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Peace treaties' environmental provisions and conflict recurrence

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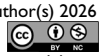

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Abstract

A fundamental idea in the environmental peacebuilding literature is that environmental cooperation can serve as a catalyst for broader collaboration and, in turn, reduce the risk of renewed conflict. While this claim has long been asserted, only a few empirical studies have examined it in cross-country and comparative analyses. This article adds to these works by providing a comprehensive quantitative analysis of conflict recurrence data and provisions for environmental cooperation in over 1,000 peace treaties since the end of the Cold War. The central finding is that environmental clauses in such agreements are associated with a significantly lower risk of conflict recurrence. This result not only provides systematic empirical evidence supporting the environmental peacebuilding thesis but also demonstrates that environmental cooperation is not merely a symbolic gesture. Rather, it plays a vital, substantive role in establishing sustainable post-conflict stability and durable resolution.

Keywords

environmental peacebuilding, environmental clauses, peace agreements, conflict recurrence, quantitative methods

1. Introduction

Environmental peacebuilding[1] refers to "all forms of cooperation on environmental issues between distinct social groups, which aim at and/or achieve creating less violent and more peaceful relations between these groups" (Ide, 2019, p. 329). A central claim in this literature thus posits that cooperation on environmental issues can foster broader political and social collaboration, thereby reducing the risk of conflict recurrence and directly contributing to

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sustained post-conflict peace (Balinskaia, 2025; Buhaug & von Uexkull, 2025; Dresse et al., 2019; Ide, 2018, 2019; Ide & Detges, 2018; Ide et al., 2021, 2023; Johnson et al., 2021; Kedem et al., 2024; Krampe et al., 2021; Sändig et al., 2024; Sommer & Fassbender, 2024).

Numerous studies explore environmental peacebuilding and its effectiveness, the latter being seen as environmental cooperation contributing "to the relationship between […] groups becoming more peaceful" (Ide, 2019, p. 329). However, empirical evidence supporting this core proposition, that is, that environmental cooperation lowers the likelihood of renewed conflict, is dispersed. Although existing research is rich in qualitative case studies, which offer valuable insights into underlying mechanisms, their limited generalizability means broader patterns remain to be systematically examined. A few notable comparative analyses of environmental peacebuilding nonetheless do exist. Ide (2018) offers a cross-country study, which concentrates on qualitative comparative analysis and six cases. And Ide and Detges (2018) quantitatively assess how international water cooperation affects transitions toward more peaceful interstate relations. The following research adds to this cross-country, comparative literature on environmental peacebuilding when presenting a comprehensive, large-*N* analysis of the impact of environmental provisions in peace agreements as derived from the Peace Agreements Database (PA-X; Bell & Badanjak, 2019) on the risk of conflict recurrence (see Kreutz, 2010; Quinn et al., 2007; Toft, 2010; Walter, 2014), using a robust empirical strategy (mainly, recursive bivariate probit models, see Coban, 2022).

Conflict recurrence is a main problem the environmental peacebuilding thesis seeks to address. Existing research on relapsed fighting suggests that disputes are likely to resume when at least one former belligerent perceives a new conflict to be more beneficial than sustained peace (D'Amico et al., 2025; Haer & Böhmelt, 2016; Hegre & Nygård, 2015; Kreutz, 2010; Mason et al., 2011; Rustad & Binningsbø, 2012; Toft, 2010; Walter, 2014). Building on accounts that stress willingness and opportunity, Walter (2014) highlights the crucial role of political and legal institutions in constraining elite behavior in post-conflict societies. Peace agreements are instrumental in fostering these constraints, often serving as "foundational, quasi-constitutional frameworks" (Bell & O'Rourke, 2007, p. 293) in post-conflict settings. Such treaties establish a legal framework after disputes have ceased (Reid, 2021; Werner & Yuen, 2005), aiming to address the root causes of violence and to ensure stability, security, and reconciliation (Harbom et al., 2006).

Peace agreements can incorporate environmental provisions, as seen in, for example, the 2006 Darfur Peace Agreement (De Juan, 2015) or the 2005 Aceh Peace Treaty (Green, 2013). While these environmental clauses often remain abstract and outline rather broad goals, as is common in international law (Epple, 2025), they are typically legally binding, and their successful implementation is directly tied to environmental cooperative success. For instance, the 2016 Colombian Peace Agreement (see Salazar et al., 2021) mandates in Section 1.3.1.2 that the National Government establishes a National Irrigation and Drainage Plan that accounts for "[p]reparatory measures to mitigate the risks of climate change." The inclusion of such clauses is therefore not costless: as Bakaki et al. (2025) argue, environmental provisions are only incorporated when their perceived benefits clearly outweigh potential costs. Despite their growing presence and legal weight, however, we know relatively little about the practical impact of these environmental terms in peace agreements on post-conflict stability.

Focusing on conflict recurrence, peace agreements, and environmental provisions as empirical manifestations of environmental cooperation,[2] this study empirically tests the central proposition of the environmental peacebuilding literature (Ide, 2018, 2019; Ide & Detges, 2018; Johnson et al., 2021; Kedem et al., 2024; Krampe et al., 2021; Sändig et al.,

2024; Sommer & Fassbender, 2024). We combine the PA-X (Bell & Badanjak, 2019) with Kreutz's (2010) conflict recurrence data, creating a dataset of more than 1,000 post-Cold War peace treaties and associated instances of resumed fighting. The analysis employs two-way fixed effects models, random effects regressions, and recursive bivariate probit models (Coban, 2022). We add to these approaches a newly developed counterfactual estimation for causal inference (Liu et al., 2024). Our focus lies on recursive bivariate probit models, which directly address the endogeneity inherent in the inclusion of environmental provisions within agreements. The main findings discussed below, supported by additional analyses in the Supporting Information (SI), demonstrate that a lower risk of conflict recurrence is significantly associated with the inclusion of environmental provisions in peace agreements.

This article makes two central contributions to the literature. First, we present another systematic, large-*N* empirical test of a central claim in the environmental peacebuilding literature. This addresses an empirical gap as few such comparative analyses exist—in essence, Ide (2018) and Ide and Detges (2018) are the only exceptions we are aware of. Specifically, we seek to add to this literature by using the PA-X information combined with conflict recurrence data and the recursive bivariate probit models. Second, we seek to contribute to the growing body of literature on the indirect effects and positive externalities of conflict resolution (Bakaki & Böhmelt, 2021; Böhmelt, 2024; Bove et al., 2022; Di Salvatore, 2019). By tracing a specific pathway from environmental provisions, that is, an area often considered less directly related to the root causes of political violence, to conflict recurrence, this study advances the field and offers new insights into the wider benefits of comprehensive peace processes (see also Badran, 2014; Joshi & Quinn, 2015).

