The impacts of climate change on violent conflict risk: a review of causal pathways

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Abstract

The potential impacts of climate change on violent conflict are high on the agenda of scholars and policy makers. This article reviews existing literature to clarify the relationship between climate change and conflict risk, focusing on the roles of temperature and precipitation. While some debate remains, substantial evidence shows that climate change increases conflict risk under specific conditions. We examine four key pathways through which climate affects conflict: (i) economic shocks, (ii), agricultural decline, (iii) natural resources competition, and (iv) migration.

Key gaps include limited long-term data, insufficient integrated studies, and the inadequate understanding of causal mechanisms, necessitating transdisciplinary research that addresses social vulnerability and underlying pathways.

Keywords

climate change; violent conflict risk; causal pathways

1. INTRODUCTION

Violent conflict has been and will remain a serious global issue despite the commitment of the United Nations to promote peace through achieving Sustainable Development Goals (SDGs), in particular SDG #16 (Nations 2015). According to the Geo-referenced Event Dataset (GED) (version 20.1) of the Uppsala Conflict Data Program's (UCDP) database statistics, there were estimated to be more than 2.86 million deaths from 1989 to 2021 (Pettersson *et al* 2021) due to armed conflict. Such conflicts of a violent nature may endanger lives and cause considerable damage, and though heterogeneous in nature, can be driven by similar risk factors (Trinn *et al* 2021).

In previous research, some studies suggested that conflict risk is associated with climate change, particularly in countries or regions highly dependent on agriculture for income and food production (Ide *et al* 2020, von Uexkull *et al* 2016). Others showed a higher probability that in cases in which social capital for adaptation is limited and society is more sensitive to climate change, such greater vulnerability leads to a higher probability of climate shocks translating into conflict risks (Buhaug *et al* 2021). Such societies may be locked in a vicious circle that traps them in conflict, vulnerability, and climate change impacts (Buhaug et al. 2021). It is

thus imperative to clarify and understand the impacts of climate change on conflict risk, especially in currently vulnerable regions, to design policies responding to conflict and mitigating future conflict risk.

Research on the climate-conflict link increasingly emerged around the year 2007 and rapidly gained traction in the last decade. According to some authors, there are over 1,000 studies in the broader research field (Sharifi *et al* 2021). A number of review articles take stock of and provide an overview about research on climate change and conflicts. Some of these reviews focus on particular aspects, such as research methods (Ide 2017, Selby *et al* 2014), expert opinions (Mach *et al* 2019), or blind spots of the research field (Adams *et al* 2018, Scartozzi 2021). Several other review articles deal with evidence on a climate-conflict nexus more broadly (Hsiang *et al* 2013, Koubi 2019, Scheffran *et al* 2012). Meanwhile, research on the topic has evolved rapidly, even since the last IPCC report in early 2022 (Ide 2023, Koren *et al* 2023, Michelini *et al* 2023, von Uexkull *et al* 2023).

This article contributes to the ongoing discourse by offering a comprehensive review of the latest evidence on climate change and conflict risk, focusing specifically on temperature and precipitation. In contrast to previous reviews, we further explore the potential causal pathways—economic shocks, agricultural decline, resource competition, and migration—that link climate change to violent conflict (Koubi 2019, van Baalen 2021). Our primary objective is to clarify these pathways and identify research priorities to deepen understanding of the climate-conflict relationship.

The literature reviewed in this paper was gathered from databases such as Scopus and Web of Science using search terms related to climate change and violent conflict. We focused on violent conflict within states—such as civil wars, community violence, and riots—as the literature suggests that climate-related

interstate conflict is less likely (Helman *et al* 2020, Mach et al. 2019, O'Loughlin *et al* 2014).

2. IS THERE A SIGNIFICANT IMPACT OF CLIMATE CHANGE ON CONFLICT RISK?

A large and increasing number of studies have explored the potential causal links between climate change and conflict, mainly focusing on short-term climate variability related to temperature and precipitation. While the latter are affected by long-term climate changes, we discuss the need to focus more on the conflict implications of climatic changes (rather than variability) below.

2.1 The impact of temperature on conflict risk

Research on the linkage between temperature and conflict has been conducted on various scales. At the individual level, psychological or physiological links have been claimed between temperature and conflict (Miles-Novelo *et al* 2019). Psychologists and sociologists have examined how uncomfortable temperatures could affect the thoughts, emotions, and aggressive behaviors of individuals, indicating that heat might have a negative effect and inspire violent feelings (Anderson *et al* 2000). Several psychological theories offered interpretations of such results. For example, the general aggression model (GAM) stated that the stimulation from the environment (e.g. temperature) could raise levels of individual irritability and thus increase their aggressiveness (DeWall *et al* 2011). The prominent routine activity theory (RAT) proposed that high temperatures would likely increase the frequency of interactions between people, thereby raising the chance of interpersonal violence (Anderson *et al* 2002).

To verify whether these phenomena observed in micro settings would translate to a larger level and to inter-group conflict, scholars have conducted several studies. On the global scale, a few analyses showed that rising temperatures are associated with the increasing probability of conflict (Ge *et al* 2022). On the regional scale, some researchers have found a similar association between higher temperatures and various forms of conflict risks (Wang *et al* 2022). Examples include Burke et al. (2009) for sub-Saharan Africa and Hsiang et al. (2011) for countries affected by El Nino-La Nina cycles. These findings were, however, heavily contested (Buhaug 2010, Buhaug *et al* 2014). Other studies also suggested rather limited impacts of temperature on the risk of various types of conflict (Bernauer *et al* 2012, Klomp *et al* 2013, Yeeles 2015).

In addition to these debates, it is important to consider the varying levels of temperature increases and their differential impacts on conflict. While moderate temperature rises have been linked to increased interpersonal violence, such as violent crime, extreme temperature events—like heatwaves—might lead to larger social disruptions or intensify resource-driven conflicts between groups(Hsiang et al. 2013). However, identifying the specific thresholds or tipping points where temperature increases significantly escalate conflict remains an ongoing challenge and an important area for further research(Scheffran et al. 2012).

In recent years, more nuanced datasets with a higher spatial and temporal resolution facilitated a new series of studies (Guo *et al* 2024, Thalheimer *et al* 2023), several of which find an effect of higher temperatures on conflict risks, for instance in tropical regions (Wang et al. 2022), Asia (Hao *et al* 2022), or Africa and the Middle East (Abdi *et al* 2023, Helman et al. 2020). However, the substantial effect is often small. Furthermore, validating the effects of temperature on conflict risks via process

tracing and specific pathways remains challenging. This makes it difficult to substantiate the statistical signal with clear causal evidence of a link between heat and conflict, and further strengthens the need to focus on causal pathways underlying the climate-conflict nexus (see section 3).

2.2 The impact of precipitation on conflict risk

Similarly, research on the effects of precipitation on conflict has evolved significantly in recent years. Just as for temperature, early scholarship was deeply divided. Several analyses found that droughts increase resource scarcity, dampen economic growth, worsen food insecurity, and are hence associated with a higher likelihood of violent conflict (Maystadt *et al* 2015, Maystadt & Ecker 2014, Raleigh *et al* 2015, von Uexkull 2014). Yet, other analyses failed to confirm such a link (Couttenier *et al* 2014, Theisen *et al* 2011, Wischnath *et al* 2014, Yeeles 2015).

Recent studies are more moderate and nuanced in their conclusions (Damette *et al* 2023, Karesdotter *et al* 2023, Petit *et al* 2023). There is an increasing scholarly consensus that droughts and precipitation declines enhance the risks of various forms of conflict, with a generally stronger impact on communal violence and riots than on high-intensity civil wars (Unfried *et al* 2022). However, climate-related precipitation declines are not the most important conflict drivers, and a drought-conflict nexus only manifests if a number of contextual factors are present. The latter include the absence of wells, dams, and irrigation infrastructures (Detges 2016, Mary 2022), agricultural dependence and ethnic discrimination (von Uexkull et al. 2016), and pre-existing grievances and a lack of proper state action (Ide *et al* 2021), among others. The presence of a drought-conflict nexus is further indicated by micro-level evidence suggesting that during droughts, altruism decreases (Döring *et al* 2023),

outgroup hostility is more explicit (Chung *et al* 2022), and people are more likely to support the use of political violence (Detges 2017, von Uexkull et al. 2023).

Two important qualifications are due here. First, increased precipitation can also make violent conflict more likely in certain settings. It allows rebels to live off the land and feed their fighters (Schon *et al* 2023b), can trigger the targeting of rich agricultural areas by state forces (Koren et al. 2023, Selby et al. 2014), or allow cattle raiders to hide in dense vegetation while their tracks are washed away (Adano *et al* 2012). Furthermore, climate change is also predicted to increase rainfall in some regions (IPCC 2022), potentially even leading to floods (see section 2.3).

