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The cost and distribution of forest conservation for national emissions reductions

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ABSTRACT

Tropical forest conservation for carbon-emission reductions (REDD+) has historically been implemented in a highly localized, directed manner, which is quickly proving unamenable to the transition towards national-scale REDD+ implementation. National REDD+ forest conservation schemes would arguably ideally adopt more spatially dispersed, voluntary and, presumably, cost-efficient modes. Yet the actual benefit of doing so is uncertain, and the prospect of a renewed reliance on familiar, localized conservation schemes cannot be discounted. An ill-designed scheme threatens costly emission reductions and, ultimately, reduced commitments to emission reductions. Here, we integrate spatial projections of forest conversion and degradation with detailed field surveys of land-use revenues to model the cost efficiency of national conservation in Panama corresponding to three emission-reduction schemes: (i) disperse conservation amenable to voluntary, incentivised landholder participation, (ii) locally-concentrated, implicitly exogenous conservation interventions, and (iii) a middle-ground between these two. Each scheme meets national emission-reduction targets (ERTs) of 5–50% of business-as-usual emissions with minimal real land-use opportunity costs accounting for the uncertainties of land-use change. Real absolute opportunity costs are $4–$62 million for a 10% ERT and 20-year horizon but tend towards the lower quarter of this range. These costs are less than previously estimated and more amenable to current REDD+ funding levels, albeit still apparently a challenge to offset given available REDD+ funding and forest carbon-emission rates. While disperse conservation is invariably most economical according to our models, opportunity costs and efficiencies amongst schemes are relatively comparable for ERTs of ≤15%. This suggests that a continued reliance on REDD+ 'projects' during early REDD+ implementation may not entail undue inefficiencies. At ERTs of > 15%, opportunity costs increase more rapidly than cost efficiencies decrease, albeit less markedly for the disperse conservation scheme, recommending it for intermediate ERTs. Avoided forest degradation underpins emission-reduction efficiencies, particularly for disperse schemes and at lower ERTs, where it accounts for slightly over ~50% of avoided emissions. Still, conservation schemes preempt forest degradation less often than expected, considering its low economic value and large national extent, highlighting practical limits to efficient 'spatial targeting' of specific agricultural systems. Modelled REDD+ conservation occurs disproportionately in indigenous territories, where opportunity costs are low. Hence most projected forest change / land use in indigenous territories is incorporated within conservation schemes by the 20% ERT. This highlights potential equity issues for least-cost conservation as well as the importance of Amerindian participation in national REDD+ schemes.

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1. Introduction

Changes to the area and condition of tropical forests are major factors in the global carbon budget (Pan et al., 2011). Tropical forest loss and degradation is a major source of carbon emissions, with forest conversion alone accounting for ~11% of global emissions (van der Werf et al., 2009; Baccini et al., 2012; Houghton, 2012). Reflecting the belief that most tropical forest conversion and degradation is driven by underproductive land use and, therefore, that forest-emission reductions may be achieved at relatively low economic and societal costs (Gullison et al., 2007), the UNFCCC adopted an agenda to Reduce Emission from Deforestation (RED) agenda in 2007, later expanded to incorporate avoided forest degradation and the enhancement of carbon stocks (REDD+). Some 111 tropical/developing countries have since collaborated with the United Nations REDD+ Programme and the World Bank Carbon Partnership Facility to prepare for REDD+ implementation, and major bi-lateral programmes have spurred forest-management reforms in high-emission countries such as Brazil and Indonesia (Sloan et al., 2012; Gibbs et al., 2015).

Progressive changes to REDD+ policy and implementation since 2007 have meant that appropriate, effective conservation schemes for emission reductions remain experimental, even conflicting. International negotiations and financial pledges for REDD+ were slowed and uncertain by the early 2010s (Angelsen and McNeill, 2012; Pistorius, 2012; Norman and Nakhooda, 2014), leading REDD+ activities to assume conservative postures characterised by local-scale 'projects' in which the State played a limited role. Indonesia, for example, hosted at least 44 REDD+ pilot/demonstration projects, mostly sponsored by non-State agents (Agung et al., 2014: Fig. 4). Revised national forest-emission accounting requirements and resurgent REDD+ funding are now shifting REDD+ activities from constellations of projects to national-level interventions in which the State is a more vested participant. National governments are increasingly developing REDD+ strategies that entail varying degrees of decentralized forest-conservation incentives and exogenous conservation interventions supported by government policy. In this context, this article assesses the cost efficiencies of achieving REDD+ emission reductions via national schemes ranging from localised projects to more generalised, spontaneous activities.

Here we model the land-use opportunity costs of REDD+ conservation according to locally-concentrated and more disperse national forest-conservation schemes. Costs were assessed over progressively greater emission-reduction targets, taking Panama as a case study. Difference in the opportunity costs and geographies of the conservation scenarios indicate the degree to which a given scheme may be preferable in terms of cost efficiency, either in isolation or in combination, and over which emission-reduction targets. Our observations cautiously suggest a comparability of opportunity costs between schemes over lower emission-reduction targets relevant to early REDD+ implementation, but also rapidly increasing and divergent cost inefficiencies thereafter. Our findings provide guidance to future REDD+ implementation pantropically in terms of potential opportunity costs, conservation design and efficacy, and the trade-offs entailed.