2. Environmental provisions in peace agreements and conflict recurrence

According to the literature, violent conflict can reignite old grievances or generate new ones, thereby increasing actors' willingness to take up arms again (Bara et al., 2021; D'Amico et al., 2025; Haer & Böhmelt, 2016; Themnér, 2011; Walter, 2014). Quinn et al. (2007) argue that former combatants may become dissatisfied with the terms of a peace agreement or with the functioning of post-conflict dispute resolution institutions (see also Hegre & Nygård, 2015; Toft, 2010; Walter, 2014). Similarly, dissatisfaction with the distribution of resources or inadequate reintegration assistance can motivate belligerents to abandon peace (see Spear, 1999; Walter, 2004). Rustad and Binningsbø (2012) emphasize the role of natural resources in facilitating renewed violence, whereas Toft (2010) suggests that decisive military victories reduce the likelihood of conflict recurrence. In a recent review article, Bara et al. (2021) identify three main clusters driving the recurrence of armed conflict. First, the intensity of the previous conflict correlates positively with the risk of renewed fighting. Second, the capacity to mobilize violence, for example, through access to weapons or networks of former combatants, heightens the probability of recurrence. Finally, as highlighted in Walter (2014) or Hegre and Nygård (2015), poor governance, such as weak political institutions or undemocratic policymaking, can incentivize actors to return to arms.

Before conflict can recur, and following the cessation of prior hostilities, peace agreements are typically negotiated and implemented (DeMeritt et al., 2014; Joshi & Quinn, 2015; Reid, 2021; Werner & Yuen, 2005). Since the end of the Cold War, such treaties have evolved beyond instruments designed merely to end violence (Badran, 2014). They now function as central mechanisms for building long-term, positive peace as they shape the institutional,

behavioral, and legal foundations of post-conflict states. Peace treaties often acquire a "quasi-constitutional status" (Bell & O'Rourke, 2007, p. 293; see also Badran, 2014) and serve as "road maps" for the development of future institutions, norms, and governance practices (Reid, 2021, p. 1,226). In this capacity, they not only impose legal constraints through binding provisions (see Bell, 2018), but also generate incentives for leaders and policymakers (see Bueno de Mesquita et al., 2005) to pursue and sustain peaceful outcomes. The breadth and comprehensiveness of a peace agreement strongly influence its effectiveness and the durability of peace (Joshi & Quinn, 2015): treaties that leave key issues unresolved are more likely to result in renewed violence.

In this context, the inclusion of environmental provisions can be beneficial—and, if implemented effectively (Jarstad & Nilsson, 2018; Joshi et al., 2017; Joshi & Quinn, 2015, 2017), such environmental clauses could contribute not only to better ecological outcomes, but also to long-term peace and stability. This makes environmental goals in peace agreements an empirical manifestation of environmental cooperation as understood by the environmental peacebuilding literature (see Balinskaia, 2025; Johnson et al., 2021; Krampe et al., 2021; Sändig et al., 2024). Yet, implementation is also crucial: if environmental provisions are not (fully) implemented in a post-conflict society, we should not observe an association with significant improvements in environmental quality or an effect on broader, more general forms of cooperation. Indeed, effective implementation plays a central role in the environmental peacebuilding literature, which holds that cooperation on environmental issues can help mitigate conflict, build trust, and strengthen institutions, thereby lowering the risk of renewed violence more broadly (Balinskaia, 2025; Buhaug & von Uexkull, 2025; Ide, 2018, 2019). The literature typically identifies three principal mechanisms linking environmental cooperation to sustainable peace (see Ide, 2019; Krampe et al., 2021).

First, drawing on the contact hypothesis (Krampe et al., 2021, p. 2f), repeated interactions between former adversaries create opportunities for direct communication, which helps clarify intentions and reduce misunderstandings. Over time, these encounters allow former rivals to update previously held negative beliefs, weakening entrenched biases. As parties experience cooperative behavior from one another, they begin to recalibrate expectations and view the other side as more trustworthy (see Zawahri, 2009). This gradual accumulation of positive interactions can build confidence and support more constructive, peaceful relations. In fact, addressing shared environmental challenges, for example, water scarcity, deforestation, or fisheries depletion, often requires sustained cross-community and cross-border collaboration. Joint environmental restoration initiatives not only restore livelihoods but also create shared identities and goals. In turn, regular engagement through joint management bodies, negotiation platforms, and monitoring mechanisms can reduce mistrust and misperceptions, gradually fostering habits of overall cooperation (Dresse et al., 2019; Ide & Detges, 2018). For instance, local projects in, for example, post-conflict Nepal promoted cooperation over land and water management, helping to bridge intergroup divisions (see Sändig et al., 2024).

Second, environmental cooperation can produce concrete gains, such as stabilizing water supplies or improving agricultural productivity, that both sides come to rely on. As these benefits materialize, communities and governments recognize that continued collaboration directly supports their economic and social well-being. These outcomes depend on maintaining peaceful relations, and as a result, actors increasingly will seek to avoid actions that could jeopardize them. In turn, the shared reliance on these gains raises the opportunity costs of renewed conflict, making violence less attractive (see also Johnson et al., 2021). When the gains from environmental collaboration are visible and distributed fairly, they can promote

the diffusion of transnational norms and good governance practices, strengthen civil society, and enhance human empowerment (see also Ide, 2019). Such equitable and transparent outcomes also build trust among stakeholders, creating a reinforcing cycle in which cooperation becomes more attractive, sustainable, and politically legitimate. Together, these effects contribute to stabilizing post-conflict societies and consolidating peace generally.

Third, Krampe et al. (2021) emphasize the role of institution-building and state capacity in linking environmental cooperation to peace. Effective management of shared ecosystems demonstrates a government's capacity to address complex, cross-border challenges, reinforcing its legitimacy with citizens and neighboring states. By coordinating resources and policies, states can ensure consistent delivery of essential services such as clean water, disaster mitigation, and sustainable livelihoods. Over time, these approaches create transparent, predictable frameworks that foster cooperation, reduce tensions, and strengthen social and political stability. Similarly, Ide et al. (2021) argue that environmental institutions often generate positive spillover effects across policy domains, fostering governance practices that reinforce accountability, inclusivity, and, thus induce long-term peace.