Second, just because drought makes conflict onset or incidence more likely, this does not mean that there are deterministic linkages between droughts and conflicts. There have been very strong claims, for instance, about droughts driving the onset of the Syrian civil war (Kelley *et al* 2015) or political instability around Lake Chad. Studies like those by Selby et al. (2017), Daoudy (2020), Selby et al (2022), and Daoust and Selby (2022) played an important role in debunking and nuancing such claims about droughts and violent conflict. Recent evidence suggests, however, that unusually low rainfall was at least one conflict driver (interacting with others, presumably more important) both in Syria (Ash *et al* 2020, Dinc *et al* 2023) and Western Africa (Newman *et al* 2023).

2.3 The impacts of weather extremes on conflict risks

There is considerable evidence that climate change increases the frequency of extreme weather events like storms, floods, heatwaves, landslides, or droughts (the latter is discussed in section 2.2). When such hazards hit vulnerable societies, they

often have disastrous consequences in terms of deaths and destruction (Boccard 2021).

Researchers have long-studied the impacts of climate-related disasters on violent conflict risks. Initially, the results were inconclusive and contradictory. For instance, Nel and Righarts (2008) and Berrebi and Ostwald (2011) find that disasters increase the likelihood of armed conflict onset and terrorist attacks. The results of Nardulli et al. (2013) are more mixed, while Omelicheva (2011) and Slettebak (2012) conclude that there is no evidence for a disaster-conflict nexus.

In recent years, more consistent evidence has appeared (Dinc *et al* 2024, Mitchell 2024). Scholars now mostly agree that climate-related disasters increase violent conflict risks, but only under certain circumstances. Both Walch (2018) and Ide (2023), for instance, point out that when disasters negatively affect conflict parties, fighting is unlikely to escalate, and rather tends to de-escalate in the short-term. However, if the disaster weakens the state or benefits of a rebel group, the latter tend to upscale their violent efforts. In line with this, but focusing on pro-state actors, Eastin and Zech (2022) present evidence that disaster-induced poverty facilitates recruitment campaigns by community militias in the Philippines.

Going beyond conflict intensity, research by Schleussner et al. (2016) and Ide et al. (2020) finds that climate-related disasters like floods or storms increase the risk of armed conflict incidence and onset if certain conditions are present, such as ethnic exclusion, ethnic heterogeneity, and low levels of human development. There is also ample evidence of protests and riots occurring after governments mishandling disaster preparation and relief (Ide et al. 2021, Petrova 2022). Climate-related disasters can also prolong civil wars if they give the conflict parties time and opportunities to regroup or if inflowing aid is diverted for military purposes (Eastin

2016). However, evidence on a disaster-conflict duration link is limited and does not hold when, for instance, disasters destroy the resource base of the rebels (Tominaga *et al* 2021).

3. HOW DOES CLIMATE CHANGE AFFECT CONFLICT RISK?

The above results show that a majority of experts and studies now agree that climate change increases violent conflict risks, even though it is usually not the most important conflict driver. Rather, climate change amplifies existing conflict risks in contexts already prone to violent confrontations. In line with this, several older studies looking for a general association between climate and conflict were unable to detect a relationship (Bernauer et al. 2012, Buhaug 2010). However, many newer studies using more fine-grained data and focusing on relevant context factors have supported the existence of a climate-conflict nexus (Ide 2023, Koubi *et al* 2021, von Uexkull et al. 2016).

In this section, we focus on four key pathways that link climate change to conflict risk, drawing on our extensive review of the literature and the relevant causal pathways attracting the most attention (Figure 1): (i) economic shocks, (ii) agricultural decline, (iii) natural resource competition, and (iv) migration. Synthesizing relevant causal pathways is important for at least three reasons. Firstly, as highlighted by Mach et al. (2019), “the mechanisms of climate–conflict linkages remain a key uncertainty”. Secondly, a more explicit consideration of causal pathways allows future studies to better specify the context factors that are conductive to the emergence (or absence) of climate-conflict links. Thirdly, understanding not only whether and when, but also how climate change impacts conflict risks is crucial for designing adequate policy responses (Abrahams 2020).

Before we proceed, it is important to note that the pathways to conflict discussed here can also be triggered by non-climate-related events (e.g., pandemics can trigger economic shocks, and war can result in large-scale migration). Here, we focus specifically on how these pathways have been discussed (and the corresponding evidence produced) in the climate security literature. Furthermore, the pathways can overlap and interact to some degree, and can hence amplify or dampen each other (Scheffran et al. 2012).

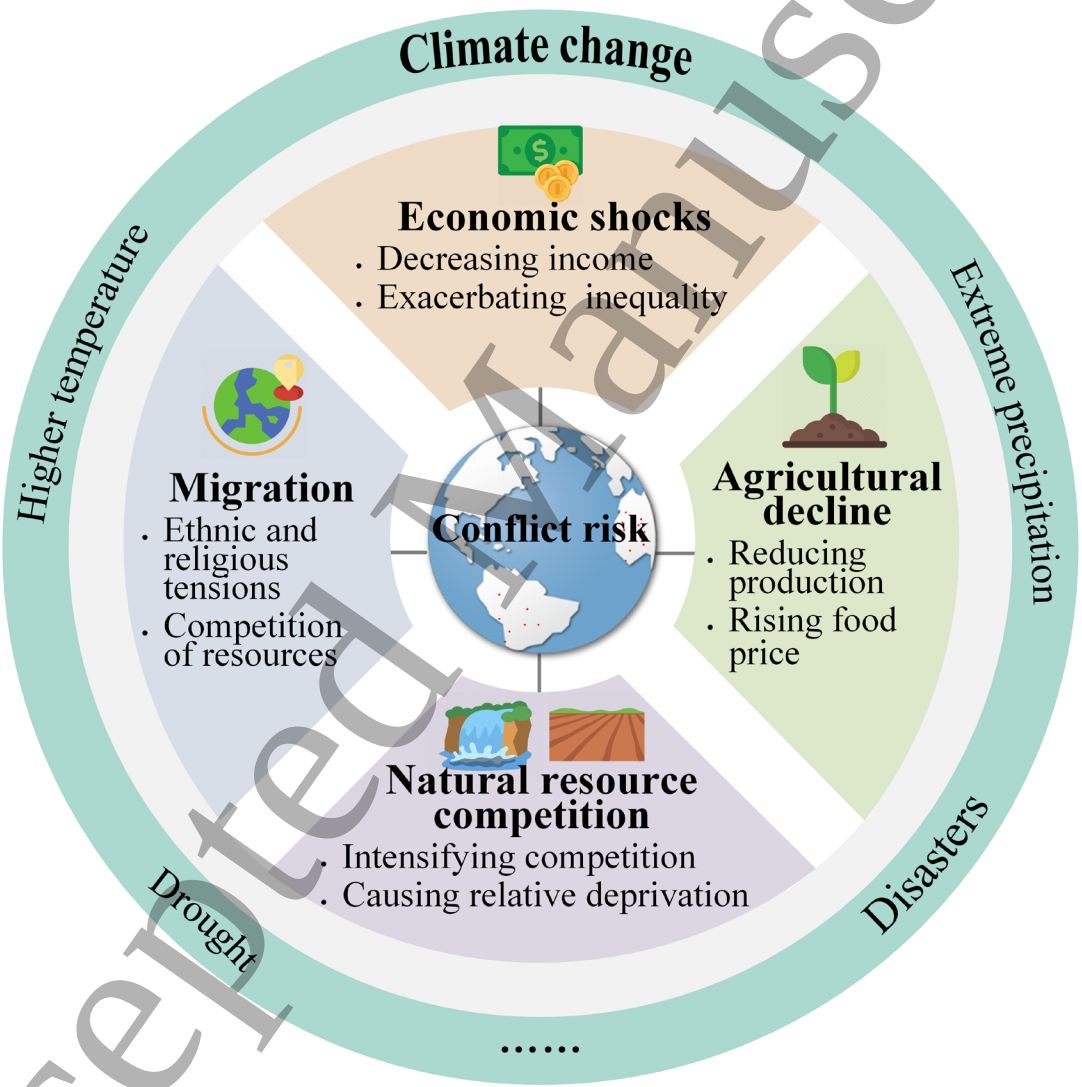

Figure 1. The impacts of climate change (e.g., higher temperature, drought, extreme precipitation, and disasters) on conflict risk can be amplified through economic shocks, agricultural decline, natural resources competition, and migration.

