CARBON OFFSETS

Action needed to make carbon offsets from forest conservation work for climate change mitigation

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Carbon offsets from voluntary avoided-deforestation projects are generated on the basis of performance in relation to ex ante deforestation baselines. We examined the effects of 26 such project sites in six countries on three continents using synthetic control methods for causal inference. We found that most projects have not significantly reduced deforestation. For projects that did, reductions were substantially lower than claimed. This reflects differences between the project ex ante baselines and ex post counterfactuals according to observed deforestation in control areas. Methodologies used to construct deforestation baselines for carbon offset interventions need urgent revisions to correctly attribute reduced deforestation to the projects, thus maintaining both incentives for forest conservation and the integrity of global carbon accounting.

For nearly two decades, the performance-based payment mechanism for reduced carbon emissions from deforestation and forest degradation known as REDD+ has been under intense debate (*1*). Although regulations and capacity for national REDD+ programs are still under development (*2*, *3*), many standalone, voluntary REDD+ projects are operational worldwide (*4*). These projects intend to conserve forests through many activities, such as improved monitoring and enforcement, promotion of sustainable practices, and local stakeholder engagement, often funded by the commercialization of carbon offsets [each corresponding to 1 Mg of carbon dioxide (CO_2) either removed from or not emitted into the atmosphere]. In 2021, two-thirds of the 227.7 million offsets from the land-use sector (excluding agriculture) traded in carbon markets, with a total value of USD $1.3 billion, originated from REDD+ projects (*5*).

Numerous policy discussions and initiatives focus on how to scale and integrate the carbon-emission reductions claimed by voluntary carbon-offset projects, particularly from REDD+ activities, into climate policies and Nationally Determined Contributions (NDCs) reported to the United Nations Framework Convention on Climate Change (*3*, *6*–*8*). However, there is little rigorous evidence on the contributions of these projects (*9*, *10*), with some studies suggesting that many are associated with little or no actual emission reductions (*11*–*17*).

Carbon offsets from REDD+ projects are issued on the basis of comparison between the observed forest cover in the project areas and deforestation baseline scenarios expected to have been realized in the absence of REDD+, which are de facto unobservable (*3*, *17*). Many project baselines are formed through the extrapolation of historical deforestation averages or trends, often spatially projected over a reference region that encompasses the project sites (*17*). These crediting baselines may become unrealistic counterfactuals with extensive changes in economic or political conditions known to affect deforestation rates (*18*), combined with questionable modeling decisions underlying the spatial projections (*19*, *20*). Baselines could also be opportunistically inflated by profiteers seeking to maximize the volume of offsets issued by a project (*21*). As a result, carbon offsets may lack "additionality"—they may not reflect actual emission reductions (*22*).

This study provides a pantropical comparison between ex post deforestation counterfactuals, informed by observable control areas, and the ex ante baselines adopted by 27 voluntary REDD+ projects in six tropical countries: Peru, Colombia, Democratic Republic of Congo (DRC), Tanzania, Zambia, and Cambodia (Fig. 1, figs. S1 and S2, and tables S1 and S2) certified under the Verified Carbon Standard (*23*). Because some projects are composed of multiple disconnected sites, we evaluated those individually, increasing our sample to 31 project sites. We present both project-specific and cross-project