While these mechanisms emphasize that environmental cooperation can promote long-term peace and, hence, that environmental peacebuilding can be effective, there are also viewpoints discussing why its impact may be limited or even counterproductive. Ide et al. (2021) remind us that environmental peacebuilding should not be viewed as a substitute for political negotiation or reconciliation, but rather as a complementary approach that supports broader processes of justice and conflict transformation. Moreover, Ide (2019, 2020) cautions that many initiatives suffer from depoliticization: by framing resource-related disputes as primarily technical or ecological, they risk obscuring underlying political and structural causes of conflict. Without addressing these, environmental cooperation may at best generate a superficial or fragile peace that easily breaks down. In addition, environmental initiatives can sometimes produce unintended negative consequences, such as new forms of displacement or exclusion (see Dresse et al., 2019; Ide et al., 2021), or they are co-opted by powerful third parties. Rather than empowering marginalized groups, such dynamics risk reinforcing existing inequalities and asymmetries of power (Ide, 2019; Kedem et al., 2024).

In sum, while environmental cooperation holds potential to contribute to sustainable peace, we rely on findings that often hinge on the dynamics of specific cases. The present study seeks to advance the existing cross-country, comparative literature (Ide, 2018; Ide & Detges, 2018) as we seek to enable generalizable claims about the relationship between environmental cooperation and post-conflict peace, focusing on the risk of conflict recurrence and environmental clauses in peace treaties. Given this focus and considering the existing environmental peacebuilding literature's proposed mechanisms, we hypothesize that *environmental provisions in peace agreements lower the risk of conflict recurrence*.

3. Research design

The framework of our empirical analysis is the PA-X data set (Bell & Badanjak, 2019). After accounting for missing values that affect some of the covariates, the final data cover about 1,000 treaties of more than 100 peace processes between 1990 and 2020. The unit of analysis is an individual peace agreement, which is not observed repeatedly, as treaties' designs do not vary over time. The data are thus cross-sectional. That said, individual agreements are nested in more aggregated peace processes involving the same actors, which suggests that some temporal dependencies persist. Standard errors are therefore clustered by

agreement-country, and we further address temporal influences and within-country path dependencies by unit fixed and random effects, year fixed effects, and the temporal cubic polynomial approximation by Carter and Signorino (2010).

The dependent variable captures in a binary fashion whether a peace treaty failed and, thus, conflict recurred (1) or not (peace continues and conflict does not resume, coded as 0). The information on conflict recurrence is taken from Kreutz (2010), who codes conflict start and end dates based on the Uppsala Conflict Data Program (UCDP) armed conflict data set. A conflict in these data is defined as a contested incompatibility that concerns government or territory or both, where the use of armed force between two parties results in at least 25 battle-related deaths in a year (N. P. Gleditsch et al., 2002; Pettersson & Öberg, 2020). A new conflict is coded whenever a conflict restarts after one or more year(s) of inactivity. The UCDP data code disputes along conflict episodes, which allows the distinction between different phases of a conflict—this matches the disaggregated approach to peace treaties in the PA-X data (Bell & Badanjak, 2019). Out of the conflict episodes associated with 1,258 peace treaties in the final data set (1990–2020), 85 of them (6.76 %) failed, and conflict broke out again.

As the dependent variable is dichotomous, binary dependent variable models (e.g., logistic regression) might seem the obvious choice for the analysis. However, the first set of models we discuss below is based on two-way fixed effects and random effects ordinary least square regression. Two-way fixed effects models comprise binary variables for the spatial (countries) and temporal units (years) in the data, which control for unobserved, time-invariant influences at the country level as well as common temporal shocks. Due to some of the weaknesses of two-way fixed effects models (see Imai & Kim, 2021), we also consider random effects. Ultimately, the first set of models is a series of fixed/random effects linear probability models, which have the advantage that all data points are used for the analysis while controlling for unobserved influences, and the findings' interpretation is straightforward. Using, for example, fixed effects in a typical binary dependent variable model would induce a drop in sample size as those observations that never observe conflict recurrence drop out of the estimation.

That said, linear probability models suffer to some degree from built-in heteroskedasticity, and they do not fully address an obvious endogeneity problem that is present in our context: environmental provisions in peace agreements are not randomly assigned. As discussed above, treaty commitments are usually not costless, and they are only incorporated in a final agreement when they seem to lead to tangible benefits: this also applies to environmental terms (Bakaki et al., 2025). When estimating the impact of environmental clauses on conflict recurrence as a direct test of the environmental peacebuilding thesis, we thus must account for the endogenous nature of the treatment variable—otherwise, the impact is over- or underestimated. A bivariate probit model (see Reid, 2021) can be used, in principle, but, as Coban (2022) discusses, it does not fully consider the recursive nature of the model, that is, the treatment is endogenous and is ultimately the main explanatory variable for the outcome of interest (conflict recurrence).

Coban (2022) then proposes a recursive bivariate probit estimation to address this problem, which allows for an unbiased calculation of the treatment effect in light of the endogeneity present. In short, this model estimates the effect of a binary treatment variable on a binary outcome if the treatment variable itself is endogenous and unobservables may correlate with the treatment and the outcome equation. This model comprises two stages: a "selection" stage that models the determinants of the endogenous treatment; and an "outcome"

stage, which uses the information of the previous stage and incorporates the treatment as a determinant of the outcome of interest. We use this approach for our second set of estimations discussed below.

In some aspects, two-stage least-squares (2SLS) regression is similar to the recursive bivariate probit model in that both approaches seek to address endogeneity directly. However, the way this is done differs. On the one hand, the recursive model handles endogeneity by estimating two equations jointly and allowing their error terms to correlate. Endogeneity is addressed through ρ, the estimated correlation of the errors. On the other hand, 2SLS deals with endogeneity via external instruments that predict the endogenous regressors in the first stage. This requires that assumptions about relevance (instrument actually predicts the endogenous variable) and exogeneity (instrument is uncorrelated with the error term) are met. We complement these models with a newly developed empirical procedure geared toward counterfactual estimation by Liu et al. (2024).