3.1 Economic shocks

Economic changes constitute one of the most important mediators that link climate change to conflict risk. Climate change, especially in the form of higher temperatures, lower precipitation, or changes in the intensity and frequency of extreme weather events, might affect agricultural productivity, economic growth, and development (Burke *et al* 2015, Zhang *et al* 2024). Consequently, the declining economic activity would exacerbate inequality and destabilize the state, as well as reducing the opportunity cost of participating in a rebellion, which are all incentives for conflict.

More specifically, when economic shocks induced by climate change cut deeply into personal income from legal production (e.g. planting corn and wheat), the opportunity cost of joining an ongoing conflict thus becomes lower (Wischnath et al. 2014). For example, a severe drought devastated agricultural production in Syria, leading to significant rural distress and mass migration to urban areas. This contributed to social tensions and played a role in the outbreak of the civil war (Kelley et al. 2015). In such situations, participation in conflict is rated more attractive when individuals (especially low-income groups) expect to earn more from criminal or insurgent activities than from lawful and peaceful ones (Chassang *et al* 2009, Koubi *et al* 2012). Several researchers tested this argument using different methods. Miguel et al. (2004) found that decreased rainfall can reduce national economic growth and hence increase the likelihood of civil war onset. Maystadt and Ecker (2014) showed that the reduction of income in the livestock sector is associated with an increased incentive to participate in violent conflicts. Burke and Leigh (2010) and Brückner and Ciccone (2012) demonstrated that output contraction caused by adverse weather shocks creates opportunities for democratic regime change, as

seen during the Arab Spring, where economic downturns fueled popular uprisings across the region. A few other studies have also found similar results when examining the links of climate change with civil conflict onset (Burke et al. 2009, Ide et al. 2020), ethnic riots (Bohlken *et al* 2010), and various types of conflict (Hendrix *et al* 2012).

Further research indicated that inequality can exacerbate the adverse effects of climate change on conflict (Gupta *et al* 2023). When climate change affects the economy, it is unlikely to equally affect all individual/household incomes within a country (Canavan *et al* 2024). Naturally, less developed regions or households would suffer economically from climate change much more than rich regions or households (Lomborg 2020, Moore *et al* 2015). The state might also prefer some groups in its response to climate and economic crises over others. Therefore, climate-driven economic downturns might amplify income and social inequalities (Ujunwa *et al* 2021), putting the poor populations in an increasingly vulnerable situation and raising their grievances. The resulting polarization might incentivize these individuals/groups to seize political power by force to redistribute wealth in their favor, thus increasing the likelihood of conflict (Cederman *et al* 2011, Guariso *et al* 2017, Koubi 2017).

Besides the rebel groups incentivized by higher recruitment potential during economic downturns, the undermined capacity of the state to mediate conflicts and guarantee public income support, food aid, employment, and human security would also give way to increasing conflict at the communal and individual levels, including criminal and gender-based violence (Kim 2016, van Daalen *et al* 2022). Empirical research pointed out that climate-related disasters could powerfully destabilize society by reducing the state's resilience and increasing grievances(Carmona 2024).

For instance, Hurricane Katrina in the U.S. show cased how a natural disaster strained public institutions and led to significant social unrest (Nicholls *et al* 2016). When experiencing such disasters, weak regimes or social systems will be financially strained through the loss of tax revenues and foreign exchange earnings during the recession caused by weather shocks (Damette et al. 2023, Hendrix et al. 2012). The fear, insecurity, scarcity of resources, reduced social welfare, and paralyzed public institutions could lead to various forms of dissatisfaction, eventually leading to violent actions (Linke *et al* 2018, Nardulli *et al* 2015) and non-violent protests (Ide et al. 2021).

In summary, the literature indicates that climate change-induced loss in economic productivity increases the risk of violent conflicts within states, particularly in societies characterized by inequality and political polarization. Key arguments underlying this causal mechanism are enhanced recruitment opportunities for armed groups, state weakness, and societal grievances.

3.2 Agricultural decline

Agriculture is primarily affected by climate through its impacts on productivity, crop yields, arable land, and water (Chen *et al* 2024, Hsiang 2010, Schlenker *et al* 2009). It is estimated that fluctuations in seasonal temperature and precipitation levels account for roughly a third of the variation in major global crop yields (Ray *et al* 2015). Consequently, loss of agricultural income and food insecurity caused by adverse climatic conditions could increase social grievances, providing motives or lowering the opportunity costs for engaging in rebellion (Maxwell *et al* 2010, Wischnath et al. 2014). Regarding the impact of climate change on conflict working through agriculture, we found evidence supporting the relationship between climate-

induced reduction in agricultural production and conflict in historical research. For example, Zhang et al. (2007) and Juna & Sethi (2021) showed that climate-induced food shortages increased the risk of conflict when climate variation undermined agricultural production in agriculture-dominated societies and economies. Recent findings were also in line with the historical evidence, especially in areas highly dependent on rain-fed agriculture, with social divisions, and with limited coping capacities (Crost *et al* 2018, Jun 2017). Empirical research regarding the Philippines showed that excessive precipitation had hugely impacted the agricultural income in acutely deprived areas and thereby increased conflict participation (Crost et al. 2018, Eastin 2018). Similarly, rainfall shocks could also increase the intensity of India's Maoist insurgency via their effect on agricultural output (Fetzer 2020, Gawande *et al* 2017). For instance, the 2015 drought in Maharashtra led to widespread farmer suicides and heightened tensions in the region, illustrating how climate-induced agricultural distress can exacerbate social unrest (Kulkarni *et al* 2016). There was also research suggesting that temperature and precipitation anomalies during the core months of the crop-growing seasons could reduce the yield of rice in Indonesia (Caruso *et al* 2016), maize in sub-Saharan Africa (Jun 2017), and main crops in the Philippines (Crost et al. 2018), resulting in the increased incidence of civil conflict.

Apart from directly affecting crop yields, climate change could also impact food prices by fluctuating the demand and supply of the affected crops, especially when the climate becomes variable (Bradbear *et al* 2013, Cater *et al* 2018, Mohamed *et al* 2024). This adds to several other factors increasing food prices, such as oil price variability, speculations on globalized food markets, and increasing investments in land for food and energy production. Rendering staple foods unaffordable for the masses increases the sense of relative deprivation, arouses new and pre-existing

grievances, and further provides a political trigger with a higher risk of protests, riots, and violent collective action (Bellemare 2015, Hendrix *et al* 2015, Jones *et al* 2017, ten Brink *et al* 2023). Evidence favoring such theories can be found in some research in Africa, revealing the complex relationship between climate change, rising food prices, and conflict (Sharma *et al* 2024). For example, the African food riots during 2007-2008 (Berazneva *et al* 2013) and the Arab Spring (Maystadt, Jean-Francois Trinh*, et al* 2014, Soffiantini 2020) have been considered partly as a consequence of price increases. Smith (2014) found that the probability of civil unrest rose with the increase in domestic food prices by using international food commodity prices and rainfall scarcity as instrumental variables. Raleigh et al. (2015) suggested that rainfall exerts an indirect effect on conflict through its impact on food prices. Another example was food riots in countries like Mozambique and Egypt that were associated with high grain prices, following drought and its associated heat wave over Russia and severe flooding in Asia (Hunt *et al* 2021). Further studies have also identified the rise in food prices as a possible explanatory mechanism linking climate change and conflict, given the positive relationship between soaring food prices (caused by climate shocks) and social unrest (Bellemare 2015, Rudolfsen 2023).

In summary, a considerable number of studies indicate that climate change's adverse impacts on agricultural productivity and food security could increase intrastate violent conflict risks. Grievances about livelihood loss and higher food prices as well as reduced opportunity costs for joining insurgents, are key underlying mechanisms identified in the literature. Specific cases, such as the the riots in Mozambique and Africa, illustrate how climate-related agricultural challenges can

catalyze conflict (Berazneva et al. 2013). This causal mechanism is most likely to occur in poor, agriculturally dependent, and already food insecure countries.

3.3 Natural resource competition

Climate change, associated with water stress and temperature change, might induce reallocation or reduction of natural resources (i.e., water and land) needed to sustain human life, and therefore induce a mismatch between supply and demand. As a consequence, natural resource reduction or allocation could trigger an agricultural collapse, increase food prices, slow economic growth, etc., which all could result in relative deprivation, and thus intensify competition over increasingly scarce resources (IPCC 2014). This is an acute issue, particularly in agriculturally dependent communities and politically fractionalized societies when they are trapped in fragile contexts characterized by demographic pressures and economic insecurities (Kelley et al. 2015), where increasing social discontent and encouraged rebellions against the government might eventually lead to civil conflict and social unrest (Schon *et al* 2023a, Vesco *et al* 2020). Recent changes in natural resource laws and the weakness of traditional conflict resolution mechanisms are also important mediating factors (Tubi *et al* 2016).

