Climate, natural resources, and conflict

SUMMARY

This paper examines how climate change and natural resource dynamics contribute to conflict, with a focus on the implications of the green transition. It reviews empirical evidence showing that extreme weather events—such as droughts, floods, and heatwaves—are linked to increased violence, particularly through economic disruptions, reduced agricultural productivity, and displacement. The analysis also explores the mechanisms through which climate shocks influence conflict, including opportunity costs, resource competition, and behavioural responses to environmental stress. The discussion then turns to the role of natural resource exploitation, especially in the context of rising demand for minerals essential to low-carbon technologies. The paper highlights how resource price and availability shocks can trigger conflict, often depending on the type of resource, extraction method, and local governance. It also addresses the overlap between climate- and resource-driven conflict risks, emphasizing that their interaction may amplify instability. Throughout, the paper identifies open research questions related to prediction, the effects of long-run environmental changes, and the design of policy responses. These include insurance schemes, climate adaptation strategies, infrastructure investment, and regulatory frameworks for resource governance. The findings point to the need for research that integrates climate and conflict dynamics, with the goal of informing policies that can mitigate the risks associated with environmental change and resource pressures.

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Climate change, natural resources, and conflict

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1. INTRODUCTION

Extreme weather spurs conflict. One of the most robust findings in the empirical conflict literature is that high temperatures, poor rainfall, droughts, and floods lead to an intensification of violence. This relationship may not be surprising, given that there is a long list of historical and modern conflicts that erupted in the wake of weather anomalies, going from the French Revolution[1] to the Arab Spring.[2] However, to establish causality, it is essential to examine the relationship between weather shocks and conflict with granular data and statistical methods. This is exactly what a large literature has done over the last 20 years. Our paper reviews the evidence produced by this literature and identifies the mechanisms through which climate shocks affect conflict.

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1 Neumann and J. Dettwiller (1990)
2 Kelley et al. (2015)

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Understanding these mechanisms is particularly important to assess the scope for public policies to mitigate climate-induced violence, especially because climate change is expected to increase the frequency and intensity of extreme weather events. As global temperatures rise, many governments try to limit temperature rises through green transition policies. These policies aim at reducing the demand for fossil fuels, but come at the cost of triggering demand shocks for critical minerals. This proves crucial as, incidentally, natural resource rents are another major cause of armed conflict, as we know from another, yet equally robust, strand of the literature. Just like for the role of climate shocks, there is an abundance of mechanisms through which conflict appears to be linked to natural resources. In this article, we review the subset of the existing research that uses careful measurement and statistical methods. Building on the insights from this work, we highlight how an effective and coordinated green transition could reshape the relationship between natural resources and conflict, saving both the planet and the lives of countless conflict victims.

2. CLIMATE SHOCKS EXACERBATE CONFLICT

2.1. The direct effects of climate shocks on conflict

Perhaps the first economic study to highlight the causal link between weather shocks and conflict was Miguel, Satyanath, and Sergenti (2004). Prior to this highly influential paper, several studies in economics and political science had shown that there was a negative statistical association between the growth rate of GDP and the incidence of conflict (e.g., Fearon and Laitin 2003; Collier and Hoefller 2004). But Miguel, Satyanath, and Sergenti (2004) used **rainfall** as an instrument for GDP growth in a panel of Sub-Saharan African countries—which are highly dependent on agriculture and lack advanced irrigation technologies, ensuring a large correlation between rainfall and GDP growth (the first stage of their instrumental variables strategy). They found that lower growth led to higher conflict. However, the article was subject to several critiques. First of all, the authors estimate a 'local average treatment effect', where the compliers are countries that are most heavily dependent on agriculture and with the least irrigation capacity. This implies that, rather than unveiling the generic effect of economic growth on conflict, their findings should really be interpreted as capturing the effect of rainfall-induced economic shocks on conflict.

But this is also precisely why that paper is relevant for the current review. Other critiques are more relevant for us. For example, the way it measured economic shocks was not suited for transitory rainfall deviations (Ciccone 2011). Also, as more and more subsequent research documented impacts of rainfall on a large number of economic outcomes, the exclusion restriction became harder to defend (Dell, Jones, and Olken 2014b).[3] In spite of these limitations, the work by Miguel,

3 The exclusion restriction is the assumption that the effect of the instrument (in this case rainfall) on the outcome (conflict) only occurs through its effect on the endogenous variable (economic growth) and not through any other direct or indirect channel.

Satyanath, and Sergenti can be credited with boosting two large branches of literature: one studying climate shocks and conflict, and another one on economic shocks and conflict. From the perspective of this review, we emphasize the first branch, which has expanded the geographical settings in which this relationship has been studied, the levels of geographical aggregation, and also the types of climate shocks.

In terms of types of climate shocks, the attention in the literature quickly turned to extreme heat conditions as an alternative trigger of violent conflict. Burke et al. (2009) find that **high temperatures** trigger violence. These results were refined in a later paper (Burke et al. 2010), in response to the methodological criticism put forward by Buhaug (2010). Beyond heat waves, climate shocks could also lead to natural disasters like droughts, wildfires, landslides, or floods. In a cross-country panel study, Besley and Persson (2011) find that natural disasters in general lead to higher conflict.

The literature inspired by Miguel, Satyanath, and Sergenti (2004) was so large that 10 years after its publication, Burke, Hsiang, and Miguel (2015) wrote a review article in which they synthesized evidence from fifty-five studies in economics, political science, and environmental science. Each of these studies considered the relationship between climate shocks and conflict, but at various levels (sub-national, regional, or global) and looking at different types of conflict, ranging from road rage and murder to full-scale civil wars. A meta-analysis of these studies confirms that extreme temperature and rainfall shocks systematically increase the likelihood of violent conflict. A one standard deviation increase in temperatures leads to a 2.4 per cent increase in interpersonal conflict and a 11.3 per cent increase in intergroup conflicts.[4]

A number of studies had revisited the setting of the original Miguel et al. paper—i.e., focus on the African continent—but have tried to improve the measurement of climate shocks. For example, Couttenier and Soubeyran (2013) use a grid-cell measure of droughts (the Palmer Drought Severity Index) and combine it with conflict events from the Localized Conflict Event Dataset (ACLED), which provides a precise geocoding of events. They find a positive but statistically insignificant relationship between drought shocks and conflict. In a closely related study, Harari and La Ferrara (2018) focus on the effect of droughts on conflict, using the Standardized Precipitation and Evapotranspiration index (SPEI). This measure combines rainfall, temperature, and potential evaporation (depending on soil conditions) to capture droughts. The grid-level analysis reveals that local SPEI shocks lead to higher conflict intensity. One conclusion from this large literature is that, even if measurement seems to matter, the original conclusion of Miguel, Satyanath, and Sergenti (2004) proves remarkably robust: climate shocks spur conflict in a variety of settings.[5] But what explains it?

