The Human Cost of Conservation: Evidence from Protected Areas in Africa

Sushant Banjara*

October 30, 2026

Click here for the latest version

Abstract

In this paper, I use the global expansion of protected areas (PAs) in the twenty-first century as a setting to show how the local costs of globally beneficial environmental policies can generate severe unintended consequences in weak states. Focusing on Africa, I combine a comprehensive database of PA boundaries with georeferenced conflict data in a difference-in-differences framework and find that PA designation increases the probability of conflict in designated locations by 0.6 percentage points—a 50% increase relative to the baseline. I further find that this effect is concentrated primarily in borderlands, where state authority tends to be limited. Investigation into the mechanism yields multiple findings suggesting that conflict is driven by grievances against the state, where the state is the salient actor imposing costs on local populations through PA designation. First, I find no statistically significant effects in strong states, which can address or credibly commit to addressing local grievances arising from PA designation. Second, the results are driven by conflict events involving the state and actors with explicit anti-state agendas. No such effects are found for conflict involving other types of violent political actors. Third, I find no increase in the probability of conflict following designation among PAs that allow greater local autonomy in PA management through community governance or plausibly generate local economic benefits through safari tourism. Finally, despite the increase in conflict, I find no meaningful effect of PA designation on environmental outcomes in either direction. Taken together, these findings highlight the importance of accounting for local political constraints and incentives when expanding PAs in fragile states, both to maximize conservation benefits and to avoid severe unintended consequences.

*Email: **sbanjara@uchicago.edu** ‖ **Website:** www.sbanjara.com ‖ I am deeply grateful to my advisors Eyal Frank, Oeindrila Dube, James Robinson, and Shaoda Wang for their continued guidance and support throughout this project. Many thanks also to Dan Black, Koichiro Ito, and Eduardo Montero for their valuable comments. This paper has benefited greatly from feedback from Daniel Kaffine, Richard Carson, Joshua Dean, Gregory Lane, and various participants at the CU Environmental and Resource Economics Workshop, the University of Chicago Harris PhD Workshop, Development Lunch Workshop, EPIC Seminar, and the EEE Student Workshop.

1 Introduction

Designing and implementing policies to address planetary-scale problems such as climate change, biodiversity loss, energy scarcity, and global pandemics requires coordination and consensus across many countries. Yet these policies are ultimately implemented and enforced by individual countries, which vary substantially in their capacity to enforce them effectively and ensure they produce the desired outcomes. At the same time, differences in local economic, political, and cultural conditions create uncertainty about the extent to which globally defined policy objectives align with local preferences and constraints. As a result, large-scale policies designed to address global problems may be poorly calibrated to countries' institutional capacities and local conditions, potentially generating unintended consequences.

How does variation in institutional capacities within and across countries affect the effectiveness of policies designed to achieve global objectives? What unintended consequences arise when such policies are implemented under different institutional capacities and local conditions? What features of policy design can mitigate these risks? I study these questions in the context of protected area (PA) expansion in Africa. To do so, I first develop a conceptual framework that traces the causal mechanisms through which PA designation may lead to conflict. Second, I estimate the causal effect of PA designation on the probability of conflict and examine whether this effect varies across PA governance regimes. Finally, I estimate the causal effect of PA designation on conservation outcomes to assess whether these policy instruments achieve their intended conservation objectives.

Protected areas are the most widely used area-based policy instrument for addressing biodiversity loss—the share of global land under protection has increased by 60 to 80% since the turn of the twenty-first century, an increase driven in large part by international treaties on biodiversity that have received near-global support.[1] Defined by the International Union for Conservation of Nature as *"a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values"*, PAs include conserved land such as national parks, conservation areas, and wildlife reserves.

On the one hand, PAs reduce human pressure on ecosystems by restricting human access to land and preserving species that serve crucial ecosystem functions. On the other hand, they can impose costs at the local level by forcibly expanding state power, intensifying territorial control, or depriving local communities of the productive use of land and related resources. Particularly in Africa, where property rights are often informal, ethnic tensions

1. One notable country that is not a party to these treaties is the United States.

persist, and anti-state actors are prevalent, fragile states or states with weak institutions may be unable to credibly commit to redressing grievances arising from PA designation. Under these conditions, externalities can lead to bargaining failure and consequently to conflict (Walter 2009).

In this paper, I conceptualize PAs not merely as neutral, apolitical instruments of environmental conservation, but as political interventions that can impose costs extending beyond those arising from restrictions on access to land and resources. A broader literature on the politics of conservation—including work on internal territorialization, fortress conservation, and green militarism—highlights how conservation can entail the assertion of state authority, the exclusion of local populations from their ancestral lands, and, in some cases, coercive enforcement (Vandergeest and Peluso 1995; Duffy 2014; Brockington 2002). From this perspective, PA designation may generate grievances associated not only with material losses but also with the exercise of state authority itself. Such grievances are difficult to capture through conventional measures of economic outcomes and may contribute to what Blattman (2023) describes as "intangible incentives to fight". I develop a conceptual framework in which these grievances strengthen incentives to resist the state and thereby increase the risk of conflict. Crucially, even when the underlying costs of PA designation are purely economic, the state, as the salient actor imposing those costs, may become the target of local discontent. Consequently, grievances against the state constitute the primary channel through which PAs generate conflict in this framework. This mechanism contrasts with commonly discussed mechanisms of resource conflict in which economic shocks directly alter the opportunity cost of engaging in conflict (see, for example, Dube and Vargas (2013) and McGuirk and Burke (2020)).

Additionally, I argue that, under this framework, PA designation is more likely to lead to conflict in places where conditions conducive to conflict against the state (what I term "conflict proneness") are already present. This is because such conditions can intensify resentment against the state in response to PA designation and lower the threshold for engaging in conflict. Conflict proneness is characterized by weak state capacity, the presence of rebel groups, and strong anti-state sentiment driven primarily by ethnic tensions. I use borderlands (areas within 50 km of an international border) as a proxy for conflict proneness. Borderlands can be conflict prone because of weak state presence or because they, especially where borders are porous, can serve as safe havens and recruitment zones for transboundary rebel groups (OECD and Sahel and West Africa Club 2022; Radil et al. 2026). In the context of Africa, ethnic partitioning—splitting of ethnic groups across multiple countries—

due to the Scramble for Africa is also an important driver of conflict (Michalopoulos and Papaioannou 2016).[2]

To estimate the impact of PAs on conflict, I construct a panel dataset of conflict events, PA boundaries, habitat ranges of major safari wildlife, and environmental outcomes in Africa at a $0.25^\circ \times 0.25^\circ$ grid-cell level. I then estimate a linear probability model (LPM) using a difference-in-differences design that compares areas that are never designated as PAs with those that are eventually designated, before and after designation. The baseline results indicate that PA designation increases the probability of both any conflict event and a conflict event involving at least one fatality by approximately 1 percentage point five years post-designation. Relative to the pretreatment baseline probabilities of 1.2% for all conflict events and 0.8% for fatal conflict events, these estimates imply increases of roughly 83% and 125%, respectively.

However, estimating the difference-in-differences model separately for borderlands and the interior reveals substantial heterogeneity. I find no statistically significant increase in conflict following PA designation in the interior. In contrast, in borderlands, PA designation increases the probability of any conflict event by approximately 2 percentage points and the probability of a fatal conflict event by 2.3 percentage points five years after designation. Relative to the pretreatment baseline, these estimates correspond to increases of roughly 133% and 255%, respectively. These findings indicate that PA designation not only increases the incidence of any conflict but also substantially raises the probability of fatal conflict events. Furthermore, consistent with the conceptual framework, these results suggest that PA designation is more likely to lead to conflict in areas with higher pre-existing conflict proneness. Motivated by these results, I focus primarily on borderlands in the subsequent analyses. I first show that the results are not sensitive to alternative distance thresholds used to define borderlands or alternative measures of pre-existing conflict proneness. I then show that the findings are robust to alternative model specifications, different assumptions about the error structure, alternative measures and datasets of conflict, and the inclusion or exclusion of various subsamples.

Second, I disaggregate conflict events by the actors involved and find that the increase in conflict probability following PA designation is driven primarily by events involving the state or anti-state actors, namely rebel groups. In contrast, PA designation has no discernible effect

2. Regardless of the underlying reasons, the general observation that borderlands are more prone to conflict against the state remains valid, and I take this as a given in this study. Nevertheless, in later sections, I assess the robustness of the findings to different distance thresholds and alternative definitions of conflict proneness.

on violence involving political militias, identity militias, or foreign forces.[3] While this result does not rule out a direct economic channel operating through changes in the opportunity cost of engaging in conflict, the concentration of the effect among state and anti-state actors is consistent with the 'grievances against the state' mechanism emphasized by the conceptual framework. If PA designation generates conflict by producing grievances against the state, its effects should be concentrated among state forces and actors that challenge state authority rather than among other armed groups, as the results indicate.

Third, I investigate the underlying mechanisms by examining heterogeneity in the effects of PA designation by type of PA governance and the presence of wildlife associated with safari tourism. The rationale for these tests is twofold. First, PA designation under community governance represents a less intrusive form of territorialization, as local communities retain a direct stake in and greater control over the governance and management of the PA. Second, PA designation in areas with wildlife associated with safari tourism may generate economic benefits for local communities and thereby mitigate grievances against the state, reducing both tangible and intangible incentives for conflict. Consequently, PAs under community governance and those with safari wildlife are expected to exhibit a smaller increase in conflict than the baseline effect. Consistent with these expectations, the estimated heterogeneous effects are negative in both cases and sufficiently large in magnitude to offset the baseline increase in conflict associated with PA designation. The results for safari wildlife are also robust to alternative definitions of the set of species associated with safari tourism.

Finally, I estimate the impact of PA designation on environmental outcomes and investigate whether the mechanisms underlying its impact on conflict also shape its impact on environmental outcomes. While direct measures of species abundance would be ideal, available datasets suffer from severe taxonomic and spatial biases. I therefore use greenery and the Biodiversity Intactness Index, a land-cover-based proxy for biodiversity. The baseline results show that PA designation leads to a modest but imprecisely estimated decline in greenery and has no significant effect on biodiversity. Heterogeneity analyses show that community-governed PAs have no significant effect on greenery but are associated with a minor decline in biodiversity relative to the treatment baseline. In contrast, PAs with safari wildlife have no significant effect on biodiversity but are associated with a small decline in greenery. While it is not possible to draw definitive conclusions about whether or how these results relate to the underlying conflict mechanisms, they are consistent with productive resource use tempering the impact of PA designation on conflict. More importantly, these

3. The key distinction between rebel groups and other militia groups is that rebel groups explicitly seek to challenge state authority, either through secession or by attempting to overthrow the government. Civilians, by definition, are unarmed actors. Section 4 provides a detailed description of each actor category.

results provide no evidence that PA designation improves the environmental outcomes in question. If anything, they point to modest declines.

The mismatch between the global desirability of a policy (or a collection of policies) and the local political economy at the site of implementation is not unique to protected areas. Another prominent example of this mismatch is the expansion of wind energy. While wind power is widely viewed as a critical tool for mitigating climate change, wind farm projects have faced substantial resistance from local communities in both Europe and North America. This opposition arises for a range of reasons, including concerns over Indigenous land rights, environmental and landscape impacts, and "not-in-my-backyard" (NIMBY) dynamics (Stokes et al. 2023; Nieminen and Laitinen 2025). A similar tension has been extensively documented in forest-carbon programs such as REDD+, which seek to generate global climate benefits by reducing deforestation and forest degradation at the local level. Although such programs can generate benefits for forest-dependent communities, their implementation has been criticized for imposing local costs through increased uncertainty over customary land and resource rights, the potential for green grabbing, and unequal distributions of the benefits from forest conservation (Chhatre et al. 2012; Larson et al. 2013). Nevertheless, the context of protected areas in Africa has distinctive features and warrants study in its own right for several reasons.

First, the availability of a global dataset of protected areas, with well-defined boundaries and designation dates, provides a suitable empirical setting for studying the impacts of PAs at scale.[4] Second, the sheer scale and rapid pace of PA expansion worldwide make this not only a globally relevant issue but also a time-sensitive one that warrants careful study. In 2022, under the Kunming-Montreal Global Biodiversity Framework (GBF), 196 countries agreed to protect at least 30% of the world's land by 2030. The current share of global land under protection is about 18%. Any meaningful progress toward the 30-by-30 target requires imposing restrictions on a large fraction of land in less than five years—a rate of expansion that is unprecedented and potentially disruptive both politically and economically. Third, and perhaps most importantly, the urgency of reducing human pressure on the environment implies that effective protected areas must be established in locations already subject to human pressure. Consequently, by construction, effective PA designation often constrains the productive use of land by the local population.[5]

In addition to the considerations above, the context of biodiversity conservation, particularly in low- and middle-income countries in Africa, renders the local political economy

4. The dataset is available at World Database on Protected Areas.

5. While some protected areas are designated on infra-marginal land to meet international targets while minimizing economic costs and political resistance, such 'residual parks' are widely regarded as ineffective and have been the subject of criticism. See Alger (2023) and Grupp et al. (2023) for more details.

of PA designation particularly complex. First, unlike infrastructure projects such as wind farms, the outputs of biodiversity conservation are not commonly traded in markets. This makes it difficult to value the benefits of PA designation and, in turn, to assess the economic feasibility of compensating local populations. This challenge is compounded by the fact that the benefits of biodiversity conservation are highly context-specific. For example, the marginal benefit of protecting an additional tiger is substantially lower in a country where the species is abundant than in one where it is near extinction. Likewise, the value of protecting different species within the same context—for instance, mice and tigers—can vary widely. By contrast, the environmental benefits of carbon removal are virtually location-independent.[6] Second, in many developed countries, interactions between local populations and supra-local authorities are typically mediated by local governments, which have both the incentive and, in some cases, the legal mandate to represent their constituents. In many low- and middle-income countries in Africa, however, such institutions are often weak or absent, leading to greater reliance on informal channels of negotiation and conflict.

Finally, this paper is related to three strands of literature. The first is what can be termed the 'policy mismatch' literature, which highlights the need to account for local sociopolitical and cultural characteristics when designing policies or development projects in the Global South (McGuirk and Nunn 2024; Lowes and Montero 2021; Ashraf et al. 2020).[7] While this literature is relatively new in economics, its foundational ideas have been discussed in other areas of social science, particularly political anthropology, and can be traced back at least to Ferguson (1994). My main contribution to this literature is that I evaluate the impact of a policy whose primary intended outcome is environmental rather than economic or developmental and which has received relatively little attention despite the fact that PA designation can be as distortionary and interventionist as, if not more so than, development projects. Additionally, rather than treating local characteristics as fixed constraints on policy effectiveness, I examine how institutions can mediate the consequences of policy mismatch. While the importance of institutions and state capacity has been extensively studied in the broader literature on comparative economic development, their role in moderating the local consequences of environmental policies has received little attention (Acemoglu et al. 2015; Acemoglu et al. 2005, 2001).

6. The cost of removal may vary across locations, but the benefit in terms of reducing climate change is global.

7. There is also an analogous literature studying technologies rather than policies, which highlights the fact that technologies developed in one part of the world may be inappropriate for the environmental or ecological conditions in another, leading to lower-than-expected gains and adoption. While this literature is not directly related to my work, it is similar in spirit to the policy mismatch literature and worth mentioning. For a recent example, see Moscona and Sastry (2025).

Second, I provide one of the first pieces of evidence of environmental policy-driven conflict on a continental scale. In doing so, I contribute to the extensive economics literature on the relationship between the environment, natural resources, and conflict, which has primarily focused on two broad drivers: commodity price shocks (Dube and Vargas 2013; Bazzi and Blattman 2014; Berman et al. 2017; McGuirk and Burke 2020) and climate shocks (McGuirk and Nunn 2025; Harari and Ferrara 2018). This paper departs from that literature by shifting the focus from economic shocks to the inherently political nature of PA designation. Specifically, I argue that PA designation can generate grievances against the state through the exercise of state authority, including processes of territorialization, and thereby increase the risk of conflict even in the absence of underlying economic shocks.

Third, this paper relates to the broadly defined literature on the economics of conservation (Robalino and Pfaff 2013; Jayachandran et al. 2017; Burgess et al. 2012; Pincus 2025; Burgess et al. 2015; Frank and Oremus 2025; Harstad 2023; Harstad and Mideksa 2017). More specifically, the paper closely relates to the strand of this literature that studies the economics of conservation in the context of biodiversity and protected areas (Dasgupta 2021; Grupp et al. 2023; Nakhmurina et al. 2026). It is worth noting that this strand is nascent, has developed partly in response to the 30-by-30 target, and largely took off following Dinerstein et al. (2019), one of the early academic calls to protect 30% of the world's land. The other papers in this strand primarily focus on enabling or evaluating conservation outcomes in the Global North. In contrast, I use a political-economy lens to evaluate the unintended consequences of PA designation, particularly in fragile states in Africa.

In addition to the academic literature, this paper also relates to one of the most ambitious, expansive, and potentially consequential environmental policy debates of this century thus far. From the exacerbation of famine to public health crises, recent studies in economics have shown that species loss—whether through planned eradication or unintentional human action—can cause serious harm to human welfare (Frank et al. 2025; Frank and Sudarshan 2024). Given that the current rate of species extinction is over 100 times the background rate, the challenge is not simply to expand the geographic scope of conservation policies but also to ensure that these policies produce their intended results. My main contribution to this policy debate is reframing the global push for biodiversity conservation as a collection of hyperlocal policy instruments (individual protected areas) and highlighting the need to calibrate each protected area to local socioeconomic and political conditions.[8] In addition, I identify governance regimes and socioeconomic conditions that can potentially temper or even eliminate the impact of PA designation on conflict.

8. Albers and Kroetz (2026) has also recently highlighted the importance of calibrating PA policy to local conditions.

The rest of the paper proceeds as follows. In Section 2, I provide a brief background on protected area designation globally and discuss theories from political science and political ecology that explain the link between PA designation and conflict. In Section 3, I describe the conceptual framework that traces the causal link between PA designation and conflict and provide supporting anecdotal evidence. In Section 4, I describe the datasets used in the analysis. Section 5 explains the empirical strategies used in the paper. In Section 6, I present the baseline results, which show that PA designation leads to an increase in conflict and that this effect is primarily driven by borderlands. Section 7 provides evidence that the increase in violence is driven primarily by conflict involving state forces and rebel groups, including violence against civilians. Section 8 shows that, consistent with the conceptual framework, PAs under community governance or those plausibly associated with safari tourism are not associated with an increased probability of conflict. In Section 9, I examine the impact of PA designation on conservation outcomes and find little evidence of improvements in either greenery or biodiversity. Finally, I conclude by discussing the results and their implications for the ongoing global conservation effort.

