Other shades of REDD: Payments for "reduced extinctions from deforestation"

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Abstract

Climate change negotiations in Copenhagen produced the clearest picture yet of the international mechanism that may emerge to pay for reduced, prevented and reversed emissions from deforestation (REDD+). Such a mechanism would put in place the monitoring, accounting, finance, and governance infrastructure for payments for forests' climate change mitigation service alone. Potentially, the institutional infrastructure put in place for REDD+ payments can also be used to facilitate extra-UNFCCC payments for "reduced extinctions from deforestation," "reduced erosion from deforestation," or other forest services. We explore the impact that such a large, organized system of payments for non-carbon forest services would have on emissions reductions produced by REDD+. We find that introducing biodiversity payments would subsidize carbon payments, lowering the price paid by REDD+ buyers, raising the price received by REDD+ sellers, and leading to greater emissions reductions than would otherwise have occurred. Thus, all stakeholders to REDD+ have an interest in enabling the emergence and development of extra-UNFCCC mechanisms to supplement REDD+ with payments for forests' other services.

Keywords: Climate change, REDD, biodiversity

I Introduction

The 15th Conference of the Parties (COP 15) of the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen in December, 2009 produced the clearest picture yet of the eventual international mechanism that may emerge for reducing emissions from deforestation and degradation, plus conservation, sustainable management and enhancement of forests (REDD+) (UNFCCC, 2009a; UNFCCC, 2009b; UNFCCC, 2009c). Once adopted, this mechanism would establish the monitoring, accounting, finance, and governance infrastructure necessary to channel up to tens of billions of dollars annually of willingness-to-pay for climate change abatement toward compensating countries across the tropics for conserving standing forest.

Climate change abatement represents just one portion of the total global willingness to pay for forests' services. Government, philanthropic and multilateral institutions currently aggregate and channel hundreds of millions of dollars annually of willingness-to-pay for conserving standing forests' contribution to biological diversity, clean water, land and soil stabilization, and culture. But high transaction costs, start-up and overhead costs, information costs, and economies of scale present barriers to isolated conservation projects and market initiatives from achieving their full potential in connecting globally dispersed demanders and suppliers of forest services.

Potentially, the institutional infrastructure put in place for REDD+ can be used to facilitate payments for other services forest provide for which there exists willingness-to-pay. A small investment in quantifying and mapping forest services could facilitate a global system of payments for "reduced extinctions from deforestation," or "reduced erosion from deforestation."

Since the goal of REDD+ is to reduce greenhouse gas emissions, we ask: What impact would the establishment of a large, organized system of payments for non-carbon forest services have on emissions reductions produced by REDD+?[1] We address this question in the context of one forest service for which reliable global data exist—biodiversity. Previous studies considered the case where financial resources for forests are fixed (Nelson et al., 2008; Venter et al., 2009). These studies found a strict tradeoff between prioritization of biodiversity and prioritization of emissions reductions. Our analysis considers methods by which additional sources of willingness-to-pay for forest biodiversity can be drawn upon. In this case, we find that introducing biodiversity payments would subsidize carbon payments, lower the price paid by REDD+ buyers, raise the received by REDD+ sellers, and lead to greater emissions reductions than would otherwise have occurred. Thus, all stakeholders to REDD+ have an interest in facilitating the emergence and development of mechanisms to supplement REDD+ with payments for forests' other services.

II Method

The response of countries to incentives produced by payments for carbon and biodiversity was modeled using OSIRIS (Busch et al 2009). In the OSIRIS model, 85 tropical or developing countries choose to "opt in" or "opt out" of REDD+ incentives, and then choose a level of deforestation, in order to maximize the sum of revenue received from agriculture production, including one-time timber harvest, and the revenue received from REDD+ carbon

[1] We restrict our analysis to impacts on land-use choice. Synergies and tradeoffs between biodiversity and carbon in land management (e.g. enhancing forest carbon stocks at the detriment of biodiversity) – are excluded from this analysis.

payments. The revenue received from REDD+ carbon payments is determined by the carbon price and the country's reference level. Reductions of deforestation in one country increase the price received for frontier agriculture, increasing the incentive for countries elsewhere to deforest. The OSIRIS model generates country-by-country estimates of the annual deforestation, emissions and carbon payments that would have occurred had a REDD+ mechanism been in place from 2000-2005. The model is consistent with either a market or a performance-based fund approach to REDD+.

