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Adding Fuel to the Fire: How Weather Shocks Intensify Conflict

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ABSTRACT: Do weather shocks worsen conflict around the world? To answer this question, this paper uses an innovative dataset created by using georeferencing to match weather and conflict data at the subregional level on a monthly frequency across 168 countries over 2013 to 2022.The empirical results show that higher temperature exacerbate conflict where it already exists. Estimations indicate that, in a high emissions scenario and all else equal, by 2060 conflict deaths as a share of the population for a median country facing conflict could increase by 12.3 percent due to rising temperatures. These findings underscore the importance of integrating climate resilience into peace and security efforts and designing climate adaptation policies that support conflict prevention and resolution.

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WORKING PAPERS

Adding Fuel to the Fire: How Weather Shocks Intensify Conflict

Prepared by Sidra Rehman and Laura Jaramillo[1]

[1] This paper expands analysis discussed in IMF Staff Climate Note 2023/001 on "Climate Challenges in Fragile and Conflict-Affected States". We would like to thank Jihad Azour, Aliona Cebotari, Yoro Diallo, Rhea Gupta, Rahim Kanani, Taline Koranchelian, Yugo Koshima, Rose Kouwenhoven, Chandana Kularatne, Jeong Dae Lee, Emanuele Massetti, Catherine Pattillo, Joe Procopio, Hugo Rojas-Romagosa, Andrea Richter, Marzie Taheri, Alexander Tieman, Kalin Tintchev, Sylke von Thadden-Kostopoulos, Fang Yang and seminar participants sat the IMF for their valuable comments. The analysis on conflict intensity benefited from expertise on high frequency data and insights from Jiaxiong Yao. We are also very grateful for excellent support by Geraldine Cruz.

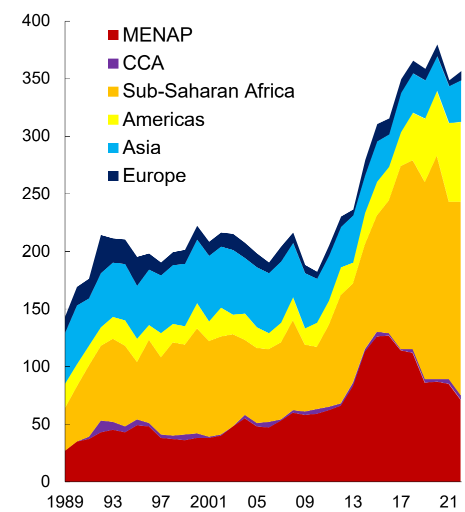
Contents

1. Introduction

Climate change is associated with increasing temperatures and erratic precipitation. The relationship between climate change and conflict has gained increasing attention from academics and policy makers alike in recent years. For instance, the COP28 declaration on climate, relief, recovery, and peace issued in December 2023 elevated the intersection of climate change, conflict, fragility, and humanitarian crises to the top policy levels at the United Nations talks. Meanwhile, the number of conflicts around the world since the early 1990s has been rising, and more sharply over the last decade (Figure 1). Possible pathways through which climate shocks can influence conflict include resource scarcity, food insecurity, displacement, and economic shocks. This paper provides insights into the effect of weather shocks—measured as fluctuations in temperature and precipitation—on conflict, to promote an understanding of the human toll and to better inform the appropriate policy responses.

We find that weather shocks—in particular higher temperatures—significantly worsen conflict. While weather shocks may not trigger the onset of new conflict (as conflicts derive from a complex range of factors), they exacerbate the intensity of conflict where it already exists. Estimations indicate that in a high emissions scenario (RCP 8.5), and all else equal, by 2060 conflict deaths as a share of the population for a median country facing conflict could increase by 12.3 percent due to rising temperatures.[1] While the results presented in this paper focusing on weather shocks cannot provide precise predictions about the impact that climate change will have on conflict, they do highlight the risks that climate change poses for peace and security. These findings underscore the importance of integrating climate resilience into peace and security efforts and designing climate adaptation policies that support conflict prevention and resolution.