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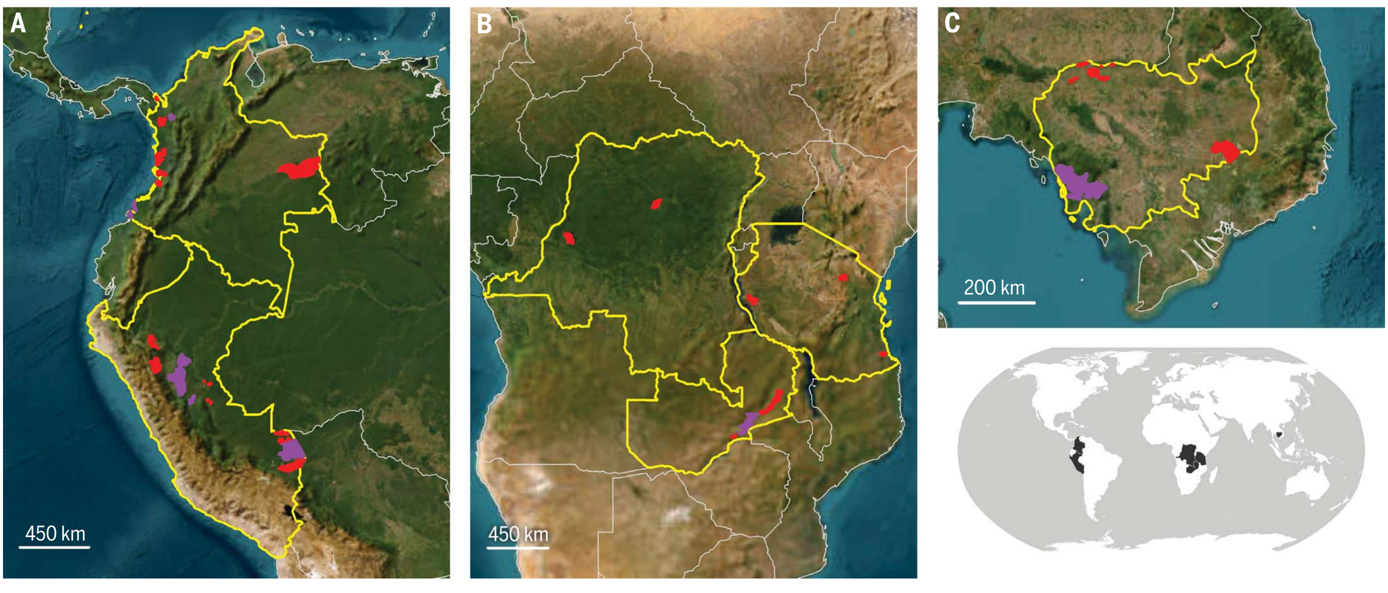

Fig. 1. Voluntary REDD+ project sites included in the study. (**A**) Peru and Colombia. (**B**) Democratic Republic of Congo (DRC), Tanzania, and Zambia. (**C**) Cambodia. Study areas are indicated in red. Purple areas are the sites excluded from the analysis.

analyses based, respectively, on the standard and generalized versions of the synthetic control (SC) method for causal inference (*24*, *25*) that estimate the reductions in deforestation in project sites attributable to the REDD+ interventions.

The SCs are constructed to be based on control areas ("donors"), selected from project-specific donor pools, which had similar levels of forest cover and other characteristics (table S2) and were exposed to similar levels of deforestation pressure (as determined by comparing the average annual deforestation in the projects' and donors' 1-km and 10-km buffer zones before the project implementation). The SC method selects and constructs a weighted combination of control areas that has similar characteristics as those of the REDD+ site and follows a similar historical trajectory of deforestation (supplementary materials). Before interpreting individual project results, we conducted project-specific "validation" tests to check whether the standard SC method (*24*) was able to construct SCs with deforestation rates similar to that of project areas during the immediate preproject period (*17*). Conservatively, we focus the discussion of our results on projects with SCs that performed well in the validation test (fig. S5 and table S3).

Average impacts were estimated with the generalized SC (GSC) method (*25*) on the basis of two independent sets of control areas. Furthermore, to address the concern that the selected control areas may not represent potential counterfactuals for REDD+ project sites, we also estimated average project impacts through comparison of operational project sites with "yet-to-become" project areas throughout the study period using matching-based methods for time-series cross-sectional analyses (*26*). Because the evaluated projects span multiple countries and contexts, our analyses shed light on the robustness of the assumptions adopted for the construction of REDD+ baselines under a wide range of deforestation conditions (fig. S2).