4 Publication bias is a clear concern for these types of meta-analyses, but as the authors argue, there are enough articles that find no relationship between climate shocks and conflict to expect that this is not a main concern.

5 It should be noted that not all authors would entirely agree with this conclusion and highlight studies that do not find a strong relationship between climate and conflict (see, e.g., the recent reviews by Gilmore 2017; Koubi 2019; Mach et al. 2019). However, the way we like to think about seemingly

2.2. Mechanisms of influence

Several mechanisms could explain the observed relationship between climate shocks and conflict.

First, extreme climate shocks wreck **agricultural productivity** and generate livelihood insecurity in rural households, especially those with limited access to insurance or other protection mechanisms. Theoretically, distressed people with limited legal economic alternatives may find joining armed groups more attractive, because of the low opportunity cost of participating in conflict or other predatory activities. This theoretical logic is commonly referred to as the 'opportunity cost channel', and it is the mechanism that Miguel, Satyanath, and Sergenti (2004) favoured. It was first suggested by Becker (1968) in a seminal paper on the economic analysis of crime, which treats crime as an occupational choice that follows a rational cost-benefit calculation. Chassang and Padró-I-Miquel (2009) refined this theoretical argument in the context of civil war violence. The theory is consistent with the empirical finding that climate shocks simultaneously increase conflict and reduce economic activity. The negative effect of climate shocks on economic activity [Miguel, Satyanath, and Sergenti (2004)'s first stage] has been confirmed in a large number of conflict studies.

Studies that provide evidence for the **opportunity cost mechanism** have relied on measures of agricultural output (Vanden Eynde 2018), rural wages (Fetzer 2020), or—in the context of Somalia—livestock prices (Maystadt and Ecker 2014). In their study of drought and conflict in Africa, Harari and La Ferrara (2018) offer insightful indirect evidence on the opportunity cost channel. They combine their drought measure (SPEI) with detailed information on the cropping cycle of the crops that are grown in particular areas to identify the drought shocks that are most likely to affect agricultural productivity. This exercise reveals that the relationship between drought and conflict is driven by those shocks that undermine agricultural output. Shocks with no effect on agriculture do not trigger conflict. To the extent that natural disasters destroy local livelihoods, it is plausible that the opportunity cost channel is not limited to droughts, but it could also be triggered by floods, wildfires, and biodiversity loss.

A literal interpretation of the opportunity cost mechanism has been criticized in the literature as being inconsistent with high levels of unemployment (Berman et al. 2011). Indeed, many mechanisms that are conceptually different from a pure opportunity cost argument are empirically indistinguishable. For example, lower economic activity may exacerbate pre-existing grievances or inequalities that can trigger conflict without requiring participants in violence to take into account the income they lose when they participate in conflict.

contradictory findings is that they reflect important heterogeneous effects parametrized by contextual factors. In other words, climate shocks do not always lead to conflict, even if the literature shows that they often do. Understanding this heterogeneity is clearly important for the design of context-relevant policies.

The opportunity cost channel is often presented in contrast to a **rapacity channel**, whereby the prize of conflict (rather than the opportunity cost) drives participation in violence (Dal Bó and Dal Bó 2011; Dube and Vargas 2013). However, the two mechanisms operate simultaneously in practice, as rapacity captures the benefits of fighting which are weighed against the costs. If the benefits of fighting are limited to local agricultural output, then climate shocks could simultaneously affect the benefits and the costs of fighting.[6] This is illustrated in recent work by Jensen et al. (2025). These authors find that when droughts trigger pasture scarcity in Ethiopia and Kenya, cattle raids increase. But, when excess rainfall leads to pasture abundance, they also find that raids increase. If the benefits from fighting come from the access to neighbouring lands less affected by climate shocks, such shocks can also spark **intergroup conflict**. The recent work by McGuirk and Nunn (2025) shows that droughts lead to conflict between herder and transhumant-pastoralist groups. Traditionally, transhumant pastoralists and sedentary agriculturalists maintain a cooperative relationship, where farmland is used for crop cultivation during the wet season and for livestock grazing in the dry season. However, droughts disrupt this balance, prompting pastoralists to move into agricultural lands before crops are harvested, thus sparking conflict. The authors show that droughts in pastoralist areas lead to conflicts in adjacent regions, particularly in agricultural zones. These conflicts occur during the wet season rather than the dry season. In related work, Eberle, Rohner, and Thoenig (2024) report similar findings but focusing on heat shocks rather than rainfall variation.

The mechanisms that drive herder-pastoralist violence are very close to the ones that drive **water disputes**, which is another context in which climate shocks reduce the costs of and increase the benefits of participating in conflict simultaneously. Indeed, Gleditsch et al. (2006) argue that water scarcity around transboundary rivers is conducive to violent conflict. Similarly, relying on grid-cell data covering the African continent, Decet and Marcucci (2024) find that reduced rainfall in a given grid-cell location leads to more conflict in neighbouring areas that are water-rich and that are located upstream along the river network. In line with the findings on herder pastoralist conflict, the water dispute effects are stronger when water is unequally distributed between ethnic groups.[7] One way of thinking about this recent work is that it highlights rapacity motives that explain the conditions under which opportunity cost shocks are more impactful. The opportunity cost logic links lower agricultural productivity directly with the participation in armed groups. However, this link could also be indirect and run through political processes. Studying historical conflicts in Egypt, Chaney (2013) finds that poor agricultural productivity (as caused by deviant floods) created **regime**

6 Inversely, we can expect climate shocks to have a bigger impact where there are independent rents from fighting, which could be the case in areas with natural resource rents, which are unaffected by agricultural productivity shocks (Vanden Eynde 2018). The role of natural resources will be discussed in more detail later.

7 This suggests that ethnicity per ser does not trigger conflict, but it can exacerbate it when present.

instability—and thus conflict—by undermining tax collection and facilitating protest. This logic is in line with the theory of Acemoglu, Johnmson, and Robinson (2001) and Acemoglu and Robinson (2006) on regime transitions, as periods of scarcity and high food prices can provide a window during which disenfranchised groups can overcome their collective action problem and coordinate on protests to challenge ruling elites.