Figure 1. Number of Conflicts by Region



Source: April 2024 Regional Economic Outlook: Middle East and Central Asia
CCA = Central Asia and Caucasus; MENAP = Middle East and North Africa, Afghanistan, and Pakistan.

Earlier studies and quantitative assessments of the link between climate shocks (including climate change, weather shocks, and climate-related natural disasters) and conflict have typically relied on country-year data. However, country-level data masks considerable variation in social, economic, and political conditions at the subregional level. Few studies that have used within country data typically focus on specific regions, in particular Africa. Annual data may also miss capturing important within year dynamics at the subregional level, including temperature and precipitation shocks of different durations. In addition, most

[1] It is important to note that there is considerable uncertainty around the global emissions trajectory as well as long-term climate and macroeconomic modeling. Predicting future emissions is inherently extremely uncertain, including because of the rapid rate of technological progress. For illustrative purposes, this note draws on models in the Intergovernmental Panel on Climate Change Sixth Assessment Report for a high emissions scenario (Representative Concentration Pathway (RCP) 8.5) and a low emissions scenario (RCP 2.6). RCP 8.5 is on the higher end of the range of possible baseline scenarios that assumes absence of global mitigation efforts in the context of high economic growth and thus high emissions.

studies have looked at the onset or incidence of conflict using a dichotomous conflict variable, which does not take into account that the intensity of conflict is different across subregions and changes over time.

Against this backdrop, this paper extends the existing literature along several dimensions: (1) to leverage within country heterogeneity, the analysis uses a unique high-frequency database with 300,480 observations that uses georeferencing to match data for 2,504 subregions across 168 countries (including advanced, emerging, and low-income countries); (2) it takes into account within year dynamics at the subregional level by using data at a monthly frequency between 2013 and 2022; and (3) the analysis looks at conflict intensity at the subregional level (defined as the number of conflict-related deaths as a share of the population), which also has significant variation across and within years.

The remainder of this paper is structured as follows. Section 2 provides a literature review and discusses the pathways through which climate shocks affect conflict. Section 3 explains the data and the empirical approach. Section 4 discusses the empirical results and robustness checks. Section 5 concludes.

2. Pathways Through Which Climate Shocks Affect Conflict

The linkages between climate shocks and conflict are complex and multifaceted. While the existing empirical literature does not provide strong evidence that climate shocks (including climate change, weather shocks, and climate-related natural disasters) affect the onset of conflict, studies suggest climate shocks can enhance conflict duration, severity, and intensity.[2] The meta-analysis by Burke, Hsiang, and Miguel (2015) shows that deviations from moderate temperatures and precipitation patterns systematically increase conflict risk. Ghimire and Ferreira (2016) find that, while large floods did not ignite new conflict, they fueled existing armed conflicts. Hendrix and Salehyan (2012) and Miguel, Satyanath, and Sergenti (2004) show that rainfall variability has a significant effect on instances of conflict in Africa. For East Africa, O'Loughlin and others (2012) find that much warmer than normal temperatures raise the risk of violence and wetter deviations from the precipitation norms decrease the risk of violence.

Furthermore, studies imply that climate-related disasters can heighten political unrest or armed conflict risk if conducive conditions coexist, including socioeconomic, political, and governance factors. IPCC (2022) recognizes that climate change does contribute to increased conflict, though depending on a variety of interconnected factors—including socio-economic conditions, governance, and political factors. The literature review by Koubi (2019) shows that climatic conditions breed conflict in regions dependent on agriculture and in interaction with other socioeconomic and political factors such as a low level of economic development and political marginalization. Ide and others (2020) find that climate-related disasters increase the risk of armed conflict onset in countries with large populations, political exclusion of ethnic groups, and a low level of human development. Von Uexkull and others (2016) show that for agriculturally dependent groups as well as politically excluded groups in very poor countries, a local drought increases the likelihood of sustained violence. Nel and

[2] For instance, several studies find no direct relationship between drought and civil conflict onset in Africa (Theisen, Holtermann, and Buhaug 2012; Owain and Maslin 2018) or Asia (Wischnath and Buhaug 2014, Petrova 2021). Bergholt and Lujala (2012) find that more frequent and severe climate-related disasters will not lead to more armed conflicts through their effects on GDP growth. See also Scartozzi (2021).