2 Background

2.1 Protected Areas and Convention on Biodiversity

For roughly the first 120 years of the history of modern protected areas, beginning with the establishment of Yellowstone National Park in 1872, they were primarily used to preserve picturesque landscapes, game populations, and charismatic species for recreational viewing and scientific research. Such land preservation could also contribute to biodiversity conservation, although this was not the primary objective of protected land. However, with the adoption of the Convention on Biological Diversity (CBD) in 1992, biodiversity conservation became a more explicit and prominent goal of international conservation effort, and PAs were formally recognized as an important policy instrument for achieving this goal through *in situ* conservation.[9]

The CBD emerged in response to growing international concern over accelerating biodiversity loss and the recognition that existing international agreements did not provide a comprehensive framework for the conservation of biological diversity. The Convention was adopted in May 1992 and opened for signature at the United Nations Conference on En-

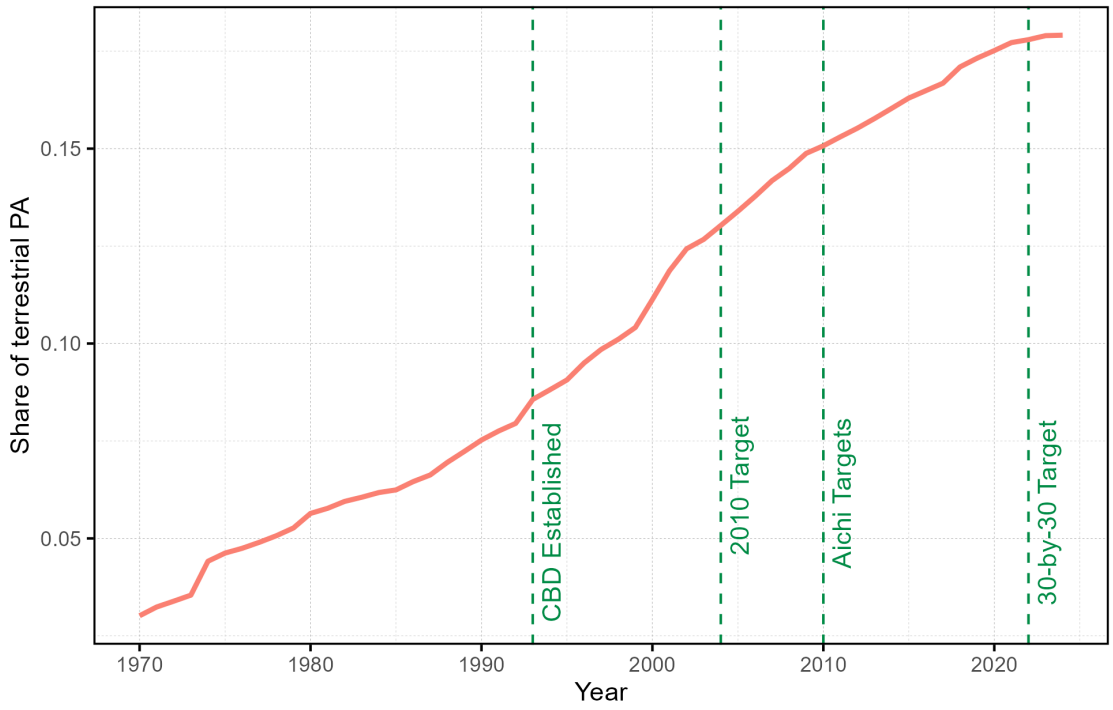
9. The CBD defines biodiversity, or 'biological diversity', as "the variability among living organisms from all sources including ... diversity within species, between species and of ecosystems". Biodiversity conservation should therefore be understood as the conservation of biological variety rather than the biomass or population size of any specific species.

vironment and Development in Rio de Janeiro the following month. It ultimately received 168 signatures and entered into force in December 1993. The CBD now has 196 Parties, making it one of the most widely adopted international environmental agreements. The Convention established three principal objectives: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the utilization of genetic resources. Protected areas became an important instrument for achieving the first objective, with Article 8 calling on Parties to establish systems of protected areas as part of their *in situ* conservation strategies.

The CBD's general commitment to establishing protected areas was subsequently translated into quantitative conservation targets. At the seventh meeting of the Conference of the Parties to the CBD (COP 7) in 2004, Parties adopted Decision VII/30, which set a target of effectively conserving at least 10% of each of the world's ecological regions by 2010. This target was expanded in 2010 through the adoption of the Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets, which called for at least 17% of terrestrial and inland-water areas to be effectively conserved by 2020. Further, in 2022, Parties adopted the Kunming–Montreal Global Biodiversity Framework, substantially raising the level of ambition by aiming to conserve at least 30% of terrestrial and inland-water areas and 30% of marine and coastal areas by 2030.[10] This concerted international effort has contributed to the rapid expansion of PA coverage during the twenty-first century, with the global area under protection increasing by somewhere between 60 and 80%, as shown in Figure 1. However, it is important to note that, with about 18% PA coverage, the world is still well below the 30% target, and any meaningful progress toward that goal will require a rapid expansion in global protected area coverage.

10. Almost all countries in the world have formally committed to all these biodiversity conservation targets, with the United States being one notable exception.

Figure 1: Share of PA coverage over time



2.2 Protected Areas and Conflict

While PAs are policy instruments for environmental conservation, they are also inherently political in many parts of the world, even when not intended to be so. Specifically, PA designation can require the state to assert control over land used by customary users and establish new and restrictive regulations governing its use. This can generate unaddressed grievances and resentment against the state among local populations, especially where the relationship between local populations and the state is already antagonistic and where restrictions are imposed without addressing local grievances. Below, I discuss three prominent theories from political ecology and sociology that explain the political nature of protected areas and how PA designation can heighten tensions between local populations and the state and create conditions conducive to conflict.[11]

Internal territorialization: The theory of internal territorialization posits that states may delineate boundaries within their territories, such as through the creation of forest reserves or national parks, not only for conservation purposes but also as a means of exerting control over land, natural resources, and the populations within these boundaries (Van-

11. The mechanisms discussed below are not mutually exclusive. Indeed, they are more likely to coincide than to operate in isolation. As a result, I cannot isolate the effect of each mechanism on conflict, nor is doing so the objective of this research. Instead, I discuss these mechanisms to illustrate the inherently political nature of protected areas and how they may create conditions conducive to conflict.

dergeest and Peluso 1995). Because territorialization often formalizes property rights and brings natural resources within the purview of the state, it may appear desirable from a state or administrative perspective. From the perspective of local populations, however, the same process may entail the loss of customary land tenure and restrictions on resource use that conflict with existing livelihoods and ways of life (Bluwstein and Lund 2018; Hochleithner 2017; Kumar and Kerr 2013).

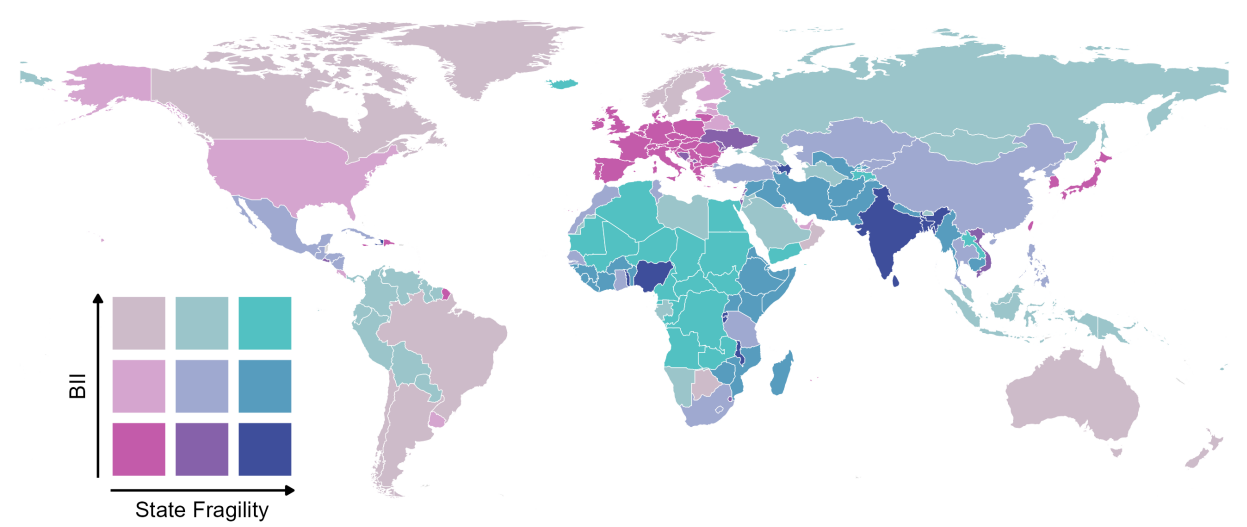
Fortress conservation: Under this model of conservation, local populations are marginalized, their livelihoods are criminalized, and they may even be forcibly evicted from their homelands in the name of preserving nature in its pristine form (Brockington 2002). This model of conservation is often considered to have been pioneered by Yellowstone National Park and remains the dominant model of conservation in Africa (Neumann 1998).

Green militarism: Green militarism refers to the use of military tactics, military-grade weapons, and sometimes even military or ex-military personnel to enforce conservation laws in and around protected areas (Ashaba and Marijnen 2025; Duffy et al. 2019). Green militarism has been on the rise in Africa over the last two decades (Duffy 2014). Prominent examples of this trend include the increasing use of private militarized law enforcement in PAs through public-private partnerships (PPPs) and the increasing allocation of international aid, particularly from the US government, towards security-related conservation activities relative to other conservation priorities (Denny et al. 2024; Massé and Margulies 2020).

2.3 The African Context

The combination of high biodiversity intactness, a high concentration of protected areas, high conflict proneness, and overall high state fragility makes Africa particularly vulnerable to the unintended political consequences of PA designation. As shown in Figure 2, much of Africa lies in the top tertile of both state fragility and the Biodiversity Intactness Index. In addition, some of the world's most iconic species, such as giraffes, gorillas, zebras, hippopotamuses, and lions, are found exclusively or predominantly in Africa, contributing to the continent being at the center of global conservation efforts for over half a century. At the same time, much of the region experiences high levels of armed conflict and political violence, further exacerbated by ethnic tensions, land disputes, and a lack of formal property rights (McGuirk and Nunn 2025, 2024). Estimates suggest that about 80% of land in Sub-Saharan Africa is informally owned (Ribar 2026). Furthermore, many attempts to introduce formal land titling have encountered resistance and achieved limited success (Vendryes 2014; Shipton 2009; Le Rossignol et al. 2024).

Figure 2: Biodiversity intactness index vs state fragility by country



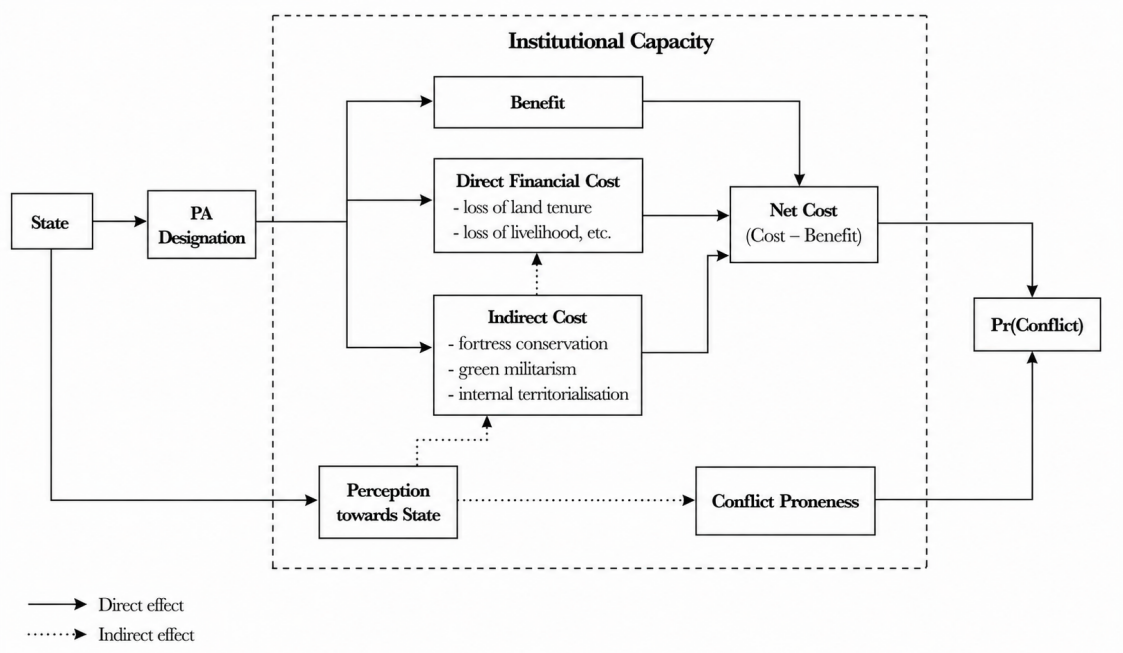
Notes: This map compares the Biodiversity Intactness Index (BII) in 2020 with countries' average state fragility index over the period 1995–2018. Both variables are divided into tertiles, and each possible combination of tertile values is represented by a distinct color. The corresponding values of state fragility index and BII for each color are shown in the bivariate legend in the bottom-left corner. As shown in the figure, most European countries fall within the lowest tertile of both state fragility and BII. In contrast, countries such as Australia and Canada fall within the lowest tertile of state fragility but highest tertile of BII.

3 Conceptual Framework

To understand the causal link between PA designation and conflict, it is useful to consider the costs a protected area imposes on a local community, the benefits it provides, and how they interact with the existing relationship the local population has with the state. Figure 3 summarizes this interaction. The eventual probability of conflict depends not only on the net costs incurred by the local community but also on whether the local community perceives the government and its actions negatively.

First, because protected areas restrict access to land and the resources within them, PA designation can impose direct economic costs on local communities. Examples of these costs include **a)** loss of access to resources such as firewood, cattle fodder, and bushmeat, leading to a loss of livelihood; and **b)** loss of land tenure or access to fertile agricultural land. Even when PA designation does not result in the loss of property or livelihoods, it may impose indirect costs due to the political nature of PA designation. For instance, even when resource use is not directly restricted, local communities may face additional regulatory burdens and formal permission requirements. Similarly, the presence of highly militarized guards may create a sense of insecurity and threaten the perceived or actual safety of local communities.

Figure 3: Schematic relation between PA designation and Conflict



Notes: This figures summarizes the key components of interaction between the state and the local population that during PA designation. Solid line denotes direct effect whereas dotted line denotes indirect effect.

On the other hand, PA designation can also provide benefits to local communities. These may include increased safety and security due to the presence of armed guards, compensation for loss of property, improved management and use of natural resources through formal regulatory organizations, or additional income and employment opportunities generated by tourism. Thus, PA designation can simultaneously impose costs and generate benefits, with the net effect depending on how these costs and benefits are distributed across the local population.

Finally, the same action by the state may be perceived as either a cost or a benefit depending on the relationship between the local community and the state. For instance, in communities with a history of state repression or discrimination, the presence of armed guards may be perceived as an intangible cost, whereas in communities with a more positive relationship with the state, their presence may be viewed as a benefit because of the security they provide. Similarly, the extent of state presence and the level of trust between the state and local communities influence whether the state can credibly signal its intention and capacity to address grievances arising from PA designation. These factors therefore shape whether actions associated with PA designation are perceived by local communities as costs or benefits.

Additionally, a non-amicable pre-existing relationship with the state can mechanically increase the probability of conflict in response to PA designation. First, when baseline grievances are high, any additional grievance is more likely to push the local population beyond the threshold for engaging in conflict. Furthermore, areas with high baseline grievances are often situated in strategic locations (in remote regions or near international borders), which can make military action against the state more viable due to tactical advantages such as access to arms and support from foreign allies and co-ethnics (Michalopoulos and Papaioannou 2016). I refer to this bundle of characteristics as *conflict proneness*. While a low barrier to reaching the threshold for conflict and access to the resources necessary to engage in conflict represent two distinct mechanisms, I combine them because, as I explain in Section 6, they often co-occur in my sample and isolating the effects of the two is beyond the scope of this paper.

The key point of this conceptual framework is that the state is at the center of the political economy of PA designation. Not only is the state the salient actor that designates PAs and potentially imposes both tangible and intangible costs on local communities, but whether actions by the state accompanying PA designation are perceived as costs or benefits by local communities also depends on the pre-existing relationship between the two. Consequently, grievances stemming from PA designation are likely to be directed toward the state, increasing the likelihood of conflict against the state. The framework also implies that the

likelihood of conflict in response to PA designation is higher in areas with greater conflict proneness and is tempered when the tangible or intangible costs imposed by PA designation are lower.

I call this mechanism *grievance-against-the-state*. This mechanism is distinct from, albeit related to, more direct economic mechanisms of conflict, such as changes in the opportunity cost of engaging in conflict (for instance, see Dube and Vargas (2013)) or conflict over resource capture (for instance, see McGuirk and Burke (2020)). Crucially, however, the grievance-against-the-state mechanism is not mutually exclusive with these more direct economic mechanisms of conflict. As such, the goal of this paper is not to isolate the effects of these mechanisms but rather to test whether the empirical evidence is consistent with the predictions of the grievance-against-the-state.

3.1 Qualitative Evidence of Link Between PA and Conflict

Many policy briefs, news reports, and academic case studies document a link between PA designation and conflict. While most of these accounts focus on aggression or violence by state or PA authorities, some document retaliation by local communities, including attacks on security personnel, alliances with rebel groups, and intentional sabotage of PA resources.[12]

For instance, in eastern Democratic Republic of the Congo, Batwa people attempted to reoccupy parts of Kahuzi-Biega National Park after 2018, decades after their forcible eviction from their ancestral land in the 1970s. When their attempt to return to Kahuzi-Biega was met with violence, Batwa people allied themselves with rebel groups active in the region in an attempt to maintain control over the territory they had reoccupied (Simpson and Geenen 2023; Simpson and Pellegrini 2023; Flummerfelt 2022). Similarly, Verweijen and Marijnen (2018) find that aggressively militarized conservation efforts have pushed local communities to engage in 'guerrilla livelihoods' in Virunga National Park in the DRC. Guerrilla livelihoods are defined as the use of park resources for subsistence despite prohibitions, often under the protection of armed groups. They conclude that strict law enforcement in the park, backed by the Congolese army, fuels rather than mitigates armed mobilization.

Additionally, Blomley et al. (2010) finds that the establishment of Bwindi Impenetrable National Park (BINP) in Uganda in 1991 caused high levels of conflict and resistance

12. For some examples on use of militarized and surveillance technology against local communities as well as human-rights activists in and around national parks in South Africa and Uganda see the article Big Brother Wildlife in ZAMmagazine. Read about complaints of violence against Baka people in 2019 during the process of creation of Messok Dja National park in DRC, here. Funding for the park creation was eventually suspended by donor agencies and park creation halted. The Secret War, an investigative report by BuzzFeed reports on WWF's involvement in funding militarized conservation resulting in human rights abuses around the world.

among surrounding communities, seriously threatening the ability of the protected area authority to manage the park. Following the establishment of BINP, 16 fires were started in or around the park during a drought in 1991, a third of which were later determined to have been deliberately started by local residents with the intent of destroying government property. Relations between local communities and park staff, many of whom were recruited locally, also deteriorated substantially, with frequent attacks on rangers and their families. Locally recruited rangers also faced social and economic exclusion from their communities, including being refused service by local businesses and excluded from traditional community institutions.