Despite the compelling evidence that economic channels mediate the link between climate change and conflict, recent research has highlighted that this picture is far from complete. A large number of studies report impacts of extreme climate—particularly heat—on violent activities in contexts where living conditions are unaffected. For example, Larrick et al. (2011) document that, in the USA, violent retaliation behaviour during baseball games spikes under heat stress. Similarly, criminal behaviour in the USA also appears to be higher during heat waves (Jacob, Lefgren, and Moretti 2007). There is in fact an established literature in psychology confirming that **behavioural factors** could make individuals more aggressive when exposed to heat (Anderson 2001; Anderson et al. 2002). Bollfrass and Shaver (2015) confirm the link between heat and sub-national level conflict across a wide range of countries, and they highlight that this link exists even in places where agricultural activity is negligible. Behavioural effects of heat exposure could be particularly important in urban settings, which are generally understudied in the economic literature on conflict. Therefore, behavioural factors could coexist with economic channels in the relationship between weather shocks and conflict. Presumably, they could also exacerbate economic incentives for rebellion, but this interaction has not yet been studied in the literature.

Climate-driven economic distress may also incite **displacement** waves, further reducing employment and other income-generating activities and aggravating existing ethnic and political cleavages. For instance, rising sea levels could become a particularly important source of land scarcity, triggering inland displacement and igniting violent disputes over land and other resources. The existence of such a climate-migration-conflict nexus is often assumed (e.g., Brzoska and Fröhlich 2015), but careful empirical investigations of this channel are rare. One exception is Ghimire, Ferreira, and Dorfman (2015), who find that large floods and the displacement they cause are likely to lengthen preexisting conflicts—but do not trigger new ones. Moreover, using a country-year panel, Cattaneo and Foreman (2023) find that migration flows triggered by drought shocks increase the likelihood that the destination country starts a war in the country from which migration originates. The authors suggest that the domestic attitude towards migrants shapes the diplomatic relations with their origin countries. This finding is consistent with older work by Docquier, Ruyssen, and Schiff (2017), who also find that both North-South and South-South migration increase conflict occurrence. However, the mechanisms behind these findings are not obvious. More generally, documenting the full causal chain between climate shocks, migration, and conflict is challenging: climate shocks are likely to affect conflict outcomes through other channels than migration, and reliable data on migration flows from conflict-affected areas are rare, especially when the displacement occurs within the affected country.

Beyond its direct effects on local agricultural production, regime stability, behavioural aspects, and displacement, climate change can most likely also affect the **global prices** of agricultural commodities. In turn, Bellemare (2015) and van Weezel (2016) find that food price increases lead to higher social unrest, even if the first author qualifies this finding by highlighting that food price volatility is not associated with higher social unrest. Recent research by McGuirk and Burke (2020) helps understand the mechanisms of the previous findings by showing that the impact of increased food prices on conflict depends crucially on whether areas are producers or consumers of these commodities—a finding that is in line with the seminal work by Dube and Vargas (2013). While in consuming areas, higher prices may likely trigger an opportunity cost-type channel, in producing areas agricultural price booms could spur conflict through a so-called 'rapacity channel', that is making predation more attractive. Climate change could increase the strategic importance of food supplies (as was illustrated by grain production in Ukraine at the time of writing this piece), and understanding how the agricultural sector is affected by and contributes to conflict is an important topic for future research.

The impact of climate shocks on food prices and agricultural productivity highlights the role of **food security** in the causal chain that links climate shocks to conflict. In fact, food insecurity and conflict are linked through a variety of causal channels (Brück and Errico 2019). For example, conflict can also be a cause of food crises. The High Level Panel of Experts on Food Security and Nutrition (HLPE-FSN 2024) reports that 135 million people were in a food crisis in 2023 because of war and conflict. Hence, there is a clear risk that climate shocks trigger a vicious cycle in which persistent food crises prolong conflict.

2.3. The environmental costs of conflict

The reverse relationship is also important: violent conflict can create environmental degradation. This would be the case if at least a fraction of the factions participating in conflict funds their operations through (legal or illegal) land-extractive activities. Examples include illegal mining and land-intensive crops that serve as drug precursors, such as coca or poppy.[8] It may also be the case if rebels attack key government infrastructure, such as oil pipelines, causing oil spills. Therefore, the territorial expansion of armed groups which engage in such activities may create **deforestation** (Fergusson, Romero, and Vargas 2013). This suggests that the relationship between climate change and conflict is **self-reinforcing**, in a vicious cycle that can only be broken by identifying causal micro-mechanisms and designing effective policy interventions.

8 See Section 3 for a discussion about the relationship between natural resources and conflict.

2.4. Climate shocks versus climate change

While the literature has made some progress in identifying channels through which climate change will make extreme weather events more likely in particular settings, this research agenda is far from concluded. Indeed, these events will directly affect millions of people and will indirectly affect millions of others through land and resource contestation. But, since the nature and the geographical incidence of weather shocks are increasingly changing over time, we need to understand the mechanisms through which climate shocks affect conflict to make **predictions** about the impact of climate shocks in the next decades, which will help us design prevention strategies and coping mechanisms.

Taking such an approach, Eberle et al. (2025) find that ethnic cleavages reinforce agricultural productivity shocks in the context of herder-settler conflicts in Africa. The authors subsequently use these insights to make precise predictions about how climate shocks will affect conflict at the level of fine-grained geographical grid-cells across the African continent by 2040. There is ample scope for new research that generates predictions incorporating alternative mechanisms, such as the role played by political uncertainty and psychological effects, as discussed earlier. If based on a wide range of conflict predictors, these predictions will help policy makers and practitioners to turn the focus on conflict prevention over the next years.

Changing the perspective from climate shocks to climate change could also make certain channels of influence more important. A channel that could be particularly important in the context of long-run climate change is **biodiversity loss.** The role of forestry, fishing, and ecotourism has not received much attention in the conflict literature. It is possible that the development of such ecosystem services can promote peace through an opportunity cost channel—and this hypothesis deserves explicit investigation. Conversely, the loss of biodiversity could harm people's economic livelihoods and threaten their health. However, the effects of historical climate shocks are unlikely to capture these impacts, as they are the result of an accumulation of shocks over time periods that are much longer than the samples of most studies. Relatedly, long-run desertification is distinct from an accumulation of droughts, and its impact on conflict could be different too. Hence, comprehensive predictions will need to move beyond pure extrapolation of historical estimates. Such an approach brings methodological challenges that are not unique to the study of conflict—they apply to any estimate of the effect of climate change on economic outcomes. General reviews like Dell, Jones, and A. Olken (2014a) provide important insights on how econometric models can be adapted to capture the long-run effects of changes in climatic factors.