Righarts (2008) find that natural disasters significantly increase the risk of violent civil conflict, specifically in low- and middle-income countries that have intermediate to high levels of inequality, mixed political regimes, and sluggish economic growth.

The literature also identifies several pathways through which climate shocks can influence conflict:

- **Resource scarcity**: Unequal distribution of resources, unequal vulnerability to climate impacts, and differential access to adaptation measures can exacerbate existing social divisions and contribute to conflicts. Climate change affects the likelihood of intragroup violence via the scarcity of renewable resources such as freshwater, arable land, forests, and fisheries (Koubi 2019, Borchmann and Gleditsch 2012). For example, shifts in rainfall patterns and desertification in the Sahel have intensified competition for resources, reinforcing long-existing rivalries and communal violence (Signé and Mbaye 2022; World Bank 2020). Perceptions of unequal distribution of disaster-related vulnerability or unequal distribution of relief and reconstruction support can fuel conflict by intensifying pre-existing inequalities (Wisner and others, 2004).

- **Food security:** Changes in climate patterns can negatively impact agricultural productivity, leading to food insecurity, which can cause social unrest and lead to conflict. Harari and La Ferrera (2018) and Johnstone and Mazo (2011) look at this channel for countries in Africa and the Middle East and North Africa region. Baptista and others (2022) find that the intensifying effects of climate change exacerbate food insecurity, reversing years of progress in health and educational achievements in sub-Saharan Africa.

- **Displacement:** Migration arising from climate shocks can lead to increased competition in both host communities and areas of origin, escalating conflict in already strained social and economic systems (Abel and others 2019; Global Center for Adaptation 2022). Climate-induced migration, especially in developing countries, might exacerbate the likelihood of conflict since these countries typically find it more difficult to absorb and manage an influx of migrants in urban settings (Reuveny 2007). Disaster-related migration flows that can accelerate competition for resources and exacerbate ethnic animosities in the receiving regions (Brzoska and Fröhlich 2016).

- **Economic shocks:** Climate change can cause significant economic shocks that destabilize countries. For instance, climate-related natural disasters can severely damage infrastructure and reduce economic productivity, leading to unemployment and social unrest. Climate shocks reduce incomes and exacerbate poverty, thus leading to more violence, conflict, and political instability (Burke and others 2009). Output contractions due to climate shocks could also shrink government coffers, limiting the resources available to provide support to those hard hit and deliver public goods and services more generally.

3. Data and Empirical Approach

The analysis in this paper is based on a novel data set created using georeferencing to match high-frequency data on conflict, climate, population, and night-light data (as a proxy for economic activity). Matching is done on a monthly frequency at the subregional level (2,504 subregions) across 168 countries (including advanced, emerging, and low-income countries) over 2013–2022, for a total of 300,480 observations. Specifically, the following indicators are used:

- **Conflict**: The conflict data used in this note is the Uppsala Georeferenced Event Dataset compiled by the Uppsala Conflict Data Program. This data set provides comprehensive information on conflict-related deaths covering the entire world at a geographically disaggregated level. Each conflict event has a pair of coordinates to identify where it occurred. On the fatalities of each event, there are three estimates in the conflict data: a low estimate, a best estimate, and a high estimate. Throughout our analysis, we use the best estimate of fatalities.

- **Population**: Population data are important for normalizing the scale of conflict. The Gridded Population of the World (version 4) is used to calculate population at the subregional level. The Gridded Population of the World only covers the years 2000, 2005, 2010, 2015, and 2020.

- **Conflict intensity**: This measure is the main dependent variable and is constructed on the basis of conflict and population by calculating total fatalities per capita at the subregional level. Figure 2 shows how conflict intensity has evolved over time in selected countries.

Figure 2. Conflict Intensity in Select Countries, 2013–22
(Conflict deaths per million people)

Sources: Uppsala Conflict Data Program, Gridded Population of the World (version 4), and authors' calculations.
Note: Countries selected for this figure are those with conflict intensity above the 85th percentile of the sample distribution or countries classified as fragile and conflict affected states (FCS) as per the World Bank's FCS list.