Our main explanatory variable pertains to the inclusion of environmental clauses in peace agreements, and it is taken from PA-X (Bell & Badanjak, 2019). Here, environmental provisions are defined as any reference to the environment, pollution, environmental disasters, epidemics, ecology, food security, and governmental bodies associated with environmental affairs, parks, and wildlife management. Treaties such as the "Belfast Agreement" between the United Kingdom and the Republic of Ireland (see Ellis, 2001; Nagle, 2018), the 2016 Colombian peace accord (see Salazar et al., 2021), or the Darfur and Aceh peace deals we pointed to above (see De Juan, 2015; Green, 2013), among others, all include provisions related to air pollution, water quality, or waste management. Examining a series of environmental clauses in the PA-X treaty data in more detail, they all seem to be formulated so that "pro-environmental" views or activities are intended. In our sample of 1,258 agreements, environmental provisions are included in about 9.1% ($N = 115$) of them.

Although the binary operationalization implies information is coded at the macro level and it does not allow for a more disaggregated analysis, it represents the only available operationalization of environmental clauses in this context. In addition, the dichotomous nature of this item addresses measurement error to some extent (see Thomas & Bond, 2015), as any form of environmental consideration is included in an agreement. While some categories, such as parks, wildlife management, or epidemics, may not relate directly to conflict recurrence (our main dependent variable), they reflect broader environmental concerns. Since our argument focuses on how environmental cooperation induces broader forms of collaboration, peace agreements can be viewed as "windows of opportunity" for establishing binding commitments across different, broad aspects of environmental protection.

We control for several other influences that may shape the risk of conflict recurrence (Bara et al., 2021; D'Amico et al., 2025; Haer & Böhmelt, 2016; Kreutz, 2010; Mason et al., 2011; Quinn et al., 2007; Rustad & Binningsbø, 2012; Toft, 2010; Walter, 2014). First, substantive peace treaties are a direct result of longer, more complex conflicts. Longer and thus more intense conflicts may be more likely to recur. To control for this, we include a binary item capturing whether a treaty is classified as substantive (1) or not (0; pre-negotiation, renegotiation, renewal, ceasefire, and other treaties are coded as such).

Second, since recurrence risk might vary across interstate and intrastate disputes (Kreutz, 2010; Mason et al., 2011; Rustad & Binningsbø, 2012), we consider a dichotomous variable on whether a conflict is a civil (an intrastate) conflict (1) as opposed to an interstate one (0). Third, third-party involvement could correlate with resumed conflict (Kreutz, 2010; Mason et al., 2011; Quinn et al., 2007; Walter, 2014). We thus take a binary item from the PA-X

data (Bell & Badanjak, 2019) that is coded as 1 if the UN were formally involved in a peace process.

Fourth, we account for countries' economic development and their size when including measures for gross domestic product (GDP) per capita (in current U.S. dollars) and population. For constructing the former, we source data from the World Bank, but address missing values with information from the International Monetary Fund and K. S. Gleditsch (2002). The population variable is taken from the World Bank without modifications. Both GDP per capita and the population variable are log-transformed to correct for their skewed distributions.

Fifth, there might be influences stemming from regime type, which features commonly in analyses of conflict, dispute resolution, and the risk of renewed fighting (see Hegre & Nygård, 2015; Walter, 2014). We operationalize this via the electoral democracy index from the Varieties of Democracy data.

The final control for the first set of models (linear probability models) addresses political exclusion. This item is taken from the Ethnic Power Relations data by Cederman et al. (2010), which codes the share of the population that is politically excluded. We focus on those groups in the population that are "discriminated," "powerless," or "self-excluded." Specific groups within a country might be more vulnerable to the impacts of environmental stress, while conflict recurrence risk should be higher with a larger proportion of the population being excluded from political decision-making (see Walter, 2014).

The two-stage nature of the recursive bivariate probit models requires the specification of a selection stage. As in the outcome equation, we include *UN* and *Democracy*. On one hand, peace agreements may be supported by international organizations, such as the UN (see Joshi & Quinn, 2015; Reid, 2021), which could also push for the inclusion of clauses that mirror their own policies, including environmental ones. On the other hand, higher levels of democracy have been associated with greater concern for environmental justice and the consideration of related provisions (see Gellers & Jeffords, 2018).

In addition, we consider covariates for environmental disasters, trade openness, and agreement length (see Bakaki et al., 2025). The data on disasters stem from the International Disasters Dataset EM-DAT of the Center for Research on the Epidemiology of Disasters.[3] The EM-DAT data are the most comprehensive and inclusive source of information on disasters. We use a measure that counts the number of environmental disasters per country-year. Such disasters pertain to droughts, earthquakes, extreme temperatures, floods, mass movements, storms, and wildfires. Any of these events, if they had at least one human fatality, are considered for the disaster item. As Bakaki et al. (2025) argue, environmental disasters highlight the urgency of environmental action, thus raising the likelihood that peace agreements comprise binding environmental commitments.

We also control for trade openness (Neumayer, 2002) as countries more economically integrated in the global system might want to appeal to other states' values (Blanton & Apodaca, 2007), including environmental ones. The chances of adding environmental clauses to peace agreements should be higher as a result. We use the World Bank's measure of imports and exports as a share of GDP. Finally, longer agreements are more likely to encompass a wide range of provisions, including those related to the environment (see Thomas, 2024). Therefore, we add a variable on the page length of an agreement as coded in the PA-X data (Bell & Badanjak, 2019) to the selection stage of the recursive bivariate probit models.

Table 1. Conflict recurrence and environmental provisions in peace agreements—Main models.

Variables	Model 1	Model 2	Model 3	Model 4
Environmental provisions	−0.035***	−0.040***	−0.030***	−0.033***
	(0.019)	(0.018)	(0.013)	(0.018)
Substantive agreement		−0.004		−0.000
		(0.015)		(0.000)
Civil conflict		−0.025		−0.021
		(0.020)		(0.020)
UN		0.017		0.014
		(0.019)		(0.018)
Democracy		0.715**		0.484**
		(0.323)		(0.218)
GDP per capita (ln)		0.015		0.021
		(0.018)		(0.016)
Population (ln)		−0.181		−0.005
		(0.253)		(0.029)
Political exclusion		0.030		−0.021
		(0.150)		(0.114)
Constant	−0.012	2.693	0.011	−0.159
	(0.032)	(4.187)	(0.030)	(0.441)
Observations	1,255	1,074	1,255	1,074
Country fixed effects	Yes	Yes	No	No
Random effects	No	No	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Temporal correction (Cubic polynomial)	Yes	Yes	Yes	Yes

Note. Table entries are coefficients; standard errors reported in parentheses. GDP = Gross domestic product.
**$p < .05$. ***$p < .01$.