Similarly, a report by the Global Initiative Against Transnational Organized Crime finds that, in and around the W–Arly–Pendjari (WAP) park complex in Benin, Burkina Faso, and Niger, violent extremist groups exploit grievances arising from restrictions on the use of park resources and violence by armed park guards to gain the support of local communities (Sampaio et al. 2023). [13]

4 Data

This section discusses the data sources, relevant variables, and construction of the final dataset used in the analysis.

4.1 Conflict Data

I use the Armed Conflict Location and Event Data Project (ACLED) as the primary source of georeferenced conflict data. ACLED provides comprehensive spatial and multi-decadal coverage of the African continent beginning in 1997. While the dataset classifies multiple forms of political violence, I focus on three categories: *battles*, *explosions/remote violence*, and *violence against civilians*, which comprise the majority of observations in the dataset. According to ACLED, *battles* are defined as 'armed clashes between at least two armed groups.' Events classified as *explosion/remote violence* are defined as events 'where an explosion, bomb or other explosive device was used to engage in conflict.' Similarly, *violence against civilians* is defined as 'violent attacks on unarmed civilians.'

ACLED also identifies the actors involved in each event, enabling disaggregated analysis by actor. In addition to State Forces, the relevant non-state actor categories are defined as follows: **a) Rebel Groups** are political organizations seeking to challenge or overthrow the government through violence, **b) Political Militias** are groups that employ violence to

13. Read a related opinion piece here

advance political objectives that do not involve challenging the government, and **c) Identity Militias** are groups that mobilize violence in pursuit of ethnic, communal, or local objectives, such as access to resources, security, or retribution.[14]

One concern with the ACLED dataset is its reliance on news reports and information from NGOs and governments, which may introduce measurement error and spatial bias. Although grid-cell and country-year fixed effects mitigate some of these concerns, I also use data from the Uppsala Conflict Data Program (UCDP) as an alternative source of conflict data as a robustness check. UCDP draws on similar sources but applies a substantially stricter threshold for recording conflict events. Specifically, UCDP assigns each event to a dyad of actors and records an event only if it results in at least one fatality and total fatalities across all conflict events involving that dyad reach at least 25 in a calendar year. This criterion substantially reduces the number of recorded events and reduce concerns about measurement error. However, the 25-fatality threshold means that UCDP captures only events associated with larger ongoing conflicts, omitting relevant events that may be affected by PA designation but do not develop into large-scale political violence.

4.2 Protected Areas Data

I use the World Database on Protected Areas (WDPA) as the source of georeferenced data on protected areas (PAs). The WDPA is the most comprehensive global dataset on terrestrial and marine protected areas, jointly managed by the UNEP World Conservation Monitoring Centre and the International Union for Conservation of Nature (IUCN). It provides spatially explicit information on the location, boundaries, designation status, and management characteristics of protected areas worldwide.

The dataset includes shapefiles of the protected areas, along with attributes such as designation type, year of establishment, and IUCN management category. While the WDPA is the most comprehensive global dataset on protected areas, it is not without limitations. In particular, there may be incomplete information on establishment dates. The WDPA user manual states that this occurs *'in old data that was submitted prior to the publication of the Protected Planet Data Standards, where the information is not available, or where the site predates any record of its establishment'*. It further notes that this often occurs *'when an indigenous people or local community has been managing an area for generations or centuries.'* Since these observations correspond to PAs established before the beginning of my sample period in 1997, they would not contribute to the identification of treatment effects and are therefore omitted from the analysis. Another potential limitation is that the dataset

14. For detailed information, see Raleigh and Dowd (2015).

captures *de jure* protection status and may not fully reflect *de facto* enforcement on the ground. Despite these limitations, the WDPA remains the most suitable and comprehensive source for analyzing the spatial distribution and characteristics of protected areas at a global scale.

4.3 Other Data

In addition to the above datasets, I use C3S land cover maps available annually starting in 1992 and updated periodically with a one- to two-year delay (Copernicus Climate Change Service (C3S) 2019). The dataset is available at 300 m resolution and provides 22 land cover classes, which are defined using the UN Food and Agriculture Organization (FAO) Land Cover Classification System. For nightlights, I use the harmonized nightlights product produced by Tang et al. (2025). The dataset is available from 1992 to 2022 and focuses on accuracy in low-light areas, making it more suitable for Africa than other nightlights products. I use ecoregion shapefiles from the RESOLVE Ecoregions and Biomes dataset. To identify the ethnic characteristics of different locations, I use the Ethnographic Atlas available in Murdock (1967).[15]

4.4 Data Construction

The final sample consists of Continental Africa and Madagascar divided into $0.25° \times 0.25°$ grid cells, with each grid cell measuring about 27.5×27.5 kilometers at the equator. This results in a total of 41,207 grid cells. I assign each grid cell to a country, ethnic group, and ecoregion according to the location of its centroid.

I then construct two main outcome variables measuring conflict: **a)** a binary conflict indicator that takes the value of 1 if at least one conflict event occurs in a grid cell during a given year, and **b)** a binary indicator for fatal conflict that takes the value of 1 if at least one conflict event in the grid cell results in one or more fatalities during that year. The environmental outcomes are continuous measures of biodiversity intactness and greenness as measured by the Enhanced Vegetation Index (EVI). At the grid-cell level, I also construct measures of land cover by computing, for each year, the fraction of each grid cell covered by various land-cover types. Finally, to ensure that my sample is balanced in event time from $t = -4$ to $t = 6$, for my main analysis, I focus on grid cells that were treated between 2001 and 2018, inclusive, and drop any grid cells that received PA designation before or after that period. The resultant dataset consists of 31,402 grid cells—76.2% of the original sample.[16]

15. I use the repackaged version of this dataset, available here.
16. In Section 6, I show results for various alternative sample compositions.

5 Empirical Strategy

To estimate the impact of protected areas on conflict, I compare conflict outcomes in grid cells that receive a PA designation with those that never do, before and after designation. Specifically, I estimate a linear probability model (LPM) within an event-study framework with staggered treatment timing and a never-treated control group. Treatment is defined as an indicator equal to one for all periods following PA designation and zero otherwise. The analysis focuses on the timing of the first PA designation. Grid cells that received a PA designation prior to the sample period do not contribute to the identification of treatment effects and are therefore excluded from the baseline sample.

I use a binary indicator of conflict incidence, following standard practice in the conflict literature (Bazzi and Blattman 2014; Berman et al. 2017; Limodio 2022). Binary measures, unlike counts, are less sensitive to measurement error in conflict data. In addition, binary outcomes reduce the influence of outlier grid cells with unusually high numbers of recorded incidents. A limitation of this approach is that it focuses on the extensive margin of conflict and does not capture variation in intensity. To address this, I complement the baseline specification with an alternative outcome measuring whether a cell-year experiences at least one conflict event resulting in one or more fatalities, which provides some information on the severity of conflict.

Because treatment is staggered over time, standard TWFE estimation may produce biased estimates, especially if treatment effects are heterogeneous over time (Callaway and Sant'Anna 2021; Goodman-Bacon 2021; De Chaisemartin and d'Haultfoeuille 2020). Therefore, I estimate the event study using the estimator proposed by Sun and Abraham (2021) and the following specification:

$$Y_{icet} = \sum_{g} \sum_{\tau \neq -1} \beta_{g,\tau} \cdot \mathbb{I}\{G_i = g\} \cdot \mathbb{I}\{t - G_i = \tau\} + \alpha_i + \lambda_{ct} + \theta_{et} + \epsilon_{icet} \quad (1)$$

where Y_{icet} is a conflict or biodiversity outcome in cell i, country c, ecoregion e, and year t. G_i is the period when unit i first receives treatment. $\mathbb{I}$ is the indicator function, which takes the value 1 when the condition inside the parentheses is true and 0 otherwise. α_i is a grid-cell fixed effects, which absorbs the time-invariant characteristics of each grid cell. λ_{ct} denotes $country \times year$ fixed effects, which absorb country-specific time-varying shocks. I also include $ecoregion \times year$ fixed effects to control for ecoregion-wide time-varying shocks, such as changes in climate patterns or species distributions. Ecoregions can be understood as ecosystems of regional extent that represent distinct assemblages of biodiversity. As such,

ecoregions are appropriate geographic units for accounting for species- or ecosystem-level shocks. Finally, to account for spatial and serial correlation, I cluster standard errors within $1^\circ \times 1^\circ$ grid cells, each of which contains 16 units of observation, i.e., $0.25^\circ \times 0.25^\circ$ grid cells.

Identification of $\beta_{g,\tau}$ comes from within-grid-cell variation over time relative to other grid cells within the same country-year, net of ecoregion-year fixed effects. The main identifying assumption is that, in the absence of PA designation, outcomes in treated and comparison grid cells would have followed parallel trends within country-years, conditional on ecoregion-year fixed effects.

5.1 Support for Parallel Trends Assumption

For the estimates from Equation 1 to be unbiased, the parallel-trends assumption must hold. While this assumption cannot be directly tested, in this subsection, I provide evidence in support of it and examine potential threats to identification. I begin by noting that more than 80% of land in Africa, particularly Sub-Saharan Africa, is characterized by very low-intensity land use and therefore relatively high biodiversity intactness (Clements et al. 2025). This means that, unlike in many highly developed regions, biodiversity in Africa is not confined to a handful of ecological enclaves. This relatively broad distribution of biodiversity, notwithstanding the presence of biodiversity hotspots, reduces concerns that PA designation is driven primarily by selection on baseline ecological conditions. Evidence relevant to this concern is presented in Table 1, which shows within-country differences between treated and never-treated grid cells across a range of baseline ecological, topographic, and economic characteristics. I estimate these differences using the following equation:

$$Y_{ic} = \beta \cdot D_{ic} + \lambda_c + \epsilon_{ic}$$

where Y_{ic} is the baseline characteristic of grid cell i in country c. D_{ic} is a binary indicator for eventual PA designation, and λ_c is a country fixed effect. β captures the within-country difference between the treated and control groups. The results in Table 1 show that the differences between treated and control grid cells across several biodiversity- and human-activity-related characteristics are statistically indistinguishable from zero. In cases where differences are precisely estimated, the magnitudes are not meaningfully large. For instance, average EVI is 0.008 higher in treated grid cells—about 5% of the control mean. More importantly, the observed imbalances are not consistently in one direction, providing little indication of systematic selection into PA designation along observable characteristics associated with higher likelihood of conflict. Below, I address concerns regarding several specific selection mechanisms and potential threats to the parallel-trends assumption:

Table 1: Balance on baseline characterstics

Dependent variable	Control mean	Treatment coef.	Variable type
EVI	0.148	0.008*	Landcover
		(0.005)	
BII	0.822	0.003	Landcover
		(0.005)	
Agriculture land (%)	0.111	0.009	Human Activity
		(0.010)	
Settlement (%)	0.000	-0.000	Human Activity
		(0.000)	
Mean Nightlights	0.188	-0.027	Human Activity
		(0.024)	
Distance to cities (km)	651.778	-24.885	Human Activity
		(17.177)	
Elevation (m)	577.636	-42.382***	Topography
		(16.097)	
Slope	4.205	-0.094	Topography
		(0.126)	
Ruggedness (TRI)	1.837	-0.045	Topography
		(0.054)	
Prob (Big five animals)	0.001	-0.000	Biodiversity
		(0.001)	
Prob (Big five plus animals)	0.002	0.002	Biodiversity
		(0.002)	
Prob (Any species)	0.002	0.002	Biodiversity
		(0.002)	
Prob (Bushmeat animals)	0.000	0.000	Biodiversity
		(0.000)	
Prob (Any conflict)	0.005	-0.002*	Conflict
		(0.001)	
Prob (Fatal conflict)	0.004	-0.001	Conflict
		(0.001)	
Mean temperature	24.496	-0.137	Climate
		(0.106)	
Total precipitation	5.282	0.553***	Climate
		(0.199)	

Notes: This table reports the within country balance between treatment and control grid-cells. The difference is given by Treatment coef. and each regression include country fixed effects. The unit of observation is $0.25^\circ \times 0.25^\circ$ grid cell. Standard errors are clustered at the level of $1^\circ \times 1^\circ$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. N Observations = 27513

Well-known confounders: I drop grid cells near large cities and those with major mineral deposits from the main analysis (including in Table 1). Both characteristics are associated with distinct and potentially outlying patterns of violence, and selection into or away from these areas may bias the estimates. For instance, mining is a well-known driver of conflict in Africa (Berman et al. 2017). If PA designation systematically avoids mining areas—where baseline violence may be high and responsive to global commodity prices—this could bias the estimates downward. In contrast, large cities are centers of state power and tend to experience less rebel violence than peripheral areas. If PA designation systematically avoids areas near major cities, the direction of the resulting bias is less clear. Figure A1 provides further evidence that urban areas and areas with mineral deposits exhibit distinct patterns and substantially higher levels of violence, reinforcing the concern that selection into or away from these areas may affect the estimates.[17] I therefore exclude grid cells with major mineral deposits and those within 100 kilometers of country capitals, the largest cities by population, or cities with populations of over one million. Together, these restrictions result in the exclusion of an additional 9.4% of observations from the original sample of 41,207 grid cells. Given that I also exclude grid cells treated before or near the end of the sample period, the final baseline sample consists of 27,513 grid cells.

Correlation between biodiversity and conflict proneness: Another potential concern is that the geographic and land-cover characteristics that make a grid cell more likely to receive a PA designation may also be correlated with the likelihood of conflict. For instance, remote areas and dense forests may be more likely to be designated as PAs because of their higher biodiversity, but these areas may also provide suitable hideouts and operational bases for rebels and other armed groups. However, Table 1 shows that the probability of observing biodiversity in treated and never-treated grid cells is statistically indistinguishable. Furthermore, greenery, as measured by EVI, is on average only marginally higher in treated grid cells than in never-treated grid cells. Additionally, treated grid cells are not systematically more remote, as measured by distance from cities, or more rugged than never-treated grid cells and, if anything, have slightly lower elevation.

Systematic avoidance of economic pressure: Another potential channel for selection is that PA designation may systematically avoid areas where it is likely to disrupt human presence and economic activities (Joppa and Pfaff 2009; Alger 2023; Grupp et al. 2023). Such selection, if anything, would suppress the channel of economic disruption and likely bias the estimated effect of PA designation on conflict downward. However, based on the

17. Even if PA designation systematically selects into or avoids these areas, the nature of enforcement may be influenced by their political and economic importance. Since the nature of enforcement is unobservable, I drop these grid cells.

observable characteristics reported in Table 1, I find no evidence of such selection. Differences between treated and control grid cells in the intensity of human activity are either statistically indistinguishable from zero or, where present, indicate marginally greater human activity in treated grid cells.

PA designation in response to conflict: Finally, another potential channel for violation of parallel trends assumption is if Protected Areas are designated in response to conflict. For example, if the government intends to protect ecological resources or biodiversity stock that is threatened by conflict, estimates from Equation 1 may be biased upward. I test the plausibility of this concern by examining whether past conflict predicts the timing of PA designation. I do so by estimating the following equation:

$$D_{icet} = \sum_{\tau=t-G_i}^{\tau\leq -1} \beta_\tau \cdot \mathbb{C}_{ice\tau} + \alpha_i + \lambda_{ct} + \theta_{et} + \epsilon_{ict} \tag{2}$$

where $D_{icet} = 1$ when $t = G$, $\mathbb{C}_{ice\tau}$ is a measure of conflict at lag τ, and the rest of the symbols have the same meanings as in Equation 2. Since PA designation is often a multi-year process, PA designation in response to an increase in conflict would imply that past violence is strongly correlated with treatment timing. However, Table 2 shows no strong and consistent correlation that would suggest that PAs are designated in response to conflict. I do find a statistically significant correlation between treatment timing and violence in the immediately preceding year, but this correlation is not present in prior years. Since it is implausible that governments can designate PAs within a year in response to violence, I interpret this pattern as a lack of evidence that PA designation occurs in response to increases in violence.

While the evidence provided in this section increases confidence that the results are unlikely to be driven by selection into treatment or violations of the parallel-trends assumption, it does not fully rule out these possibilities. In Section 6, I provide additional evidence and discussion in support of the parallel-trends assumption.

Table 2: Past Conflict and Timing of Protected Area Designation

(a) Any conflict event

	(1)	(2)	(3)	(4)	(5)
$Any\ Conflict_{t-1}$	0.022	0.022	0.022	0.022	0.022
	(0.014)	(0.014)	(0.014)	(0.015)	(0.015)
$Any\ Conflict_{t-2}$		-0.004	-0.004	-0.004	-0.004
		(0.013)	(0.012)	(0.013)	(0.013)
$Any\ Conflict_{t-3}$			0.000	0.000	0.001
			(0.015)	(0.015)	(0.016)
$Any\ Conflict_{t-4}$				-0.003	-0.003
				(0.014)	(0.014)
$Any\ Conflict_{t-5}$					0.005
					(0.015)
Adj. R^2	0.670	0.670	0.670	0.670	0.670

(b) Fatal conflict event

	(1)	(2)	(3)	(4)	(5)
$Fatal\ Conflict_{t-1}$	0.026*	0.026*	0.026*	0.025*	0.026*
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
$Fatal\ Conflict_{t-2}$		0.000	0.000	-0.001	-0.001
		(0.016)	(0.016)	(0.017)	(0.017)
$Fatal\ Conflict_{t-3}$			-0.007	-0.008	-0.007
			(0.015)	(0.015)	(0.015)
$Fatal\ Conflict_{t-4}$				-0.015	-0.015
				(0.019)	(0.019)
$Fatal\ Conflict_{t-5}$					0.012
					(0.018)
Observations	20,273	20,273	20,273	20,273	20,273
Adj. R^2	0.670	0.670	0.670	0.670	0.670
Clusters	545	545	545	545	545

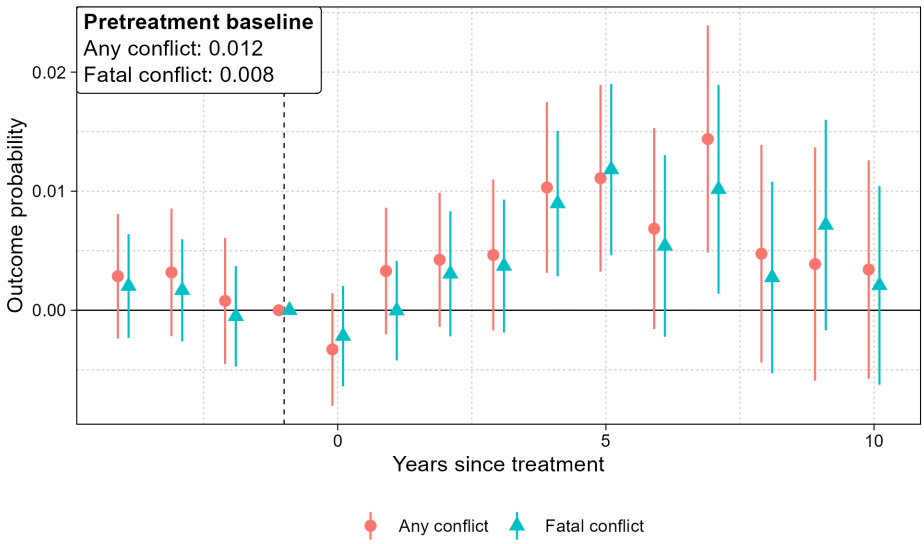
Notes: This table reports the event study estimates from equation **??**. The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variable takes the value of 1, the year the grid cell receives PA designation and 0 otherwise. Independent variables are binary indicators for presence of conflict. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clusters at the level of $1° \times 1°$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6 Baseline Results

In this section I present the overall impact of PA designation on conflict. Figure 4 shows the event study estimates, and Table 3 shows the corresponding static estimates from Equation 1. The probability of conflict gradually increases in response to PA designation, peaks at seven years past designation, and then begins to subside. The average increase for any conflict is 0.6 p.p. (50% relative to the treatment baseline), and for fatal conflict, it is 0.5 p.p. ($\sim$ 60% relative to the treatment baseline). At the peak (seven years post-designation), the probabilities of any conflict and fatal conflict increase by about 1.5 and 1 percentage points, respectively. Relative to the treatment baseline, these correspond to increases of $\sim$ 125% for both outcomes. These estimates are comparable to studies that estimate the impact of commodity price shocks or weather shocks on conflict in Africa (McGuirk and Burke 2020; McGuirk and Nunn 2025).