- **Climate variables**: Both precipitation and temperature data are taken from the Climatic Research Unit Gridded Time Series, which is a widely used climate dataset on a 0.5-degree latitude by 0.5-degree longitude grid over all land domains of the world (except Antarctica). It is derived by the interpolation of monthly climate anomalies from extensive networks of weather station observations.[3]

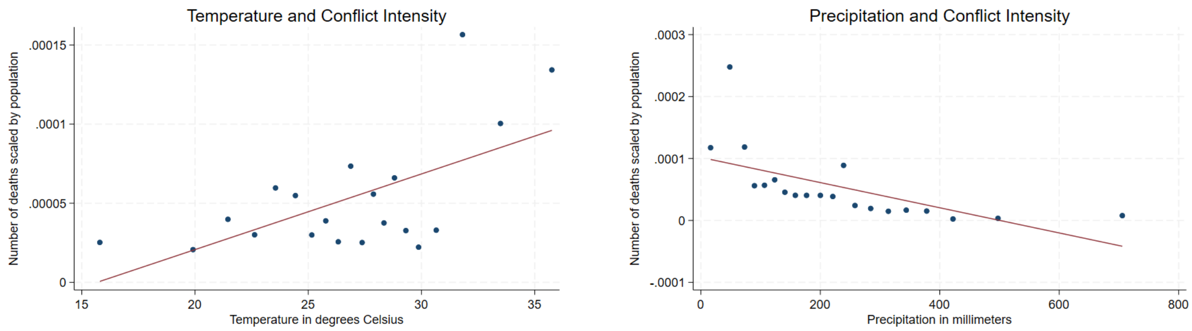
[3] Papers in the literature use a variety of climate measures. Burke, Hsiang, and Miguel (2015) and Scartozzi (2021) list a number of papers that use temperature and precipitation when looking at the link between climate and conflict.

- **Nighttime lights**: This data, used as a proxy for economic activity, is based on the Visible Infrared Imaging Radiometer Suite onboard the Suomi National Polar-orbiting Partnership satellite at a monthly frequency at a regional level. Nighttime lights are included in the regression analysis as a robustness check as a potential confounding factor.

Figure 3 illustrates the correlation between conflict intensity and temperature and precipitation levels across the sample. Conflict intensity tends to be higher when temperatures are high and when precipitation is low. Figure 4 further illustrates this correlation with the examples of Afghanistan, Burkina Faso, Nigeria and Somalia.

Figure 3. Temperature, Precipitation, and Conflict Intensity

(Binned scatter plots)



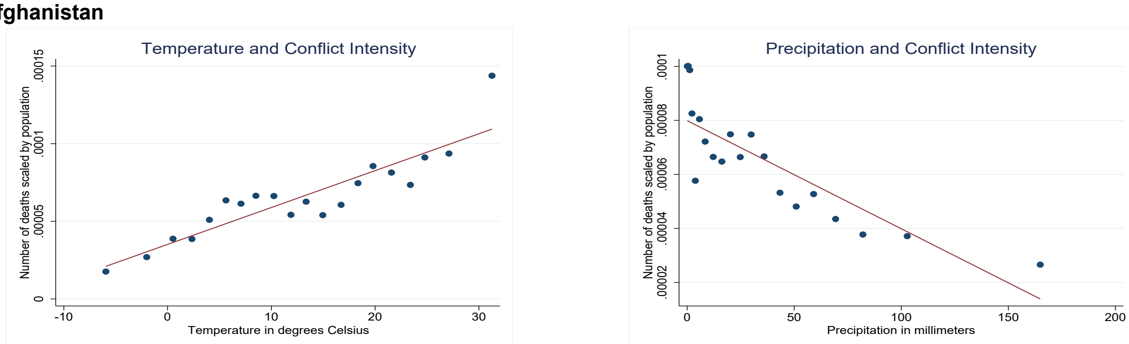
Source: Uppsala Conflict Data Program, Gridded Population of the World (version 4), and authors' calculations.