Thus far, research has mainly focused on the relationships linking water and land resources to conflict, especially inter-communal violence and civil conflict, given the necessity of these resources that sustain the lives of farmers and pastoralists (Gleick *et al* 2023, Lu *et al* 2023, Mertz *et al* 2016, Prediger *et al* 2014). For instance, by studying 79 conflict cases in Bangladesh and Nepal, Sultana et al. (2019) found that droughts and floods have caused shortages and imbalances in water, which directly exacerbated conflicts over resources. This is illustrated by the drought in

Nepal, where farmers in the region faced severe water shortages, leading to violent clashes between agricultural communities over limited irrigation supplies. Likewise, Ide (2015) showed that the scarcity of land, water, fish, and forest resources (all of which are climate-sensitive) could trigger violent communal conflict around the world under certain circumstances. In Nigeria and Mali, for example, climate change, through increasing drought and desertification, heightens competition for limited resources such as land and water, fueling conflicts and causing displacement (Lenshie *et al* 2022). Studies of African and Middle East communities have also reported evidence about water resources transmitting climate change effects on community conflict (conflict between different farmers, pastoralists, and fisher communities) (Bukari *et al* 2018, Gleick 2014, Landis *et al* 2017, Spijkers *et al* 2021). On the other hand, it is worth noting that resource scarcity caused by climate change does not always incite conflict. Instead, in some cases, it might provide potential opportunities for cooperation and peace (Doring 2020, Johnson *et al* 2021). On the international level, water cooperation is also more prevalent than violent competition (Karesdotter et al. 2023).

In summary, earlier evidence for the impact of natural resource scarcity on civil war was mixed (Koubi *et al* 2014). However, the majority of studies now agree that climate-related natural resource scarcity likely contributes to intergroup competition and amplifies local grievances, which can result in riots and community conflict if not mediated by strong local or state institutions. Further relevant context factors for such a causal link include agricultural dependence, pre-existing political polarization, and recent changes in relevant laws and policies.

3.4 Migration

Migration is a potential adaptation strategy to climate change. Seasonal or permanent migration has been associated with climate-driven ecological change, including lengthened droughts, increased climatic disasters that exacerbated unfitness for habitation, and land degradation (Dallmann *et al* 2017, Kwanhi *et al* 2024, Raimi *et al* 2024, Thiede *et al* 2016), and decreased access to natural capital (McMichael *et al* 2012). Although poor infrastructures, scarcity of livelihood opportunities, and credit constraints still limit the ability of the poorest to migrate as an adaptation strategy (Beine *et al* 2015, Cattaneo *et al* 2016, Gray *et al* 2012, Hunter *et al* 2022, Nawrotzki *et al* 2018), climate change could affect migration patterns (Berlemann *et al* 2017, Borderon *et al* 2019, Moore *et al* 2022, Rikani *et al* 2023).

It is argued that climate change-induced migration might promote conflict through increasing competition over resources in communities while igniting ethnic and religious tensions between migrants and domestic people in some contexts (Brzoska *et al* 2016, Burrows *et al* 2016, Saraiva *et al* 2023, Wiederkehr *et al* 2022). Such tensions also depend on the nature of the inter-group antagonism (Amodio *et al* 2018, Bazzi *et al* 2019, Esteban *et al* 2012). For example, a survey in Kenya showed that relocation driven by drought or water shortages could lead to conflict due to labor and residential housing market competition (Linke et al. 2018). In Sudan's Darfur region, De Juan (2015) showed that migrations fostered by ecological changes from resource-reducing areas to more thriving neighborhoods have aggravated resource scarcity and interethnic tensions in areas of high immigration, thus escalating the risk of conflict. In northern Nigeria, climate change has degraded vegetation, prompting Fulani herders to migrate south into Christian areas, leading to violent conflicts with local farmers over resources (Okunade *et al*

2023). Similar patterns have been found in Nigeria (Akinyemi *et al* 2017) and India (Bhavnani *et al* 2015). The group around Vally Koubi also concluded that climate-related migrants are more likely to experience conflicts and participate in social movements in their new homes (Koubi *et al* 2018, Koubi et al. 2021). A well-known – although contested (Selby et al. 2017) – case study is the one on Syria by Kelley et al. (2015) where the Syrian civil war is argued to result from drought-induced migration.

On the other hand, several studies argued against the above theory and claimed that the climate change-migration nexus likely doesn't directly lead to violent conflict. Instead, they suggested that migration might alleviate climate-induced pressure on economies and the environment by decongesting and redistributing the population to countries with higher carrying capacity without provoking social unrest (Bosetti *et al* 2021, Byravan *et al* 2017, Cattaneo *et al* 2017). Cottier and Salehyan (2021) found that climate change reduces international migration because it deprives households of the resources to fund migration moves. In line with this, a recent analysis finds no impact of disaster on migration for the conflict in Bangladesh (Petrova 2021).

In summary, empirical evidence for migration as the causal mechanism between climate change and violent conflict remains ambiguous, with some studies finding a link, while other researchers remain skeptical. This indicates the requirement for additional research, which might either disregard this causal mechanism or specify context factors under which it usually occurs. More research should also be devoted to studying the risk of conflict among the immobile population.

3.5 Reflection

Early research showed considerable disagreement about the existence of a climate-conflict nexus. Recent studies accounting for relevant scope conditions tend to show stronger support for climate change to have effects on conflict risks. Specifying the pathways underlying the climate-conflict nexus further advances the research field and increases the policy relevant to results.

For example, by simultaneously considering the underlying pathways such as economics, agriculture, and resources that drive climate conflict, Helman et al. (2020) quantified the direct and indirect effects of climate change on conflict risk in Africa and the Middle East. They illustrated that climate-conflict connections were complex due to multiple mechanisms working simultaneously (Helman et al. 2020). Similarly, Xie et al. (2022) revealed the complex link between climate change and conflict risk in South Asia. By partitioning impact channels into detailed paths, they found some pathway effects that offset each other, leading to a net-zero synthesized effect of the related factors. Likewise, Ide et al (2020) find that climate-related disasters increase the risks of conflict, primarily by providing opportunities for rebel groups in connection with economic decline and agricultural losses. This is observed only in situations where low levels of development and ethnic exclusion coincide. By contrast, studies find rather limited support for the migration pathway (Cottier et al. 2021, Petrova 2021).

To better understand these dynamics, applying rigorous methodological approaches is crucial. For example, Large-N statistical analyses can effectively test for indirect and interaction effects among variables, enabling researchers to control for confounding factors and isolate the specific influence of climate on conflict. Additionally, process tracing in qualitative case studies can provide deeper insights into the causal mechanisms, allowing researchers to track the sequence of events

that lead from climate change to conflict and reveal contextual influences. Mixed-methods approaches that integrate both quantitative and qualitative data further enhance our understanding of the climate-conflict nexus. Therefore, it is imperative to break down climate-conflict mechanisms, specify relevant scope conditions, and include these specifications in the research design. Incorporating a variety of methods—such as large-N statistical analyses, process tracing, and mixed-methods approaches—will strengthen causal claims and enhance our understanding of the complex relationship between climate change and conflict (see (Ide 2017) for a review specifically on methods.)

4. CONCLUSION

The potential causal links between climate change and conflict risk have attracted much scientific, public, and political attention. In this review, we have summarized the recent literature on the links between climate change and conflict, and noted that most recent studies (particularly those utilizing fine-grained data and considering relevant contextual factors) provide support for the claim that climate change increases conflict risks. In addition, we have outlined possible key pathways through which climate change affects conflict risk: economic shocks, agricultural decline, natural resource competition, and migration. These pathways help clarify the climate-conflict linkage and are essential for advancing research and policy. However, other pathways, such as political institutions, ethnic divisions, maladaptation, energy vulnerability, geopolitical rivalry, and biodiversity loss, also warrant further exploration.

Despite past research identifying potential climatic effects on conflict, more targeted investigations are needed to fully grasp the complexity of this relationship.

In particular, future research should emphasize specific regions and conflict types where vulnerabilities to climate impacts are more pronounced. For example, regions with high resource dependency or geopolitical tensions, such as the Sahel, South Asia, or coastal zones threatened by sea-level rise, present critical case studies for further exploration. The role of different conflict types, ranging from inter-state disputes to communal violence, also needs further exploration to understand how climate pressures exacerbate specific forms of conflict.

In addition, varying social and geographical contexts create diverse vulnerabilities, leading to inconsistent responses to climate-induced conflict across regions (Buhaug et al. 2021). There is a need for greater attention to the concept of vulnerability, shaped by socio-economic contexts, political institutions, and historical legacies such as colonialism. Climate-conflict research should engage more with political ecology and other critical approaches (Ide *et al* 2023), which would help shift focus beyond "state-centric" perspectives to examine how not only rebels or local communities but also political elites and state actors may respond violently to climate stress (Selby et al. 2014). A systematic exploration of feedback loops between climate change, vulnerability, and conflict risk is critical (Buhaug et al. 2014).