These results provide strong evidence that PA designation increases both the probability of conflict and its severity. It is important to note, however, that the outcome variable for a fatal event is still a binary indicator and measures the probability of at least one conflict-related fatality. The probability of a conflict-related death increases when the number of conflict events increases, when an incident becomes more violent, or both. A binary indicator of fatality cannot distinguish between these two mechanisms of intensification.

Figure 4: Effect of PA designation on conflict events



Notes: This figure reports the event study estimates from equation 1 as proposed by Sun and Abraham (2021). The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables take a value of 1, when there is at least one event in a grid cell in a given year and 0 otherwise. 'Any conflict' refers to all conflict events and 'Fatal conflict', refers to conflicts with at least one fatality. Each regression includes grid, country-by-year, and ecoregions-by-year fixed effects. Standard errors are clusters at the level of $1° \times 1°$ grid cells, which contain 16 units of observation.

Table 3: Impact of PA designation on conflict

	Any conflict	Fatal conflict
	(1)	(2)
PA Designation	0.006**	0.005**
	(0.003)	(0.002)
Pretreatment baseline	0.012	0.008
Observations	770,168	770,168
Adj. R^2	0.3318	0.2927
NCluster	2,463	2,463

Notes: This table reports effect of PA designation on conflict estimated from equation 1 (Sun and Abraham 2021) and aggregated over 0 to 7 years. The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables are binary indicators of conflict events in a grid cell-year. each regression includes grid, country-by-year, and ecoregions-by-year fixed effects. Standard errors are clustered at the level of $1° \times 1°$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6.1 Impact of PA on Conflict Near International Border

As outlined in Section 2, if PAs increase conflict through a grievance-against-the-state mechanism, the effect of PA designation should be stronger in areas with higher conflict proneness. In such settings, the imposition of new restrictions on land and resource use may be more likely to encounter resistance. I argue that borderlands provide a strong, albeit imperfect, proxy for conflict proneness.

It is well documented that borderlands experience higher levels and distinct patterns of conflict compared with the rest of the country. For instance, in 2023 alone, $\sim$ 19% of all observed conflict events occurred within 50 km of an international border, despite the relatively low population density of these areas (Richard and Vanden Eynde 2026). Border areas not only tend to have a weaker state presence but also provide conditions conducive to insurgency by allowing rebels access to foreign cross-border sanctuaries (OECD and Sahel and West Africa Club 2022; Fearon and Laitin 2003). Additionally, in Africa, country borders often split or overlap with the boundaries of ethnic homelands, contributing to higher levels of interethnic conflict as well as conflict against the state (Michalopoulos and Papaioannou 2016; Mueller et al. 2022). In my main sample, slightly more than half of all conflict events occur within 50 km of an international border, even though these areas account for only $\sim$ 21% of the continent.

Figure A2 shows the raw probability of conflict in grid cells within and outside borderlands. Two patterns stand out. First, the probability of a conflict event is substantially higher in borderlands. Second, unlike in the rest of the country, grid cells in borderlands that eventually receive PA designation have a lower overall probability of conflict than grid cells that never receive PA designation. Given these distinct patterns of conflict incidence, I conduct separate analyses for borderlands (within 50 km of an international border) and the interior (more than 50 km from an international border).

Figure 5 shows separate results for the two samples, and Table 4 shows the corresponding static estimates. The dynamic estimates for borderlands broadly mirror the results for the entire sample—conflict probability gradually increases, peaks at year seven, and then begins to subside—but, on average, the magnitude of the effect is about 80% larger than in the baseline results. At seven years post-designation, the probability of a conflict event increases by about 153% for all conflicts and a striking 220% for fatal conflicts. In contrast, the impact of PA designation on conflict in the interior is statistically indistinguishable from zero for most post-treatment periods. The results also suggest that the lack of a detectable effect in the interior cannot be attributed to an overall low propensity for violence. While the pretreatment baseline probability of conflict is lower in the interior, it is still comparable to

that in borderlands and is far from negligible. For instance, the baseline probability of fatal conflict is 0.9% in borderlands and about 0.7% in the interior.

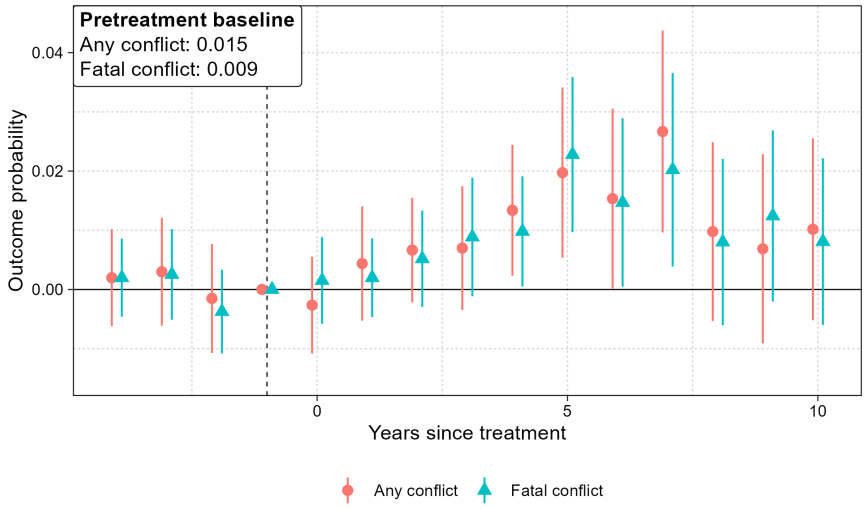
Table 4: Impact of PA designation on conflict by distance from country border

	Any conflict		Fatal conflict	
	(1)	(2)	(3)	(4)
PA Designation	0.011**	0.003	0.011**	0.001
	(0.005)	(0.003)	(0.004)	(0.002)
Pretreatment baseline	0.015	0.009	0.009	0.007
Observations	249,732	520,324	249,732	520,324
Adj. R^2	0.3470	0.3230	0.3089	0.2841
NCluster	1,286	1,900	1,286	1,900
Subsample	Within 50km	Over 50km	Within 50km	Over 50km

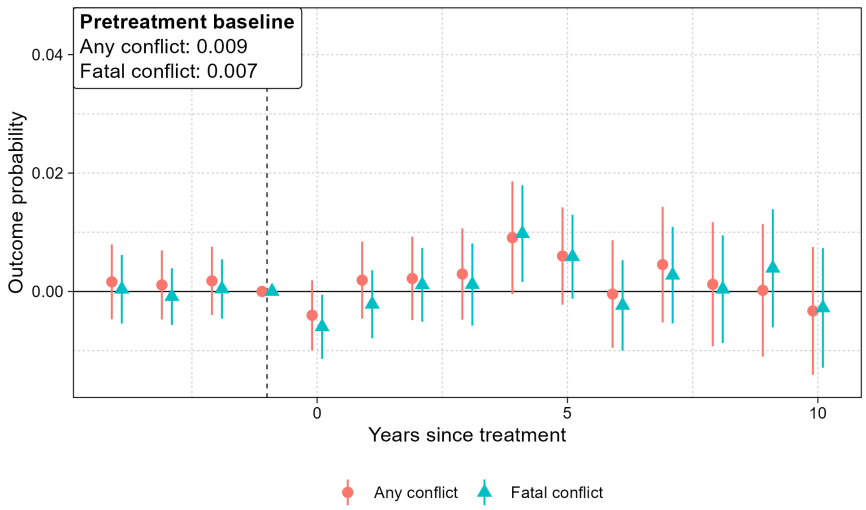
Notes: This table reports effect of PA designation on conflict estimated from equation 1 (Sun and Abraham 2021) and aggregated over 0 to 7 years. Columns (1) and (3) show results for gridcells with one edge within 50 km of country border and columns (2) and (4) for gridcells that are more than 50km away from the border. The unit of observation is $0.25^\circ \times 0.25^\circ$ grid cell. Dependent variables are binary indicators of conflict events in a grid cell-year. each regression includes grid, country-by-year, and ecoregions-by-year fixed effects. Standard errors are clustered at the level of $1^\circ \times 1^\circ$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 5: Effect of PA designation on conflict events, separately by distance from border

(a) Within 50km of country border



(b) Over 50km of country border



Notes: This figure reports the event study estimates from equation 1 as proposed by Sun and Abraham (2021). The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables take a value of 1, when there is at least one event in a grid cell in a given year and 0 otherwise. Pretreatment baselines are reported on the top-left corner of each plot. 'Any conflict' refers to all conflict events and 'Fatal conflict', refers to conflicts with at least one fatality. **Panel (a)** shows results for grid cells within 50km of country's border and **panel (b)**, for grid cells over 50km. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clusters at the level of $1° \times 1°$ grid cells, which contain 16 units of observation.

One potential concern with this analysis is that the choice of a 50 km threshold may have arbitrarily partitioned the sample in a way that mechanically generates the observed heterogeneity. Figure A3 addresses this concern by showing that the estimated effect declines smoothly as the distance threshold used to define borderlands increases. This pattern is consistent with existing evidence that conflict proneness exhibits a distance-decay relationship, with political violence gradually declining with distance from international borders (OECD and Sahel and West Africa Club 2022).

Furthermore, as an additional robustness check, I show results using an alternative proxy for a higher conflict proneness—split ethnicity. Michalopoulos and Papaioannou (2016) show that, due to longstanding discrimination by the government, split ethnicities have a higher propensity to contest state authority and engage in conflict. To examine this heterogeneity, I split the sample based on split-ethnicity status rather than borderland status and estimate separate regressions. The results are shown in Table A1. The estimates for split ethnicities are meaningfully large and statistically significant, whereas those for non-split ethnicities are small in magnitude and statistically indistinguishable from zero.

I further examine whether the conflict-inducing effect of PA designation depends on the state's ability to manage grievances. I use the State Fragility Index (SFI) from the Polity V Project as a proxy for this ability (Marshall and Gurr 2020). I then estimate heterogeneity in the treatment effect according to whether a country falls in the bottom quartile of the state fragility distribution. The SFI measures two aspects of governance—effectiveness and legitimacy—across security, political, economic, and social dimensions (Monty G Marshall and Benjamin R Cole 2008). Effectiveness is defined as 'applied coordination', which captures the administrative capacity of a state to implement and enforce policy. Legitimacy is defined as 'voluntary compliance', which captures the moral authority of the state and the extent to which citizens voluntarily accept policies instituted by the state without the state having to resort to coercion.[18] The results in Table A2 provide no evidence of a conflict-inducing effect of PA designation in states that are less fragile. The interaction effects for states in the first quartile of the fragility index are negative, statistically significant, and sufficiently large to offset the positive baseline effect. Taken together, these results suggest that states with some combination of effective and legitimate institutions can mitigate the conflict-inducing effects of PA designation.

These results support the hypothesis that PA designation increases conflict primarily in already conflict-prone areas, where the threshold for engaging in violence against the state

18. "A country's fragility is closely associated with its state capacity to manage conflict; make and implement public policy; and deliver essential services and its systemic resilience in maintaining system coherence, cohesion, and quality of life; responding effectively to challenges and crises; and sustaining progressive development." (Monty G. Marshall and Benjamin R. Cole 2014)

may be relatively low. However, these findings do not say much about the nature of the resulting conflict or the conditions under which the conflict-inducing effect of PA designation is amplified or attenuated. I investigate these questions Sections 7 and 8 by examining whether the observed increase in conflict reflects social and economic grievances generated by PA designation—for instance, through disruptions to local livelihoods—or broader political grievances associated with increased state presence and control over land. I also examine the conditions under which these effects are mitigated or exacerbated. Because the estimated increase in conflict is concentrated almost entirely in borderlands, the subsequent analysis focuses primarily on the borderland sample.

6.2 Robustness and Sensitivity

In this subsection, I provide robustness checks and sensitivity analyses to address concerns that the results may be driven by violation in parallel trends assumption or by specific choices made during data construction or model estimation.

Additional support for parallel trends assumption: In Section 5, I provided evidence in favor of the parallel trends assumption, which is further supported by the lack of any significant pre-trends in Figure 5. I provide additional evidence by showing that the results are insensitive to using only nearby never-treated grid cells as controls. The logic behind this test is that nearby control grid cells are likely to be more similar to treated grid cells than those that are farther away. If this is the case, progressively including more distant control grid cells should meaningfully change the estimates. However, Figure C6 shows that the estimates become slightly more precise but otherwise change little as I include controls that are increasingly farther away from treated grid cells. The estimates remain similar even when controls more than 75 km away are excluded, which removes about 40% of the original sample from the analysis.

Furthermore, there may be endogeneity concerns whereby governments declare protected areas in response to conflict. This is unlikely because PA designation is usually a multi-year process, and designations take place in tranches to fulfill macro-level conservation targets rather than local conservation requirements.I provide further evidence in Figure C7, which shows the results of anticipation tests. The treatment estimates are statistically indistinguishable from zero when the treatment dates are shifted three and six periods earlier.

Alternative outcome measure: To account for measurement error and outlying areas with an extremely high number of conflict events, a standard practice is to use a binary indicator of conflict incidence (Bazzi and Blattman 2014; Berman et al. 2017; Limodio 2022; McGuirk and Nunn 2025). As a robustness check, Figure C8 shows results using

log(1 + number of events) as the outcome variable. The estimates are consistent with the main results using the binary outcome.

Alternative estimators: Table C5 shows the results from estimating the event study using OLS. The pattern of results closely mirrors that reported in Table 4.

Alternative clustering strategy: Table C6 shows the results using Conley standard errors computed with 100 km and 200 km distance cutoffs instead of clustering standard errors within $1^\circ \times 1^\circ$ grids. The standard errors increase slightly but do not change the statistical inference.

Alternative specification: In Table C7, I show results using a modified version of Equation 1 that excludes ecoregion-by-year fixed effects. The estimates become slightly smaller and noisier for any conflict event, but the results for fatal conflict events do not change materially.

Potential concern for reporting bias: Another potential concern is that the results may be driven by reporting bias or geolocation bias toward landmarks, including protected areas. To address this concern, I show results using the Uppsala Conflict Data Program (UCDP) Georeferenced Event Dataset. UCDP applies much more stringent inclusion criteria and rigorous standards for validating events before including them in the dataset and is therefore less likely to be susceptible to these biases than ACLED (Eck 2012). The results are reported in Table C8 and are very similar to the main results.

Alternative subsample: The main results in this paper exclude grid cells that are either near major urban centers or contain major mineral deposits, resulting in the exclusion of $\sim$10% of the final sample. I do this because these areas experience distinct patterns of violence. Furthermore, in areas with major mineral deposits, mineral price shocks are likely to be a more important determinant of violence than protected area designation. Table C9 shows the results using the full sample. As expected, the estimates for borderlands are slightly noisier and attenuated relative to the main results in Table 4, but the overall inference does not change. For areas in the interior, the estimated effect on any conflict is larger in magnitude and statistically significant, while the estimated effect on fatal conflict is unchanged.

7 Role of State in Conflict

Another implication of the grievances-against-the-state mechanism is that the resulting conflict is most likely to occur between the state and anti-state actors. However, this prediction does not necessarily hold if conflict is driven primarily by mechanisms related to resource capture or changes in the opportunity cost of engaging in conflict (McGuirk and Burke 2020; Dube and Vargas 2013). For example, when land is expropriated from customary users for PA designation, it may intensify competition over scarce resources among contending ethnic or political groups, leading to conflict between them without the state being directly or prominently involved. Similarly, organized armed groups may perpetrate violence against civilians to gain control over resources as competition increases following PA designation. Conversely, conflict may arise against the state in response to PA designation, but if the state's objective is not to expand territorial control or political authority, such conflict may be relatively short-lived. To distinguish between these alternative mechanisms, I follow Michalopoulos and Papaioannou (2016) and estimate Equation 1 separately by both the type of violence—namely, violence against civilians, battles, and explosions—and the actors involved (state forces and rebel groups). To reiterate, rebel groups are defined by ACLED as political actors who explicitly seek to challenge or overthrow the government and thus are anti-state actors. The results are presented in Table 5.

In the table, each column is assigned an event type (battles/explosions or violence against civilians) and an actor type (state or rebel group), along with a binary indicator for the involvement of the assigned actor type. A value of 1 indicates that the assigned actor type is involved in the corresponding conflict event, while a value of 0 indicates that the assigned actor type is not involved. For instance, column (1) presents results for battles and explosions in which no rebel group is involved, while column (2) presents results for battles and explosions in which a rebel group is involved.

The overall takeaway from the results is that PA designation leads to a significant increase in armed confrontation between state and rebel groups and both actors also engage in violence against civilians at a considerably higher rate post PA designation. To see this, let's focus on panel (a). Column (2) and (4) show that probability of battles and explosions involving rebel groups increases by 100% of the treatment baseline and for the ones involving state, increases by over 30%. These magnitudes are statistically significant, but also meaningfully large. In contrast, we see no impact on conflict that either doesn't involve state or the rebel groups. Similarly, the coefficients of PA designation for violence against civilians involving both rebel groups and state (columns (6) and (8)) are statistically significant and meaningfully large. The violence perpetrated by rebel groups against civilians

increases by 700% compared to treatment baseline, and for violence perpetrated by state, this increase is by 200%.

It is also important to note that the estimated effects for violence against civilians are statistically significant and economically meaningful for events not involving rebel groups and for events not involving state forces (columns (5) and (7), respectively). This finding is partly driven by the fact that events excluding state forces still includes violence perpetrated by rebel groups and vice versa. Additionally, the null effects for battles and explosions not involving either state forces or rebel groups cannot be attributed to low baseline conflict incidence. In fact, baseline conflict incidence is higher for events that do not involve state forces or rebel groups (columns (1) and (3)).