Individual REDD+ project impacts

The individual SC analyses show mixed impacts of the voluntary REDD+ projects on deforestation. Results from the validation tests suggest that the SC method could replicate pre-REDD+ deforestation trends in the "to-be" project sites (fig. S6 and table S3). We discarded only one project (1775-1) from the analyses because of the poor fit between the deforestation in the SC and the REDD+ site before project implementation in our validation test. Four other projects (985, 1360-1, 1389, and 1748) were also discarded out of an abundance of caution because despite the agreement in pre-project deforestation between the SCs and the REDD+ sites, their buffer deforestation rates suggested substantially different levels of deforestation pressure. Our final sample was thus reduced to 26 project sites.

Eight of the remaining 26 project sites showed some evidence of additional reductions in deforestation compared with their individual SCs (figs. S7 and S8), although generally not to the extent claimed by the projects based on their ex ante crediting baselines. Additionality was most likely in Peru, where half of the REDD+ sites had significantly less deforestation than that of the ex post counterfactuals, with statistical significance judged by means of placebo tests. Three of the seven Colombian project sites and one of two Cambodian sites achieved significant deforestation reductions according to the SCs and placebo tests. No evidence of avoided deforestation was found for the REDD+ sites in the DRC, Tanzania, and Zambia with regard to their counterfactuals.

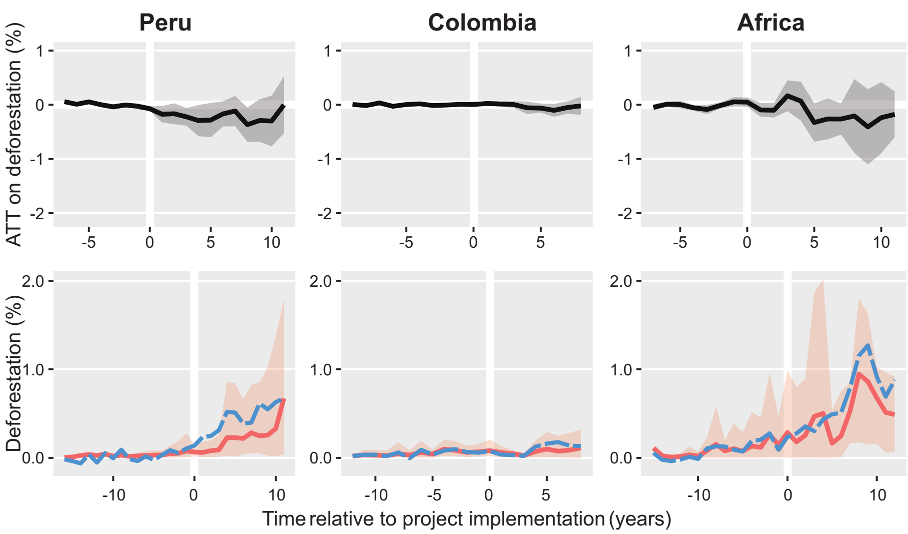

Fig. 2. Estimated average impacts of REDD+ projects in Peru, Colombia, and Africa on annual deforestation. Averages are based on the GSC method and the donor pool of control areas selected for the individual project's SCs. (**Top**) The average treatment effect on the treated (ATT) project sites. (**Bottom**) Projects' (solid red line) and counterfactuals' (dashed blue line) deforestation averages. Shaded red areas indicate bootstrapped 95% confidence intervals around the projects' deforestation average.

Average REDD+ project impacts

Average project impacts on deforestation [average treatment effects on the treated (ATT)] in Peru, Colombia, and Africa (DRC, Tanzania, and Zambia) were estimated with the GSC method (Fig. 2, top). Cambodian projects were excluded from this analysis because of the limited sample size. Unlike the individual project evaluations, the GSC analyses were based exclusively on annual deforestation rates and time-variant covariates. The GSC analyses were based on two independent sets of selected control areas for each region: In the first set, only the donors selected for the construction of the individual SCs were considered, whereas in the second set, controls were selected through cardinality matching (*27*), independent of the SC analyses. Our conclusions are robust to all of these methodological variations.