The OSIRIS model was extended (Busch, in review) to produce estimates of the reduction in the extinction rate of endemic, forest-obligate[2] mammal and amphibian species ("forest species") – the only taxa for which comprehensive status assessments were available (Stuart et al. 2004; Schipper et al. 2008). Extinction rates were estimated using the species-area relationship $E_i = S_i[1-(1-d_i)^z]$, where E_i represents the rate at which species in country i become committed to extinction ("extinction rate"), S_i represents the current number of forest species in country i, d_i represents the deforestation rate (%/year) in country i, and parameter z equals 0.25, from the archipelagic species-area relationship.

Reductions in greenhouse gas emissions and forest species extinctions rates relative to the estimated 2000-2005 business-as-usual scenario were estimated with REDD+ carbon payments alone, and under three alternative methods for channeling willingness-to-pay for forest biodiversity to supplement REDD+ carbon payments (Table 1). In the first method of channeling willingness-to-pay for forest biodiversity, buyers of forest biodiversity made additional purchases of REDD+ carbon abatement. In the second method, differentiation of the biodiversity value of the forests from which carbon abatement originated enabled existing buyers of REDD+ to pay a price premium for carbon abatement from more biodiverse forests. In the third method, carbon payments from REDD+ buyers were bundled together with biodiversity payments from a new pool of biodiversity buyers. This third method reflects multiple scenarios. Biodiversity buyers could select especially biodiverse forests in which to fund reductions of deforestation, and then countries or communities could sell the resulting carbon abatement to the REDD+ mechanism. Or, biodiversity buyers could purchase REDD+ carbon abatement from especially biodiverse forests above market price, and then sell the abatement back into the market at market price. In this way the buyers would have paid an incremental price for the biodiversity value. Or, a biodiversity mechanism could stand alone, such that when countries or communities reduce deforestation, they could sell their carbon abatement through the REDD+ mechanism, and sell their contribution to biodiversity conservation through the biodiversity mechanism.

With REDD+ carbon payments alone, the global emissions from deforestation at a given level of finance available for REDD+ was determined as follows:

[2] Forest-obligate species are species whose only habitat is forest.

$$E_{global} = \sum_{i=1}^{85} D_i \, CD_i \quad | \quad F_c = P_c \sum_{i=1}^{85} \max\{0, REL_i - D_i(P_c, REL_i)\} * CD_i \tag{1}$$

Here E_{global} is the global emissions from deforestation, i=1:85 are countries, D_i is deforestation in country i, and CD_i is the average forest carbon density in country i. F_c is annual finance for carbon payments under REDD+. P_c, the price of a ton of carbon dioxide abatement, varies according to demand for REDD+ . REL_i is the reference emission level for country i.

Table 1 – Characteristics of alternative methods for channeling willingness-to-pay for forest biodiversity

Method for channeling willingness-to-pay for forest biodiversity	Requires new pool of REDD+ buyers?	Requires differentiating forests based on biodiversity value?	Requires standardized, exchangeable unit of biodiversity value?	Requires centralized registry for biodiversity transactions?	Offset-quality biodiversity credits?	Timing of payments	Precedent
Biodiversity buyers pay for additional REDD+ carbon abatement	YES	NO	NO	NO	NO	*ex post*	Environmental NGOs paying to retire pollution rights (U.S. Clean Air Act) or fishing rights
Existing REDD+ buyers pay a premium for carbon abatement from biodiverse forests	NO	YES	NO	NO	NO	*ex post*	CCBA (voluntary market for REDD+)
Biodiversity buyers support site-level interventions; countries and communities sell resulting carbon abatement to REDD+ mechanism	YES	YES	NO	NO	NO	*ex ante*	NGOs; CEPF; GEF; bilateral budget support
Biodiversity buyers buy carbon abatement from biodiverse forests above market price; sell to REDD+ mechanism at market price	YES	YES	NO	NO	NO	*ex post*	?
Countries and communities sell carbon abatement to REDD+ mechanism; sell biodiversity contribution to biodiversity mechanism	YES	YES	YES	YES	YES	*ex post*	Biodiversity offset markets