Furthermore, the corresponding event studies presented in Figure A4 show that state involvement in conflict increases over time, reaching its peak five years after PA designation rather than dissipating quickly. This pattern is consistent with sustained state projection of force in borderlands following PA designation. Combined with the evidence of a considerable increase in violence perpetrated by state forces against civilians following PA designation this pattern is consistent with green militarism (Duffy 2014; Duffy et al. 2019).

Table 5: Impact of PA on conflict by violence types and actors involved

(a) Any conflict

	Battles Explosions				Violence against civilians			
	Rebel		State		Rebel		State	
	0	1	0	1	0	1	0	1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PA Designation	0.000	0.008**	0.002	0.008***	0.004	0.008**	0.007*	0.003**
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.001)
Control mean	0.007	0.004	0.004	0.006	0.007	0.001	0.007	0.001
Adj. R^2	0.2399	0.2830	0.2541	0.2609	0.2519	0.2323	0.2818	0.1392

(b) Fatal conflict

	Battles Explosions				Violence against civilians			
	Rebel		State		Rebel		State	
	0	1	0	1	0	1	0	1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PA Designation	0.001	0.006**	0.002	0.006**	0.004*	0.005**	0.007**	0.002***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)
Control mean	0.004	0.003	0.003	0.004	0.002	0.001	0.003	0.000
Observations	249,732	249,732	249,732	249,732	249,732	249,732	249,732	249,732
Adj. R^2	0.1982	0.2490	0.2116	0.2243	0.2136	0.1943	0.2375	0.1074
NCluster	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286

Notes: This table reports effect of PA designation on conflict estimated from equation 1 (Sun and Abraham 2021) and aggregated over 0 to 6 years. Panel (a) shows results for any conflict event and panel (b) for conflict events with at least one death. The unit of observation is $0.25^\circ \times 0.25^\circ$ grid cell. Dependent variables are binary indicators of conflict events in a grid cell-year. Each regression include grid, country-by-year, and eco-regions-by-year fixed effect. Standard errors are clustered at the level of $1^\circ \times 1^\circ$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

8 Role of PA Governance and Economic Activity

In this section, I investigate how community governance or potential financial benefits to local communities can temper the impact of PA designation on conflict or, conversely, how

financial costs may exacerbate this impact. To do so, I estimate heterogeneous effects using the following equation:

$$Y_{icet} = \sum_{g} \sum_{\tau \neq -1} \beta_{g,\tau} \cdot \mathbb{I}\{G_i = g\} \cdot \mathbb{I}\{t - G_i = \tau\} + \sum_{g} \sum_{\tau \neq -1} \gamma_{g,\tau} \cdot \mathbb{I}\{G_i = g\} \cdot \mathbb{I}\{t - G_i = \tau\} \cdot X_{ice} + \alpha_i + \lambda_{ct} + \theta_{et} + \epsilon_{icet} \quad (3)$$

where X_{ice} is a binary indicator for the PA characteristic with respect to which heterogeneity is estimated, and $\gamma_{g,\tau}$ is the additional treatment effect of PA designation relative to the omitted category.

First, I estimate heterogeneity by whether a protected area is designated within the habitat range of wildlife species commonly associated with safari tourism. Africa is the global center of safari tourism, and wildlife tourism accounts for a substantial share of the continent's travel and tourism economy. Protected areas designated within the habitat ranges of iconic safari species are therefore more likely to generate income for local communities through tourism. These potential economic benefits may increase local acceptance of PA designation, even when it also functions as an instrument of territorialization. To examine this mechanism, I use habitat range maps from the IUCN Red List of Threatened Species to construct an indicator equal to one if a grid cell overlaps the habitat of at least one major safari species. The species include lions, elephants, leopards, rhinoceroses, cheetahs, giraffes, zebras, chimpanzees, and gorillas.

Second, I estimate heterogeneity by community governance status. To do so, I use the governance type information available in the WDPA dataset. For PAs for which governance type is not reported, I classify them as community-governed if their names contain the terms 'communal' or 'community'. Under the conceptual framework, community-governed PAs should be associated with lower levels of conflict because they are less likely to be perceived as instruments of state expansion. Instead, they are more likely to reflect local participation and ownership in conservation. Additionally, they are less likely to impose costs on local communities because local communities retain autonomy over the use of resources.

Third, I estimate heterogeneity by the baseline share of agricultural land. I divide the sample into quartiles based on the baseline share of agricultural land and add an interaction term for the upper quartile, with the other three quartiles serving as the omitted category. A high share of agricultural land indicates greater economic activity that may be disrupted by PA designation, potentially increasing the probability of conflict.

The results are presented in Table 6 for the borderlands and Table 7 for the interior. In the borderlands, a high share of agricultural land is associated with a 1.9 percentage point higher probability of conflict relative to the baseline effect. In contrast, the presence of safari species is associated with a 3.7 percentage point lower probability of conflict relative to the baseline effect—enough to offset the baseline increase. Tables A3 and A4 report results using an alternative definition of safari wildlife that includes only the Big Four species (lion, rhinoceros, elephant, and leopard). The findings remain consistent under this alternative classification. This result also reduces concerns that poaching is driving the conflict results.

However, an alternative mechanism could generate the same result: a stronger security presence in PAs associated with safari wildlife. Because safari species can attract tourists and increase state revenue and reputation, these locations may have stronger security arrangements, leading to lower levels of conflict without necessarily improving income-earning opportunities for local communities. Since I cannot fully rule out this alternative mechanism, I interpret the result as suggestive evidence that the economic benefits associated with safari tourism temper the effect of PA designation on conflict.

Similarly, community-governed protected areas in the borderlands are associated with lower levels of violence—enough to offset the baseline effect. Additionally, in contrast to the borderlands, effects in the interior (as shown in Table 7) are mostly statistically indistinguishable from zero. While the heterogeneous effect for any conflict event is statistically significant for PAs overlapping safari wildlife habitat, the effect size is much smaller than the corresponding borderland effect.

Table 6: Heterogeneity in impact of PAs on conflict by PA type (Borderland)

	Any conflict			Fatal conflict		
	(1)	(2)	(3)	(4)	(5)	(6)
PA Designation	0.004	0.034***	0.013***	0.008**	0.022***	0.012***
	(0.004)	(0.007)	(0.005)	(0.004)	(0.008)	(0.004)
× Share Ag > Q3	0.019**			0.007		
	(0.007)			(0.006)		
× Safari species		-0.037***			-0.019**	
		(0.009)			(0.010)	
× Community-managed PA			-0.019*			-0.016
			(0.011)			(0.011)
Pretreatment baseline	0.023	0.011	0.022	0.018	0.007	0.014
Observations	249,732	249,732	249,732	249,732	249,732	249,732
Adj. R^2	0.348	0.348	0.347	0.310	0.310	0.309
NCluster	1,286	1,286	1,286	1,286	1,286	1,286

Notes: This table reports heterogeneous effect of PA designation by PA type. Effects are estimated using equation 3 (Sun and Abraham 2021). The results are aggregated over 0 to 7 years. The unit of observation is $0.25^\circ \times 0.25^\circ$ grid cell and dependent variables are binary indicator of conflict. Each regression include grid, country-by-year, and eco-regions-by-year fixed effect. Standard errors are clustered at the level of $1^\circ \times 1^\circ$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Heterogeneity in impact of PAs on conflict by PA type (Interior)

	Any conflict			Fatal conflict		
	(1)	(2)	(3)	(4)	(5)	(6)
PA Designation	0.003	0.011*	0.003	0.000	0.007	0.001
	(0.003)	(0.007)	(0.003)	(0.002)	(0.006)	(0.003)
× Share Ag > Q3	0.000			0.003		
	(0.007)			(0.006)		
× Safari species		-0.013			-0.010	
		(0.008)			(0.008)	
× Community-managed PA			-0.001			0.000
			(0.007)			(0.005)
Pretreatment baseline	0.018	0.009	0.005	0.012	0.007	0.000
Observations	520,324	520,324	520,324	520,324	520,324	520,324
Adj. R^2	0.324	0.324	0.323	0.285	0.285	0.284
NCluster	1,900	1,900	1,900	1,900	1,900	1,900

Notes: This table reports heterogeneous effect of PA designation by PA type. Effects are estimated using equation 3 (Sun and Abraham 2021). The results are aggregated over 0 to 7 years. The unit of observation is $0.25° \times 0.25°$ grid cell and dependent variables are binary indicator of conflict. Each regression include grid, country-by-year, and eco-regions-by-year fixed effect. Standard errors are clustered at the level of $1° \times 1°$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

9 Impact of PAs on Conservation

In this section, I estimate the impact of protected area designation on conservation outcomes. Conservation is the primary objective of PA designation. In the previous sections, I focused on the unintended consequences of PA designation using conflict outcomes, but it is also important to understand whether these policy instruments deliver environmental benefits. In addition to estimating the impact of PA designation on conservation, I investigate another question that naturally emerges: Do the mechanisms underlying conflict outcomes also shape the impact of PA designation on conservation outcomes? To do so, I use two measures of environmental outcomes:

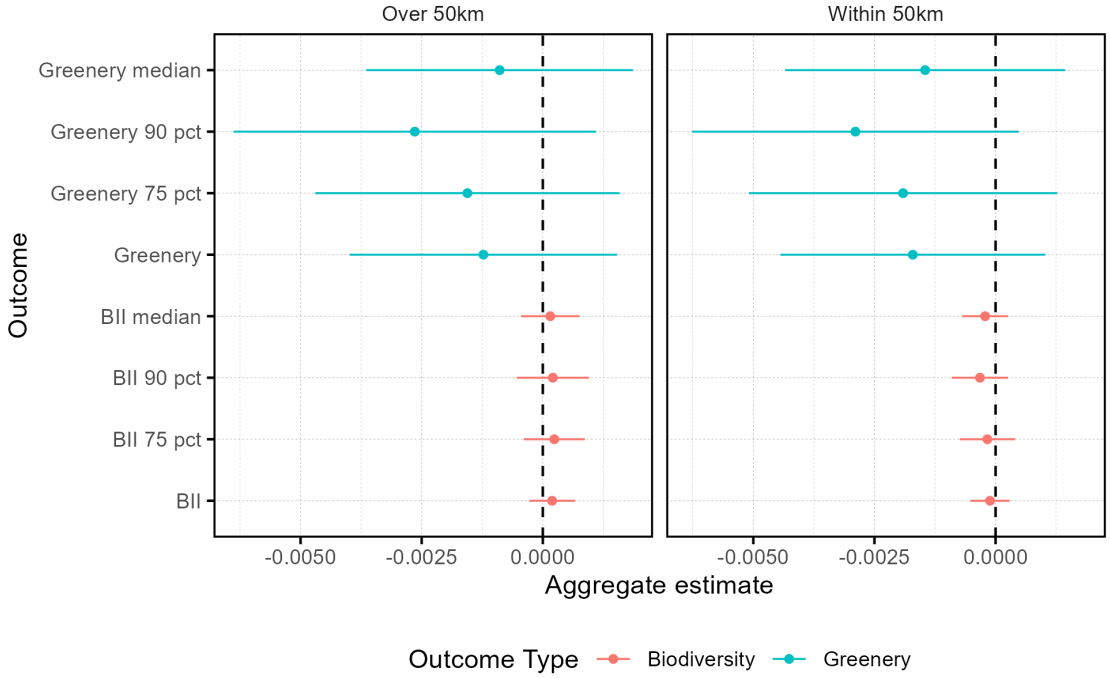
Biodiversity Intactness Index (BII): The Biodiversity Intactness Index (BII) measures the average abundance of native terrestrial species relative to an undisturbed reference condition. A BII value of 100% indicates that the average abundance of native species is equal to that expected under the reference baseline, while lower values indicate reductions in abundance due to human activities. Importantly, BII is a relative rather than an absolute measure of biodiversity. As a result, a location with naturally low species abundance can still exhibit a high BII if its current abundance is close to the expected abundance under baseline conditions. In this study, I use the annual global BII dataset developed by Nguyen et al. (2025). The theoretical range of BII is 0 to 1, with 1 corresponding to 100%.

Greenery: I measure vegetation condition using the annual Enhanced Vegetation Index (EVI) derived from Landsat imagery (Huete et al. 2002). EVI is a widely used indicator of vegetation greenness and productivity that is less susceptible to saturation in densely vegetated areas than the Normalized Difference Vegetation Index (NDVI). It is particularly well suited to Africa because it provides a consistent measure of vegetation condition across diverse land-cover types, including forests, savannas, shrublands, and grasslands. The theoretical range of EVI is -1 to 1.

I present the results in Figure 6. In addition to the mean, I also present results for each quartile and the 90^{th} percentile of the measured variables. I do so to account for the possibility that effects may be concentrated in one part of the distribution and for the fact that the treated grid cells and PAs only partially overlap. The results show small and consistently negative, though imprecisely estimated, effects on greenery across the distribution, both in the borderlands and the interior. Considering that the pretreatment mean for greenery is about 0.20, the estimated decline is about 1% of the baseline. In contrast, the estimated effects on BII are precisely estimated zeroes in both the borderlands and the interior. Taken together, these results provide no evidence that PA designation meaningfully improves biodiversity outcomes.

Next, Figure 7 shows the heterogeneity in treatment effects by community governance status and presence of safari wildlife. Again, there is no meaningful change in BII compared to its pretreatment baseline of around 0.80. In case of greenery however, we see modest gains in community governed PAs in the interior. In contrast, PAs in the borderland aren't associated with any gains in environmental outcomes even in PAs associated with lower conflict levels.

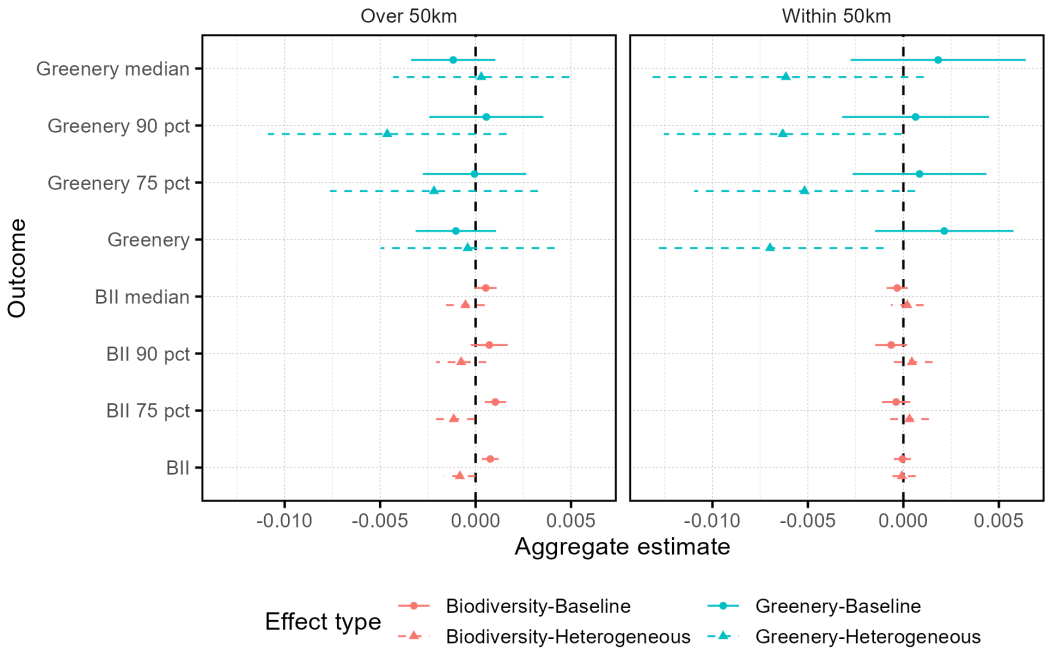
Figure 6: Effect of PA designation on environmental outcomes



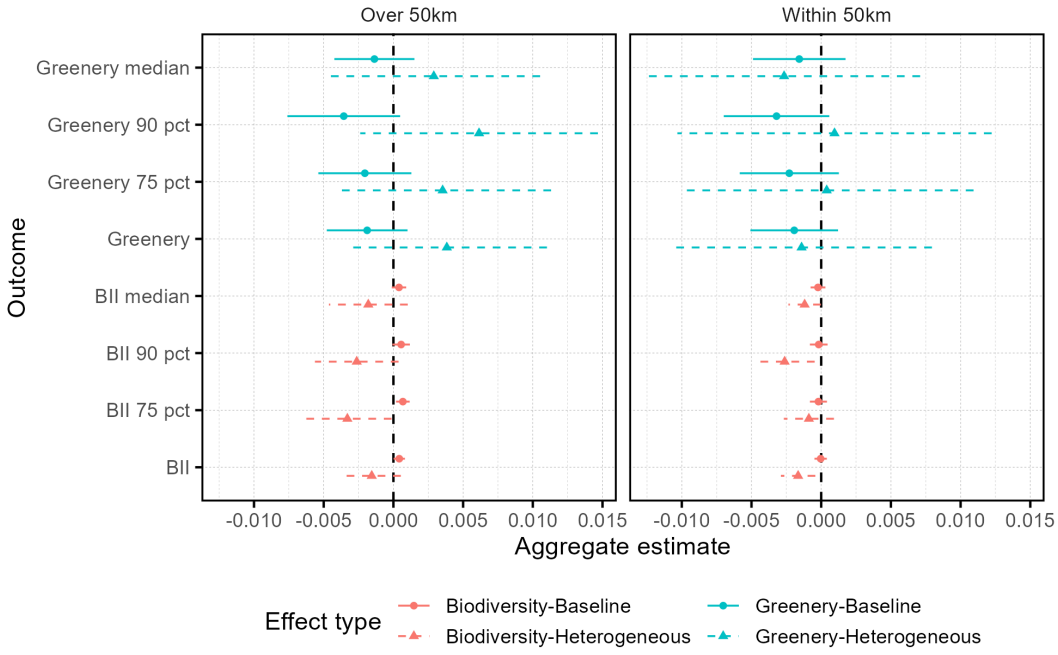
Notes: This figure reports estimates from equation 1 aggregated over 0 to 7 years. The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables are Greenness (EVI) and Biodiversity Intactness Index. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clusters at the level of $1° \times 1°$ grid cells.

Figure 7: Effect of PA designation on environmental outcomes (Heterogeneity)

(a) Heterogeneity by presence of safari wildlife



(b) Heterogeneity by community governance status



Notes: This figure reports estimates from equation 3 aggregated over 0 to 7 years. The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables are Greenness (EVI) and Biodiversity Intactness Index. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clusters at the level of $1° \times 1°$ grid cells.

10 Discussion of Results

The results show that PA designation increases the probability of conflict. However, this effect is concentrated in areas that are already conflict-prone. This suggests that PA designation interacts with pre-existing grievances and a lower underlying threshold for engaging in conflict against the state. I use borderland status as a proxy for conflict proneness, but the results are robust to an alternative definition based on whether an area lies within the historical territory of a split ethnic group. PA designation has no statistically significant effect on conflict in states with low values of the State Fragility Index, even within borderlands. Finally, the finding that the increase in conflict is primarily driven by battles involving state and anti-state actors suggests that a mechanism operating through grievances against the state is an important channel through which PA designation leads to conflict.

