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Biodiversity co-benefits of policies to reduce forest-carbon emissions

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Climate change and biodiversity loss are leading environmental crises that converge most critically in tropical forests. Policies for reducing emissions from deforestation and degradation are often portrayed as win–win solutions for forest-based climate change mitigation and biodiversity conservation. However, the win–win narrative has obscured necessary trade-offs and a range of alternative policy approaches, insulating policymakers from difficult, potentially unpopular decisions. We provide a typology that characterizes the five underlying policy approaches for linking forest-based climate change mitigation and biodiversity conservation and their related trade-offs. Such clarification will enable policymakers and stakeholders to better articulate their positions in the protracted and controversial biodiversity co-benefits debate that is at the centre of contemporary conservation efforts.

Policies for Reducing Emissions from Deforestation and forest Degradation (REDD+) under development through the United Nations Framework Convention on Climate Change (UNFCCC) will financially reward developing countries that reduce forest-based carbon emissions through initiatives to decrease deforestation and forest degradation, conserve and enhance forest-carbon stocks and promote sustainable forest management[1]. REDD+ policies have been widely recognized for their potential to jointly address declines in forest-based carbon stores and biodiversity[2]. Yet, the prospect of win–win solutions has obscured the differences among prospective REDD+ policies, insulating decision-makers from difficult choices. In fact, the options for linking biodiversity conservation to proposed forest-based climate change mitigation strategies have yet to be clearly articulated[3], even though they are at the heart of contemporary debates about the environment and involve transformative policies for forests across the tropics[2,4–6]. Based on a review of the REDD+ literature, we identify the five principal approaches to linking forest-based climate change mitigation and tropical biodiversity conservation and their related trade-offs (Table 1). This clarification[7] should enable REDD+ policymakers and stakeholders to state their positions regarding the expected biodiversity outcomes of REDD+ interventions.

Recent UNFCCC decisions have encouraged tropical countries to optimize additional biodiversity co-benefits[1,8], the issue addressed here. UNFCCC decisions have also raised the related but distinct issue (not the focus here) of REDD+ safeguards to avoid perverse incentives or unintentional harm to biodiversity. There is now widespread recognition that REDD+ policies should safeguard against unintended consequences such as the displacement of deforestation and degradation activities into neighbouring low-carbon ecosystems that nonetheless host important biodiversity[1,9,10]. As with other environmental regulations, the costs associated with applying and monitoring these types of safeguard are likely to be integrated into the cost of REDD+ implementation[6,11].

However, REDD+ debates, including those within the UNFCCC, often reference safeguards as a catch-all term. This has led to some confusion. Following the work of others[6], we enforce a necessary distinction and define safeguards as minimum requirements for avoiding apparent risks to biodiversity that are considered necessary for all participating countries. Biodiversity co-benefits, also referred to as additional benefits, refer to additional biodiversity benefits above an agreed-upon baseline and are neither necessarily standard nor required. This Perspective addresses biodiversity co-benefits, as a much more uncertain and contentious prospect.

Biodiversity concerns lie on many scales[12] and prioritization schemes are based on diverse criteria (for example, Conservation International's biodiversity hotspots and Alliance for Zero Extinction's priority sites). It is widely recognized that the high biodiversity of tropical forests suggests that many REDD+ interventions could provide ancillary biodiversity co-benefits[4,13]. More than 20 developing countries have commenced forest-sector reforms linked to REDD+ policies[14]. Review of pioneer REDD+ initiatives reveals a bias towards countries with both high carbon densities and high numbers of threatened species[15], suggesting that early project developers are indeed seeking win–win outcomes. Nearly every large organization for biodiversity conservation in the world and the secretariat of the Convention on Biological Diversity have now also established REDD+ programmes[16–18]. International donors pledged approximately US$4 billion in REDD+ funding between 2010 and 2012 (ref. 19), overshadowing traditional conservation finance[20]. Many donors are explicitly seeking joint carbon–biodiversity outcomes[21]. Contemporary tropical conservation is thus heavily guided by REDD+ policies, even though the biodiversity outcomes of REDD+ interventions remain uncertain.