Research that predicts how climate change affects conflict will have to incorporate the role of adaptation strategies, which by and large deserve more attention. Populations who are suffering from the increased frequency of extreme weather events could develop strategies (e.g., crop choices, investments in human capital, migration

etc.) to mitigate the impact of weather shocks in their communities. Providing them with opportunities to accelerate this adaptation should be a policy priority.

2.5. Policy interventions

For all these questions, a mechanism-centred approach can help identify **policy interventions** and institutional reforms that can mitigate these impacts.

For instance, in the case of mitigating the impact of climate shocks, an obvious policy solution (at least in theory) consists of offering **insurance** products against these shocks. In the context of India's Maoist conflict, Fetzer (2020) finds that a social protection program helps breaking the link between droughts and conflict. In a context of herder-settler tensions in Kenya, Gehring and Schaudt (2023) report that Index-Based Livestock Insurance enabled pastoralist groups to stay closer to their homelands, and as a result, it reduced violence over scarce land with settler communities. In Ethiopia, (Sakketa, et al., 2025) also find that index insurance reduces conflict risk in times of poor rainfall. These findings are very promising, but they also raise a set of crucial questions about feasibility and external validity. First, the administrative capacity required to offer insurance products is quite important. Second, we know from a large literature in development economics that the take-up of insurance products tends to be surprisingly low (see, e.g., Cole and Xiong 2017). Third, insurance products may not be sustainable when the shocks they protect against are aggregate in nature—which is often the case of climate shocks, and in particular of the expected long-run changes that characterize the current climate crisis. Finally, recent work by Jensen et al. (2025) suggests that insurance could also increase conflict—thus highlighting concerns about external validity. These authors confirm that drought insurance does indeed mitigate drought-induced conflict, through the opportunity cost channel. However, at the same time, they find that insurance changes behaviour ex ante and makes cattle raids more likely when pastures are abundant, through a rapacity logic driven by moral hazard. This last finding calls for carefully designed (and if necessary, adjusted) interventions that are based on mechanism-centred evidence and are inventive-compatible.

In the case of aggregate shocks, the only possibly policy priority may be **humanitarian interventions** that can mitigate conflict risk. However, the evidence on the effectiveness of humanitarian interventions is mixed. In an influential article, Nunn and Qian (2014) find that US food aid increases conflict risk at the country level. The authors suggest that such aid could directly or indirectly prolong conflicts. These findings have been criticized on methodological grounds by Christian and Barret (2017), who argue that there is in fact no robust relationship between food aid and conflict. A more recent study by Mary and Mishra (2020) finds that humanitarian food aid decreases conflict onset and duration at the country level. These questions are not just topics of academic debate—designing effective humanitarian support is a key policy challenge for international donors and domestic governments alike. There is an urgent need for research that uses more fine-grained data, documenting precise mechanisms of

influence, to understand under which conditions and through which channels humanitarian aid is most effective in mitigating the impact of climate shocks and in reducing the risk of conflict.[9] In particular, understanding the optimal timing of such aid and the potential of forecasting (including early warning systems) to improve targeting during food crises are important questions for policymakers (see, e.g., Lazzarin et al. 2022).

In addition to short-run aid, long-run **public investment** in infrastructure could also mitigate the impact of climate shocks. In principle, better trade links could reduce the impact of local climate shocks. For example, Burgess and Donaldson (2010) show that railways helped to reduce famines in colonial India. However, infrastructure development can also affect conflict dynamics directly and in complex ways (Muller-Crepon, Hunziker, and Cederman 2020). This is true for any type of investment in infrastructure, especially when it opens markets for both legal as well as illegal goods or exacerbates the rapacity effect. Therefore, there is a real need for work that assesses directly whether infrastructure investment can mitigate the impact of climate shocks on conflict.

Over a long-term horizon, the **adaptation** of agricultural practices to climatic risks could also weaken the impact of climate shocks on the well-being of local populations. Historical evidence for China offers clear support for this idea. Jia (2014) finds that droughts tended to spur peasant revolts, but that the introduction of the (drought-resistant) sweet potato (around the seventeenth century) weakened this relationship substantially. Focusing on (present-day) Indonesia, Gatti, Baylis, and Crost (2021) similarly find that irrigation attenuates the link between rainfall and conflict. In general, agricultural technologies have a large potential to play a mitigating role, and their impact deserves more research. However, it is worth keeping in mind that many adaptation strategies (including irrigation) also put more pressure on scarce resources,[10] and they also can contribute to conflict through those channels. Hence, there is a real need for research on the conditions under which adaptation strategies can prevent and reduce climate-induced conflict.

Where climate change causes land deterioration or water scarcity, managing access to these key resources could be a particularly important policy lever.[11] The decentralized **management of scarce resources** in particular holds a lot of promise. Krakowski and Mazur (2024) present evidence on India suggesting that decentralized water management helps to reduce conflict induced by droughts. There is clear scope to expand the evidence on how decentralized resource management can mitigate

9 Brück and Errico (2019) also call for more micro-evidence on policies that help households to escape the hunger-conflict trap.

10 Aragón et al. (2021) find that Peruvian farmers respond to extreme heat by increasing their land use.

11 A World Bank report by Ahmadnia et al. (2022) gives many examples of how unequal access to land contributes to conflict. They also highlight that land disputes tend to escalate in post-conflict settings.

conflict.[12] However, ambitious interventions that change access to resources are often impossible in the absence of more structural societal changes. Indeed, Besley and Persson (2011) argue that more cohesive political **institutions** can prevent natural disasters from triggering conflict by lowering wages (opportunity cost mechanism) and increasing foreign aid (rapacity effect mechanism). However, more evidence on this is necessary. There is a clear scope for future research that causally evaluates how development interventions and institutional factors affect the impact of climate change in specific settings.

3. NATURAL RESOURCES AND CONFLICT

The topics of climate change and natural resources are closely linked. The mechanisms through which climate shocks impact conflict include agricultural crops, land, and access to water, which are important renewable resources. However, as this section emphasizes, there is a close link between non-renewable resources—which do not depend directly on climatic conditions—and climate-induced conflict risk.