For the first set of controls, the average impact of the Peruvian projects on forest loss over 10 years was −0.24% or avoided deforestation of 686 ha year^{-1} (table S7). This effect was statistically significant in the first 4 years of project implementation (Fig. 2, bottom). An ATT of −0.14% or 414 ha year^{-1} (table S8) was found for the African projects, whereas a smaller effect was associated with the Colombian projects (−0.03% or 49 ha year^{-1}) (table S9). Neither the estimates for the Colombian nor the African groups of projects were statistically significant. Even assuming the estimated average reductions in deforestation to be significant in all three regions (a plausible assumption given our small sample sizes), they would still be substantially lower than avoided deforestation calculated from the average ex ante baseline deforestation rates adopted by the projects in Peru (3661 ha year^{-1}), Colombia (2550 ha year^{-1}), and Africa (2700 ha year^{-1}) through 2020.

These results are robust to using control areas selected through cardinality matching. On the basis of our second control set, we estimated ATTs of the Peruvian, Colombian, and African REDD+ sites as −0.42% (1266 ha) year^{-1}, −0.01% (30 ha) year^{-1}, and −0.21% (423 ha) year^{-1}, respectively (fig. S10, top, and tables S10 to S12). Again, only the estimate for the Peruvian projects was statistically significant, and only in the first 4 years of project implementation (fig. S10, bottom). Although the estimated impacts in Peru were −0.18 percentage points larger as compared with the first control set, the translated absolute average reduction still represents just one-third of the average reductions claimed by the Peruvian projects.