According to a decision at COP 15 of the UNFCCC Subsidiary Body on Science and Technical Advice (SBSTA), national reference levels are to be determined based on historical data, adjusted for national circumstances (UNFCCC, 2009c). Following the spirit of this decision, reference levels were determined using the "combined incentives" design (Strassburg et al, 2009). In the combined incentives design, reference levels for countries with historically low deforestation rates are adjusted upward from historical rates to incentivize conservation of carbon stocks in those countries. A historic global reference level is maintained by adjusting reference levels for countries historically high deforestation rates downward from historical rates. Some level of "own effort" in deforestation reduction by these countries is required prior to compensation. That is,

$$REL_i = CD_i * \left[\alpha D_i^{o} + (1-\alpha) D_{global}^{o} \right] \quad (2)$$

where D_i^{o} is the recent historical deforestation rate in country *i*, D_{global}^{o} is the recent historical deforestation rate across all REDD+ countries, and α is a weighting parameter. A weight of α =0.85 is chosen for this analysis, reflecting the "best foot forward" approach from Busch (2009).

In the first method, where biodiversity buyers purchase additional REDD+ carbon abatement, the global emissions from deforestation at a given level of finance available for REDD+ was determined as follows:

$$E_{global} = \sum_{i=1}^{185} D_i \, CD_i \mid F_c + F_b = (P_c^{f} + P_c^{b}) \sum_{i=1}^{185} \max\{0, REL_i - D_i(P_c^{f} + P_c^{b}, REL_i)\} * CD_i\} \quad (3)$$

where F_b is annual finance for forest biodiversity. P_c^{f} is fixed to the price of carbon for which total annual finance for forest carbon, F_c, equals \$10 billion in equation (1). P_c^{b}, the increase to the price of REDD+ carbon abatement generated by buyers of biodiversity, varies according to biodiversity buyers' demand for REDD+.

In the second method, where existing REDD carbon demanders are willing to pay a price premium for carbon abatement from more biodiverse forests, the global emissions from deforestation at a given level of finance available for REDD+ was determined as follows:

$$E_{global} = \sum_{i=1}^{185} D_i \, CD_i \mid F_c + F_b = P_c \sum_{i=1}^{185} \max\{0, REL_i - D_i(P_b, P_c, REL_i, RBL_i)\} * CD_i\} + P_b \sum_{i=1}^{185} \max\{0, RBL_i - D_i(P_b, P_c, REL_i, RBL_i)\} * BD_i\} \; ; \; F_b = \rho F_c \quad (4)$$

where ρ represents an additional aggregate market premium for biodiversity, arbitrarily fixed to 0.05. BD_i represents biodiversity density (endemics species per hectare). RBL_i is a reference level of biodiversity loss for country *i*, determined here using the same design as the reference emission level:

$$RBL_i = BD_i * \left| \alpha D_i^{o} + (1-\alpha) D_{global}^{o} \right| \quad (5)$$

P_c, the price paid by REDD+ buyers for carbon abatement, and P_b, the premium paid by REDD+ buyers for reductions in the loss of forests' biodiversity value, vary according to REDD+ buyers' proportional demand for forest carbon and biodiversity.