Five approaches to forest-carbon–biodiversity links

Despite the widespread interest in optimizing carbon and biodiversity outcomes, policymakers face trade-offs, especially when high carbon and high biodiversity do not geographically overlap, and where REDD+ interventions to protect or enhance carbon stocks would not equally promote biodiversity co-benefits[22]. Moreover, policymakers face diverse approaches for conceptualizing the relations between biodiversity conservation and the reduction of forest emissions. Figure 1 depicts five distinct ways in

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Table 1 | Five policy approaches to biodiversity co-benefits of REDD+ policies — principal strengths and limitations.

Main policy approaches	Strengths	Limitations
(1) REDD+ policies provide biodiversity-conservation benefits at no extra cost.	• Establishes a basic prioritization scheme for targeting REDD+ investments[2,64]. • Protects biodiversity across broad areas threatened by deforestation, even at a relatively low price for carbon[28]. • Maximizes investments by offering many environmental services in return for carbon payments[35]. • Provides biodiversity co-benefits without compromising the efficiency of REDD+ emissions reductions[49]. • Minimizes political resistance as a policy approach because it meets the needs of diverse stakeholders[49]. • Reduces the potential of funding duplication at priority sites[35].	• Overlooks countries and sites with high biodiversity but relatively low carbon densities, or high opportunity costs[10,22,26,43–47,65]. • Assumes that REDD+ interventions automatically benefit biodiversity, whereas REDD+ actions would actually require careful planning to ensure co-benefits (for example, best practices in forest restoration[30]) and some prospective REDD+ interventions may harm or provide limited biodiversity co-benefits (for example, plantation development[11]). • Lacks landscape-level approach to resource management and might allow the displacement of deforestation and forest-degradation pressures (leakage) to non-REDD+ sites[2,9,49]. • Overlooks carbon–biodiversity trade-offs facing many REDD+ decision-makers[22,43]. • May redirect traditional biodiversity-conservation funding towards initiatives that also promote carbon benefits.
(2) Carbon and biodiversity are different ecosystem attributes that represent separate policy concerns.	• Prioritizes cost-efficiency of REDD+ emissions reductions. • Avoids overburdening a future REDD+ mechanism with excessive biodiversity monitoring and reporting requirements that could restrict participation and investor interest[32–34,47]. • Allows countries and donors flexibility in their conservation strategies and allocation of resources by allowing projects to take different areas of focus[2,9,35,37].	• Represents a political compartmentalization of carbon and biodiversity[9,31]. • Requires parallel REDD+ and biodiversity-conservation programmes and fails to seek synergies that could enhance conservation efficiency[38,40,44]. • Limits the potential for landscape-level management[31] and might allow the displacement of deforestation and forest-degradation pressures (leakage) to sites not prioritized based on carbon criteria[9,49]. • Potentially overlooks biodiversity in forests protected exclusively for carbon services and could result in loss of forest-dwelling species[50]. • May establish competition for funding between conservation projects that target biodiversity and carbon.
(3) A REDD+ mechanism can achieve significant biodiversity conservation through separate add-on incentive mechanisms.	• Prioritizes cost-efficiency of REDD+ emissions reductions. • Biodiversity co-benefits would be achieved in the most cost-effective ways and places. • Politically attractive approach to integrating co-benefits into REDD+, as it avoids excessive regulations and taxes, allowing investors and donors to choose whether they will absorb the additional costs associated with biodiversity co-benefits[34,37,52,66]. • Allows for a diversity of incentive mechanisms, including biodiversity premiums, credit auctioning, philanthropic support, technical support and parallel markets[5,35,47,53,65,67]. • Could combine REDD+ financing with other revenue streams to offset opportunity costs, including at sites with relatively low carbon densities[10,34,45,49,65]. • Allows for verification of co-benefits through external certification schemes, depending on project needs[52].	• Overlooks the limited scale of voluntary payments for co-benefits and the potential for future carbon markets to demand low-cost emissions reductions[9,34,55]. • Fixed biodiversity premiums for co-benefits would reduce efficiency by overlooking site-specific opportunity costs[47]. • Represents a political compartmentalization of carbon and biodiversity[9,31]. • May disproportionately favour the conservation of sites with charismatic species that can recruit voluntary support[50]. • Overlooks sites with very low carbon stocks and very high opportunity costs, where conservation might not be cost-effective.
(4) REDD+ provides an opportunity to conserve biodiversity through targeted interventions, at only a marginal increase in cost.	• Delivers biodiversity co-benefits in the most cost-effective ways and places. • Expands the areas across which REDD+ could be financially viable, increasing biodiversity co-benefits[38–40,44,65]. • Introduces widespread biodiversity monitoring[9,48].	• Marginally reduces cost-efficiency of REDD+ emissions reductions (though not as much as approach (5)). • Increases burden on implementing countries and project developers[22,34,56]. • Presents the challenge of identifying adequate biodiversity indicators and consensus for their global application[10,22,34]. • Relies on a subjective valuation of biodiversity to justify the increased costs of including co-benefits, which could prove contentious during debates over REDD+ financing[49]. • Overlooks sites with very low carbon stocks and high opportunity costs, where conservation might not be cost-effective.