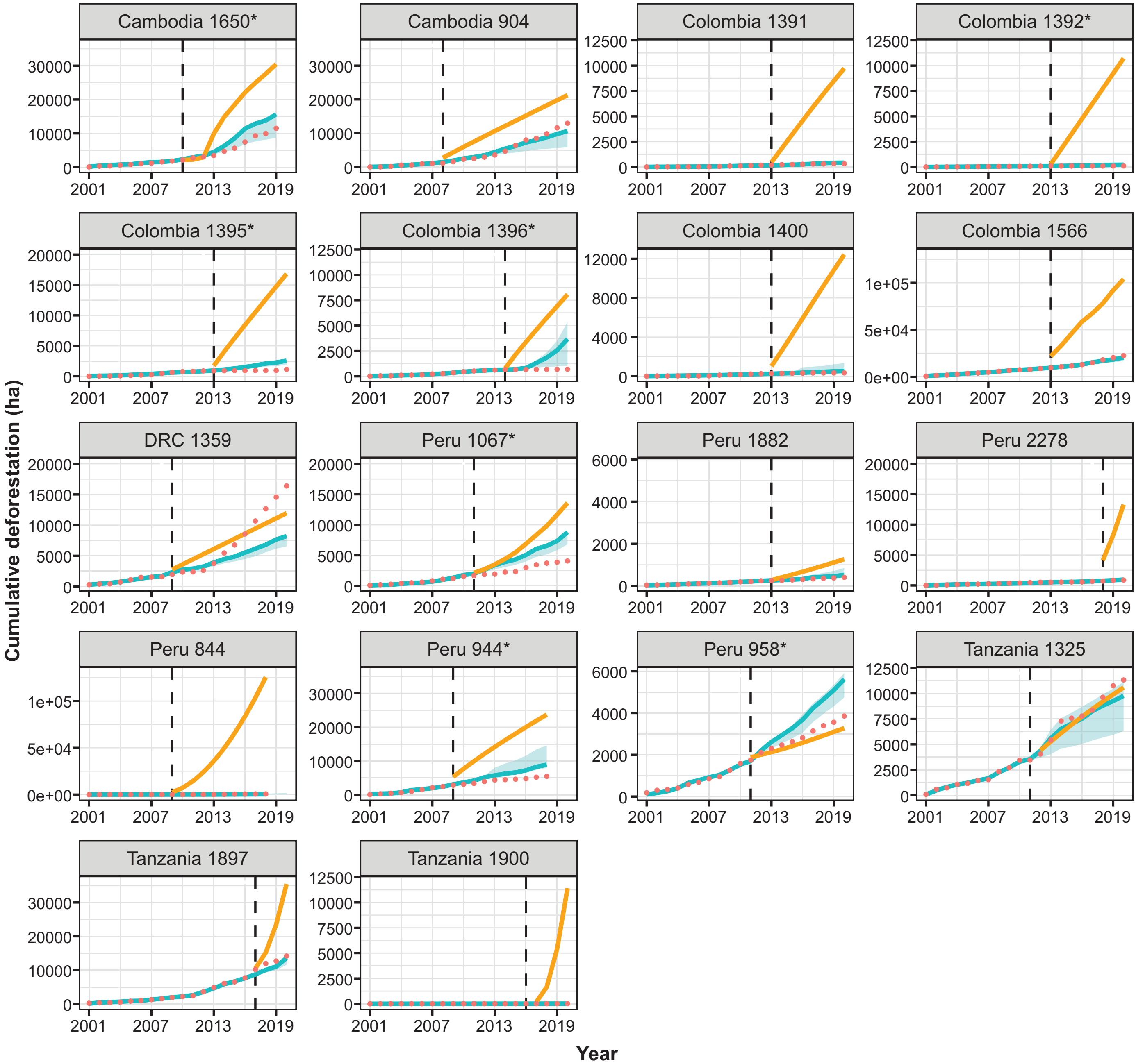

Fig. 3. Cumulative deforestation from the baseline scenarios adopted by the REDD+ projects versus observed cumulative deforestation in the SCs. Orange, REDD+ projects; SCs, blue. Shaded blue areas are possibility intervals. Dotted red lines indicate the observed cumulative deforestation in the project sites. Dashed black lines indicate the project implementation year. Asterisks indicate a significant reduction in deforestation in the REDD+ site compared with the SC based on placebo tests (scales differ).

Last, results from the analysis of already operational versus "to-become" project sites corroborate the findings from the GSC analyses. The average REDD+ impacts on deforestation ranged from −0.01% to 0.12% year^{-1} (or −113 to 121 ha year^{-1}), across different model specifications, but the estimates were not significant in any of the regions (fig. S14).

Carbon-offset implications

We investigated the implications of our findings for the environmental integrity of the credits issued by the REDD+ projects. These implications are based on the 18 out of 26 projects with sufficient publicly available information about baseline deforestation rates (Fig. 3 and tables S5 and S6). Only one project baseline was lower than its SC (project 958), and only one project baseline was similar to its SC (project 1325). All other ex ante baselines posited more deforestation than estimated ex post according to SCs. According to the projects' ex ante estimates, up to 89 million carbon offsets could potentially have been generated by these 18 REDD+ projects through 2020. Yet 60.2 million of these offsets (68%) would have originated from projects that have not significantly reduced deforestation (and carbon emissions) compared with their SCs. The remaining 28.8 million offsets (32%) would have originated from projects likely associated with some avoided deforestation, but not to the extent expected by the project developers. If we replace the ex ante baselines adopted by the projects with the deforestation observed in the SCs, our estimates suggest that only 5.4 million (6.1%) of the

89 million expected offsets from the REDD+ projects would be associated with additional carbon emission reductions.

As of November 2021, those 18 REDD+ projects had issued 62 million carbon-offset credits (table S4). Out of those, at least 14.6 million (24%) have already been used by individuals or organizations around the world to offset their greenhouse gas emissions. Thus, according to our SC-based estimates, these projects have already been used to offset almost three times more carbon emissions than their actual contributions to climate change mitigation—with another 47.4 million carbon offsets being readily available in the market.

Discussion

Overall, the weight of evidence suggests that the voluntary REDD+ projects in our sample across six tropical countries achieved much less avoided deforestation than forecast by project developers. Only a minority of projects achieved statistically significant reductions in comparison with ex post counterfactuals. Our findings corroborate prior studies that questioned the additionality, and thus environmental integrity, of carbon-offset interventions (*11–17*). Ex ante baselines that exaggerate the deforestation that would occur without REDD+, likely facilitated by methodological flexibility in their construction and exacerbated by adverse site selection (*14*), are a major reason for the gap between offsets projected ex ante and actual offsets estimated ex post. Poor performance by the REDD+ projects (failure to de facto reduce deforestation) may also be a factor (*21*, *28*).