4. Empirical results

Table 1 summarizes the linear probability models: Models 1 to 2 are two-way fixed effects estimations, while Models 3 to 4 incorporate unit-level random effects. The results in Table 1—irrespective of which econometric approach, sample, or controls are used—are consistent with the theoretical expectation of the environmental peacebuilding literature (see, Balinskaia, 2025; Ide, 2018; Ide & Detges, 2018): if environmental provisions are included in peace agreements, the likelihood of conflict recurrence is significantly lower than without such clauses. Hence, environmental cooperation is associated with broader collaboration. As Table 1 is based on linear probability models, the coefficient estimates of *Environmental Provisions* can be interpreted directly: the risk of conflict recurrence goes down by about 3% to 4% points across the estimations. When simulating the coefficient of *Environmental Provisions* using King et al. (2000), there is a decrease of 4% points in the risk of conflict recurrence if environmental clauses are in a treaty. Out of 1,000 simulations, only 22 (2.1%) have a marginal-effect estimate greater than or equal to 0. Hence, there is robust evidence emphasizing that the relationship between environmental provisions in peace agreements and conflict recurrence is, in fact, negative and statistically significant.

Figure 1 summarizes a sensitivity analysis based on Cinelli and Hazlett (2020) and Cinelli et al. (2024), while we plot substantive quantities of interest pertaining to the effect of *Environmental Provisions* in Figure 2. Both graphs provide empirical support for the

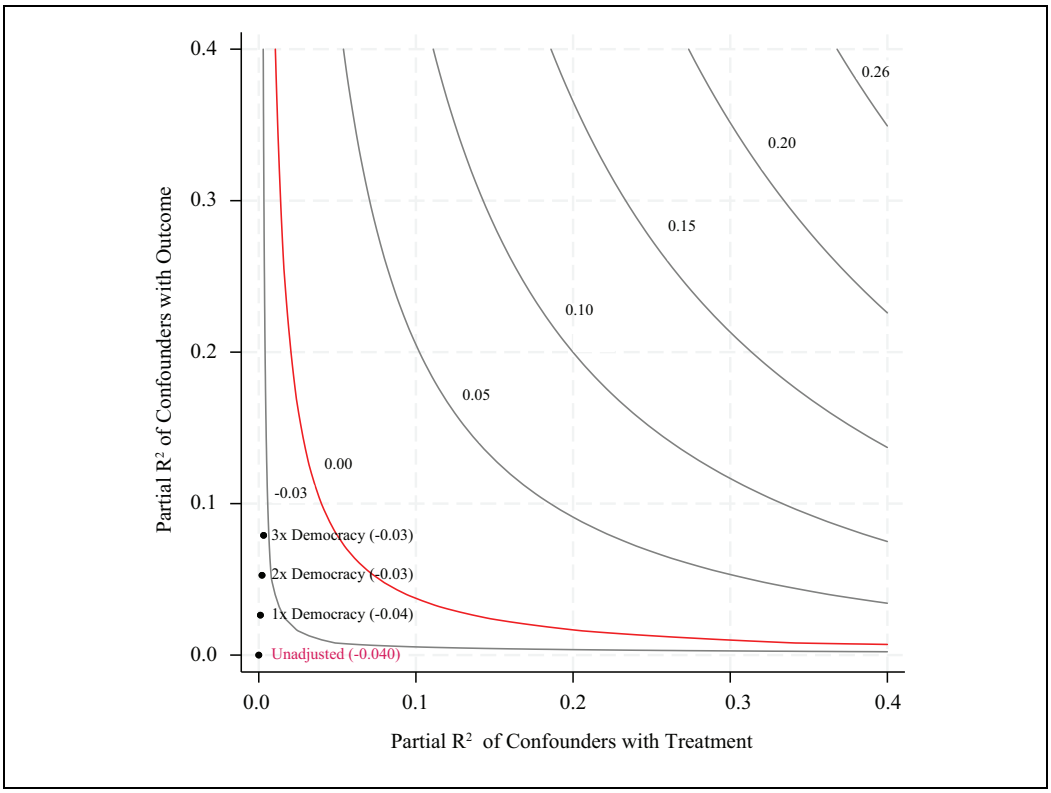

Figure 1. Sensitivity contour plots in the partial R^2 scale.

Note. Graph displays sensitivity contour plot of the point estimate of *Environmental Provisions* with benchmark bounds; points are included to show the bounds for a confounder as strong as *Democracy* (twice as strong and three times as strong) as summarized in Table 1; graph based on Model 2 and the code is derived from Cinelli and Hazlett (2020) and Cinelli et al. (2024).

argument that environmental provisions are indeed associated with a lower risk of conflict relapse. First, Figure 1 is a sensitivity contour plot as advanced in Cinelli and Hazlett (2020) and Cinelli et al. (2024). This graph is based on an extension of the omitted variable bias framework and demonstrates "how confounders of different types would affect point estimates […], while showing where bounds on such confounders would fall under different assumptions on how unobserved confounders compare with observables […]. The horizontal axis describes the fraction of the residual variation in the treatment (partial R^2) explained by the confounder; the vertical axis describes the fraction of the residual variation in the outcome explained by the confounder" (Cinelli & Hazlett, 2020, p. 57). In turn, the contours show the adjusted estimate of *Environmental Provisions* that would be obtained for an unobserved confounder with the hypothesized values of the sensitivity parameters (Cinelli & Hazlett, 2020, p. 57). To this end, we assess the sensitivity—robustness—of the coefficient of *Environmental Provisions* with respect to key confounders. Given the results summarized in Table 1, we opt for *Democracy* as the only other statistically significant estimate in the models. Figure 1 clearly shows that the estimated effect of *Environmental Provisions* is robust to confounding with such strengths as *Democracy* (one time, two times, or three times as