In addition, I find that community-owned or community-governed PAs are not associated with higher levels of conflict following designation. This result suggests that greater local autonomy over land and its governance can temper grievances against the state. Furthermore, PAs that overlap with the habitats of safari wildlife are also not associated with a higher probability of conflict post-designation. Taken together, these findings suggest that, while the mechanism linking PA designation to conflict has an important political dimension, the additional income and employment opportunities associated with wildlife tourism may provide compensating benefits that mitigate the conflict-inducing effects of PA designation.

However, designating PAs in areas with potential for safari tourism poses a conundrum. On the one hand, concentrating conservation efforts in these areas may reduce the risk of conflict, but doing so risks the over-protection of a few charismatic species and their associated ecosystems and the under-protection of other species, potentially undermining the broader objective of biodiversity conservation. In fact, conservation efforts worldwide have long been criticized for their 'taxonomic bias' (Clark and May 2002; Courchamp et al. 2018; Mammola et al. 2020; Troudet et al. 2017). Moreover, concentrating conservation efforts on particular species may reduce the option value associated with biodiversity. Preserving a broad range of species maintains the possibility of future discoveries of welfare-enhancing species or previously unknown welfare-enhancing properties of known species. An overwhelmingly large share of global biodiversity remains severely understudied in terms of its potential to generate benefits for humankind (Oldham et al. 2013).[19] Thus, while the economic benefits associated with safari wildlife may help mitigate the local political costs of PA designation,

19. For a recent example of how conservation can generate dividends through increased species-related scientific inquiry, research output, and patenting, see Chen et al. (2026).

prioritizing areas based on their potential for wildlife tourism could come at the cost of conserving a broader and potentially more valuable range of biodiversity.

Turning to environmental outcomes, the estimated effects of PA designation on both greenery and the Biodiversity Intactness Index are modest. This finding is consistent with the observation that land use across much of Africa remains relatively low-intensity and has changed little over time. This interpretation suggests that, on average, PAs in Africa face relatively limited pressure from competing economic activities. Consequently, PA designation may generate smaller additional conservation benefits because there is less economic activity and associated land-use change for protection to displace or prevent in the first place. This contrasts with evidence from other regions, where the location of PAs is often shaped by incentives to avoid areas with high economic opportunity costs, resulting in protection being disproportionately allocated to relatively remote or economically infra-marginal land (Alger 2023; Joppa and Pfaff 2009; Grupp et al. 2023). Africa is the world's fastest-growing continent in terms of population, and continued population growth may intensify land-use pressures across the region in the coming decades. How the economic pressures associated with such land-use intensification will alter incentives governing PA location choice—and how these changes may, in turn, affect conflict—is beyond the scope of this paper. Nevertheless, understanding these dynamics is particularly important in the context of efforts to expand conservation coverage to 30% by 2030.

Finally, this study has several limitations. First, due to the nature of the empirical design, I can estimate the impact of PA designation only on the extensive, rather than intensive, margin. Consequently, the final sample excludes hundreds of designated protected areas, potentially limiting the external validity of the findings. Second, the results indicate that community ownership or governance may reduce the conflict-inducing effects of PA designation. However, this paper does not provide the micro-level institutional detail necessary to identify which features of community-owned PAs account for this mitigating effect or how they interact with PA design. More detailed research, ideally incorporating field-based evidence, is needed to understand how, and under what institutional conditions, community ownership tempers the potential for conflict following PA designation. Finally, conflict is a relatively rare and extreme manifestation of underlying grievances. PA designation may generate other forms of resistance, opposition, or contestation that are not sufficiently intense to be recorded as conflict in the data used here. The estimates should therefore be interpreted as capturing only the more severe manifestations of opposition to PA designation, rather than the full range of potentially adverse social consequences arising from PA designation in Africa.

Another limitation concerns the measurement of environmental outcomes. The measures used in the main analysis largely capture changes in land cover and land use, with the Biodiversity Intactness Index serving as a land-cover-based proxy for biodiversity. Yet intact land cover does not necessarily imply that species-level conservation outcomes remain unchanged. PA designation may affect the presence or abundance of particular species even in the absence of detectable changes in habitat. Directly examining such effects, however, is complicated by the highly uneven spatial and taxonomic coverage of available species-occurrence data. Observations tend to be concentrated among particular taxa and in more intensively sampled locations, making it difficult to interpret estimated changes in species presence as representative of broader changes in biodiversity.

11 Conclusion

In this paper, I use the context of protected areas (PAs) to show that environmental policies with intended benefits can nevertheless generate serious unintended consequences when local political economies are not taken into account. Specifically, I show that PA designation increases conflict in areas that are relatively more susceptible to conflict against the state, i.e., borderlands, and that the increase is driven primarily by conflict between state forces and anti-state actors (rebel groups). I also present suggestive evidence that the adverse effects of PA designation on conflict are substantially mitigated when local communities retain authority over protected areas or when PA designation generates financial benefits for local populations.

Together, these findings lend support to the grievances-against-the-state mechanism, whereby the state, as the salient actor implementing potentially restrictive policies, exacerbates anti-state sentiment among local populations and increases the propensity for conflict. At the same time, I find no evidence that PA designation has a meaningful effect on environmental outcomes in either direction.

These findings have broader implications for the design of policies that pursue global objectives while imposing costs that are concentrated locally. In particular, they highlight the importance of accounting for the political, institutional, and economic conditions at the site of implementation and of identifying policy designs that can mitigate local costs or compensate affected populations. More broadly, the results point to the importance of understanding how globally defined policy objectives interact with local political economies in determining both intended and unintended policy outcomes.

References

Acemoglu, Daron, Camilo García-Jimeno, and James A Robinson. 2015. "State capacity and economic development: A network approach." *American economic review* 105 (8): 2364–2409.

Acemoglu, Daron, Simon Johnson, and James A Robinson. 2001. "The colonial origins of comparative development: An empirical investigation." *American economic review* 91 (5): 1369–1401.

———. 2005. "Institutions as a fundamental cause of long-run growth." *Handbook of economic growth* 1:385–472.

Albers, Heidi J, and Kailin Kroetz. 2026. "The Economics of Designing Protected Areas for Biodiversity Conservation: A Call to Integrate Pre-and Post-implementation Human Threats into Planning." *Review of Environmental Economics and Policy* 20 (1): 000–000.

Alger, Justin. 2023. "The political economy of protected area designations: Commercial interests in conservation policy." *Global Environmental Politics* 23 (2): 54–73.

Ashaba, Ivan Mugyenzi, and Esther Marijnen. 2025. "'We are soldiers now': green militarism and (foreign-assisted) military training in conservation." *International Affairs* 101 (2): 565–582.

Ashraf, Nava, Natalie Bau, Nathan Nunn, and Alessandra Voena. 2020. "Bride price and female education." *Journal of Political Economy* 128 (2): 591–641.

Bazzi, Samuel, and Christopher Blattman. 2014. "Economic shocks and conflict: Evidence from commodity prices." *American Economic Journal: Macroeconomics* 6 (4): 1–38.

Berman, Nicolas, Mathieu Couttenier, Dominic Rohner, and Mathias Thoenig. 2017. "This mine is mine! How minerals fuel conflicts in Africa." *American Economic Review* 107 (6): 1564–1610.

Blattman, Christopher. 2023. *Why we fight: The roots of war and the paths to peace.* Penguin.

Blomley, Tom, Agrippinah Namara, Alastair McNeilage, Phil Franks, Helga Rainer, Andrew Donaldson, Rob Malpas, William Olupot, J Baker, C Sandbrook, et al. 2010. "Development AND gorillas." *Assessing fifteen years of integrated conservation and deveopment in south-western Uganda. IIED, London.*

Bluwstein, Jevgeniy, and Jens Friis Lund. 2018. "Territoriality by conservation in the Selous–Niassa Corridor in Tanzania." *World Development* 101:453–465.

Brockington, Dan. 2002. *Fortress conservation: the preservation of the Mkomazi Game Reserve, Tanzania.* Indiana University Press.

Burgess, Robin, Matthew Hansen, Benjamin A Olken, Peter Potapov, and Stefanie Sieber. 2012. "The political economy of deforestation in the tropics." *The Quarterly journal of economics* 127 (4): 1707–1754.

Burgess, Robin, Edward Miguel, and Charlotte Stanton. 2015. "War and deforestation in Sierra Leone." *Environmental Research Letters* 10 (9): 095014.

Callaway, Brantly, and Pedro HC Sant'Anna. 2021. "Difference-in-differences with multiple time periods." *Journal of econometrics* 225 (2): 200–230.

Chen, Minhao, Lin William Cong, Haoyu Gao, Andrew Karolyi, and Hui Wang. 2026. *The Scientific Return of Biodiversity Conservation: Evidence from Fishing Bans Along the Yangtze River.* Technical report. National Bureau of Economic Research.

Chhatre, Ashwini, Shikha Lakhanpal, Anne M Larson, Fred Nelson, Hemant Ojha, and Jagdeesh Rao. 2012. "Social safeguards and co-benefits in REDD+: a review of the adjacent possible." *Current Opinion in Environmental Sustainability* 4 (6): 654–660.

Clark, J Alan, and Robert M May. 2002. "Taxonomic bias in conservation research." *Science* 297 (5579): 191–192.

Clements, Hayley S, Reinette Biggs, Alta De Vos, Emmanuel Do Linh San, Gareth P Hempson, Birthe Linden, Bryan Maritz, Ara Monadjem, Chevonne Reynolds, Frances Siebert, et al. 2025. "A place-based assessment of biodiversity intactness in sub-Saharan Africa." *Nature,* 1–9.

Copernicus Climate Change Service (C3S). 2019. *Land Cover Classification Gridded Maps from 1992 to Present Derived from Satellite Observation.* Accessed: DD-MMM-YYYY. https://doi.org/10.24381/cds.006f2c9a. https://cds.climate.copernicus.eu.

Courchamp, Franck, Ivan Jaric, Céline Albert, Yves Meinard, William J Ripple, and Guillaume Chapron. 2018. "The paradoxical extinction of the most charismatic animals." *PLoS biology* 16 (4): e2003997.

Dasgupta, P. 2021. *The Economics of Biodiversity: The Dasgupta.* London: HM Treasury.

De Chaisemartin, Clément, and Xavier d'Haultfoeuille. 2020. "Two-way fixed effects estimators with heterogeneous treatment effects." *American economic review* 110 (9): 2964–2996.

Denny, Sean, Gabriel Englander, and Patrick Hunnicutt. 2024. "Private management of African protected areas improves wildlife and tourism outcomes but with security concerns in conflict regions." *Proceedings of the National Academy of Sciences* 121 (29): e2401814121.

Dinerstein, Eric, Carly Vynne, Enric Sala, Anup R Joshi, Sanjiv Fernando, Thomas E Lovejoy, Juan Mayorga, David Olson, Gregory P Asner, Jonathan EM Baillie, et al. 2019. "A global deal for nature: Guiding principles, milestones, and targets." *Science advances* 5 (4): eaaw2869.

Dube, Oeindrila, and Juan F Vargas. 2013. "Commodity price shocks and civil conflict: Evidence from Colombia." *Review of Economic studies* 80 (4): 1384–1421.

Duffy, Rosaleen. 2014. "Waging a war to save biodiversity: the rise of militarized conservation." *International Affairs* 90 (4): 819–834.

Duffy, Rosaleen, Francis Massé, Emile Smidt, Esther Marijnen, Bram Büscher, Judith Verweijen, Maano Ramutsindela, Trishant Simlai, Laure Joanny, and Elizabeth Lunstrum. 2019. "Why we must question the militarisation of conservation." *Biological conservation* 232:66–73.

Eck, Kristine. 2012. "In data we trust? A comparison of UCDP GED and ACLED conflict events datasets." *Cooperation and Conflict* 47 (1): 124–141.

Fearon, James D, and David D Laitin. 2003. "Ethnicity, insurgency, and civil war." *American political science review* 97 (1): 75–90.

Ferguson, James. 1994. *Anti-politics machine: Development, depoliticization, and bureaucratic power in Lesotho.* U of Minnesota Press.

Flummerfelt, Robert. 2022. *To purge the forest by force: Organized violence against Batwa in Kahuzi-Biega National Park.* Minority Rights Group.

Frank, Eyal, and Anant Sudarshan. 2024. "The social costs of keystone species collapse: Evidence from the decline of vultures in India." *American Economic Review* 114 (10): 3007–3040.

Frank, Eyal G, and Kimberly Oremus. 2025. *Regulating biological resources: lessons from marine fisheries in the United States.* Technical report. National Bureau of Economic Research.

Frank, Eyal G, Qinyun Wang, Shaoda Wang, Xuebin Wang, and Yang You. 2025. *Campaigning for extinction: Eradication of sparrows and the Great Famine in China.* Technical report. National Bureau of Economic Research.

Goodman-Bacon, Andrew. 2021. "Difference-in-differences with variation in treatment timing." *Journal of econometrics* 225 (2): 254–277.

Grupp, Tristan, Prakash Mishra, Mathias Reynaert, and Arthur A van Benthem. 2023. *An evaluation of protected area policies in the european union.* Technical report. National Bureau of Economic Research.

Harari, Mariaflavia, and Eliana La Ferrara. 2018. "Conflict, climate, and cells: a disaggregated analysis." *Review of Economics and Statistics* 100 (4): 594–608.

Harstad, Bård. 2023. "The conservation multiplier." *Journal of Political Economy* 131 (7): 1731–1771.

Harstad, Bård, and Torben K Mideksa. 2017. "Conservation contracts and political regimes." *The Review of Economic Studies* 84 (4): 1708–1734.

Hochleithner, Stephan. 2017. "Beyond contesting limits: Land, access, and resistance at the Virunga National Park." *Conservation and Society* 15 (1): 100–110.

Huete, Alfredo, Kamel Didan, Tomoaki Miura, E Patricia Rodriguez, Xiang Gao, and Laerte G Ferreira. 2002. "Overview of the radiometric and biophysical performance of the MODIS vegetation indices." *Remote sensing of environment* 83 (1-2): 195–213.

Jayachandran, Seema, Joost De Laat, Eric F Lambin, Charlotte Y Stanton, Robin Audy, and Nancy E Thomas. 2017. "Cash for carbon: A randomized trial of payments for ecosystem services to reduce deforestation." *Science* 357 (6348): 267–273.

Joppa, Lucas N, and Alexander Pfaff. 2009. "High and far: biases in the location of protected areas." *PloS one* 4 (12): e8273.

Kumar, Kundan, and John M Kerr. 2013. "Territorialisation and marginalisation in the forested landscapes of Orissa, India." *Land Use Policy* 30 (1): 885–894.

Larson, Anne M, Maria Brockhaus, William D Sunderlin, Amy Duchelle, Andrea Babon, Therese Dokken, Thu Thuy Pham, Ida Aju Pradnja Resosudarmo, Galia Selaya, Abdon Awono, et al. 2013. "Land tenure and REDD+: The good, the bad and the ugly." *Global environmental change* 23 (3): 678–689.

Le Rossignol, Etienne, Sara Lowes, and Eduardo Montero. 2024. *Fallow lengths and the structure of property rights.* Technical report. National Bureau of Economic Research.

Limodio, Nicola. 2022. "Terrorism financing, recruitment, and attacks." *Econometrica* 90 (4): 1711–1742.

Lowes, Sara, and Eduardo Montero. 2021. "The legacy of colonial medicine in Central Africa." *American Economic Review* 111 (4): 1284–1314.

Mammola, Stefano, Nicoletta Riccardi, Vincent Prié, Ricardo Correia, Pedro Cardoso, Manuel Lopes-Lima, and Ronaldo Sousa. 2020. "Towards a taxonomically unbiased European Union biodiversity strategy for 2030." *Proceedings of the Royal Society B: Biological Sciences* 287 (1940): 20202166.

Marshall, Monty G, and Benjamin R Cole. 2008. "Global report on conflict, governance and state fragility 2008." *Foreign Policy Bulletin* 18 (1): 3–21.

Marshall, Monty G, and Ted Robert Gurr. 2020. "Polity5: Political regime characteristics and transitions, 1800–2018." *Center for Systemic Peace* 2:1–81.

Marshall, Monty G., and Benjamin R. Cole. 2014. *Global Report 2014: Conflict, Governance, and State Fragility.* Technical report.

Massé, Francis, and Jared D Margulies. 2020. "The geopolitical ecology of conservation: The emergence of illegal wildlife trade as national security interest and the re-shaping of US foreign conservation assistance." *World Development* 132:104958.

McGuirk, Eoin, and Marshall Burke. 2020. "The economic origins of conflict in Africa." *Journal of Political Economy* 128 (10): 3940–3997.

McGuirk, Eoin F, and Nathan Nunn. 2024. *Development mismatch? evidence from agricultural projects in pastoral africa.* Technical report. National Bureau of Economic Research.

———. 2025. "Transhumant pastoralism, climate change, and conflict in Africa." *Review of Economic Studies* 92 (1): 404–441.

Michalopoulos, Stelios, and Elias Papaioannou. 2016. "The long-run effects of the scramble for Africa." *American Economic Review* 106 (7): 1802–1848.

Moscona, Jacob, and Karthik A Sastry. 2025. *Inappropriate technology: Evidence from global agriculture.* Technical report. National Bureau of Economic Research.

Mueller, Hannes, Dominic Rohner, and David Schönholzer. 2022. "Ethnic violence across space." *The Economic Journal* 132 (642): 709–740.

Murdock, George Peter. 1967. "Ethnographic atlas: a summary." *Ethnology* 6 (2): 109–236.

Nakhmurina, Anya, Dale T Manning, and Eli P Fenichel. 2026. "The fiscal impact of biodiversity loss and a pathway for conservation finance." *Science* 391 (6790): 1110–1113.

Neumann, Roderick P. 1998. *Imposing wilderness: struggles over livelihood and nature preservation in Africa.* Vol. 4. Univ of California Press.

Nguyen, Can Trong, Davina Vačkářová, and Jan Weinzettel. 2025. "Consistent global dataset on biodiversity intactness footprint of agricultural production from 2000 to 2020." *Scientific Data* 12 (1): 1613.

Nieminen, Giovanna Sanchez, and Essi Laitinen. 2025. "Understanding local opposition to renewable energy projects in the Nordic countries: A systematic literature review." *Energy Research & Social Science* 122:103995.

OECD and Sahel and West Africa Club. 2022. *Borders and Conflicts in North and West Africa.* West African Studies. Paris: OECD Publishing. https://doi.org/10.1787/6da6d21e-en. https://doi.org/10.1787/6da6d21e-en.

Oldham, Paul, Stephen Hall, and Oscar Forero. 2013. "Biological diversity in the patent system." *PloS one* 8 (11): e78737.

Pincus, Guy. 2025. "Wildlife and Conflict: The Cost of Protecting Biodiversity."