In an evaluation of voluntary REDD+ projects in the Brazilian Amazon, West *et al.* (*17*) pointed to the potential confounding effect created by Brazil's post-2004 policy interventions to control deforestation, triggering a widespread reduction in forest loss between 2004 and 2012 (*29*). As a result, the high regional deforestation rates observed before 2004, used to inform the Brazilian project ex ante baselines, likely led to an overestimation of the projects' performance. Yet unlike Brazil, the six countries in this study did not experience a similar nationwide reduction in deforestation after the REDD+ projects were implemented (fig. S3). Hence, the unrealistic ex ante baselines adopted by many projects likely resulted from the use of methodologies that systematically fail to produce credible counterfactuals for the REDD+ interventions, compromising the evaluation of the projects' effect on mitigating deforestation and thus carbon emissions. This may be due to potentially four complementary reasons: poor foresight, adverse site selection, limited room for adjustments over time, and "gaming." First, projects may have (unintentionally) overestimated future deforestation pressures by following baseline methodologies that heavily rely on the continuation of historical trends that no longer represent current conditions, often combined with problematic spatial deforestation projections (*19*, *30*). Second, projects may have been preferentially sited where conditions are conducive to reducing deforestation and therefore where deforestation may have been lower than suggested by ex ante baselines constructed from deforestation trends in the surrounding region (*14*). Third, rules adopted by certification standards require baselines to be fixed for a period of usually 10 years, restricting adjustments to reflect changes in deforestation drivers over time (*23*). Last, flexibility in baseline methodologies may have been opportunistically exploited to maximize revenues from offset sales.

By contrast, both standard and generalized SC methods use pre-REDD+ information to identify control areas but use contemporaneous ex post information on deforestation in the project and control areas to measure additionality. Following well-accepted guidelines for rigorous impact evaluation (*31*), if properly selected, such ex post counterfactuals can capture the effects of contemporaneous changes in deforestation drivers and thus are less likely to generate effect estimates confounded by external factors (*10*, *17*). REDD+ projects adopting a similar dynamic approach would likely reduce the additionality problems with project ex ante baselines and offsets identified in this study.

Despite the clear advantages (from a causal inference perspective) of using ex post methods such as SCs to construct deforestation baselines for REDD+ interventions, some implementation and monitoring challenges would likely arise from their adoption. First, given the biophysical heterogeneity of tropical regions, and limited data, ideal control areas for the project sites may not always exist or be possible to identify (supplementary materials, appendix A). Second, those control areas could be manipulated (for example, intentionally degraded or conserved) to misleadingly improve or reduce estimated project performance. Third, dynamic baselines may still fail to account for all relevant determinants of deforestation owing to data constraints. Last, long-lasting voluntary REDD+ projects may eventually outlive their SCs as new interventions or other regime shifts occur in control sites.

One alternative would be to require projects to adopt transparent ex ante jurisdictional baselines that are preestablished by government agencies. Although these baselines might still fall short at demonstrating causal links and thus additionality, they could be both more transparent and updated more frequently than individual project baselines to reflect emerging deforestation pressures and spatial patterns. Reductions in deforestation relative to jurisdictional baselines would still have to be correctly attributed to either government efforts to control forest loss or to private REDD+ interventions (*10*), in addition to changes in external deforestation drivers (such as agricultural commodity prices). Transferring the responsibility of baseline construction from project developers to jurisdictions could reduce the room for "baseline gaming," although the risk of adverse site selection could remain (*14*). On balance, nesting voluntary projects into subnational jurisdictions appears to be a promising future pathway for REDD+, a practice that is gaining traction globally (*6*). However, the specifics of implementation are crucial and require careful consideration.