Note: To visualize the 300,480 observations in the dataset (that corresponds to 2,504 subregions across 168 countries at a monthly frequency between 2013 and 2022), the binned scatter plot groups the x-axis variable into 20 equal-sized bins (15,024 observations in each bin), computes the mean of the x-axis and y-axis variables within each bin, and creates a scatter plot of these data points. Conflict intensity is defined as the number of conflict-related deaths as a share of the population.

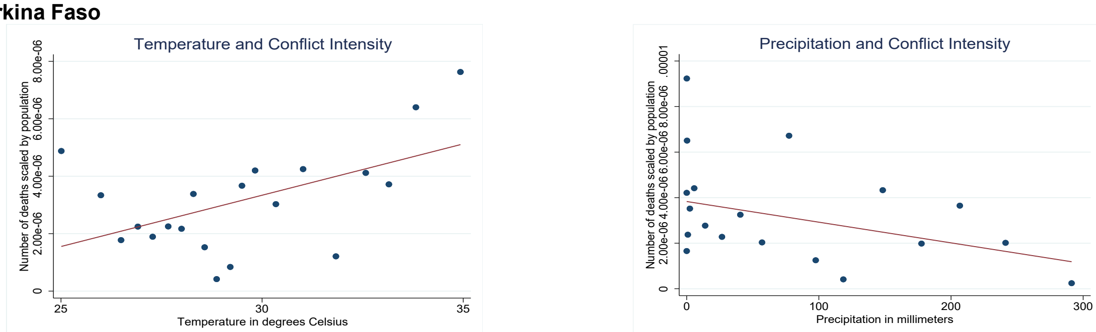
Figure 4. Temperature, Precipitation, and Conflict Intensity in Selected Countries

(Binned scatter plots)

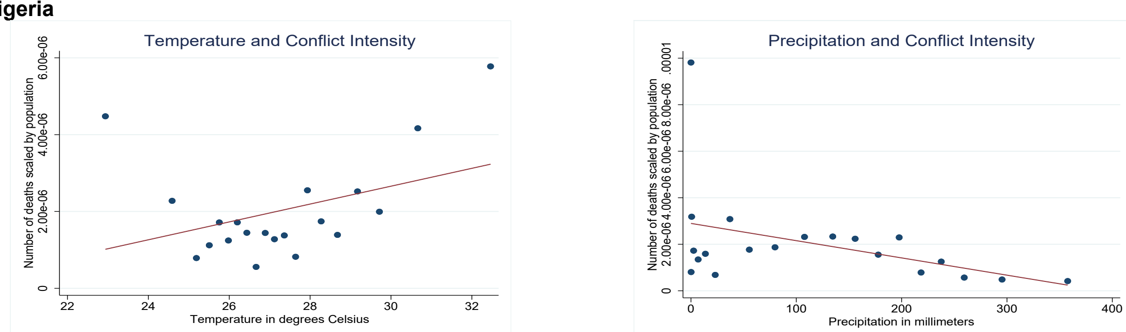
Afghanistan



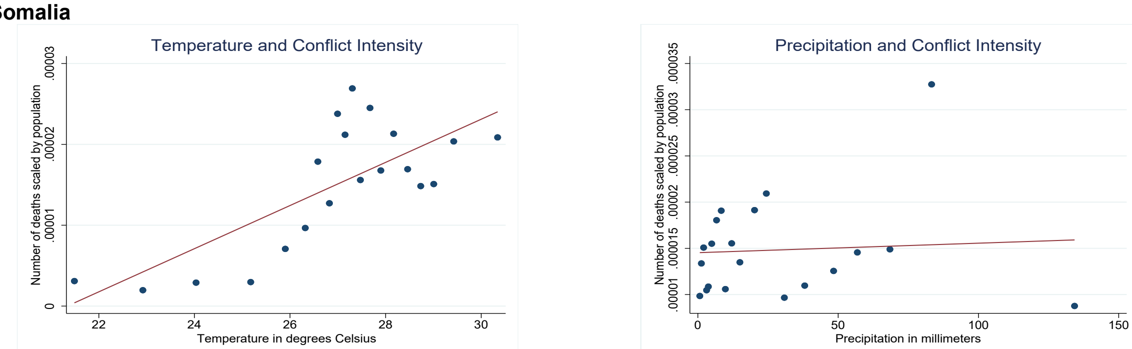
Burkina Faso



Nigeria



Somalia



Source: Uppsala Conflict Data Program, Gridded Population of the World (version 4), and authors' calculations.