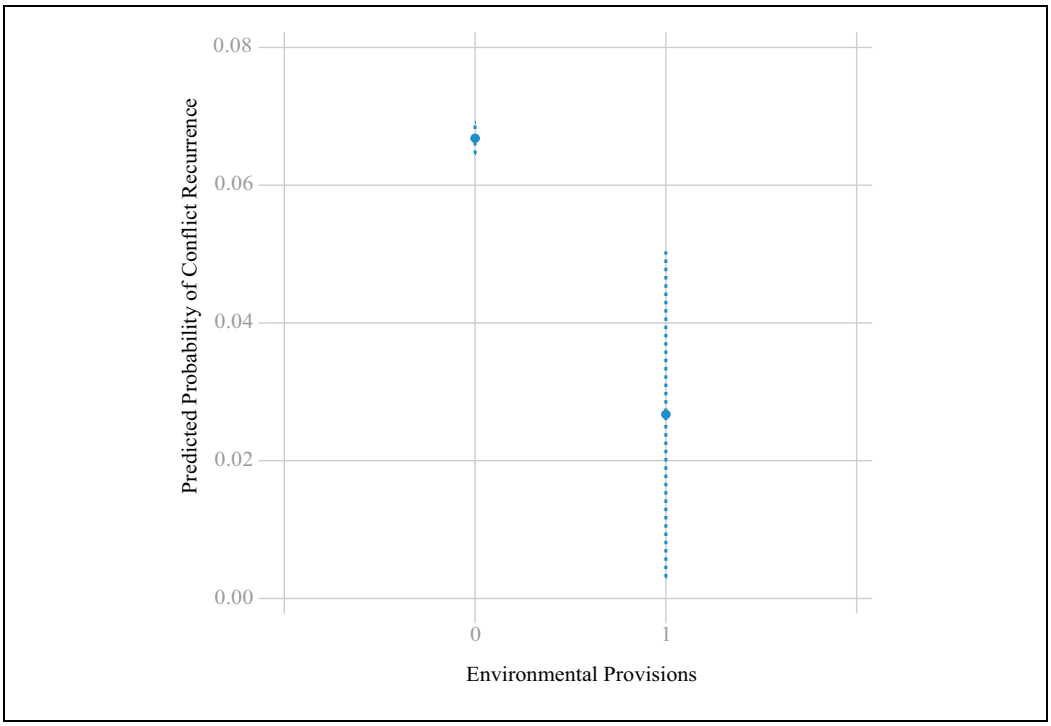

Figure 2. Predicted probability of conflict recurrence.
Note. Graph displays predicted probabilities of conflict recurrence with and without environmental provisions in an agreement; dashed lines stand for 95% confidence intervals; graph based on Model 2; all other variables are held constant at observed values.

strong). The negative effect on conflict recurrence persists, while the magnitude seems to only slightly decrease to about −0.030 (confounder three times as strong as *Democracy*) from the original estimate of −0.040.

Figure 2 shows the predicted probabilities of conflict recurrence for *Environmental Provisions*. All other variables are held constant at observed values. When there are no environmental clauses, holding all other variables constant, Model 2, as illustrated in Figure 2, predicts that conflict recurs with a probability of 6.7%. Conversely, when environmental provisions are considered, the risk of conflict recurrence decreases to about 2.7% (0.027 in Figure 2). This is clear evidence in favor of the environmental peacebuilding literature's core claim. In sum, Table 1 and Figures 1 and 2 consistently point to the conclusion that environmental provisions in peace agreements are strongly linked to a lower risk of conflict relapse. The identified effect is both statistically significant and substantially important. Having said that, the models in Table 1 might be affected by built-in heteroskedasticity and do not fully take the endogenous nature of environmental provisions into account.

We thus continue with Table 2, which presents the findings of the recursive bivariate probit models (Coban, 2022). Model 5 leaves out the substantive controls, and we just add the cubic polynomial approximation by Carter and Signorino (2010) to both the selection and the outcome stages. The substantive controls are included in Model 6, however, which is then our most preferred specification. Variables enter the selection or the outcome equation

Table 2. Conflict recurrence and environmental provisions in peace agreements—Recursive bivariate probit models.

Variables	Model 5	Model 6
Environmental provisions	−1.487***	−1.450***
	(0.169)	(0.218)
Substantive agreement		0.231*
		(0.138)
Civil conflict		0.086
		(0.175)
UN		0.220
		(0.205)
Democracy		1.639**
		(0.728)
GDP per capita (ln)		0.097
		(0.123)
Population (ln)		−0.093
		(0.095)
Political exclusion		−0.867
		(0.830)
Constant	−0.710***	−0.587
	(0.164)	(1.746)
Disasters	0.023*	0.035***
	(0.012)	(0.010)
Agreement length		0.031***
		(0.008)
UN		0.430*
		(0.220)
Democracy		1.716***
		(0.402)
Trade openness		−0.007*
		(0.004)
Constant	−1.166***	−2.021***
	(0.125)	(0.298)
Observations	1,249	1,036
Temporal correction (Cubic polynomial)	Yes	Yes

Note. Table entries are coefficients; standard errors reported in parentheses. GDP = Gross domestic product.
*$p < .10$. **$p < .05$. ***$p < .01$.

as detailed in the research design. As the recursive bivariate probit model is nonlinear, only the signs and statistical significance levels can be interpreted directly. Substantive quantities of interest are depicted in Figure 3, which offers a comparison between the baseline model (Model 5) and the full model (Model 6) as summarized in Table 2. Here, we present average treatment effects. As discussed in Coban (2022), the average treatment effect in Figure 3 is the effect of a discrete change in the treatment, holding all other observed and unobserved variables constant. This, specifically, translates into the finite difference between the risk of conflict recurrence given environmental provisions in peace agreements and the risk of conflict recurrence given that no environmental clauses are considered. In other words, Figure 3's average treatment effects capture the difference between the marginal probability of outcome success (i.e., conflict recurrence) given treatment success (i.e., environmental provisions