Radil, Steven M, Nick Dorward, Olivier Walther, and Levi John Wolf. 2026. "Mapping the long-term trajectories of political violence in Africa." *arXiv preprint arXiv:2603.06502.*

Raleigh, Clionadh, and Caitriona Dowd. 2015. "Armed conflict location and event data project (ACLED) codebook." *Find this resource,* 651–660.

Ribar, Matthew K. 2026. "Land, power, and property rights: The political economy of land titling in sub-Saharan Africa." *American Political Science Review* 120 (2): 399–418.

Richard, Marion, and Oliver Vanden Eynde. 2026. "Cooperation between national armies: Evidence from the Sahel borders." *Journal of Development Economics,* 103726.

Robalino, Juan, and Alexander Pfaff. 2013. "Ecopayments and deforestation in Costa Rica: A nationwide analysis of PSA's initial years." *Land Economics* 89 (3): 432–448.

Sampaio, Antônio, Aziz Mossi, Eleanor Beevor, and Emmanuel N Sambieni. 2023. "Reserve assets: Armed groups and conflict economies in the national parks of Burkina Faso, Niger and Benin." *Global Initiative Against Transnational Organized Crime.*

Shipton, Parker. 2009. *Mortgaging the Ancestors: ideologies of attachment in Africa.* Yale University Press.

Simpson, Fergus O'Leary, and Sara Geenen. 2023. "Batwa return to their Eden? Intricacies of violence and resistance in eastern DRCongo's Kahuzi-Biega National Park." *The Journal of Peasant Studies* 50 (3): 1106–1124.

Simpson, Fergus O'Leary, and Lorenzo Pellegrini. 2023. "Agency and Structure in Militarized Conservation and Armed Mobilization: Evidence from Eastern DRC's Kahuzi-Biega National Park." *Development and Change* 54 (3): 601–640.

Stokes, Leah C, Emma Franzblau, Jessica R Lovering, and Chris Miljanich. 2023. "Prevalence and predictors of wind energy opposition in North America." *Proceedings of the National Academy of Sciences* 120 (40): e2302313120.

Sun, Liyang, and Sarah Abraham. 2021. "Estimating dynamic treatment effects in event studies with heterogeneous treatment effects." *Journal of econometrics* 225 (2): 175–199.

Tang, Hui, Yongde Zhong, Jinyang Deng, Hongling Xia, and Juan Wei. 2025. "Global nighttime light dataset from 1992 to 2022 with focus on low-light areas." *Scientific Data* 12 (1): 982.

Troudet, Julien, Philippe Grandcolas, Amandine Blin, Régine Vignes-Lebbe, and Frédéric Legendre. 2017. "Taxonomic bias in biodiversity data and societal preferences." *Scientific reports* 7 (1): 9132.

Vandergeest, Peter, and Nancy Lee Peluso. 1995. "Territorialization and state power in Thailand." *Theory and society,* 385–426.

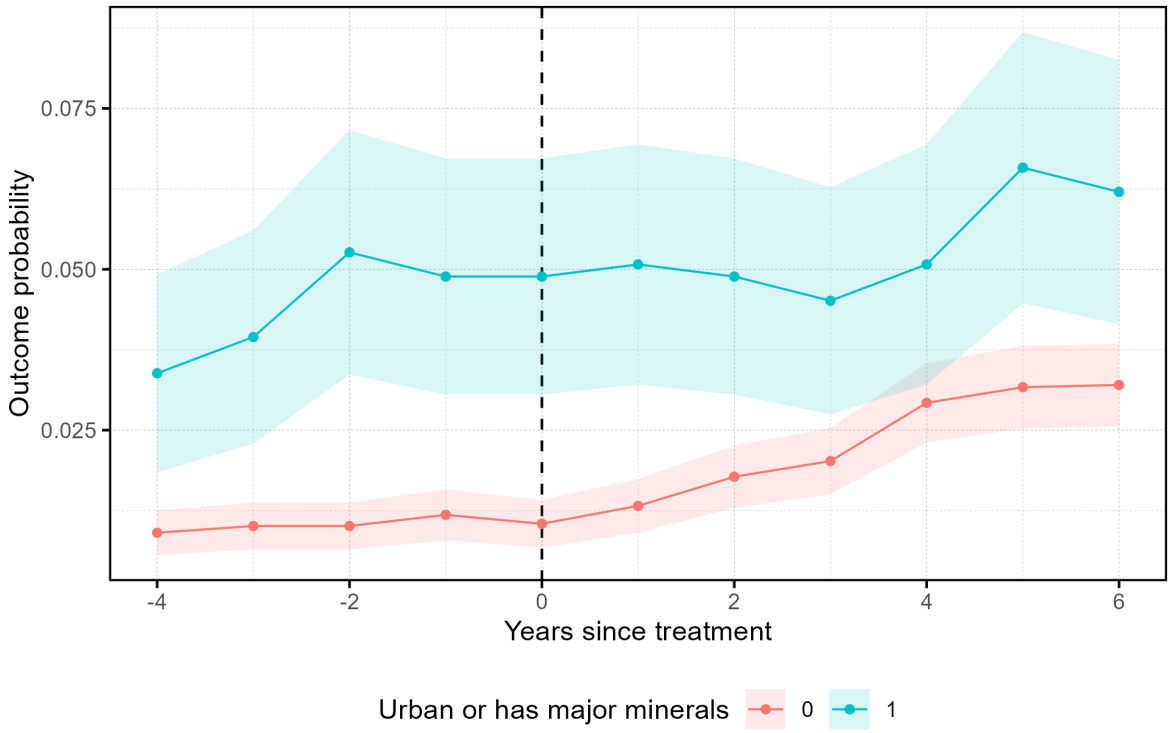
Vendryes, Thomas. 2014. "Peasants against private property rights: A review of the literature." *Journal of Economic Surveys* 28 (5): 971–995.

Verweijen, Judith, and Esther Marijnen. 2018. "The counterinsurgency/conservation nexus: guerrilla livelihoods and the dynamics of conflict and violence in the Virunga National Park, Democratic Republic of the Congo." *The Journal of Peasant Studies* 45 (2): 300–320.

Walter, Barbara F. 2009. "Bargaining failures and civil war." *Annual review of political science* 12 (1): 243–261.

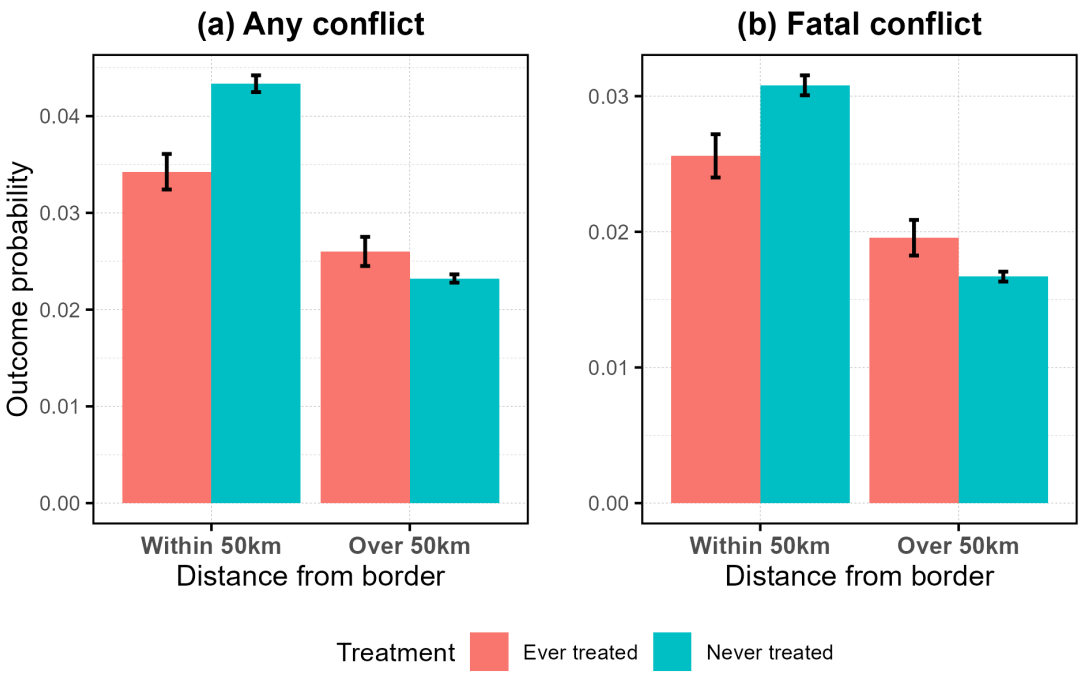
A Additional Results

Figure A1: Raw means of violence by confounding factors



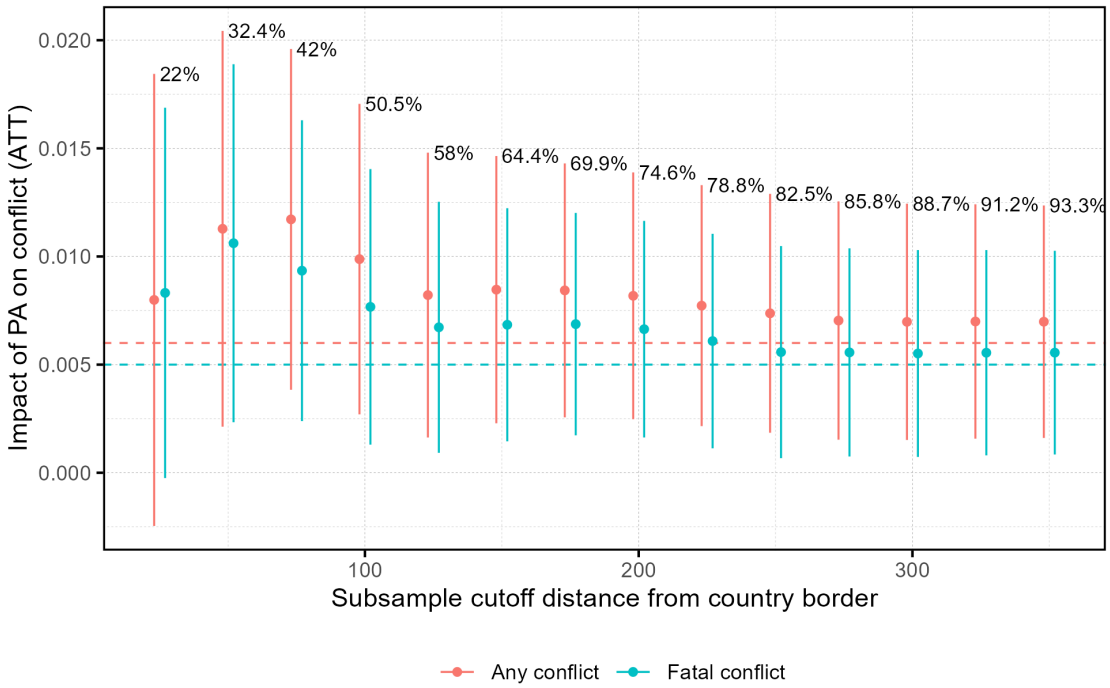
Notes: This figure reports raw means of conflict probability separately for urban grid cells or grid cells with major minerals and rest of the grid cells. The unit of observation is $0.25° \times 0.25°$ grid cell.

Figure A2: Raw conflict probability by distance from border



Notes: This figure shows raw means of binary conflict in incidence by borderland (within 50 km) and interior (over 50 km) status and within and outside protected areas. Ever treated group include grid cells that receive a protected areas during the sample period.

Figure A3: Effect of PA designation on conflict by distance from border



Notes: This figure shows how estimates equation 1 changes when sample is restricted within various distance from international border. Percentage at the top of each error bar represents the fraction of full sample used in the estimation. The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables take a value of 1, when there is at least one event in a grid cell in a given year and 0 otherwise. Fatal conflict, refers to conflict events with at least one fatality. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clusters at the level of $1° \times 1°$ grid cells.

Table A1: Impact of PA designation on conflict by split ethnicity status

	Any conflict		Fatal conflict	
	(1)	(2)	(3)	(4)
PA Designation	0.008**	-0.001	0.006*	-0.001
	(0.004)	(0.004)	(0.003)	(0.004)
Pretreatment baseline	0.010	0.015	0.006	0.011
Observations	464,072	305,816	464,072	305,816
Adj. R^2	0.3565	0.3052	0.3153	0.2700
NCluster	1,728	1,353	1,728	1,353
Subsample	Split Ethnicity	Not Split Ethnicity	Split Ethnicity	Not Split Ethnicity

Notes: This table reports effect of PA designation on conflict estimated from equation 1 (Sun and Abraham 2021) and aggregated over 0 to 7 years. Columns (1) and (3) show results for gridcells that lie within split ethnic homelands and columns (2) and (4) for gridcells that lie within ethnic homelands that are not split by country border. The unit of observation is $0.25^\circ \times 0.25^\circ$ grid cell. Dependent variables are binary indicators of conflict events in a grid cell-year. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clustered at the level of $1^\circ \times 1^\circ$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

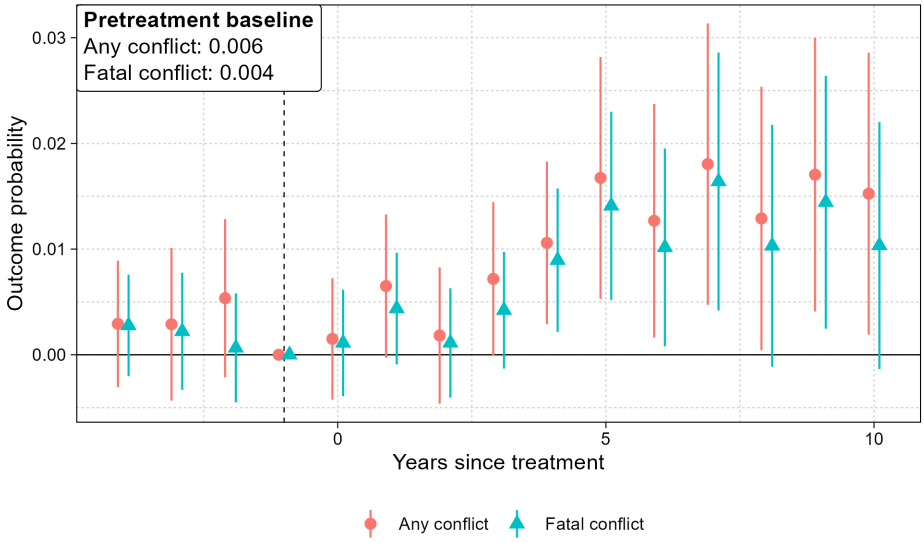
Table A2: Heterogeneity in impact of PAs on conflict by State Fragility

	Any conflict		Fatal conflict	
	(1)	(2)	(3)	(4)
PA Designation	0.002	0.014***	0.000	0.014***
	(0.004)	(0.005)	(0.003)	(0.005)
× SFI <= Q1	0.005	-0.017**	0.005	-0.016**
	(0.006)	(0.007)	(0.005)	(0.007)
Pretreatment baseline	0.000	0.006	0.000	0.003
Observations	512,064	242,340	512,064	242,340
Adj. R^2	0.309	0.344	0.269	0.306
NCluster	1,859	1,268	1,859	1,268
Subsample	Over 50km	Within 50km	Over 50km	Within 50km

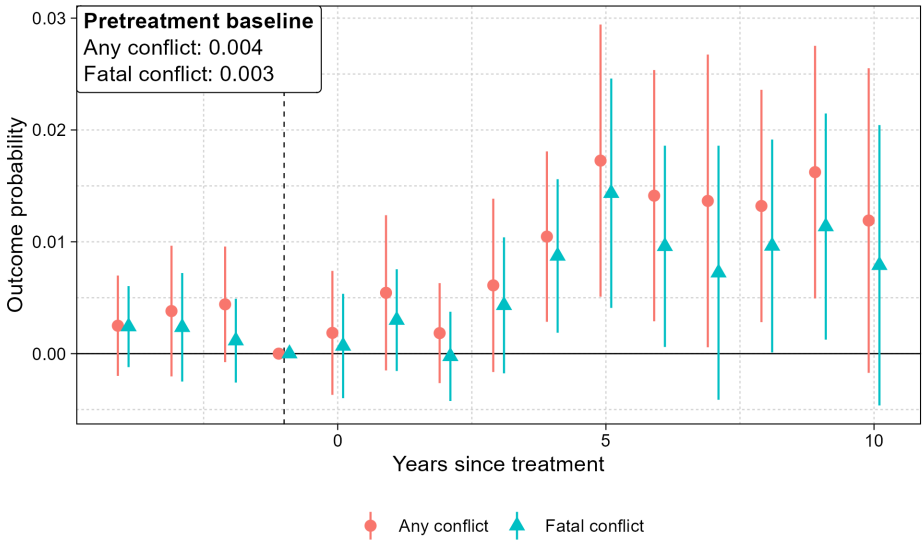
Notes: This table reports heterogeneous effect of PA designation by State Fragility Index. Effects are estimated using equation 3 (Sun and Abraham 2021). The results are aggregated over 0 to 7 years. Columns (1) and (3) show results for sample within 50km of international border. Columns (2) and (4) show results for sample more than 50km away from the international border.. The unit of observation is $0.25^\circ \times 0.25^\circ$ grid cell and dependent variables are binary indicator of conflict. Each regression include grid, country-by-year, and eco-regions-by-year fixed effect. Standard errors are clustered at the level of $1^\circ \times 1^\circ$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A4: Impact of PA on Battles and Explosions

(a) State = 1



(b) Rebel groups = 1



Notes: This figure reports the event study estimates from equation 1 as proposed by Sun and Abraham (2021). The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables take a value of 1, when there is at least one event in a grid cell in a given year and 0 otherwise. Fatal conflict refers to any conflict event with at least one death. Pretreatment baselines are reported on the top-left corner of each plot. **Panel (a)** shows results for battles and explosions where one of the belligerent actors is state and **panel (b)** refers to battles and explosions where one of the belligerent actors is a rebel group. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clusters at the level of $1° \times 1°$ grid cells.