Table 1 | Continued

Main policy approaches	Strengths	Limitations
(5) Biodiversity conservation is necessary to sustain stores of forest carbon.	• Seeks to address the permanence of emissions reductions by protecting long-term ecosystem function[18,41,58]. • Links climate change mitigation and adaptation through focus on ecosystem function, stability and resilience[5]. • Values diverse ecosystem attributes and ensures that REDD+ supports biodiversity conservation. • Introduces standardized biodiversity monitoring across the tropics[9,42].	• Increases REDD+ monitoring costs[34,56]. • Reduces the cost-efficiency of emissions reductions through REDD+[55,34]. • Prioritizes high-biodiversity sites that may also be associated with higher opportunity costs[9,38,59], further reducing efficiency of REDD+ emissions reductions. • Relies on a subjective valuation of biodiversity to justify the increased costs of including co-benefits, which could prove contentious during debates over REDD+ financing[49]. • Relies on uncertain premises, as there is limited scientific evidence of a link between forest-based biodiversity and long-term carbon storage[58]. • Represents a long-term approach towards forest management and conservation, when most REDD+ investments are 20–40 years[55]. • Increases the burdens on implementing countries and project developers that could reduce participation in REDD+[34,56]. • Presents the challenge of identifying adequate biodiversity indicators and consensus in their global application[10,22,34].

which the links between carbon and biodiversity are conceptualized in debates about REDD+ mechanisms. These potentially offer very different carbon and biodiversity outcomes.

(1) REDD+ policies provide benefits to biodiversity conservation at no extra cost. This approach highlights REDD+ as a win–win opportunity[23,24]. It holds that the high biodiversity of tropical forests and geographical overlaps between forests with high carbon density, high biodiversity and conservation-priority designation suggests that REDD+ offers inherent biodiversity conservation co-benefits at many sites[23–28]. It also suggests that many REDD+ interventions, such as incentives to reduce deforestation and to enhance carbon stocks through reforestation, will generally deliver positive biodiversity outcomes[28–30].

(2) Carbon and biodiversity are different ecosystem attributes that represent separate policy concerns. This approach decouples the issues of biodiversity conservation and climate change mitigation[9,31]. It holds that a future REDD+ mechanism should focus on its climate change mandate and maximize carbon-emissions reductions[32,33] rather than attempt to integrate extra measures for biodiversity protection. Any negative impacts of REDD+ projects on biodiversity would need to be dealt with through the process of environmental impact assessment, such as that used for any other major development.