In the third method, where carbon payments from REDD+ buyers were bundled with biodiversity payments from biodiversity buyers, the global emissions from deforestation at a given level of finance available for REDD+ was determined as follows:

$$E_{global} = \sum_{i=1}^{85} D_i \, CD_i \quad | \; F_c + F_b = P_c \sum_{i=1}^{85} \max\{0, REL_i - D_i(P_b, P_c, REL_i, RBL_i)\} * CD_i + P_b \sum_{i=1}^{85} \max\{0, RBL_i - D_i(P_b, P_c, REL_i, RBL_i)\} * BD_i \qquad (6)$$

P_c' is fixed to the price of carbon for which total annual finance for forest carbon, F_c, equals $10 billion in equation (1). P_b, the price paid by buyers of biodiversity for reductions in the loss of forests' biodiversity value, varies according to biodiversity buyers' demand for forest biodiversity.

III Results

A REDD+ mechanism in place during 2000-2005 would have generated substantial reductions in deforestation, emissions from deforestation, and extinctions of forest species from deforestation, even with no supplemental payments for biodiversity (Figure 1). Under an illustrative set of model parameters, annual finance for REDD+ of $10 billion (in 2008 US$) would have reduced deforestation by nearly half, reduced emissions from deforestation by just over half, and reduced extinctions from deforestation by nearly three-quarters.[3] The reduction in emissions slightly exceeded the reduction in deforestation because REDD+ incentives preferentially target higher-carbon forests for avoided deforestation. The reduction in extinctions substantially exceeded the reduction in deforestation, due to the nature of the species-area relationship. As forest habitat is diminished, each unit of habitat lost becomes successively more valuable in preventing extinctions. So in reverse, the first units of forest habitat loss avoided in each country are the most valuable.

[3] The sensitivity of impacts to reference level design, carbon price, elasticity of demand for frontier agriculture, and other parameters was fully explored in Busch et al (2009).

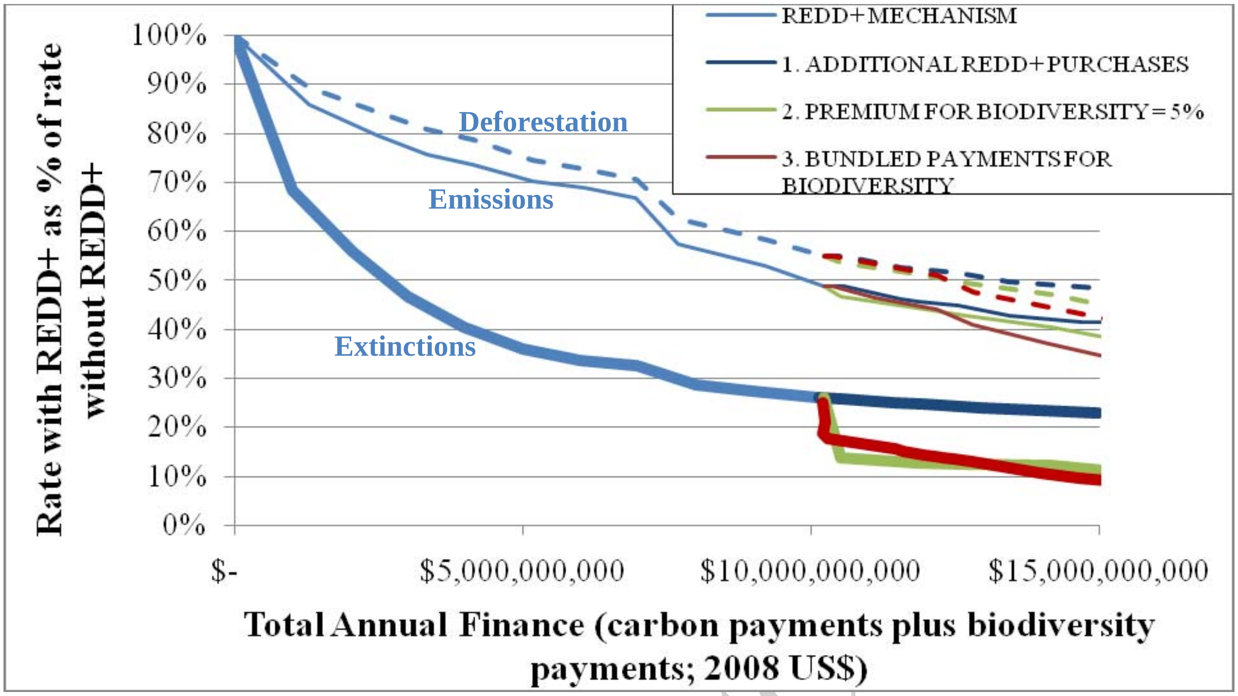

Figure 1 – Percent reduction in deforestation, emissions from deforestation, and exctinctions of forest species under alternative methods of financing biodiversity

