additional variables are largely the dynamic pressures that result in fragile livelihoods and unsafe locations – root causes that explain disaster and conflict (separately or in interaction). Levels of development, democratic stability, dependency control and use of natural resources, therefore, are affected by and affect the manifestation of disasters and, thus, may also affect conflict dynamics.

The previous idea leads a second reflection: Disasters should be considered processes rather than discrete events. Flooded streets, collapsing buildings and injured people are the most visible elements of disasters – the onset of an event with severe consequences. However, the disaster itself is more than that; it is a long and slow process through which vulnerability is created and coping mechanisms are diminished. This process is related to historical and political decisions about how and where we live that ultimately manifest in the onset of disastrous events. From this perspective, then, a model attempting to link the onset of a disaster event with armed conflict cannot be expected to find a strong correlation – unless the model can capture the underlying processes.

Importantly, our analysis is at the macro scale and should not be interpreted as suggesting a universal understanding that can be applied across all contexts; the estimated relationships pertain to average effects based on a large sample and, thus, fail to capture varied context-specific elements that may be important. Although different conflict (and disaster) events often share certain characteristics (e.g. regarding their nature, causes and impacts), each event also has unique characteristics. For this reason, both cross-country analyses at the macro level and (qualitative and quantitative) research conducted at the micro (local and community) and meso (provincial, national and regional) levels are necessary for understanding these phenomena. Analyses at the macro scale can uncover general patterns in factors associated with conflict, whereas micro- and meso-scale analyses help with understanding deviations from these generic predictions. Future quantitative research should explore the nature of disaster–conflict relationships at a disaggregated level (e.g. by using regional within-country data) and compare their results with those presented in the present cross-country analysis.

Notes

1. These dates were selected because of data availability.
2. The Armed Conflict Data set is a joint project between the UCDP and the PRIO.
3. The CRED EM-DAT categorizes the following disasters 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 extra-terrestrial objects and space weather events. We included these disaster types in our analysis.
4. Results available from the authors upon request.
5. Table A1 in the Appendix presents a list of countries included in the analysis. Table A2 presents the correlation matrix for the key explanatory and control variables.
6. We estimated several regression models to examine the autoregressive component of conflict occurrence and its lag length. Table A3 in the Appendix presents the estimated correlations of armed conflict with its past occurrence. We found that the first three lags of the armed conflict dummy were statistically significant.

7. We also replicated all regression models in Table 2 including the Gini index as an additional explanatory variable (to account for the role of vertical inequality); however, the coefficient and marginal effect for this variable were consistently statistically nonsignificant across all estimations.

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Appendix

Continent	Region	Country	Continent	Region	Country
Africa	East Africa	Burundi	Asia	Central Asia	Kazakhstan
		Comoros			Kyrgyz Republic
		Djibouti			Tajikistan
		Eritrea			Turkmenistan
		Ethiopia			Uzbekistan
		Kenya		East Asia	China
		Madagascar			Japan
		Malawi			Republic of Korea
		Mauritius			Mongolia
		Mozambique		Southeast Asia	Cambodia
		Rwanda			Indonesia
		Tanzania			Lao People's Democratic Republic
		Uganda			Malaysia
		Zambia			Myanmar
		Zimbabwe			Philippines
	Central Africa	Angola			Singapore
		Cameroon			Thailand
		Central African Republic			Timor-Leste
		Chad			Vietnam
		Democratic Republic of Congo		South Asia	Afghanistan
		Republic of Congo			Bangladesh
		Equatorial Guinea			Bhutan
		Gabon			India
	North Africa	Algeria			Islamic Republic of Iran
		Arab Republic of Egypt			Nepal
		Libya			Pakistan
		Morocco			Sri Lanka
		South Sudan		West Asia	Armenia
		Sudan			Azerbaijan
		Tunisia			Bahrain
	Southern Africa	Botswana			Cyprus
		Eswatini			Georgia
		Lesotho			Iraq
		Namibia			Israel
		South Africa			Jordan
	West Africa	Benin			Kuwait
		Burkina Faso			Lebanon
		Cabo Verde			Oman
		Côte d'Ivoire			Qatar
		The Gambia			Saudi Arabia
		Ghana			Syrian Arab Republic
		Guinea			Turkey
		Guinea-Bissau			United Arab Emirates

(*continued*)

Table A1.
Countries included in the analysis

Continent	Region	Country	Continent	Region	Country
		Liberia			Republic of Yemen
		Mali	Americas	Caribbean	Cuba
		Mauritania			Dominican Republic
		Niger			Haiti
		Nigeria			Jamaica
		Senegal			Trinidad and Tobago
		Sierra Leone		Central America	Costa Rica
		Togo			El Salvador
Europe	Eastern Europe	Belarus			Guatemala
		Bulgaria			Honduras
		Czech Republic			Mexico
		Hungary			Nicaragua
		Moldova			Panama
		Poland		North America	Canada
		Romania			The USA
		Russian Federation		South America	Argentina
		Slovak Republic			Bolivia
		Ukraine			Brazil
	Northern Europe	Denmark			Chile
		Estonia			Colombia
		Finland			Ecuador
		Ireland			Guyana
		Latvia			Paraguay
		Lithuania			Peru
		Norway			Suriname
		Sweden			Uruguay
		The UK			Bolivarian Republic of Venezuela
	Southern Europe	Albania	Oceania	Australia and New Zealand	Australia
		Bosnia and Herzegovina			New Zealand
		Croatia		Melanesia	Fiji
		Greece			Papua New Guinea
		Italy			Solomon Islands
		Montenegro			
		North Macedonia			
		Portugal			
		Serbia			
		Slovenia			
		Spain			
	Western Europe	Austria			
		Belgium			
		France			
		Germany			
		Luxembourg			
		The Netherlands			
		Switzerland			

Source: Authors' own work

Table A1.

Table A2.
Explanatory and control variables: correlation matrix

Variables	Armed conflict occurrence dummy	Armed conflict occurrence in previous year dummy	Long-lasting conflict dummy	Human development index	Polity IV index	Population size	Population density	Natural resource rents as % of GDP	Natural disaster dummy	Total no. of natural disasters
Armed conflict occurrence dummy	1.00									
Armed conflict occurrence in previous year dummy	0.78	1.00								
Long-lasting conflict dummy	0.69	0.73	1.00							
Human Development Index	−0.25	−0.25	−0.25	1.00						
Polity IV index	−0.17	−0.17	−0.15	0.30	1.00					
Population size	0.18	0.17	0.18	0.13	0.01	1.00				
Population density	−0.03	−0.03	−0.03	−0.23	−0.00	0.02	1.00			
Natural resource rents as % of GDP	0.11	0.10	0.08	−0.12	−0.28	−0.07	−0.12	1.00		
Natural disaster dummy	0.17	0.17	0.17	−0.12	0.05	0.16	−0.09	−0.12	1.00	
Total number of natural disasters	0.23	0.23	0.23	0.00	0.02	0.72	−0.01	−0.11	0.40	1.00

Source: Authors' own work

Table A3. Probability of armed conflict in year t: marginal effects of armed conflict in previous years

Variable	Armed conflict dummy in year t (Marginal effect)	SE	p-value
Armed conflict dummy ($t-1$)	2.859	0.122	0.000
Armed conflict dummy ($t-2$)	1.128	0.145	0.000
Armed conflict dummy ($t-3$)	0.627	0.162	0.000
Armed conflict dummy ($t-4$)	0.018	0.158	0.910

Source: Authors' own work

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