(3) A REDD+ mechanism can achieve significant biodiversity conservation through separate add-on incentive mechanisms. This approach views REDD+ as a co-financing opportunity for biodiversity conservation[5,34], whereby biodiversity co-benefits can be obtained cheaply if interventions are developed alongside REDD+ projects. It suggests that additional costs of biodiversity co-benefits should be addressed through voluntary add-on incentives, such as a premium in a future carbon marketplace, donor government subsidies, technical support and parallel ecosystem-service markets[34–36]. Policies based on this approach would seek to maximize biodiversity conservation without compromising the cost-efficiency of REDD+ emissions reductions.

(4) REDD+ provides an opportunity to conserve biodiversity through targeted interventions, at only a marginal increase in cost. This approach seeks to maximize biodiversity co-benefits at a marginal reduction to the efficiency of climate change mitigation. It suggests that biodiversity conservation through REDD+ could be enhanced by targeting priority regions and sites, with limited trade-offs in emission reductions and slightly increased costs[9,37–40], which would be explicitly incorporated into REDD+ payments[38].

(5) Biodiversity conservation is necessary to sustain stores of forest carbon. This approach argues that the long-term ability of forest ecosystems to sequester and retain carbon depends on the maintenance of ecosystem integrity and biological diversity[4,18,41]. It holds that a future REDD+ mechanism must therefore also prioritize non-carbon ecosystem and biodiversity co-benefits — integrating biodiversity-priority sites, landscape-level management and the monitoring and reporting of biodiversity alongside carbon emissions[18,31,42]. This approach thus makes little distinction between biodiversity co-benefits and safeguards, as it conceives biodiversity as an integral part of REDD+ planning.

Differentiating policy approaches

The five approaches in this typology are often conflated. Yet, the approaches involve trade-offs that have not been comprehensively explored[3,22,43] (Table 1). We consider the leading strengths and weaknesses of REDD+ conducted under each approach (Table 1), anticipating the principal responses of on-the-ground conservation actions.

(1) REDD+ policies on forest protection provide a win–win solution for biodiversity conservation and climate change mitigation. This approach suggests that carbon–biodiversity synergies widely exist, such that mutual benefits would be widespread and possible at no additional cost[25–28]. Stakeholders subscribing to this approach would, however, be likely to focus on sites and interventions capable of maximizing benefits (for example, the conservation of forests rich in both carbon and biodiversity). On-the-ground conservation would tend to focus on site-specific management and on strengthening REDD+ initiatives with planning, training and monitoring support to ensure they effectively protect biodiversity.

Achievement of such win–win outcomes depends on the degree of spatial congruence between areas of high biodiversity and high carbon stocks and on demonstrable carbon and biodiversity benefits of specific REDD+ interventions. In practice this approach may be limited by the fact that the conditions for win–win outcomes are