Another possible explanation for limited additionality is poor performance by the projects. This would be likely if projects were failing to control deforestation in project areas. We observed generally low deforestation rates in project areas, but we cannot compare that with the projects' targeted deforestation rates in those areas because those are not always reported in the publicly available information on projects. However, it is clear that some projects have struggled with on-the-ground implementation and execution of envisioned conservation activities; others may have promoted ineffective actions, whether because of funding uncertainties, slow commercialization of carbon credits, lack of experience, or poor management (*21*, *28*, *32*). Many projects claimed to have started much earlier than the year they were certified. Although this allows projects to issue and sell retroactive offsets immediately after certification (*33*), it also implies that they did not have access to carbon funding during their initial years, potentially compromising the execution of planned conservation actions.

A recent evaluation on the effectiveness of the same type of REDD+ interventions reported significant reductions in average deforestation rates (*34*). The study, based on satellite pixel matching, estimated an average deforestation rate of 0.2% year^{-1} in the REDD+ sites versus 0.4% year^{-1} for their matched control areas. The size of these estimates is similar to some of our estimates from GSC analyses; but in our case, they were statistically insignificant, potentially because of our smaller sample sizes compared with the pixel-based samples from the previous study. And from the offsetting perspective, the average reductions—significant or not—were substantially lower than the additional reductions in deforestation projected and claimed by the projects.

Our study provides further evidence on the effectiveness of voluntary REDD+ projects and questions their de facto additionality (*35*). Only a minority of the projects significantly reduced deforestation in the project areas compared with the ex post counterfactuals, and even those, with one exemption, did not reduce deforestation to the extent claimed. Although REDD+ payments are typically conditioned on performance in project areas, only the offsets associated with additional reductions in deforestation relative to a counterfactual genuinely offset emissions of potential buyers in the voluntary carbon markets (*7*, *21*). Certification schemes are allegedly in place to safeguard the additionality of offsets, but our results indicate that currently used baseline methodologies do not guarantee additionality. It is critical to develop new and rigorous methods for the construction of credible deforestation baselines for voluntary REDD+ interventions and to properly and regularly assess their contribution to climate change mitigation.

Last, the evidence from this and other studies indicates that some voluntary projects have effectively reduced deforestation (*34*), particularly in Peru. For REDD+ to be scaled and achieve its ambitious goals worldwide, it is paramount that we better understand the factors that drive both mitigation performance and impacts on local communities. Building on this knowledge, academics, practitioners, and policy-makers must form effective partnerships to help REDD+ fulfill its original promise.