1.1. A brief history of REDD+ developments and related forest-conservation schemes

REDD+ was originally conceived as nested payment-for-environmental service (PES) schemes ranging from local to national scales, with the goal of reducing national forest-carbon emission reductions via nationally-coordinated initiatives by State and non-State agents (Angelsen and Wertz-Kanounnikoff, 2008). The underlying idea is that REDD+ would compensate countries for emission reductions proportionate to the opportunity costs of foregone land use and associated implementation costs, yielding an efficient outcome without net losers (Chomitz et al., 2007). Efficient REDD+ design quickly proved more challenging than envisaged (Angelsen and McNeill, 2012; Pistorius, 2012; Minang et al., 2014), culminating in a three-phase implementation approach since 2007 (Angelsen et al., 2008; Wertz-Kanounnikoff and Angelsen, 2009) (*UNFCCC 2007 Decision 2/CP13)*. In Phase 1, 'REDD+ readiness', governments undertake capacity building and local REDD+ demonstration activities. In Phase 2, 'nested REDD+', local REDD+ projects are complemented, enhanced, and/or incorporated by national conservation schemes as governments increasingly coordinate national implementation (Pedroni et al., 2010). Phases 1 and Phase 2 were largely and increasingly characterised by locally-targeted, spatially-concentrated, explicitly-delineated REDD+ 'projects', e.g., designations of new protected areas, management of local forest 'buffer' zones (Wertz-Kanounnikoff and Kongphan-apirak, 2009; Sunderlin and Sills, 2012; Agung et al., 2014). In Phase 3, 'results-based payments', countries would be financially rewarded for reducing national emissions below a reference level. Four countries have commenced Phase 3, and eight others are likely to commence imminently (GCF, 2017:[27]).

A legacy of 'localised REDD+' owes to uncertainties over the global REDD+ agenda and an ascendency of conservation-and-development activities. Momentum towards Phase 3 waned following the failure to negotiate a global climate treaty at the 15th Conference of the Parties to the UNFCCC in late 2009, on which Phase-3 funding was presumed contingent, followed by the failure of a remedial 2010 REDD+ Partnership seeking to "scale-up REDD+ actions and finance" (Viña and Lee, 2014). Governments also became more aware that REDD+ funding may not cover the full opportunity costs of conservation (Fosci, 2013; Borrego and Skutsch, 2014; Cacho et al., 2014). Conservative attitudes favouring risk-adverse, locally-concentrated conservation schemes were strengthened. Official development aid (ODA) agreements increasingly and significantly filled this void (Streck, 2012; Streck and Parker, 2012; Norman and Nakhooda, 2014), shaping REDD+ activities according to the norms of this sector. ODA financiers strengthened linkages with NGOs, conservation interests, and indigenous advocates to incorporate REDD+ into local conservation-and-development agendas (Putz and Romero, 2012; Sunderlin and Sills, 2012; Visseren-Hamakers et al., 2012; Agung et al., 2014: Fig. 4), culminating in the 'NGOisation' of REDD+ (Runeberg, 2012). Resultant 'hybrid' local REDD+ projects suited ODA interests. Projects facilitated quick expenditures for short-term 'deliverables' from tangible activities. Risks and rewards were 'known quantities' from well-delineated sites (e.g., indigenous territories). Risks of REDD+ non-compliance or limited REDD+ income were hedged against parallel conservation-and-development activities. The degree of REDD+ hybridisation became such that REDD+ "risk[ed] losing the essential features of results-based payments and national level reforms and becoming merely another form of development assistance in support of conventional forest management projects" (Angelsen and McNeill, 2012: 49).

Recent developments in global REDD+ policy have undermined localised REDD+ and renewed the impetus for national schemes, which remain experimental. The 'Warsaw Pillars' of REDD+ implementation, defined at the 19th Conference of the Parties in late 2013, re-affirmed REDD+ as a national-scale endeavour and tasked countries with defining national reference-emission levels and monitoring national emissions from forests. These developments had far-reaching implications for REDD+ conservation design. The nesting of REDD+ projects within national emissions accounting frameworks quickly proved to be very difficult. REDD+ projects differ in their emission reference levels and monitoring systems, both amongst each other and relative to those adopted by their host countries. (Some 25 countries have submitted reference levels to the UNFCCC (GCF, 2017:[27])). This incompatibility excluded projects from national accounting frameworks, or at least demanded costly concessions upon integrating them, as in Ecuador. Recently resurgent REDD+ funding mechanisms (e.g., the UNFCCC Green Climate Fund, the Carbon Fund of the Forest Carbon Partnership Facility, and bilateral agreements with Norway, Germany, and the UK) also adopted the Warsaw Pillars, closing these funds to REDD+ projects