Note: The binned scatter plot groups the x-axis variable into 20 equal-sized bins, computes the mean of the x-axis and y-axis variables within each bin, and creates a scatter plot of these data points. Includes monthly data between 2013-2022.

To empirically test the relationship between weather shocks and conflict, a panel regression model with the following specification is employed:

$$Conflict_{st} = \beta Weather_{st} + \theta X_{st} + \alpha_s + \delta_t + \varepsilon_{st},$$

where the dependent variable $Conflict_{st}$ is a continuous variable (in log) measuring conflict intensity (number of conflict-related deaths as a share of the population); $Weather_{st}$ includes the relevant climate variables, namely temperature and precipitation (in log); X is nighttime lights which serves as a control variable (in log)[4]; α are subregion fixed effects that capture regional factors, and δ are time-country fixed effects that capture time-varying common shocks at the country level.[5] The subregion fixed effects control for all characteristics at the subregional level that are time-invariant (such as culture and geography), so that the effect of *Weather* on *Conflict* is identified purely based on time- rather than cross-sectional information. The time-country fixed effects, in turn, imply that the effect of changes in *Weather* on changes in *Conflict* are isolated from any effects that are common to all the subregions in a given country in a given month and year (including political, socioeconomic and governance factors). Standard errors are clustered at the subregional level.

4. Empirical Results

The empirical analysis shows that, where conflict exists, higher temperatures exacerbate conflict intensity (Table 1). Regressions results testing if changes to temperature and precipitation explain the incidence of conflict were not statistically significant. This is as expected, as conflict situations derive from a complex range of factors, such as governance, social dynamics, politics, historical conflicts, and socioeconomic conditions. However, when the regression was applied to the sample of subregions where conflict already exits (conflict intensity is greater than zero), a strong significant relationship was found between temperature and conflict intensity. Panel regressions on a monthly frequency show that a 1 percent increase in temperature is associated with a 0.2 percent increase in conflict intensity at the subregional level (Table 1, column 4).[6] Annualizing these results show that, in a high emissions scenario (RCP 8.5) and all else equal, by 2060 conflict deaths as a share of the population for a country already facing conflict could increase by 12.3 percent due to rising temperatures.[7] Higher temperatures can influence conflict through resource scarcity, food insecurity, displacement, and economic shocks—as discussed in Section 2—though a separate analysis would be needed to shed light on the specific pathways. Note that these results underestimate the destructive impact of conflict that does not result in higher deaths, including destruction of human and physical capital.

[4] The regression specification including nighttime lights is not taken as the baseline because it is possible that the nighttime lights are themselves affected by climate variation.

[5] Alternative specifications are tested including time fixed effects and country fixed effects separately (Table 1, columns 1-3).

[6] The empirical results are consistent with findings in the literature. However, as discussed in Section 2, this paper is unique in its use of a continuous conflict intensity variable at high-frequency and at the subregional level across a large set of countries, therefore the coefficients are not directly comparable to previous findings in the literature. Burke and others (2009), O'Loughlin and others (2012), and Landis (2014) all find a significant positive relationship between temperature and conflict, based on country-year regressions using a dichotomous variable for conflict onset or incidence.

[7] Estimates are based on the median effect in the subsample of fragile and conflict affected states (FCS). FCS are defined based on the World Bank's FCS list.