Moreover, most prior research has primarily focused on short-term climate variability (e.g., seasonal or annual changes) rather than on the long-term shifts in climatic averages or increasing variability (van Weezel 2020). Future studies should investigate how gradual climatic shifts, such as rising temperatures or sea-level rise, influence conflict dynamics over extended periods.

Finally, future research must aim to quantify the underlying mechanisms driving the climate-conflict relationship, paying closer attention to the interactions between

climate impacts and social, economic, and political drivers. Advanced methods, such as Structural Equation Modeling and GIS-based risk analysis, alongside micro-level data (e.g., satellite imagery and social media), could refine our understanding of pathways that previous research has only broadly outlined (Ide 2017, Mach *et al* 2020). Researchers should also examine a broader range of climate factors beyond temperature and precipitation, such as sea-level rise, climate tipping points (Franzke *et al* 2022, Scheffran 2020), and the implications of climate actions on conflict (Buhaug *et al* 2023, Dabelko *et al* 2017, Nadiruzzaman *et al* 2022).

ACKNOWLEDGMENTS

This work was financially supported by the Strategic Priority Research Program of the Chinese Academy of Sciences (XDA19040305), the National Natural Science Foundation of China (42001238 and 42201497), Youth Innovation Promotion Association (2023000117), and the Wellcome Trust [Grant number 220211]. For the purpose of open access, the author has applied a CC BY public copyright licence to any Author Accepted Manuscript version arising from this submission. This study contributes to the CLICCS Cluster of Excellence funded by the German Research Foundation (DFG). The funders of the study had no role in study design, data collection, data analysis, data interpretation, in preparing the paper or in our decision to publish.

References

Abdi A H, Mohamed A A and Sugow M O 2023 Exploring the effects of climate change and government stability on internal conflicts: evidence from selected sub-Saharan African countries *Environmental Science and Pollution Research, 30*(56), 118468-118482

Abrahams D 2020 Conflict in abundance and peacebuilding in scarcity: Challenges and opportunities in addressing climate change and conflict *World Development, 132*

Adams C, Ide T, Barnett J and Detges A 2018 Sampling bias in climate-conflict research *Nature Climate Change, 8*(3), 200-+

Adano W R, Dietz T, Witsenburg K and Zaal F 2012 Climate change, violent conflict and local institutions in Kenya's drylands *Journal of Peace Research, 49*(1), 65-80

Akinyemi T E and Olaniyan A 2017 Nigeria: Climate War. Migratory Adaptation and Farmer-Herder Conflicts *Conflict Studies Quarterly*(21), 3-21

Amodio F and Chiovelli G 2018 ETHNICITY AND VIOLENCE DURING DEMOCRATIC TRANSITIONS: EVIDENCE FROM SOUTH AFRICA *Journal of the European Economic Association, 16*(4), 1234-1280

Anderson C A, Anderson K B, Dorr N, DeNeve K M and Flanagan M. (2000). Temperature and aggression. In M. P. Zanna (Ed.), *Advances in Experimental Social Psychology, Vol 32* (Vol. 32, pp. 63-133).

Anderson C A and Bushman B J 2002 Human aggression *Annual Review of Psychology, 53*, 27-51

Ash K and Obradovich N 2020 Climatic Stress, Internal Migration, and Syrian Civil War Onset *Journal of Conflict Resolution, 64*(1)

Bazzi S, Gaduh A, Rothenberg A D and Wong M 2019 Unity in Diversity? How Intergroup Contact Can Foster Nation Building *American Economic Review, 109*(11), 3978-4025

Beine M and Parsons C 2015 Climatic Factors as Determinants of International Migration *Scandinavian Journal of Economics, 117*(2), 723-767

Bellemare M F 2015 Rising Food Prices, Food Price Volatility, and Social Unrest *American Journal of Agricultural Economics, 97*(1), 1-21

Berazneva J and Lee D R 2013 Explaining the African food riots of 2007-2008: An empirical analysis *Food Policy, 39*, 28-39

Berlemann M and Steinhardt M F 2017 Climate Change, Natural Disasters, and Migration-a Survey of the Empirical Evidence *Cesifo Economic Studies, 63*(4), 353-385

Bernauer T, Boehmelt T and Koubi V 2012 Environmental changes and violent conflict *Environmental Research Letters, 7*(1)

Berrebi C and Ostwald J 2011 Earthquakes, hurricanes, and terrorism: do natural disasters incite terror? *Public Choice, 149*(383)

Bhavnani R R and Lacina B 2015 THE EFFECTS OF WEATHER-INDUCED MIGRATION ON SONS OF THE SOIL RIOTS IN INDIA *World Politics, 67*(4), 760-794

Boccard N 2021 Analysis of trends in disaster risk *International Journal of Disaster Risk Reduction, 53*

Bohlken A T and Sergenti E J 2010 Economic growth and ethnic violence: An empirical investigation of Hindu-Muslim riots in India *Journal of Peace Research, 47*(5), 589-600

Borderon M, Sakdapolrak P, Muttarak R, Kebede E, Pagogna R and Sporer E 2019 Migration influenced by environmental change in Africa: A systematic review of empirical evidence *Demographic Research, 41*, 491-544

Bosetti V, Cattaneo C and Peri G 2021 Should they stay or should they go? Climate migrants and local conflicts *Journal of Economic Geography, 21*(4), 619-651

Bradbear C and Friel S 2013 Integrating climate change, food prices and population health *Food Policy, 43*, 56-66

Brueckner M, Ciccone A and Tesei A 2012 OIL PRICE SHOCKS, INCOME, AND DEMOCRACY *Review of Economics and Statistics, 94*(2), 389-399

Brzoska M and Fröhlich C 2016 Climate change, migration and violent conflict: vulnerabilities, pathways and adaptation strategies *Migration and Development, 5*(2), 190-210

Buhaug H 2010 Climate not to blame for African civil wars *Proceedings of the National Academy of Sciences of the United States of America, 107*(38), 16477-16482

Buhaug H, Benjaminsen T A, Gilmore E A and Hendrix C S 2023 Climate-driven risks to peace over the 21st century *Climate Risk Management, 39*

Buhaug H, Nordkvelle J, Bernauer T, Bohmelt T, Brzoska M, Busby J W *et al.* 2014 One effect to rule them all? A comment on climate and conflict *Climatic Change, 127*(3-4), 391-397

Buhaug H and von Uexkull N 2021 Vicious Circles: Violence, Vulnerability, and Climate Change *Annual Review of Environment and Resources, 46*, 545-568

Bukari K N, Sow P and Scheffran J 2018 Cooperation and Co-Existence Between Farmers and Herders in the Midst of Violent Farmer-Herder Conflicts in Ghana *African Studies Review, 61*(2), 78-102

Burke M, Hsiang S M and Miguel E 2015 Global non-linear effect of temperature on economic production *Nature, 527*(7577), 235-+

Burke M B, Miguel E, Satyanath S, Dykema J A and Lobell D B 2009 Warming increases the risk of civil war in Africa *Proceedings of the National Academy of Sciences of the United States of America, 106*(49), 20670-20674

Burke P J and Leigh A 2010 Do Output Contractions Trigger Democratic Change? *American Economic Journal-Macroeconomics, 2*(4), 124-157

Burrows K and Kinney P L 2016 Exploring the Climate Change, Migration and Conflict Nexus *International Journal of Environmental Research and Public Health, 13*(4)

Byravan S and Rajan S C 2017 Taking Lessons from Refugees in Europe to Prepare for Climate Migrants and Exiles *Environmental Justice, 10*(4), 108-111

Canavan C and Ide T 2024 Contention, cooperation, and context: A systematic review of research on disasters and political conflicts *International Journal of Disaster Risk Reduction, 108*

Carmona R 2024 Global guidelines, local interpretations: ethnography of climate policy implementation in Mapuche territory, Southern Chile *Climate Policy, 24*(8), 1018-1033

Caruso R, Petrarca I and Ricciuti R 2016 Climate change, rice crops, and violence: Evidence from Indonesia *Journal of Peace Research, 53*(1), 66-83

Cater B and Lew B 2018 The impact of climate on the law of one price: A test using North American food prices from the 1920s *Canadian Journal of Economics-Revue Canadienne D Economique, 51*(4), 1191-1220

Cattaneo C and Bosetti V 2017 Climate-induced International Migration and Conflicts *Cesifo Economic Studies, 63*(4), 500-528

Cattaneo C and Peri G 2016 The migration response to increasing temperatures *Journal of Development Economics, 122*, 127-146