3.1. Non-renewable resource shocks and conflict

To stem the adverse impacts of climate change, the global community has committed to a **green transition** to reduce carbon dioxide emissions. The green transition will profoundly affect the **natural resource sector** by boosting demand for key minerals (Hund et al. 2020; Herrington 2021). An important concern is that these changes will contribute to violent conflict. Indeed, a remarkably robust finding in the literature on conflict is that oil and mineral price booms spur violence (see Ross 2012 and Blair, Christensen, and Rudkin 2021 for comprehensive reviews).

In an interesting parallel to the literature on climate shocks and conflict, the causal effect of natural resource shocks on conflict appears to be relatively weak at the country level. Indeed, Bazzi and Blatmann (2014) find that commodity price shocks have no effect on the onset of new conflicts, even in high-risk nations.[13] The only robust relationship they find is that rising prices appear to both shorten wars and make them less intense. The lack of effect on the onset of conflict is consistent with the idea that, while increasing the incentives for a violent contestation of the valuable resources, commodity price shocks also generate revenues for the state that can be used to suppress such insurgencies. These effects seem to offset each other. A different picture emerges when

12 Libois et al. (2022) finds that community management of forests improves environmental and economic outcomes in Nepal. This work does not focus on conflict reduction directly.

13 An older literature based on cross-country correlations had found a positive association between natural resources and the onset, incidence, and duration of conflict (Fearon and Laitin 2003; Collier and Hoeffler 2004; Fearon 2004).

focusing on shocks in the availability of natural resources rather than price shocks. Indeed, Lei and Michaels (2014) find that the discovery of giant oil fields spurs violent conflict.

The lack of effect of commodity price shocks documented by Bazzi and Blattman (2014) contrasts with the findings of studies that focus on sub-national conflict. For instance, exploiting variation at the level of Colombian municipalities, Dube and Vargas (2013) show that oil price shocks increase conflict in oil-producing municipalities—and the authors report similar findings for price shocks on other natural resources such as coal and gold. In the same vein, exploiting variation at the level of grid cells in Sub-Saharan Africa, Berman et al. (2017) find that mineral price shocks spur conflict in mining zones. In a meta-analysis of forty-six natural experiments, Blair, Christensen, and Rudkin (2021) confirm that price increases in capital-intensive or lootable commodities (including oil and minerals) increase conflict.

These results are consistent with mineral and oil resource shocks triggering a **rapacity mechanism**. The exact way in which this mechanism operates depends on the context. In Colombia, before 2012, municipalities received royalties linked to their mining output, and armed groups engaged in a range of extortionary methods (including abduction of public officials) to access these resources. Dube and Vargas (2013) show that oil price shocks do not just trigger more violence, they also show that they raise abductions by paramilitary groups—which suggests that these shocks operate through extortion. Interestingly, in the same context of Colombia, coffee price shocks have the opposite effect on conflict intensity: high coffee prices reduce conflict. Reassuringly, in their meta-analysis, Blair, Christensen, and Rudkin (2021) also find that price increases in agricultural commodities tend to reduce conflict.

These results are consistent with the **opportunity cost** channel dominating when commodity price shocks increase in a labour-intensive sector (for a renewable resource in the case of coffee). This confirms a theoretical argument proposed by Dal Bó and Dal Bó (2011). Conversely, for mineral resources, which tend to be capital intensive, one could expect the rapacity channel to dominate. In fact, both mechanisms can operate at the same time and interact in complex ways. For example, as highlighted by Vanden Eynde (2018), the funding provided by mining resources could make it easier for armed groups to benefit from economic conditions in which potential fighters have a higher opportunity cost.

Recent work also highlights the importance of understanding the economic structure of natural resource extraction, focusing on mining in particular. In the context of the Democratic Republic of Congo (DRC), Sanchez de la Sierra (2020) finds that the impact of price booms depends on the **type of minerals**. A surge in demand for coltan, a bulky mineral that can be easily detected if stolen, prompts armed groups to provide protection at coltan mine and tax these revenues at the source. In contrast, a similar demand surge for gold, which is easy to conceal, leads to stationary bandits forming in villages where gold-generated income is spent. These results underline that natural

resources do not just shape conflict outcomes, but also the development of governance and administrative capacity by armed groups and the state.

Consistent with the described differences between Bazzi and Blattman (2014) and Dube and Vargas (2013), Rigterink (2020) emphasizes how mineral-price shocks could have different effects at different units of analysis. Considering diamonds, she finds that price booms increase conflict locally because of higher returns to looting, but it reduces conflict at a higher geographical level because of increased opportunity costs of fighting. These effects are specific to alluvial (or secondary) diamonds, the extraction of which is labour-intensive and is easy to loot—they do not translate to primary diamonds embedded in rocks. In fact, such an opportunity cost channel linking conflict to natural resources may not be negligible in a variety of settings. For instance, Aragón and Rud (2014) find that gold mining in Peru raises local incomes through backward linkages.

These findings point at the importance of understanding the economic structure of mining activity. **Artisanal mining** plays a particularly important role in this sense. Artisanal mining activity is rather hard to measure—it is worth noting that the data used in the seminal study of Berman et al. (2017) only comprise industrial-scale mining. However, the labour-intensive nature of artisanal mining implies that price booms could actually improve local economic conditions (Bazillier and Girard 2020). Rigterink et al. (2025) use machine learning to estimate the feasibility of artisanal mining based on geological conditions. In their sample, which covers most of the African continent, they find that the impact of price shocks on violent conflict is more than three times larger in areas where industrial and artisanal mining are both feasible, compared to places that are just suitable for artisanal exploitation. These findings suggest that competition between industrial and artisanal miners could constitute a source of conflict in its own right. However, artisanal mining could also trigger specific types of violence. A recent study finds that it increases sexual violence committed by armed groups in Africa (Fourati, Girard, and Laurent-Lucchetti 2023).

The extent to which mining activity spurs conflict could also depend on **geographical features** such as vulnerability, risk, and governance (Le Billon 2008). For instance, some minerals are easily lootable because their production is concentrated in just a few geographical areas. Moreover, Adhvaryu et al. (2021) find that mineral price shocks boost conflict when neighbouring countries also have mineral deposits. Using information on oil deposits, Caselli, Morelli, and Rohner (2015) find that these deposits tend to generate conflict when they are closer to national borders (or, if both countries have these resources, when there is asymmetry in the location relative to the border). Also, focusing on cross-border spillovers, Malo Rico and Zeng (2024) find that the opening of a gold refinery in Uganda increased violence around artisanal gold mines in the DRC—showing that rapacity mechanisms can operate across the supply chain of minerals.