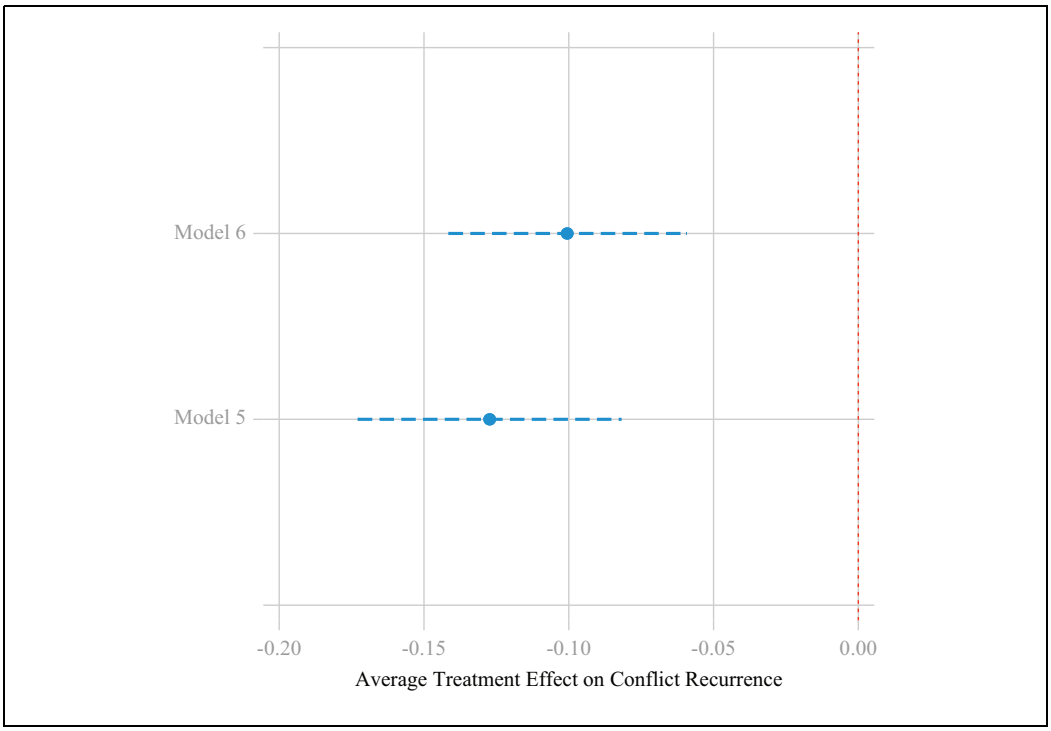

Figure 3. Average treatment effects of *environmental provisions*.
Note. Graph displays average treatment effects of *Environmental Provisions*; red dotted line stands for treatment effect of 0; dashed horizontal lines stand for 95% confidence intervals; graph based on Model 5 and Model 6.

in a peace treaty) and the marginal probability of outcome success given treatment failure (i.e., conflict recurrence when there are no environmental provisions in a peace agreement).

According to Table 2 and Figure 2, environmental provisions in peace treaties still exert a negative and significant effect, which is robust across model specifications. This is similar to the linear probability models discussed above, and is consistent with the environmental peacebuilding thesis. Having said that, when assessing the average treatment effects of *Environmental Provisions* in Figure 3, it seems that the models in Table 1 underestimate the true impact. In Model 5, the average treatment effect is estimated at around −13% points, while it is about −10% points in Model 6. These effect sizes are more than twice as large as the substantive effects derived from the linear probability models (Table 1). What is more, the results for the selection stage in Model 6 show that all substantive variables are solid predictors of environmental provisions: disasters, longer agreements, the UN, democracy, and trade openness all increase the chances that environmental goals will be added to peace agreements. These findings are consistent with Bakaki et al. (2025).

In Table 3, we re-estimate the main model, but employ a counterfactual estimation for causal inference (Liu et al., 2024). Specifically, Liu et al. (2024, p. 160) propose a "simple framework of counterfactual estimation for causal inference with time-series cross-sectional data," in which "the average treatment effect on the treated is estimated by directly imputing counterfactual outcomes for treated observations." The corresponding estimation procedures outperform "traditional" two-way fixed effects models and allow for a more precise

Table 3. Conflict recurrence and environmental provisions—Counterfactual estimator.

Variables	Model 7
Environmental provisions	−0.058**
	(0.028)
Substantive agreement	0.013
	(0.020)
Civil conflict	−0.031
	(0.027)
UN	−0.008
	(0.032)
Democracy	0.576
	(0.502)
GDP per capita (ln)	0.001
	(0.037)
Population (ln)	−0.376
	(0.280)
Political exclusion	0.178
	(0.455)
Constant	6.123
	(4.416)
Observations	1,074
Country fixed effects	Yes
Year fixed effects	Yes
Temporal correction (Cubic polynomial)	Yes

Note. Table entries are coefficients; standard errors reported in parentheses. GDP = Gross domestic product.
**$p < .05$.

estimation of causal treatment effects—in our case, the effect stemming from environmental provisions in peace agreements. Several different approaches are developed by Liu et al. (2024), but we focus on the fixed effects counterfactual (FEct) estimator. This is likely more efficient than two-way fixed effects models, and unbiased as well as consistent in the parameter estimation. It is essentially a weighting estimator in which "each treated observation is matched with its predicted counterfactual [...], which is the weighted sum of all untreated observations" (Liu et al., 2024, p. 165). The FEct model in Table 3 includes both unit and time fixed effects. The main quantity of interest is the dynamic treatment effect, "or the average treatment effects on the treated (ATT) over different periods, without assuming treatment effect homogeneity of any kind" (Liu et al., 2024, p. 161).

The ATT in Model 7 is estimated at −0.058, and it is statistically significant at the 5% level. This is less than what we estimate for the recursive models (Table 2), but slightly larger than the calculations based on the linear probability models in Table 1. For the model in Table 3, we also carried out several tests as suggested in Liu et al. (2024). First, there is a Placebo Test to address the concern of over-fitting in the pre-trend. We specified two pre-treatment periods as "placebo periods" to remove observations for model fitting to test in turn whether the estimated treatment effect in this range is significantly different from 0. Second, we evaluated whether the identification assumption is met or not via the Equivalence Test. This procedure checks whether the 90% confidence intervals for the

estimated average treatment effect on the treated at the pre-treatment period exceed a pre-specified range. Third, under a general treatment pattern where treatments may exit and switch off, Liu et al. (2024) also recommend conducting a Carryover Test, which addresses the concern that the treatment effect persists for some time after its "exit." Two post-treatment periods are defined as "carryover periods," where we remove observations for model fitting, and then test whether the average treatment effect on the treated in this range is significantly different from 0. Model 7 passes all three tests, which further increases the confidence in a negative effect of peace agreements' environmental provisions on the risk of conflict recurrence.

Putting the results across all tables and figures together, we obtain evidence for the argument of the environmental peacebuilding literature: fixed effects models, random effects models, recursive bivariate probit models, and the counterfactual estimator all stress that peace agreements' environmental clauses are associated with a lower likelihood of conflict breaking out again. In the SI, we present additional analyses, and the results from these continue to support the main findings presented above. First, we consider several additional control variables (Table A1). Second, we implement a different operationalization of *Disasters* (Table A2). In Table A3, the outcome variable of conflict recurrence is operationalized in a more conservative way. Table A4 controls for environmental legislation, while we address concerns over the political ideology of the government in Table A5. Finally, in Table A6, we use data on state capacity and foreign aid to, at least preliminarily, shed light on the individual mechanisms as proposed by the environmental peacebuilding literature.