REFERENCES AND NOTES

1. A. Angelsen, *Rev. Dev. Econ.* **21**, 237–264 (2017).
2. J. Börner *et al*., in *Transforming REDD+: Lessons and new directions*, A. Angelsen *et al*., Eds. (CIFOR, 2018), pp. 105–116.
3. FAO, "From reference levels to results reporting: REDD+ under the United Nations Framework Convention on Climate Change. 2019 update" (Food and Agriculture Organization, Rome, 2019).
4. S. S. Atmadja *et al*., *Environ. Res. Lett.* **17**, 044038 (2022).
5. S. Donofrio, P. Maguire, C. Daley, C. Calderon, K. Lin, *The Art of Integrity: State of the Voluntary Carbon Markets 2022 Q3* (Forest Trends' Ecosystem Marketplace, 2022).
6. D. Lee, P. Llopis, R. Waterworth, G. Roberts, T. Pearson, *Approaches to REDD+ Nesting: Lessons Learned from Country Experiences* (World Bank, 2018).
7. Taskforce on Scaling Voluntary Carbon Markets, *Phase 1—Final Report* (Institute of International Finance, 2021).
8. Voluntary Carbon Markets Integrity Initiative, *Aligning Voluntary Carbon Markets with the 1.5°C Paris Agreement Ambition* (Voluntary Carbon Markets Integrity Initiative, 2021).
9. A. E. Duchelle, G. Simonet, W. D. Sunderlin, S. Wunder, *Curr. Opin. Environ. Sustain.* **32**, 134–140 (2018).
10. E. O. Sills *et al*., *Glob. Environ. Change* **43**, 148–160 (2017).
11. G. Badgley *et al*., *Glob. Change Biol.* **28**, 1433–1445 (2022).
12. R. Calel, J. Colmer, A. Dechezleprêtre, M. Glachant, *SSRN Electron. J.* **5709** (2021).
13. M. Cames *et al*., *How Additional is the Clean Development Mechanism?* (Öko-Institut e.V., 2016).
14. P. Delacote, G. Le Velly, G. Simonet, *Resour. Energy Econ.* **67**, 101277 (2022).
15. B. Haya *et al*., *Clim. Policy* **20**, 1112–1126 (2020).
16. A. Kollmuss, L. Schneider, V. Zhezherin, *Has Joint Implementation Reduced GHG Emissions? Lessons Learned for the Design of Carbon Market Mechanisms* (Stockholm Environment Institute, 2015).
17. T. A. P. West, J. Börner, E. O. Sills, A. Kontoleon, *Proc. Natl. Acad. Sci. U.S.A.* **117**, 24188–24194 (2020).
18. J. Busch, K. Ferretti-Gallon, *Rev. Environ. Econ. Policy* **11**, 3–23 (2017).
19. S. Sloan, J. Pelletier, *Glob. Environ. Change* **22**, 440–453 (2012).
20. M. Ehara *et al*., *For. Policy Econ.* **129**, 102474 (2021).
21. C. Seyller *et al*., *Int. For. Rev.* **18**, 231–246 (2016).
22. S. Wunder, *Conserv. Biol.* **21**, 48–58 (2007).
23. Verra, VCS Standard, version 4.0 (Verra, 2019).
24. A. Abadie, A. Diamond, J. Hainmueller, *J. Stat. Softw.* **42**, 1–17 (2011).
25. Y. Xu, *Polit. Anal.* **25**, 57–76 (2017).
26. K. Imai, I. S. Kim, E. H. Wang, *Am. J. Pol. Sci.* **0**, 1–19 (2021).
27. J. R. Zubizarreta, R. D. Paredes, P. R. Rosenbaum, *Ann. Appl. Stat.* **8**, 204–231 (2014).
28. M. S. Verra, Suruí Forest Carbon Project (2018); https://verra.org/media-statement-surui-forest-carbon-project.
29. T. A. P. West, P. M. Fearnside, *Land Use Policy* **100**, 105072 (2021).
30. O. Mertz *et al*., *J. Land Use Sci.* **13**, 1–15 (2018).
31. P. J. Ferraro, M. M. Hanauer, *Annu. Rev. Environ. Resour.* **39**, 495–517 (2014).
32. S. Wunder *et al*., *Front. For. Glob. Change* **3**, 11 (2020).
33. N. Linacre, R. O'Sullivan, D. Ross, L. Durschinger, I. Deshmukh, "REDD+ Supply and Demand 2015–2025" (US Agency for International Development, 2015).
34. A. Guizar-Coutiño, J. P. G. Jones, A. Balmford, R. Carmenta, D. A. Coomes, *Conserv. Biol.* **36**, e13970 (2022).
35. A. Angelsen, *Moving ahead with REDD: Issues, Options and Implications* (CIFOR, 2008), vol. 6.
36. T. A. P. West, Replication Data for: Action needed to make carbon offsets from forest conservation work for climate change mitigation. *DataverseNL* (2023); https://doi.org/10.34894/IQC9LM.

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SUPPLEMENTARY MATERIALS

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Materials and Methods
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Editor's summary
Reducing emissions from deforestation and forest degradation (REDD) projects are intended to decrease carbon emissions from forests to offset other carbon emissions and are often claimed as credits to be used in calculating carbon emission budgets. West *et al*. compared the actual effects of these projects with measurable baseline values and found that most of them have not reduced deforestation significantly, and those that did had benefits substantially lower than claimed (see the Perspective by Jones and Lewis). Thus, most REDD projects are less beneficial than is often claimed. —H. Jesse Smith

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