An understudied, but potentially very important mechanism through which mining activity affects conflict is **pollution**. It is well documented that metal mining has severe negative externalities on water systems (Macklin et al. 2023) and contributes to land degradation (OECD 2025). In principle, pollution could trigger conflict through the

same mechanisms as extreme climate shocks, by destroying rural livelihoods. For instance, Aragón and Rud (2016) show that being located close to a mine lowers agricultural productivity by 40 per cent in Ghana—with pollution being the most plausible explanation. Recent work by Vashold et al. (2024) confirms that water pollution from mining activity reduces downstream agricultural output across the African continent.[14] However, the literature has not shown so far if and how this mechanism contributes to violent conflict. The same is true for the role of displacement from mining areas (because of pollution or to develop mines) and migration to mining zones (in response to economic benefits). These population movements could in principle trigger tensions and contribute to conflict, especially when mediated by ethnic tensions, but there is not much systematic evidence on their role.

Another parallel with our earlier discussion of climate risks is that conflict could make the implementation of environmental regulations harder. This could generate a vicious cycle in which illegal mining, conflict, and environmental degradation reinforce each other. While such settings exist anecdotally, quantitative empirical studies are lacking on this topic. Pollution deserves particular attention though. Unlike climate risks, which are the result of global externalities, pollution can often be attributed to a small set of actors and lends itself more easily to regulation and prevention without requiring international cooperation and coordination. If the implementation of environmental regulations is harder in conflict zones, firms could actually benefit from operating in such environments.

This argument that **firms could benefit from conflict** actually applies more broadly. Guidolin and La Ferrara (2007) document how the end of the civil war in Angola following the sudden death of the main rebel leader, decreased by 4 per cent the abnormal returns of mining firms holding concessions in the country. They argue that mining firms could benefit from competition between the government and armed groups. The converse may also be true when armed groups act as de facto environmental regulators. Prem et al. (2020) show that, in Colombia, the end of the conflict with the Fuerzas Armadas Revolucionarias de Colombia (FARC) generated a power vacuum that extractive firms took advantage of, increasing their activity in former FARC strongholds with no state monitoring or regulatory capacity. This resulted in a substantial increase of deforestation.

Another important dimension to consider is the interaction between mineral wealth and **political power**.[15] Recent work by Berman, Couttenier, and Girard (2023) shows

14 Girard, Molina-Millán, and Vic (2022) show that artisanal mining activity and adverse weather shocks both trigger deforestation—a finding that underlines once more how closely climate change and natural resource management are linked.

15 The concept of the resource curse is not restricted to the study of conflict, there is an influential literature showing negative effects on economic growth (e.g., Sachs and Warner 1999). Focusing on this economic resource curse, Mehlum, Moene, and Torvik (2006) highlight that natural resources have a negative effect on economic activity when institutions are weak. Of course, conflict could be part of the mechanism underlying the relationship between natural resource shocks and growth—and is typically not studied directly in this older literature.

that ethnic identities become more salient due to the extraction of natural resources. As we know from a large literature on how ethnic polarization can drive conflict, political processes may reinforce the rapacity channel. In this spirit, De Luca, Sekeris, and Vargas (2018) develop a theory showing that autocratic leaders have an incentive to promote civil conflict between ethnic groups in order to maximize the rents they can extract from natural resources—and they find empirical confirmation for this idea in a cross-country panel.

3.2. Prediction

A priority for future research is to make **predictions** about the impact of the green transition on the conflicts that are induced by natural resources. Such an exercise requires a more complete understanding of causal mechanisms, but also needs to account for changes in economic shocks. Unfortunately, the changing nature of such shocks implies that insights from historical data cannot be carried forward easily. In particular, the volatility of mineral price shocks could be much higher during the green transition due to the rapid development of new technologies that spur demand for different commodities.

The role of the oil sector also deserves particular attention, as oil production simultaneously contributes to climate change and conflict. Even if oil deposits spur conflict (Caselli, Morelli, and Rohner 2015), the fast decline of this sector is not necessarily peace-enhancing due to the political tensions that this process entails.

3.3. Policies

Beyond the design and implementation of an effective green transition, there is plenty of scope for a range of **policy-oriented work** on the role of natural resources, building on the existing literature on how policies and political institutions can prevent or at least reduce the scope of the 'natural resource curse'.

Existing **international regulation and transparency initiatives** target conflict minerals explicitly. In their study of Sub-Saharan Africa, Berman et al. (2017) find that mineral price shocks are less likely to spur violence when mines are owned by companies that are subject to transparency rules. These authors study a range of initiatives aimed at reducing corruption and the financing of armed groups. These initiatives include the Mineral Certification Scheme of the International Conference on the Great Lakes Region, the International Council on Mining and Metals, and the Extractive Industries Transparency Initiative. In the USA, the Dodd-Frank Act requires publicly traded companies that use tantalum, tin, tungsten, or gold ('3TG') to take steps to determine the origin of these minerals and to make sure that their extraction does not contribute to conflict in the DRC and its neighbouring countries.[16] However, in contrast to

16 The EU's Conflict Mineral Regulation imposes similar constraints.

the findings of Berman et al. (2017), Parker and Vadheim (2017), Stoop, Verpoorten, and van der Windt (2018), and Bloem (2021) all find that the Dodd-Frank Act increased violence in the countries targeted by the regulation. In contrast, recent work by Chang and Christensen (2023) finds that the certification of artisanal gold mines in the DRC, which responds to the requirements of the Dodd-Frank act, reduces local conflict.

When it comes to diamond mining, the results are less ambiguous. The Kimberley Process, which covers eighty-one countries, tries to eliminate conflict diamonds and restrict trade to certified diamonds. Heffernan (2016) and Binzel, Fehr, and Link (2023) find that the Kimberley process has a conflict-reducing effect in areas with deposits of alluvial diamonds (i.e., the type of diamonds that tend to spur conflict). While they do not focus on conflict in particular, Chistensen et al. (2024) find that the US Foreign Corrupt Practices Act increased the economic benefits of mining activity in Africa. As is clear from this overview, the research on international regulation and transparency initiatives is very active. Most of the results point at a positive impact of such tools, but it is important for future research to shed light on the structural characteristics of conflict areas and the details of the regulatory tools that explain why the estimated effects go in different directions, and hence how can existing policy tools be optimized.