Meanwhile, precipitation is not found to be significantly associated with conflict intensity once controlling for time-country fixed effects (Table 1, column 5). Possible explanations of why precipitation does not significantly impact on conflict maybe because of opposing effects. On one hand, exceptionally dry conditions increase the risk of conflict because of the impact on resource scarcity, agriculture incomes, and food security. On the other, extremely wet conditions can damage public infrastructure, destroy crops and livestock, and can worsen scarcity that can lead to conflict.

These results are robust to alternative specifications (Table 2). The results are robust to including the temperature and precipitation variables in the regression at the same time. The results are robust to adding economic activity at the regional level as an additional control variable—proxied by nightlight data (Table 2, columns1-3). The results are also significant when using alternative subsamples: (1) only using a sample of low-income countries (Table 2, columns 4-6); (2) only using a sample of emerging market economies (Table 2, columns 7-9).

Table 1. Impact of Weather Shocks on Conflict: Baseline Results

	1	2	3	4	5	6
Temperature	0.121***		0.098**	0.175***		0.166***
	(3.25)		(2.44)	(0.05)		(0.05)
Precipitation		-0.026***	-0.015**		0.006	0.001
		(-4.30)	(-2.43)		(0.01)	(0.012)
Constant	-12.390***	-11.936***	-12.276***	-12.53***	-12.01***	-12.50***
	(-111.41)	(-645.40)	(-96.27)	(0.15)	-0.04	(0.16)
Observations	18,024	18,010	17,645	16,947	16,942	16,577
R-squared	0.661	0.661	0.664	0.781	0.781	0.783
Time FE	YES	YES	YES			
Subregion FE	YES	YES	YES	YES	YES	YES
Time X Country FE				YES	YES	YES

Note: Robust *t*-statistics in parentheses. ****p* < 0.01, ***p* < 0.05, **p* < 0.1. FE = fixed effects.

Table 2. Impact of Weather Shocks on Conflict: Robustness Checks

	Controlling for Economic Activity			Sample of only Low Income Countries			Sample of only Emerging Market Countries		
	1	2	3	4	5	6	7	8	9
Temperature	0.207***		0.199***	0.168***		0.152***	0.200**		0.182*
	(0.052)		(0.05)	(0.06)		(0.06)	(0.10)		(0.10)
Precipitation		0.008	0.003		0.038	0.024		-0.023	-0.019
		(0.02)	(0.01)		(0.05)	(0.02)		(0.02)	(0.02)
Nighttime Lights	-0.067**	-0.070**	-0.066**						
	(0.03)	(0.03)	(0.03)						
Constant	-12.13***	-11.50***	-12.12***	-11.70***	-11.29***	-11.71***	-13.31***	-12.65***	-13.21***
	(0.33)	(0.27)	(0.34)	(0.17)	(0.06)	(0.18)	(0.29)	(0.05)	(0.30)
Observations	15,435	15,425	15,074	7,935	8,073	7,816	9,012	8,869	8,761
R-squared	0.791	0.791	0.793	0.662	0.656	0.661	0.806	0.808	0.808
Subregion FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time X Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: Robust *t*-statistics in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. FE = fixed effects.

5. Summary and Conclusions

This paper show that weather shocks—in particular higher temperature—significantly worsen conflict. The analysis is based on a unique dataset that leverages within country and within year heterogeneity that uses georeferencing to match data for 2,504 subregions across 168 countries at a monthly frequency between 2013 and 2022. Importantly, the analysis looks at conflict intensity, which differs across subregions and varies across and within years. The results show that, while weather shocks may not trigger the onset of new conflict (as conflicts derive from a complex range of factors), they exacerbate the intensity of conflict where it already exists. Estimations indicate that in a high emissions scenario, and all else equal, by 2060 conflict deaths as a share of the population for a median country facing conflict could increase by 12.3 percent due to rising temperatures.

The results presented in this paper focusing on weather shocks cannot provide precise predictions about the impact that climate change will have on conflict, Nonetheless, these results highlight the risks that climate change poses for peace and security. This underscores the importance of integrating climate resilience into peace and security efforts and designing climate adaptation policies that support conflict prevention and resolution. Further work will be needed to better understand the pathways through which climate shocks influence conflict and to identify specific policies and climate-resilience interventions that can help countries mitigate conflict.

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