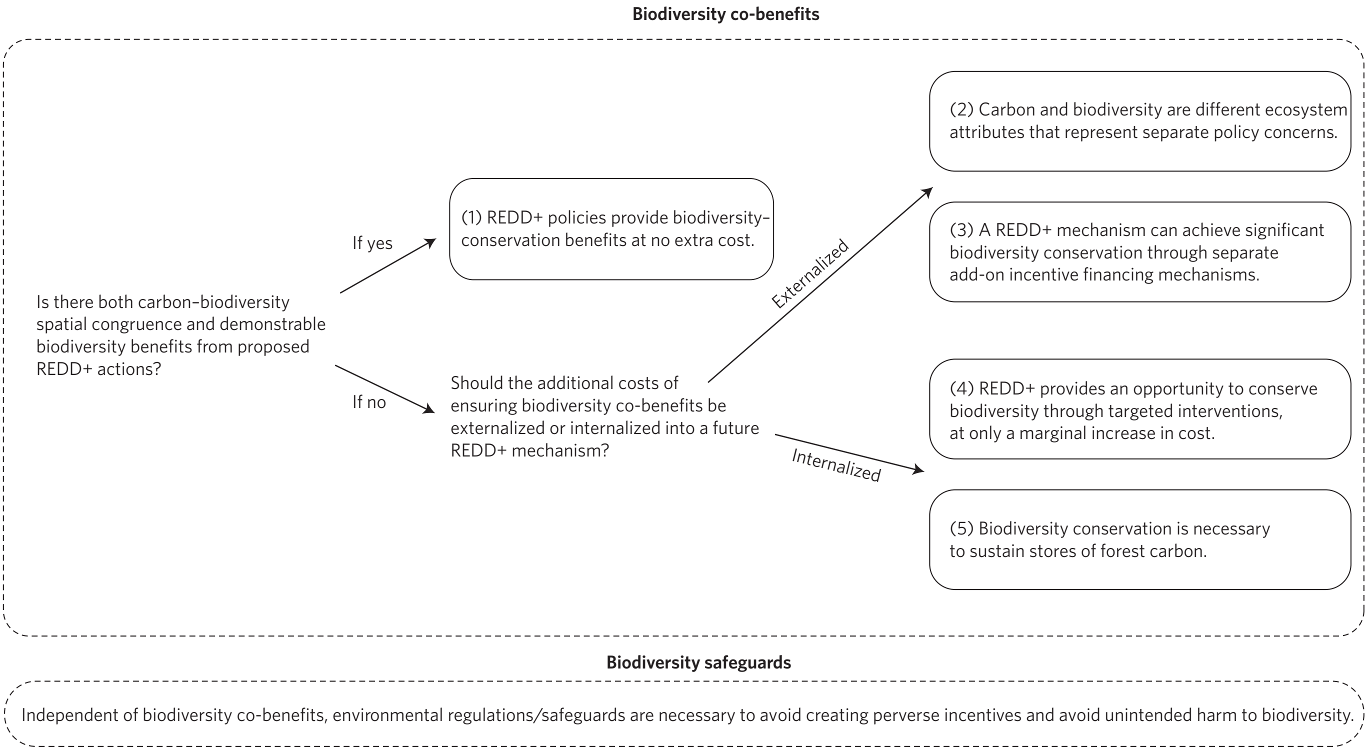

Figure 1 | Conceptualization of the relationships between forest-based carbon and tropical biodiversity through REDD+. Carbon–biodiversity REDD+ links involve both safeguards and co-benefits. Synergies (through geographical and activity overlaps) can yield joint biodiversity and carbon outcomes, (1). Where synergies are absent, the literature reveals four principal approaches, (2)–(5). Among the features that differentiate these, the greatest relates to the ways in which they internalize or externalize the additional costs of providing biodiversity co-benefits.

stringent and require planning that specifically considers co-benefits[22,30,44]. As a result, conservation-priority sites with lower carbon densities would lack REDD+ protection[26,43–47], so conservationists would require other means for protecting excluded sites (Fig. 1). Furthermore, national and landscape-level planning would be imperative to prevent a site-specific focus from allowing deforestation and degradation pressures to shift among sites[2,9,47] (so-called leakage). As such, proponents of this approach might need to nest stand-alone conservation actions within larger, landscape-level planning[48], through the use of tools such as gap analysis[18].

(2) Carbon and biodiversity are different ecosystem attributes that represent separate policy concerns. This approach prioritizes low-cost emissions reductions and avoids overburdening a future REDD+ mechanism with biodiversity co-benefits and associated planning and monitoring[32–34,47]. Under this approach, introducing plantation forestry into heavily degraded areas to increase carbon stocks would be acceptable, even if it offered no biodiversity co-benefits. Agencies with biodiversity-conservation mandates would probably pursue their goals independently of REDD+ projects, limiting their involvement in REDD+ to ensure that impact assessments were conducted and negative impacts on biodiversity mitigated. This approach recognizes that incidental biodiversity co-benefits may result from REDD+ where there is carbon–biodiversity overlap, but would not seek to make them a focus of REDD+ site selection or project design.