Domestic regulation could in principle be a powerful policy tool in conflict-affected resource-rich countries. Mining activity is almost universally regulated through leases. However, weak state capacity often prevents the enforcement of such contracts, which is exactly why foreign transparency initiatives that entail strong enforcement mechanisms are so prevalent. However, there is substantial variation in the state capacity of conflict-affected regions, and some types of mining lend themselves more easily to regulation than others—the difference between artisanal and industrial mining being an obvious example. This implies that regulation could impact the size and type of mining activities, for instance, by shaping the competition between artisanal and industrial mines that Rigterink et al. (2025) identify as crucial to trigger conflict. Regulation could also reduce the pollution generated by mines—which, as mentioned, entails conflict impacts that are still poorly understood. In addition, land degradation and biodiversity loss can result from or be reinforced by climate change, so this is an area in which policies need to take these different dimensions of the natural environment into account.

A final priority for future research is to evaluate initiatives that aim to increase the local **economic benefits** of mines and that create mechanisms for the horizontal co-optation of local communities in mining projects, as well as for the vertical cooperation with higher administrative government levels. It is an open question the extent to which such interventions can successfully reduce the risk of conflict or not. Moreover, as highlighted in our discussion of biodiversity loss, the question of how to generate economic benefits that promote peace extends to the management of renewable natural resources like forests.

Political institutions could also play a role in mitigating the resource curse. Fetzer and Kyburz (2022) find that the relationship between oil price shocks and conflict

weakens in Nigeria when local governments, whose revenues depend directly on oil production, are democratically elected.[17] These results are all the more relevant in the light of the evidence that natural resource extraction could exacerbate ethnic tensions (Berman, Couttenier, and Girard 2023). Of course, the design of political institutions is not usually under the control of policymakers, but powerful complementary interventions exist. For example, information interventions could mitigate the political resource curse. Armand et al. (2020) studied a large-scale communication campaign on a giant oil discovery in Mozambique. They find that this campaign is effective in reducing violence, but only if it reaches the population at large (and not just elite groups). In addition, fiscal interventions could also be powerful levers for policymakers. These include the rules that govern how mining revenues are taxed by different levels of government (local and national) as well as distributed (across producing areas and other administrative units). Shapiro and Vanden Eynde (2023) find that a royalty hike on iron ore increased violence in India's Maoist conflict, as the incentives for state-led security forces to intervene in the conflict increased.[18] In the context of non-renewable natural resources, the promise of decentralization appears less clear than for the management of water and forest resources we discussed earlier. The success of institutional changes and decentralization initiatives for the management of non-renewable natural resources is also likely to be context specific—and expanding the evidence on this topic is particularly important from a policy perspective.

4. GEOGRAPHICAL INCIDENCE OF CLIMATE AND RESOURCE DRIVEN CONFLICT

As discussed above, natural resources play an important role in climate-driven conflict. Still, the economic literature has not fully explored the **complementarities** that exist between different causes of conflict.[19] A first question is if regions at risk of climate-induced conflicts overlap with those that are at risk of resource-fuelled conflict. This question is relatively easy to answer descriptively for the African continent, thanks to readily available replication data from Berman et al. (2017) and Harari and La Ferrara (2018).

17 Couttenier, Grosjean, and Sangnier (2017) find that gold discoveries in the US have a persistent effect on homicides when the discoveries are made before formal institutions are in place, confirming that political institutions can mitigate the effect of natural resource shocks.

18 These authors report an increase in illegal mining in response to the royalty hike, which could be consistent with corrupt state officials exploiting their improved bargaining position when their legal tax revenues increase. These findings appear to be context specific. In Colombia, Saavedra and Romero (2021) find that a reduction of local government revenues led to an increase in illegal mining.

19 The question of complementary impacts is also understudied in the literature on development interventions in general (e.g., Vanden Eynde and Wren-Lewis 2023).

Panel A of Fig. 1 maps drought shocks[20] and industrial mining sites[21] in the African continent. This map shows that there are several areas where historical exposure to droughts and industrial mining activity overlap, especially in West Africa. This raises the question of whether these conflict risks are additive in nature, or if the probability of conflict increases more than proportionally when regions are exposed to several risk factors at the same time. While we leave these questions for future research, it is worth noting that such 'meta' work is greatly facilitated by the ACLED database, which allows for granular panel datasets (at the level of grid cells or small sub-national units) of conflict for the African region (from 1997 onwards). In panel B, we map conflict events from ACLED for the period 1997–2011. Indeed, many of the seminal works in the literature rely on ACLED and focus on (sub-Saharan) Africa. While ACLED has branched out to other regions (in particular after 2016), the literature has not converged yet on an integrated **global conflict panel**. Testing whether key insights about the role that climate shocks and natural resources play in conflicts from Sub-Saharan Africa translate to the global level is an important question for future research. This is particularly true as well for the prediction efforts that investigate the impact of climate change and the green transition.

5. PRIORITIES FOR FUTURE RESEARCH

Climate change and the green transition are likely to affect global conflicts profoundly. We can build on the progress that economists and other social scientists have made in studying the role of weather shocks and natural resource booms on a range of outcomes that cover the spectrum from political corruption to full-scale civil war. Still, there is a need for future research to contribute to a better understanding of the underpinnings of how these changes affect conflict outcomes, to improve the predictions about the likely impacts (together with their timing and intensity), and to unveil novel but feasible policy solutions that can mitigate conflict risks.

Table 1 presents a (non-exhaustive) list of priority areas for future research that this paper identifies. Several of them are common to climate change and renewable natural resources.

20 Drought measures are from the SPEI Global Drought Monitor, focusing on standardized precipitation-evapotranspiration index (SPEI) in the growing season (following Harari and La Ferrara, 2018). This variable captures anomalies in local water balance, reflecting short- to medium-term drought and wetness conditions. A negative value reflects drier-than-average (drought-like) conditions, while a positive value indicates excess moisture.

21 The industrial mining sites are from the replication materials of Berman et al. (2017). Their measures are based on the Raw Material Data (RMD) compiled by IntierraRMG.