Cederman L-E, Weidmann N B and Gleditsch K S 2011 Horizontal Inequalities and Ethnonationalist Civil War: A Global Comparison *American Political Science Review, 105*(3), 478-495

Chassang S and Padro i Miquel G 2009 Economic Shocks and Civil War *Quarterly Journal of Political Science, 4*(3), 211-228

Chen X, Anderson W, You L and Pope E 2024 Observed trends in multiple breadbasket yield shocks *Environmental Research Letters, 19*(10)

Chung E and Rhee I 2022 Disasters and intergroup peace in sub-Saharan Africa *Journal of Peace Research, 59*(1), 58-72

Cottier F and Salehyan I 2021 Climate variability and irregular migration to the European Union *Global Environmental Change-Human and Policy Dimensions, 69*, 2275-2275

Couttenier M and Soubeyran R 2014 DROUGHT AND CIVIL WAR IN SUB- SAHARAN AFRICA *Economic Journal, 124*(575), 201-244

Crost B, Duquennois C, Felter J H and Rees D I 2018 Climate change, agricultural production and civil conflict: Evidence from the Philippines *Journal of Environmental Economics and Management, 88*, 379-395

Dabelko G D, Risi L H, Null S, Parker M and Sticklor R. (2017). *Backdraft: Conflict Potential of Responding to Climate Change Adaptation and Mitigation*. Retrieved from

Dallmann I and Millock K 2017 Climate Variability and Inter-State Migration in India *Cesifo Economic Studies, 63*(4), 560-594

Damette O and Goutte S 2023 Beyond climate and conflict relationships: New evidence from a Copula-based analysis on an historical perspective? *Journal of Comparative Economics, 51*(1), 295-323

Daoudy M. (2020). *The Origins of the Syrian Conflict*. Washington DC: Cambridge University Press.

Daoust G and Selby J 2022 Understanding the Politics of Climate Security Policy Discourse: The Case of the Lake Chad Basin *Geopolitics*, 1-38

De Juan A 2015 Long-term environmental change and geographical patterns of violence in Darfur, 2003-2005 *Political Geography, 45*, 22-33

Detges A 2016 Local conditions of drought-related violence in sub-Saharan Africa: The role of road and water infrastructures *Journal of Peace Research, 53*(5), 696-710

Detges A 2017 Droughts, state-citizen relations and support for political violence in Sub-Saharan Africa: A micro-level analysis *Political Geography, 61*, 88-98

DeWall C N, Anderson C A and Bushman B J 2011 The General Aggression Model: Theoretical Extensions to Violence *Psychology of Violence, 1*(3), 245-258

Dinc P and Eklund L 2023 Syrian farmers in the midst of drought and conflict: the causes, patterns, and aftermath of land abandonment and migration *Climate and Development*, 1-14

Dinc P and Eklund L 2024 Syrian farmers in the midst of drought and conflict: the causes, patterns, and aftermath of land abandonment and migration *Climate and Development, 16*(5), 349-362

Doring S 2020 From Bullets to Boreholes: A Disaggregated Analysis of Domestic Water Cooperation in Drought-prone Regions *Global Environmental Change-Human and Policy Dimensions, 65*, 2147-2147

Döring S and Hall J 2023 Drought exposure decreases altruism with salient group identities as key moderator *Nature Climate Change, 13*(8), 856-+

Eastin J 2016 Fuel to the Fire: Natural Disasters and the Duration of Civil Conflict *International Interactions, 42*(2), 322-349

Eastin J 2018 Hell and high water: Precipitation shocks and conflict violence in the Philippines *Political Geography, 63*, 116-134
Eastin J and Zech S T 2022 Environmental pressures and pro-government militias: Evidence from the Philippines *Conflict Management and Peace Science, 40*(5), 489-510
Esteban J, Mayoral L and Ray D 2012 Ethnicity and Conflict: An Empirical Study *American Economic Review, 102*(4), 1310-1342
Fetzer T 2020 CAN WORKFARE PROGRAMS MODERATE CONFLICT? EVIDENCE FROM INDIA *Journal of the European Economic Association, 18*(6), 3337-3375
Franzke C L E, Ciullo A, Gilmore E A, Matias D M, Nagabhatla N, Orlov A *et al.* 2022 Perspectives on tipping points in integrated models of the natural and human Earth system: cascading effects and telecoupling *Environmental Research Letters, 17*(1), 15004-15004
Gawande K, Kapur D and Satyanath S 2017 Renewable Natural Resource Shocks and Conflict Intensity: Findings from India's Ongoing Maoist Insurgency *Journal of Conflict Resolution, 61*(1), 140-172
Ge Q, Hao M, Ding F, Jiang D, Scheffran J, Helman D *et al.* 2022 Modelling armed conflict risk under climate change with machine learning and time-series data *Nature Communications, 13*(1)
Gleick P H 2014 Water, Drought, Climate Change, and Conflict in Syria *Weather Climate and Society, 6*(3), 331-340
Gleick P H and Shimabuku M 2023 Water-related conflicts: definitions, data, and trends from the water conflict chronology *Environmental Research Letters, 18*(3)
Gray C and Mueller V 2012 Drought and Population Mobility in Rural Ethiopia *World Development, 40*(1), 134-145
Guariso A and Rogall T 2017 Rainfall Inequality, Political Power, and Ethnic Conflict in Africa *Social Science Electronic Publishing, 391*
Guo Y, Gao Y, He C, Zhu Y, Zhou L, Kan H *et al.* 2024 Short-term high temperature may increase the incidence risk of collective conflicts: A case-crossover study in the Greater Middle East *Science of the Total Environment, 915*
Gupta T D, Carneiro B, Schapendonk F, Pacillo G, Suza M and Laederach P 2023 Through the lens of inequality: what can we learn from CGIAR as a case study of research on the climate-security nexus? *International Development Planning Review, 45*(4), 351-375
Hao M, Ding F, Xie X, Fu J, Qian Y, Ide T *et al.* 2022 Varying climatic-social-geographical patterns shape the conflict risk at regional and global scales *Humanities & Social Sciences Communications, 9*(1)
Helman D, Zaitchik B F and Funk C 2020 Climate has contrasting direct and indirect effects on armed conflicts *Environmental Research Letters, 15*(10)
Hendrix C S and Haggard S 2015 Global food prices, regime type, and urban unrest in the developing world *Journal of Peace Research, 52*(2), 143-157
Hendrix C S and Salehyan I 2012 Climate change, rainfall, and social conflict in Africa *Journal of Peace Research, 49*(1), 35-50
Hsiang S M 2010 Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America *Proceedings of the National Academy of Sciences of the United States of America, 107*(35), 15367-15372
Hsiang S M, Burke M and Miguel E 2013 Quantifying the Influence of Climate on Human Conflict *Science, 341*(6151), 1212-+
Hsiang S M, Meng K C and Cane M A 2011 Civil conflicts are associated with the global climate *Nature, 476*(7361), 438-441
Hunt E, Femia F, Werrell C, Christian J I, Otkin J A, Basara J *et al.* 2021 Agricultural and food security impacts from the 2010 Russia flash drought *Weather and Climate Extremes, 34*
Hunter L, M., Gray C, L. and Veron J. (2022). *International Handbook of Population and Environment*. Switzerland: Springer.
Ide T 2015 Why do conflicts over scarce renewable resources turn violent? A qualitative comparative analysis *Global Environmental Change-Human and Policy Dimensions, 33*, 61-70
Ide T 2017 Research methods for exploring the links between climate change and conflict *Wiley Interdisciplinary Reviews-Climate Change, 8*(3)
Ide T. (2023). *Catastrophes, Confrontations, and Constraints: How Disasters Shape the Dynamics of Armed Conflicts*: The MIT Press.
Ide T, Brzoska M, Donges J F and Schleussner C-F 2020 Multi-method evidence for when and how climate-related disasters contribute to armed conflict risk *Global Environmental Change-Human and Policy Dimensions, 62*, 2063-2063