To achieve positive biodiversity outcomes under approach (2), governments and other actors would have to ensure that both REDD+ and biodiversity-conservation programmes were effective and adequately funded. Compartmentalization could increase financial and human-resource burdens and fail to identify biodiversity–carbon synergies[38,40,44]. Indeed, this approach could create financial competition between biodiversity-conservation efforts and carbon projects. Narrow planning might also result in REDD+ projects that overlook landscape and ecosystem dynamics, failing to account for biodiversity impacts or leakage[2,9,47]. This could result in isolation of protected areas, biodiversity loss outside REDD+ sites[9,49] and the loss of forest-dwelling species within REDD+ sites that are protected exclusively for their carbon services[50].

(3) A REDD+ mechanism can achieve significant biodiversity conservation through separate add-on incentive mechanisms. This approach offers a politically attractive and flexible solution[51]; it prioritizes low-cost emissions reductions while addressing co-benefits through various external incentives, allowing for voluntary third-party certification schemes to verify co-benefits[52]. Proponents would need to identify what specific add on incentives would be most appropriate (for example, extra technical support, direct payments and alternative livelihoods[53,54]) and would probably focus efforts on specific sites where additional investments would have the greatest impacts. Conservation action would also require recruiting, funding and directly providing the extra support that these incentives entail (for example, training, lobbying for financial support and external monitoring).

However, this approach depends on the unproven scale of voluntary support for biodiversity co-benefits by donors and/or through market mechanisms. Donors and industry are unlikely to voluntarily and indefinitely absorb the additional costs associated with co-benefits[34,55]. This method may provide only piecemeal biodiversity co-benefits for specific sites that attract voluntary support, such as those with charismatic megafauna[50]. Less-attractive sites for REDD+, notably those with low carbon storage or high opportunity costs, could elicit conservation interest but lack adequate financial support.

(4) REDD+ provides an opportunity to conserve biodiversity through targeted interventions, at only a marginal increase in cost. This approach would deliver biodiversity co-benefits at conservation-priority sites, even if they lack maximum carbon–biodiversity synergies. Although sites with high opportunity costs would not be protected because they would remain beyond the threshold of cost-effective REDD+ interventions, extra funding for biodiversity interventions would expand the areas where REDD+ is feasible, increasing biodiversity outcomes[36,38–40,44]. The additional costs of co-benefit optimization could be explicitly incorporated into carbon payments[36,38], potentially resulting in a joint carbon–biodiversity tax. Proponents of this method would probably approach planning and management on a national level, to identify where investments would be most cost-effective and seek to avoid leakage[48]. A system of payments for co-benefits would further require standard biodiversity accounting based on reliable indicators and baselines[10,51,52].

However, these improvements would increase burdens and costs on implementing countries and REDD+ project developers[34,56]. Although participants could adopt different levels of biodiversity-monitoring rigour based on data availability and expertise[57], international agreement on how to measure the biodiversity outcomes of REDD+ remains contentious[10,34,42,51]. Moreover, this approach could prove to be politically and financially infeasible, as it would reduce the cost-effectiveness of REDD+ emissions reductions in favour of promoting biodiversity co-benefits (see below). Proponents would need to fundraise and lobby to secure the significant additional funds to monitor biodiversity, ensure co-benefits and protect biodiversity outside the REDD+ target areas.

(5) Biodiversity conservation is necessary to sustain stores of forest carbon. Proponents of this approach seek to make biodiversity conservation a core goal of REDD+, introducing pantropical biodiversity monitoring, large-scale REDD+ planning and valuation of low-carbon, high-biodiversity sites within REDD+. The extra costs would be justified because the approach links permanent reductions in carbon emissions to long-term ecosystem function[18,41,58].