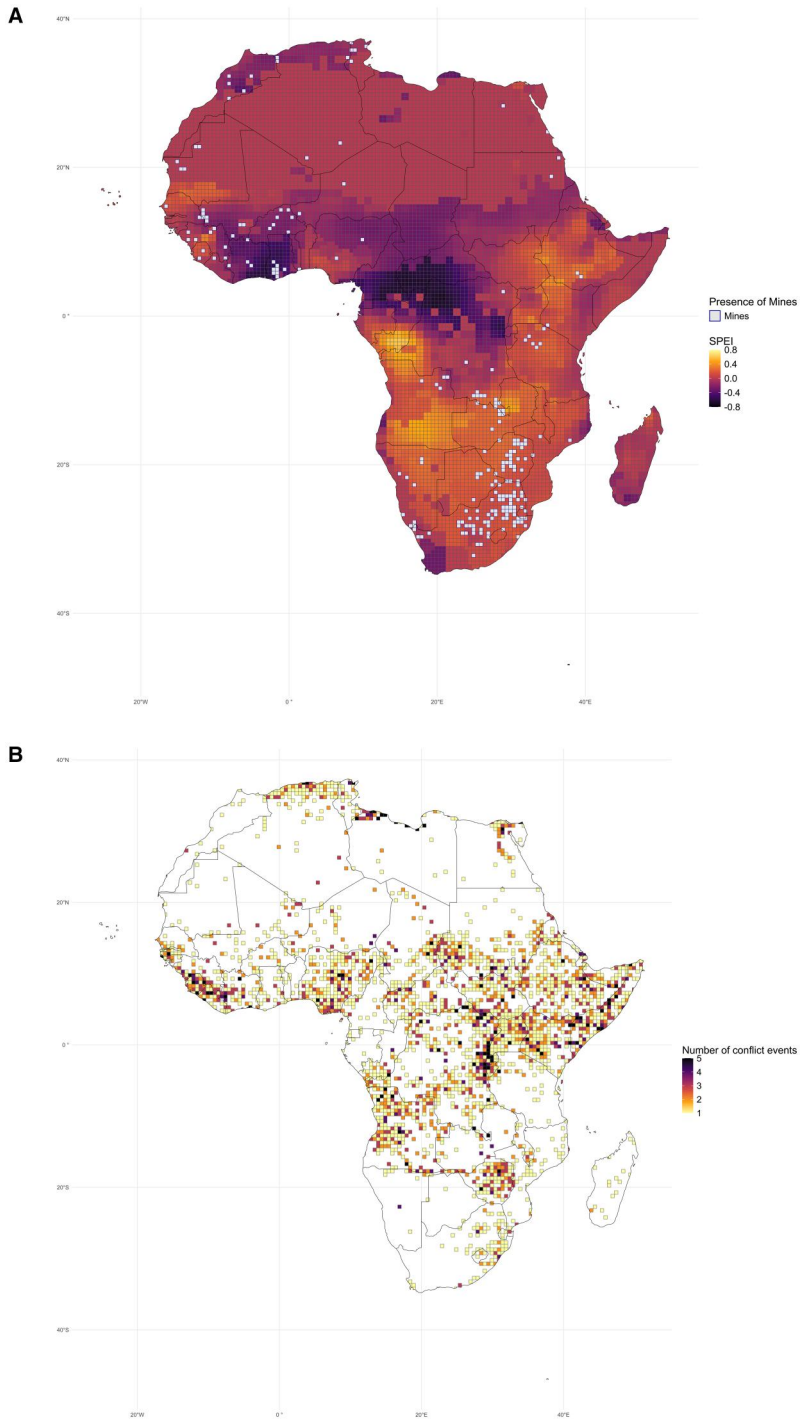

Figure 1. Drought shocks, mining activity, and conflict in Sub-Saharan Africa.

Source: Maps are based on replication data from Berman et al. (2017) and Harari and La Ferrara (2018). Grid cells are at the 55 km × 55 km level. SPEI is the Standardized Precipitation and Evapotranspiration Index, calculated as the mean in the growing season of each grid cell (1997–2011). Mining sites include large-scale industrial mines (active in 1997–2010). Conflict events are from ACLED and cover 1997–2011. A more detailed description of the data can be found in the text.

Table 1. Priority areas for future research.

Mechanisms	
Biodiversity and pollution	Understand how ecosystem services can promote peace and what are the risks of land degradation and biodiversity loss (caused by climate shocks or resource extraction).
Migration	Examine whether migration due to climate and natural resource shocks contributes to conflict risk. Understand the role of growing urbanization trends.
Food security and conflict	Understand the role of food security in the causal chain linking climate shocks to conflict.
Complementarities	Understand better how different risk factors interact.
External validity	Construct integrated datasets at a global level, generate evidence from a variety of settings.
Prediction	
Long-run changes	Develop predictions about conflict induced by climate change and the green transition. Account for the fact that the accelerating rate of climate change makes the structural parameters that can be learned from past events less useful to predict future trends.
Policies	
Insurance	Develop effective insurance products and schemes to protect vulnerable populations.
Infrastructure and climate	Can public infrastructure investment reduce climate-induced conflict without exacerbating other forms of rapacity-induced conflict?
Climate adaptation strategies	How can policies promote adaptation strategies for populations affected by climate shocks, including crop choices and human capital investments.
Regulation of natural resources	How can the regulation of natural resources promote peace, both at the international and at the domestic level. Which activities can be effectively regulated at the national level.
Economic benefits of natural resource extraction	Which policies generate broad-based local economic benefits of natural resource extraction that neutralize the rapacity channel
Political institutions	Assess how political institutions and governance structures (including decentralized management) can mitigate the impact of climate change and resource extraction on conflict.

6. CONCLUSION

In the light of the evidence discussed in this paper, there is a clear risk that climate change, the green transition, and the degradation of the natural environment will interact in complex ways and lead to an escalation of armed conflicts in the next decades. Significant progress has been made on identifying the causal mechanisms that underlie the impact of climate shocks and natural resource extraction on conflict. However, future research should build on predictions from climate science and resource economics to understand the nature of future climate changes, and to expand (where necessary) the evidence we have on the mechanisms that link the natural environment to conflict.

Such work will both help identify the contexts that are most vulnerable to future conflict and evaluate policy interventions that can mitigate the effects of weather shocks, environmental degradation, and natural resource extraction.

As climate variability exacerbates resource scarcity and governance challenges, policymakers must adopt integrated strategies that promote both sustainability and resilience. Our review highlights a few policy priorities that could be implemented while the scientific community gathers additional evidence. These include strengthening decentralized renewable resource management to enhance local adaptive capacity, increasing investment in climate-resilient infrastructure and early warning systems to mitigate risks, and developing regulatory frameworks that prevent resource conflicts. Ultimately, our call is for a policy-oriented research agenda that helps policymakers align climate action with resource governance in order to build more adaptive and sustainable systems in the face of ongoing climate change.

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