Ide T, Johnson M F, Barnett J, Krampe F, Billon P L and Maertens L 2023 The Future of Environmental Peace and Conflict Research *Environmental Politics, 32*(6), 1077-1103
Ide T, Lopez M R, Froehlich C and Scheffran J 2021 Pathways to water conflict during drought in the MENA region *Journal of Peace Research, 58*(3), 568-582
IPCC. (2014). *Climate change 2014: impacts, adaptation, and vulnerability* Retrieved from
IPCC. (2022). *Climate Change 2022: Mitigation of Climate Change*. Retrieved from
Johnson M F, Rodriguez L A and Quijano Hoyos M 2021 Intrastate environmental peacebuilding: A review of the literature *World Development, 137*, 5150-5150
Jones B T, Mattiacci E and Braumoeller B F 2017 Food scarcity and state vulnerability: Unpacking the link between climate variability and violent unrest *Journal of Peace Research, 54*(3), 335-350
Jun T 2017 Temperature, maize yield, and civil conflicts in sub-Saharan Africa *Climatic Change, 142*(1-2), 183-197
Jun T and Sethi R 2021 Extreme weather events and military conflict over seven centuries in ancient Korea *Proceedings of the National Academy of Sciences of the United States of America, 118*(12)
Karesdotter E, Skoog G, Pan H and Kalantari Z 2023 Water-related conflict and cooperation events worldwide: A new dataset on historical and change trends with potential drivers *Science of the Total Environment, 868*
Kelley C P, Mohtadi S, Cane M A, Seager R and Kushnir Y 2015 Climate change in the Fertile Crescent and implications of the recent Syrian drought *Proceedings of the National Academy of Sciences of the United States of America, 112*(11), 3241-3246
Kim N K 2016 Revisiting Economic Shocks and Coups *Journal of Conflict Resolution, 60*(1), 3-31
Klomp J and Bulte E 2013 Climate change, weather shocks, and violent conflict: a critical look at the evidence *Agricultural Economics, 44*, 63-78
Koren O and Schon J 2023 Climate change, cash crops, and violence against civilians in the Sahel *Regional Environmental Change, 23*(3)
Koubi V 2017 Climate Change, the Economy, and Conflict *Current Climate Change Reports, 3*(4), 200-209
Koubi V 2019 Climate Change and Conflict *Annual Review of Political Science, 22*, 343-360
Koubi V, Bernauer T, Kalbhenn A and Spilker G 2012 Climate variability, economic growth, and civil conflict *Journal of Peace Research, 49*(1), 113-127
Koubi V, Bohmelt T, Spilker G and Schaffer L 2018 The Determinants of Environmental Migrants' Conflict Perception *International Organization, 72*(4), 905-936
Koubi V, Nguyen Q, Spilker G and Bohmelt T 2021 Environmental migrants and social-movement participation *Journal of Peace Research, 58*(1), 18-32
Koubi V, Spilker G, Boehmelt T and Bernauer T 2014 Do natural resources matter for interstate and intrastate armed conflict? *Journal of Peace Research, 51*(2), 227-243
Kulkarni A, Gadgil S and Patwardhan S 2016 Monsoon variability, the 2015 Marathwada drought and rainfed agriculture *Current Science, 111*(7), 1182-1193
Kwanhi T, Modiba F S, Mago S, Matindike S and Damiyano D 2024 Conceptualizing climate-induced migration in Africa *Environmental Development, 52*
Landis S T, Rezaeedaryakenari B, Zhang Y, Thies C G and Maciejewski R 2017 Fording differences? Conditions mitigating water insecurity in the Niger River Basin *Political Geography, 56*, 77-90
Lenshie N E, Ojeh V N, Oruonye E D, Ezeibe C, Ajaero C, Nzeadibe T C *et al.* 2022 Geopolitics of climate change-induced conflict and population displacement in West Africa *Local Environment, 27*(3), 287-308
Linke A M, Witmer F D W, O'Loughlin J, McCabe J T and Tir J 2018 The consequences of relocating in response to drought: human mobility and conflict in contemporary Kenya *Environmental Research Letters, 13*(9)
Lomborg B 2020 Welfare in the 21st century: Increasing development, reducing inequality, the impact of climate change, and the cost of climate policies *Technological Forecasting and Social Change, 156*
Lu Y and Yamazaki S 2023 Fish to fight: Does catching more fish increase conflicts in Indonesia? *World Development, 170*
Mach K J, Adger W N, Buhaug H, Burke M, Fearon J D, Field C B *et al.* 2020 Directions for Research on Climate and Conflict *Earths Future, 8*(7)
Mach K J, Kraan C M, Adger W N, Buhaug H, Burke M, Fearon J D *et al.* 2019 Climate as a risk factor for armed conflict *Nature, 571*(7764), 193-+

Mary S 2022 Dams mitigate the effect of rainfall shocks on Hindus-Muslims riots *World Development, 150*, 1-5
Maxwell D, Webb P, Coates J and Wirth J 2010 Fit for purpose? Rethinking food security responses in protracted humanitarian crises *Food Policy, 35*(2), 91-97
Maystadt J-F, Calderone M and You L 2015 Local warming and violent conflict in North and South Sudan *Journal of Economic Geography, 15*(3), 649-671
Maystadt J-F and Ecker O 2014 Extreme Weather and Civil War: Does Drought Fuel Conflict in Somalia through Livestock Price Shocks? *American Journal of Agricultural Economics, 96*(4), 1157-1182
Maystadt J-F, Jean-Francois Trinh T and Breisinger C 2014 Does food security matter for transition in Arab countries? *Food Policy, 46*, 106-115
McMichael C, Barnett J and McMichael A J 2012 An Ill Wind? Climate Change, Migration, and Health *Environmental Health Perspectives, 120*(5), 646-654
Mertz O, Rasmussen K and Rasmussen L V 2016 Weather and resource information as tools for dealing with farmer-pastoralist conflicts in the Sahel *Earth System Dynamics, 7*(4), 969-976
Michelini S, Šedová B, Schewe J and Frieler K 2023 Extreme weather impacts do not improve conflict predictions in Africa *humanities and social sciences communications 10*(522), 1-10
Miguel E, Satyanath S and Sergenti E 2004 Economic shocks and civil conflict: An instrumental variables approach *Journal of Political Economy, 112*(4), 725-753
Miles-Novelo A and Anderson C A 2019 Climate Change and Psychology: Effects of Rapid Global Warming on Violence and Aggression *Current Climate Change Reports, 5*(1), 36-46
Mitchell S M 2024 Cross-border troubles? Interstate river conflicts and intrastate violence *Political Geography, 111*
Mohamed J, Abdi M J, Mohamed A I, Muhumed M A, Abdeeq B A, Abdi A A *et al.* 2024 Predicting the short and long term effects of food price inflation, armed conflicts, and climate variability on global acute malnutrition in Somalia *Journal of Health Population and Nutrition, 43*(1)
Moore F C and Diaz D B 2015 Temperature impacts on economic growth warrant stringent mitigation policy *Nature Climate Change, 5*(2), 127-131
Moore M and Wesselbaum D 2022 Climatic factors as drivers of migration: a review *Environment Development and Sustainability*
Nadiruzzaman M, Scheffran J, Shewly H J and Kley S 2022 Conflict-Sensitive Climate Change Adaptation: A Review *Sustainability, 14*(13)
Nardulli P F, Peyton B and Bajjalieh J 2013 Climate Change and Civil Unrest: The Impact of Rapid-onset Disasters *Journal of Conflict Resolution, 59*(2), 310-335
Nardulli P F, Peyton B and Bajjalieh J 2015 Climate Change and Civil Unrest: The Impact of Rapid-onset Disasters *Journal of Conflict Resolution, 59*(2), 310-335
Nations U. (2015). *Transforming our world: The 2030 agenda for sustainable development*. Retrieved from New York:
Nawrotzki R J and DeWaard J 2018 Putting trapped populations into place: climate change and inter-district migration flows in Zambia *Regional Environmental Change, 18*(2), 533-546
Nel P and Righarts M 2008 Natural disasters and the risk of violent civil conflict *International Studies Quarterly, 52*(1), 159-185
Newman E, Pegah Hashemvand K and Chandran R 2023 Intercommunal violence, insurgency, and agropastoral conflict in the Lake Chad Basin region *Small Wars & Insurgencies*, 1-31
Nicholls K and Picou J S 2016 The Impact of Hurricane Katrina on Trust in Government *Social Science Quarterly, 94*
O'Loughlin J, Linke A M and Witmer F D W 2014 Effects of temperature and precipitation variability on the risk of violence in sub-Saharan Africa, 1980-2012 *Proceedings of the National Academy of Sciences of the United States of America, 111*(47), 16712-16717
Okunade S K and Kohon H S. (2023). *Climate Change and Emerging Conflict Between Herders and Farmers in Nasarawa and Plateau States, Nigeria*.
Omelicheva M Y 2011 Natural Disasters: Triggers of Political Instability? *International Interactions, 37*(4), 441-465
Petit S, Castel T, Henrion G, Richard Y, Traore M, Vergote M-H *et al.* 2023 Changing local climate patterns through hail suppression systems: conflict and inequalities between farmers and wine producers in the Burgundy Region (France) *Regional Environmental Change, 23*(3)
Petrova K 2021 Natural hazards, internal migration and protests in Bangladesh *Journal of Peace Research, 58*(1), 33-49

Petrova K 2022 Floods, communal conflict and the role of local state institutions in Sub-Saharan Africa *Political Geography, 92*, 1-11