Table A3: Heterogeneity in impact of PAs on conflict by PA type

	Any conflict		Fatal conflict	
	(1)	(2)	(3)	(4)
PA Designation	0.028***	0.020***	0.023***	0.018**
	(0.009)	(0.007)	(0.008)	(0.008)
× Major safari species	-0.031***		-0.023**	
	(0.012)		(0.010)	
× N safari species		-0.008**		-0.006*
		(0.003)		(0.004)
Pretreatment baseline	0.012	0.012	0.008	0.008
Observations	249,732	249,732	249,732	249,732
Adj. R^2	0.348	0.348	0.310	0.310
NCluster	1,286	1,286	1,286	1,286

Notes: This table reports heterogeneous effect of PA designation by PA type. Effects are estimated using equation 3 (Sun and Abraham 2021). The results are aggregated over 0 to 7 years. The unit of observation is $0.25° \times 0.25°$ grid cell and dependent variables are binary indicator of conflict. Each regression include grid, country-by-year, and eco-regions-by-year fixed effect. Standard errors are clustered at the level of $1° \times 1°$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A4: Heterogeneity in impact of PAs on conflict by PA type

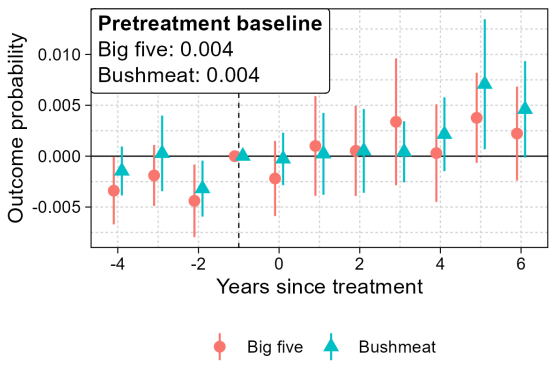
	Any conflict		Fatal conflict	
	(1)	(2)	(3)	(4)
PA Designation	0.014*	0.006	0.007	-0.001
	(0.007)	(0.006)	(0.005)	(0.005)
× Major safari species	-0.020*		-0.011	
	(0.011)		(0.008)	
× N safari species		-0.004		0.001
		(0.004)		(0.003)
Pretreatment baseline	0.011	0.017	0.008	0.014
Observations	520,324	520,324	520,324	520,324
Adj. R^2	0.324	0.323	0.285	0.285
NCluster	1,900	1,900	1,900	1,900

Notes: This table reports heterogeneous effect of PA designation by PA type. Effects are estimated using equation 3 (Sun and Abraham 2021). The results are aggregated over 0 to 7 years. The unit of observation is $0.25^\circ \times 0.25^\circ$ grid cell and dependent variables are binary indicator of conflict. Each regression include grid, country-by-year, and eco-regions-by-year fixed effect. Standard errors are clustered at the level of $1^\circ \times 1^\circ$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

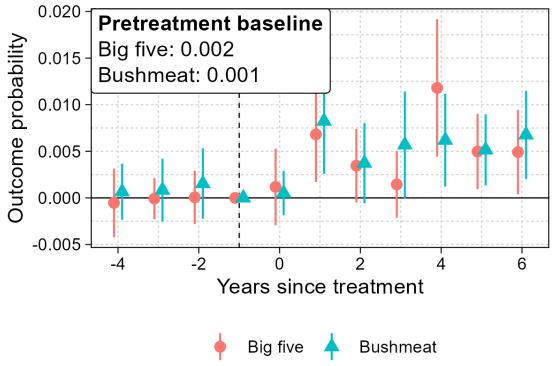
B Results for Species Occurrence Data

Figure B5: Effect of PA designation on biodiversity occurrence, separately by distance from border

(a) Within 50km of country border



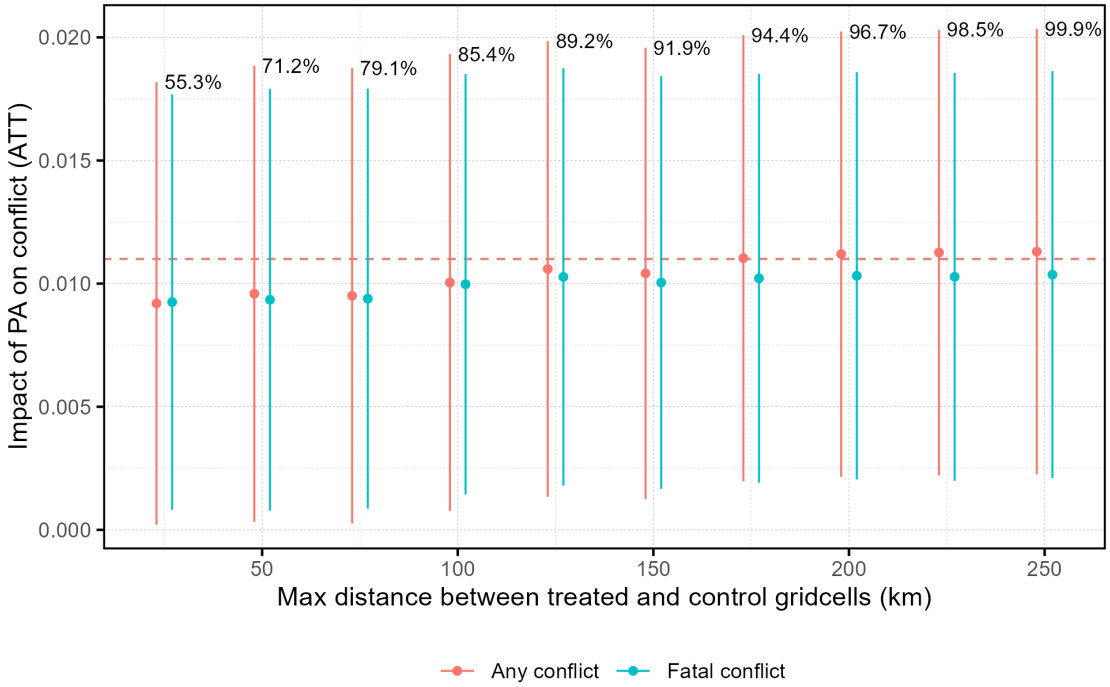
(b) Over 50km of country border



Notes: This figure reports the event study estimates from equation 1 as proposed by Sun and Abraham (2021). The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables take a value of 1, when there is at least one event in a grid cell in a given year and 0 otherwise. 'is_fatality', refers to a conflict event with at least one fatality. Pretreatment baselines are reported on the top-left corner of each plot. 'is_event' refers to all conflict events and 'is_fatality', refers to conflicts with at least one fatality. **Panel (a)** shows results for grid cells within 50km of country's border and **panel (b)**, for grid cells over 50km. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clusters at the level of $1° \times 1°$ grid cells, which contain 16 units of observation.

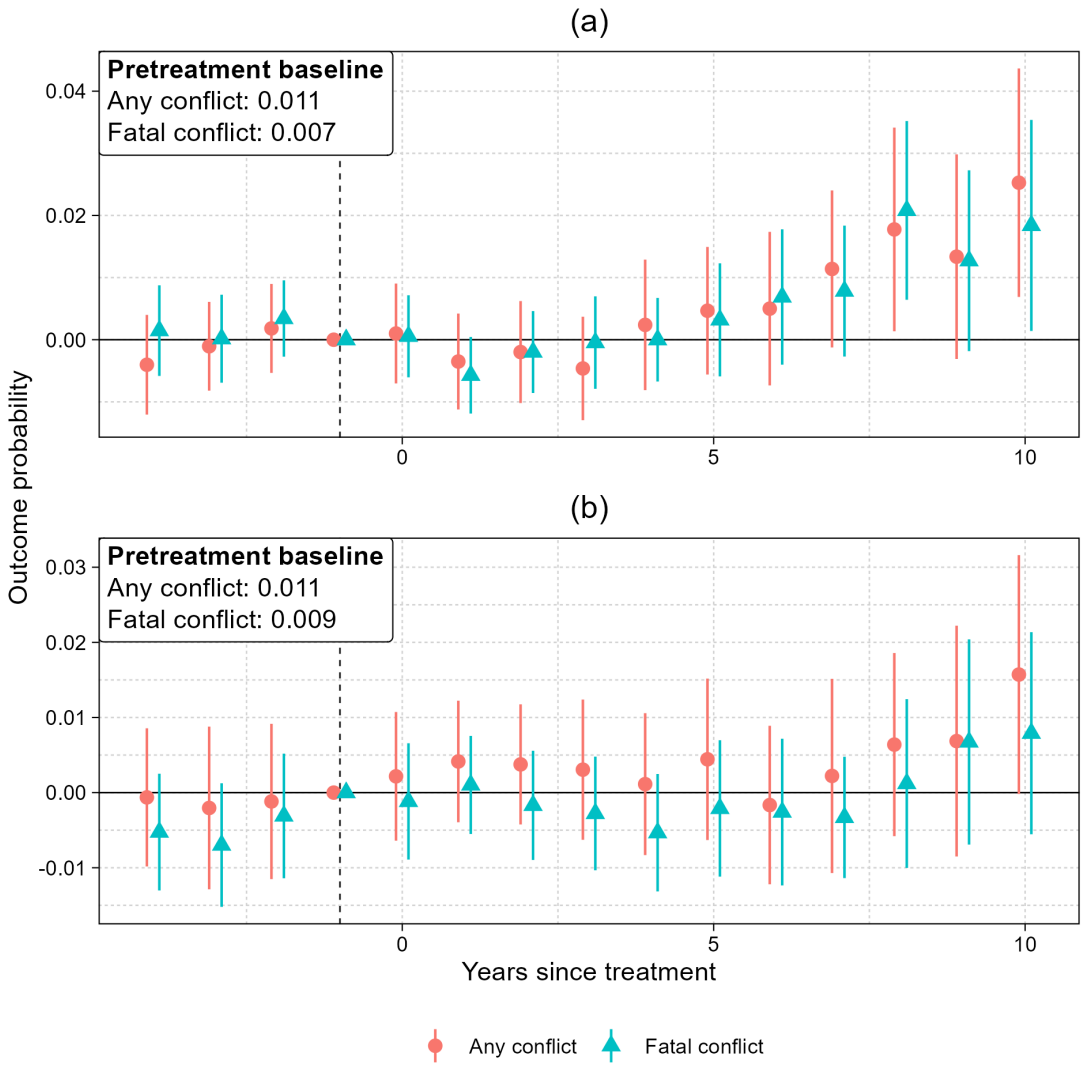
C Robustness and Sensitivity Checks

Figure C6: Effect of PA designation on conflict by restricted control sample



Notes: This figure shows how estimates equation 1 changes when control group is restricted to be within a certain distance of treated group. Percentage at the top of each error bar represents the fraction of total data used when restricting the control group to a given distance of treated group. The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables take a value of 1, when there is at least one event in a grid cell in a given year and 0 otherwise. Fatal conflict, refers to conflict events with at least one fatality. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clusters at the level of $1° \times 1°$ grid cells.

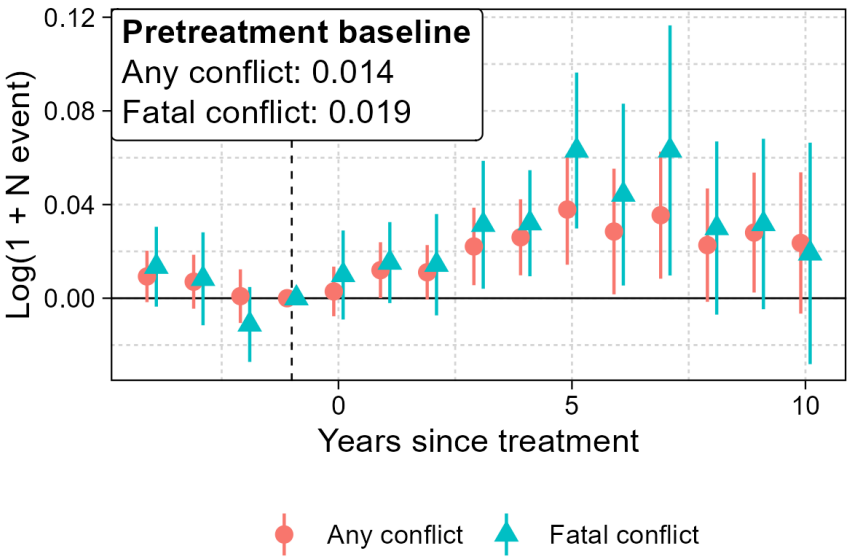
Figure C7: Anticipation Test



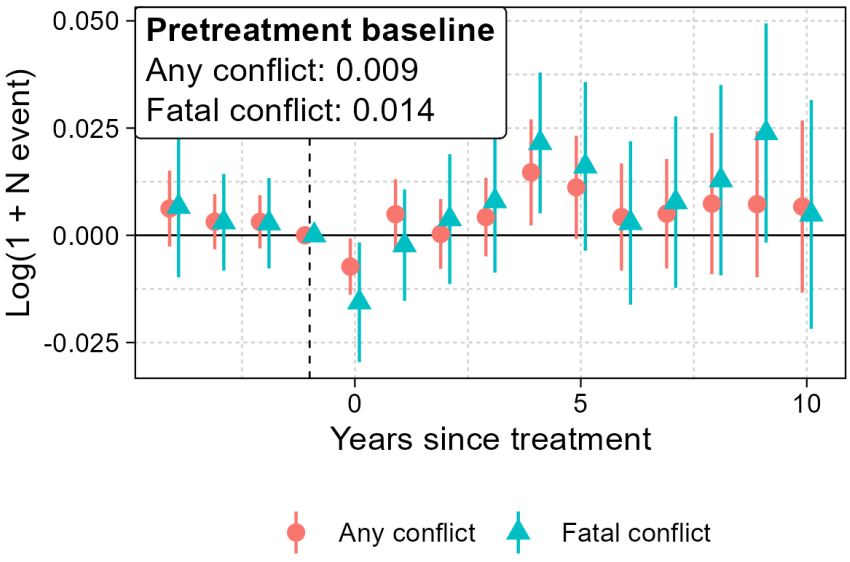
Notes: This figure shows anticipation tests using equation 1. Panel (a) shows results when treatment date is artificially shifted by 3 periods and panel (b) by 6 periods. The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables take a value of 1, when there is at least one event in a grid cell in a given year and 0 otherwise. Fatal conflict, refers to conflict events with at least one fatality. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clusters at the level of $1° \times 1°$ grid cells.

Figure C8: Effect of PA designation on conflict events, Log (1 + N event)

(a) Within 50km of country border



(b) Over 50km of country border



Notes: This figure reports the event study estimates using OLS instead of Sun and Abraham (2021). The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables are defined as Log(1 + N event). Pretreatment baselines are reported on the top-left corner of each plot. 'Any conflict' refers to all conflict events and 'Fatal conflict', refers to conflicts with at least one fatality. **Panel (a)** shows results for grid cells within 50km of country's border and **panel (b)**, for grid cells over 50km. Each regression include grid, country-by-year, and eco-regions-by-year fixed effects. Standard errors are clustered at the level of $1° \times 1°$ grid cells.

Table C5: Impact of PA designation on conflict (OLS)

	Any conflict		Fatal conflict	
	(1)	(2)	(3)	(4)
PA Designation	0.011**	0.003	0.010**	0.001
	(0.005)	(0.003)	(0.005)	(0.002)
Pretreatment baseline	0.015	0.009	0.009	0.007
Observations	249,732	520,324	249,732	520,324
Adj. R^2	0.3467	0.3227	0.3085	0.2837
NCluster	1,286	1,900	1,286	1,900
Subsample	Within 50km	Over 50km	Within 50km	Over 50km

Notes: This table reports effect of PA designation on conflict estimated using OLS method (Sun and Abraham 2021) and aggregated over 0 to 7 years. Columns (1) and (3) show results for gridcells with one edge within 50 km of country border and columns (2) and (4) for gridcells that are more than 50km away from the border. The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables are binary indicators of conflict events in a grid cell-year. Standard errors are clustered at the level of $1° \times 1°$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C6: Impact of PA designation on conflict (Conley Standard Errors)

	Any conflict		Fatal conflict	
	(1)	(2)	(3)	(4)
PA Designation	0.011**	0.011**	0.011**	0.011**
	(0.005)	(0.006)	(0.004)	(0.005)
Pretreatment baseline	0.015	0.015	0.009	0.009
Observations	249,732	249,732	249,732	249,732
Adj. R^2	0.3470	0.3470	0.3089	0.3089
Conley SE cutoff	100 km	200 km	100 km	200 km

Notes: This table reports effect of PA designation on conflict estimated from modified version of equation 1 (Sun and Abraham 2021) and aggregated over 0 to 7 years. Unlike equation 1 which cluster standard errors at $1° \times 1°$ grid cells, the results show Conley standard errors with 100 km and 200 km cutoff respectively. The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables are binary indicators of conflict events in a grid cell-year. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C7: Impact of PA designation on conflict by distance from country border

	Any conflict		Fatal conflict	
	(1)	(2)	(3)	(4)
PA Designation	0.009*	0.001	0.009**	0.000
	(0.005)	(0.003)	(0.004)	(0.002)
Pretreatment baseline	0.015	0.009	0.009	0.007
Observations	249,900	520,464	249,900	520,464
Adj. R^2	0.3241	0.3016	0.2867	0.2647
NCluster	1,287	1,901	1,287	1,901
Subsample	Within 50km	Over 50km	Within 50km	Over 50km

Notes: This table reports effect of PA designation on conflict estimated from a modified version of equation 1 (Sun and Abraham 2021) and aggregated over 0 to 7 years. Columns (1) and (3) show results for gridcells with one edge within 50 km of country border and columns (2) and (4) for gridcells that are more than 50km away from the border. The unit of observation is $0.25^\circ \times 0.25^\circ$ grid cell. Dependent variables are binary indicators of conflict events in a grid cell-year. Each regression include grid and country-by-year fixed effects. Standard errors are clustered at the level of $1^\circ \times 1^\circ$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C8: Impact of PA designation on conflict by distance from country border (UCDP)

	Any conflict		Fatal conflict	
	(1)	(2)	(3)	(4)
PA Designation	0.008**	-0.003	0.009**	-0.003
	(0.004)	(0.002)	(0.003)	(0.002)
Pretreatment baseline	0.005	0.008	0.004	0.007
Observations	249,732	520,324	249,732	520,324
Adj. R^2	0.2614	0.2162	0.2506	0.2034
NCluster	1,286	1,900	1,286	1,900
Subsample	Within 50km	Over 50km	Within 50km	Over 50km

Notes: This table reports effect of PA designation on conflict estimated from equation 1 (Sun and Abraham 2021) and aggregated over 0 to 7 years. Columns (1) and (3) show results for gridcells with one edge within 50 km of country border and columns (2) and (4) for gridcells that are more than 50km away from the border. The unit of observation is $0.25^\circ \times 0.25^\circ$ grid cell. Dependent variables are binary indicators of conflict events in a grid cell-year. Standard errors are clustered at the level of $1^\circ \times 1^\circ$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C9: Impact of PA designation on conflict (full sample)

	Any conflict		Fatal conflict	
	(1)	(2)	(3)	(4)
PA Designation	0.010**	0.005*	0.008**	0.002
	(0.004)	(0.003)	(0.004)	(0.002)
Pretreatment baseline	0.021	0.010	0.013	0.007
Observations	295,764	578,844	295,764	578,844
Adj. R^2	0.3619	0.3306	0.3271	0.2875
NCluster	1,398	2,012	1,398	2,012
Subsample	Within 50km	Over 50km	Within 50km	Over 50km

Notes: This table reports effect of PA designation on conflict estimated using OLS method (Sun and Abraham 2021) and aggregated over 0 to 7 years. Columns (1) and (3) show results for gridcells with one edge within 50 km of country border and columns (2) and (4) for gridcells that are more than 50km away from the border. The unit of observation is $0.25° \times 0.25°$ grid cell. Dependent variables are binary indicators of conflict events in a grid cell-year. Standard errors are clustered at the level of $1° \times 1°$ grid cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.