However, proponents would need to identify stronger links between biodiversity and carbon stocks to make biodiversity more central to climate change policy. This approach would also face considerable political challenges as it would require a dramatic increase in financing for co-benefits; policies related to this approach — notably, biodiversity taxes — are likely to meet resistance[34]. Moreover, internalization of biodiversity costs into REDD+ will reduce the efficiency of forest-based emissions reductions because: (1) many conservation-priority sites are associated with high human-population densities[59] and significant opportunity costs[9,38]; and (2) large-scale monitoring and reporting on biodiversity co-benefits increases project costs[56]. Reduced returns as a result of mandated co-benefit payments could decrease the attractiveness of REDD+ as a low-cost emissions-mitigation strategy and yield it financially unreliable in the long term[34,55].

Despite overlaps, the five approaches represent profoundly different views of the relations between biodiversity and carbon. Notably, our review shows that the approaches vary in: (1) scale of resource-management planning; (2) monitoring and reporting demands; and (3) management of the costs associated with co-benefits. These differences would profoundly influence REDD+ programme design and on-the-ground conservation actions.

Facing controversy head-on

Parties to the UNFCCC at Cape Town in 2011 restated that REDD+ interventions should avoid harming biodiversity and should support and promote enhanced benefits for biodiversity, but provided rudimentary, non-binding guidelines and little clarity on how to approach co-benefits[1,8]. Frameworks for assessing the impacts of REDD+ on biodiversity are also externally under development, including the Forest Carbon Partnership Facility's Strategy Environmental and Social Assessment, and the Climate, Community and Biodiversity Alliance's REDD+ Social and Environmental Standards. These are providing guidelines that are more targeted, though biodiversity co-benefits have yet to be mainstreamed[52]. For example, the United Nations–REDD *Draft Social and Environmental Principles and Criteria* specifically address safeguarding against unintended biodiversity loss, but qualify biodiversity co-benefits "in relation to local and other stakeholder's values and potential synergies and trade-offs between different benefits"[60]. Similarly, efforts by the secretariat of the Convention on Biological Diversity to identify indicators for assessing biodiversity outcomes have faced party demands to accommodate diverse national circumstances[51].

Moreover, although parties to the UNFCCC have resolved to identify adequate funding for REDD+ and associated safeguards[1], it remains uncertain whether the costs of biodiversity co-benefits will be externalized, or partially/fully internalized into a future REDD+ mechanism (Fig. 1). In recognition of the substantial funding gaps, parties are seeking numerous revenue streams to support REDD+ and associated co-benefits[61]. However, UNFCCC financing negotiations — including for the proposed multibillion-dollar donor-supported Green Climate Fund — are at a "complete impasse"[62].

Until now, loose guidelines, uncertain funding and a lack of consensus on universal standards for biodiversity co-benefits[51,56,60] suggest that standards will be largely country-specific and voluntary, with associated costs mostly externalized (see approaches (2) and (3)). However, aside from a few notable exceptions (for example, the Philippines[63]), most countries that have produced national REDD+ strategies either largely overlook biodiversity co-benefits, or provide few details regarding how they will integrate biodiversity into REDD+ planning[14]. Despite extensive interest in synergies and common ground in tropical forests, widespread carbon–biodiversity-conservation solutions are neither simple nor direct (Table 1). It remains surprisingly uncertain how many key stakeholders will pursue biodiversity co-benefits.

A REDD+ mechanism will need to avoid cumbersome regulations, remain efficient to ensure the financial viability and stay flexible enough to promote widespread participation[52,56]. However, a viable global mechanism will also require consensus, standards and regulations. As stakeholders with explicit biodiversity-conservation mandates engage with REDD+, there is increased need for clarity regarding whether and how biodiversity will be integrated.

Upfront planning and transparency are necessary to avoid unintended negative consequences and suboptimal conservation outcomes[29,30,44]. Although a mechanism flexible enough to accommodate numerous approaches to co-benefits might facilitate consensus and expedite REDD+ implementation, it might also overlook the differences and significant trade-offs among policy options, failing to meaningfully reduce long-term forest-carbon emissions and conserve imperilled tropical biodiversity. The five approaches outlined in this paper can inform the debate on whether, and by which path, REDD+ biodiversity co-benefits can be maximized.

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Additional information

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