Pettersson T, Davies S, Deniz A, Engstrom G, Hawach N, Hogbladh S *et al.* 2021 Organized violence 1989-2020, with a special emphasis on Syria *Journal of Peace Research, 58*(4), 809-825

Prediger S, Vollan B and Herrmann B 2014 Resource scarcity and antisocial behavior *Journal of Public Economics, 119*, 1-9

Raimi K T, Sarge M A, Geiger N, Gillis A and Cunningham J L 2024 Effects of communicating the rise of climate migration on public perceptions of climate change and migration *Journal of Environmental Psychology, 93*

Raleigh C, Choi H J and Kniveton D 2015 The devil is in the details: An investigation of the relationships between conflict, food price and climate across Africa *Global Environmental Change-Human and Policy Dimensions, 32*, 187-199

Ray D K, Gerber J S, MacDonald G K and West P C 2015 Climate variation explains a third of global crop yield variability *Nature Communications, 6*

Rikani A, Otto C, Levermann A and Schewe J 2023 More people too poor to move: divergent effects of climate change on global migration patterns *Environmental Research Letters, 18*(2)

Rudolfsen I 2023 Food Insecurity and Unrest Participation: Evidence from Johannesburg, South Africa *International Studies Quarterly, 67*(3)

Saraiva A and Monteiro A 2023 Climate change as a risk to human security: a systematic literature review focusing on vulnerable countries of Africa-causes and adaptation strategies *International Journal of Global Warming, 29*(4), 362-382

Scartozzi C M 2021 Reframing Climate-Induced Socio-environmental Conflicts: A Systematic Review *International Studies Review, 23*, 696–725

Scheffran J. (2020). Climate extremes and conflict dynamics. In *Climate Extremes and Their Implications for Impact and Risk Assessment* (pp. 293-315).

Scheffran J, Brzoska M, Kominek J, Link P M and Schilling J 2012 CLIMATE CHANGE AND VIOLENT CONFLICT *Science, 336*(6083), 869-871

Schlenker W and Roberts M J 2009 Nonlinear temperature effects indicate severe damages to US crop yields under climate change *Proceedings of the National Academy of Sciences of the United States of America, 106*(37), 15594-15598

Schleussner C-F, Donges J F, Donner R V and Schellnhuber H J 2016 Armed-conflict risks enhanced by climate-related disasters in ethnically fractionalized countries *Proceedings of the National Academy of Sciences of the United States of America, 113*(33), 9216-9221

Schon J, Koehnlein B and Koren O 2023a The need for willingness and opportunity: analyzing where and when environmental variability influences conflict in the Sahel *Population and Environment, 45*(1)

Schon J, Koehnlein B and Koren O 2023b The need for willingness and opportunity: analyzing where and when environmental variability influences conflict in the Sahel *Population and Environment, 45*(2)

Selby J, Dahi O S, Froehlich C and Hulme M 2017 Climate change and the Syrian civil war revisited *Political Geography, 60*, 232-244

Selby J, Daoust G and Hoffmann C. (2022). *Divided Environments: An International Political Ecology of Climate Change, Water and Security*: Cambridge University Press.

Selby J and Hoffmann C 2014 Beyond scarcity: Rethinking water, climate change and conflict in the Sudans *Global Environmental Change-Human and Policy Dimensions, 29*, 360-370

Sharifi A, Simangan D and Kaneko S 2021 Three decades of research on climate change and peace: a bibliometrics analysis *Sustainability Science, 16*(4), 1079-1095

Sharma T, Amarnath G, Amarasinghe U and Seid A 2024 Footprints of drought risk on Africa's agricultural, water and nutritional security *Environmental Research Letters, 19*(10)

Slettebak R T 2012 Don't blame the weather! Climate-related natural disasters and civil conflict *Journal of Peace Research, 49*(1), 163-176

Smith T G 2014 Feeding unrest: Disentangling the causal relationship between food price shocks and sociopolitical conflict in urban Africa *Journal of Peace Research, 51*(6), 679-695

Soffiantini G 2020 Food insecurity and political instability during the Arab Spring *Global Food Security-Agriculture Policy Economics and Environment, 26*

Spijkers J, Merrie A, Wabnitz C C C, Osborne M, Mobjörk M, Bodin Ö *et al.* 2021 Exploring the future of fishery conflict through narrative scenarios *One Earth, 4*(3), 386-396

Sultana P, Thompson P M, Paudel N S, Pariyar M and Rahman M 2019 Transforming local natural resource conflicts to cooperation in a changing climate: Bangladesh and Nepal lessons *Climate Policy, 19*, S94-S106

ten Brink B, Giesen P and Knoope P 2023 Future responses to environment-related food self-insufficiency, from local to global *Regional Environmental Change, 23*(3)

Thalheimer L, Schwarz M P and Pretis F 2023 Large weather and conflict effects on internal displacement in Somalia with little evidence of feedback onto conflict *Global Environmental Change-Human and Policy Dimensions, 79*

Theisen O M, Holtermann H and Buhaug H 2011 Climate Wars? Assessing the Claim That Drought Breeds Conflict *International Security, 36*(3), 79-+

Thiede B, Gray C and Mueller V 2016 Climate variability and inter-provincial migration in South America, 1970-2011 *Global Environmental Change-Human and Policy Dimensions, 41*, 228-240

Tominaga Y and Lee C-y 2021 When Disasters Hit Civil Wars: Natural Resource Exploitation and Rebel Group Resilience *International Studies Quarterly, 65*(2), 423–434

Trinn C and Wencker T 2021 Integrating the Quantitative Research on the Onset and Incidence of Violent Intrastate Conflicts *International Studies Review, 23*(1), 115-139

Tubi A and Feitelson E 2016 Drought and cooperation in a conflict prone area: Bedouin herders and Jewish farmers in Israel's northern Negev, 1957-1963 *Political Geography, 51*, 30-42

Ujunwa A, Okoyeuzu C, Nkwor N and Ujunwa A 2021 Potential Impact of Climate Change and Armed Conflict on Inequality in Sub-Saharan Africa *South African Journal of Economics, 89*(4), 480-498

Unfried K, Kis-Katos K and Poser T 2022 Water scarcity and social conflict *Journal of Environmental Economics and Management, 113*

van Baalen S 2021 Local elites, civil resistance, and the responsiveness of rebel governance in Côte d'Ivoire *Journal of Peace Research, 58*(5), 930-944

van Daalen K R, Kallesoe S S, Davey F, Dada S, Jung L, Singh L *et al.* 2022 Extreme events and gender-based violence: a mixed-methods systematic review *Lancet Planetary Health, 6*(6), E504-E523

van Weezel S 2020 Local warming and violent armed conflict in Africa *World Development, 126*

Vesco P, Dasgupta S, De Cian E and Carraro C 2020 Natural resources and conflict: A meta-analysis of the empirical literature *Ecological Economics, 172*

von Uexkull N 2014 Sustained drought, vulnerability and civil conflict in Sub-Saharan Africa *Political Geography, 43*, 16-26

von Uexkull N, Croicu M, Fjelde H and Buhaug H 2016 Civil conflict sensitivity to growing-season drought *Proceedings of the National Academy of Sciences of the United States of America, 113*(44), 12391-12396

von Uexkull N, Loy A and d'Errico M 2023 Climate, flood, and attitudes toward violence: micro-level evidence from Karamoja, Uganda *Regional Environmental Change, 23*(2)

Walch C 2018 Weakened by the storm: Rebel group recruitment in the wake of natural disasters in the Philippines *Journal of Peace Research, 55*(3), 336-350

Wang Q, Hao M, Helman D, Ding F, Jiang D, Xie X *et al.* 2022 Quantifying the influence of climate variability on armed conflict in Africa, 2000-2015 *Environment Development and Sustainability*

Wiederkehr C, Ide T, Seppelt R and Hermans K 2022 It's all about politics: Migration and resource conflicts in the global south *World Development, 157*

Wischnath G and Buhaug H 2014 Rice or riots: On food production and conflict severity across India *Political Geography, 43*, 6-15

Xie X, Hao M, Ding F, Helman D, Scheffran J, Wang Q *et al.* 2022 Exploring the direct and indirect impacts of climate variability on armed conflict in South Asia *iScience*

Yeeles A 2015 Weathering unrest: The ecology of urban social disturbances in Africa and Asia *Journal of Peace Research, 52*(2), 158-170

Zhang D D, Brecke P, Lee H F, He Y-Q and Zhang J 2007 Global climate change, war, and population decline in recent human history *Proceedings of the National Academy of Sciences of the United States of America, 104*(49), 19214-19219

Zhang Y, Liu L, Lan M, Su Z and Wang K 2024 Climate change and economic policy uncertainty: Evidence from major countries around the world *Economic Analysis and Policy, 81*, 1045-1060