5. Conclusion

This study contributes to the cross-country, comparative empirical tests (Ide, 2018; Ide & Detges, 2018) of the core environmental peacebuilding proposition (Balinskaia, 2025; Dresse et al., 2019; Ide, 2019; Ide et al., 2021; Johnson et al., 2021; Kedem et al., 2024; Krampe et al., 2021; Sändig et al., 2024; Sommer & Fassbender, 2024): environmental cooperation can contribute to sustained post-conflict stability by lowering the risk of resumed conflict. Drawing on an original data set combining information from Bell and Badanjak (2019) and Kreutz (2010), the analysis reveals that peace agreements incorporating environmental provisions are statistically associated with a significantly lower risk of violence recurrence. This finding holds across multiple model specifications, including two-way fixed effects models, random effects regressions, recursive bivariate probit models (Coban, 2022) designed to account explicitly for potential endogeneity, and a counterfactual estimation procedure (Liu et al., 2024). Environmental provisions thus play a meaningful, stabilizing role for post-conflict peace. Even when these clauses appear broad or unspecific, their inclusion may encourage dialogue, build institutional capacity, and reduce incentives for renewed confrontation.

Beyond substantiating this central claim of the environmental peacebuilding literature, the study also advances more general debates in peace and conflict research about the indirect and cross-sectoral effects of peace processes. By demonstrating that environmental provisions can have measurable impacts on conflict recurrence, our findings highlight that peace agreements should not be seen solely as instruments for disarmament or power-sharing (Bell & O'Rourke, 2007; Reid, 2021; Werner & Yuen, 2005). Rather, they can function as platforms for wider societal cooperation, addressing long-term structural risks that, if left unattended, may undermine post-conflict stability. This insight aligns with emerging scholarship

on the positive externalities of conflict resolution and comprehensive peace design (see Bakaki & Böhmelt, 2021; Böhmelt, 2024; Di Salvatore, 2019).

However, while the models control for a range of confounding factors and account for selection bias, causal inference remains challenging. The recursive bivariate probit models, as well as the counterfactual estimator (Liu et al., 2024), help mitigate concerns here, but they cannot fully disentangle causal pathways. Future research should deepen our understanding of the conditions under which environmental cooperation most effectively *causes* peace.

Another limitation of our study is that we rely on data that necessarily simplify the complex realities of post-conflict environmental governance. While large-*N* designs enable generalization, they do not capture the nuanced, context-specific processes through which environmental cooperation unfolds on the ground. Case-based research remains essential for tracing mechanisms such as trust-building, institution formation, or the creation of shared resource management bodies.

Moreover, reliable data on the actual implementation of environmental provisions remains scarce. The distinction between the formal inclusion of environmental clauses and their actual enforcement is critical. Indeed, the empirical analysis is based on the implementation of environmental provisions. It is plausible that the peace-enhancing effects may materialize more strongly when exploring implementation more directly. We address this aspect to some degree when assessing the impact of actual legislation implementation in the SI, but future research should seek to more integrate data on implementation and environmental program outcomes to study whether and how environmental clauses induce genuine cooperative practices.

In this context, scholars and policymakers alike would benefit if we could test the individual mechanisms proposed by the literature. However, we simply lack the data to conduct such tests. For example, individual-level public-opinion data would enable us to investigate the contact hypothesis in detail, but such information does not exist for the large set of countries and years in our sample. And the options for thoroughly capturing the other two mechanisms are limited, too. That said, we make use of data on governance quality and foreign aid to proxy the core elements of the mechanisms of mutually beneficial outcomes and state capacity. These analyses are summarized in the SI, though future research may want to disentangle the effects pertaining to the individual mechanisms of the environmental peacebuilding thesis more comprehensively than we do.

We measure environmental provisions in peace agreements using a binary indicator. Although this is useful for our purposes, a more disaggregated operationalization would better capture the nuances of different types of provisions. One could try to code the PA-X data on environmental provisions in a more fine-grained way, and the corresponding disaggregated provisions could then be linked to different determinants.

Finally, there are forms of environmental cooperation other than environmental provisions in peace agreements, which may be related to post-conflict peace. For instance, one could think of communities creating institutions for sharing natural resources without the involvement of state actors. We do not claim to capture all possible forms of environmental cooperation that may exist. Instead, using recent data on peace agreements and conflict recurrence, we offer a fresh cross-country comparative analysis of one empirical manifestation of the environmental peacebuilding literature. But other forms of environmental cooperation, including those at the non-state actor level, or alternative manifestations of general conflict and cooperation, for example, intercommunal violence, are not represented in our analysis. Future research may want to focus on those other levels of analysis.

From a policy perspective, this research demonstrates that environmental issues should not be treated as secondary or purely technical concerns in peace processes. Instead, they can be strategically leveraged as entry points for cooperation. Incorporating environmental provisions can create non-contentious, problem-solving spaces that encourage joint management of shared resources, helping to rebuild trust and re-establish channels of communication between former adversaries. At the same time, careful attention must be paid to implementation. Symbolic or poorly designed environmental clauses may raise expectations without delivering actual benefits. Effective environmental peacebuilding requires not only formal provisions but also institutional capacity, inclusive governance structures, and sustained international support to ensure that cooperative mechanisms function beyond the initial post-agreement phase (see Ide, 2019; Krampe et al., 2021).

In conclusion, this study reinforces the notion that environmental cooperation can be a vital, if often underappreciated, pillar of sustainable post-conflict peace. By integrating environmental considerations into peace agreements, policymakers can help lay the foundations for not only ending violence but also building the resilience necessary to prevent its recurrence.

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Data availability statement

The data set used in this study will be made available at: Böhmelt, Tobias; Bakaki, Zorzeta, 2025, "Replication Data for: Peace Treaties' Environmental Provisions and Conflict Recurrence." https://doi.org/10.7910/DVN/P9LGB4, Harvard Dataverse.

Supplemental material

Supplemental material for this article is available online.

Notes

1. As discussed in Ide (2019, p. 328), there are different terms for this concept in the literature, including "environmental peacekeeping" or "environmental peace perspective." In this article, we rely on the term "environmental peacebuilding," which arguably is the most commonly used label in existing studies.
2. Needless to say, peace agreements can fail or several of their provisions are not implemented. We do not assume otherwise. Rather, we examine empirically whether environmental provisions are

associated with a lower risk of conflict recurrence. If these provisions would not have been implemented, we would find no evidence for such a relationship.

3. Available online at: https://www.emdat.be/

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