Additional purchases of REDD+ carbon abatement by biodiversity buyers further increased reductions in deforestation, emissions and extinctions, by increasing the scale of finance available for REDD+ above the $10 billion from existing REDD+ buyers.

A five percent price premium for REDD+ carbon abatement from more biodiverse forests, created by willingness of existing REDD+ buyers to pay more for forests differentiated based on their biodiversity value, had two effects. First, when the premium was implemented there was an immediate shift in the composition of forest conserved toward more biodiverse forest. Thus, the premium immediately reduced extinctions from deforestation by half, even while little altering emissions from deforestation. Second, the scale of finance available for REDD+ increased slightly by drawing upon existing REDD+ buyers' additional willingness-to-pay for biodiversity. But since willingness-to-pay for carbon and willingness-to-pay for biodiversity are proportional with a premium, additional reductions in extinctions were contingent upon additional demand for REDD+ carbon abatement.

Bundling of payments for biodiversity with payments for carbon had three effects. First, the scale of finance available for forest conservation increased, as biodiversity funding was added to the original $10 billion of REDD+ funding. This increased scale of funding reduced deforestation, emissions and extinctions. Second, the composition of forest conserved shifted in favor of biodiverse forests. This shift in composition occurred rapidly, first conserving high-biodiversity forests which were not conserved by REDD+ carbon payments. Third, payments for forest biodiversity subsidized payments for forest carbon. Biodiversity payments lowered the price of carbon at which carbon payments could out-compete forests' opportunity costs. So as more biodiversity funding was added, more carbon funding was catalyzed as well. Biodiversity payments of $1.5 billion catalyzed $3.5 billion in additional carbon payments, bringing overall finance for reducing deforestation to $15 billion. This total funding reduced emissions by about two-thirds and extinctions by more than nine-tenths.

IV Discussion

Three effects of payments for biodiversity

Payments for forest biodiversity have three effects on deforestation reduced by a REDD+ mechanism—scale, composition, and subsidy (Table 2). First, forest biodiversity payments increase the scale of funding available for REDD+ by drawing on additional sources of willingness-to-pay. This is the case whether biodiversity buyers pay for additional REDD+ abatement, or whether biodiversity buyers' payments for biodiversity can be bundled with payments for carbon. The increase in the scale of funding for forests created by a premium among existing REDD+ buyers for biodiverse forests is limited by the extent to which additional carbon abatement is demanded as well.

Second, forest biodiversity payments shift the composition of conserved forest toward more biodiverse forest. In principle this shift in composition could present a tradeoff where more biodiverse forests are conserved at the expense of more carbon-rich forests. But a shift in composition in favor of biodiversity need not necessarily occur at the expense of carbon. In our model, a premium for biodiversity actually caused a slight increase the average carbon density of conserved forest. As the composition of conserved forest shifted away from high-carbon low-biodiversity forest countries, not only did more low-carbon high biodiversity forest choose to opt in, but high-carbon high-biodiversity forest countries which had already opted in chose to abate more.

Third, forest biodiversity payments subsidize forest carbon payments. This subsidy lowers the price paid by REDD+ demanders, while increasing the price received by REDD+ suppliers. A lower price for REDD+ catalyzes the entry of new REDD+ buyers to the market who are willing to pay the new, lower price for REDD+. As a result, more forest is conserved, causing greater reductions in emissions and extinctions. This subsidy effect helps even countries without high biodiversity value—since supply of REDD+ carbon abatement is fungible, increased demand from buyers for carbon abatement from one region increases the price received by producers of carbon abatement in other areas as well.

Table 2 – Three effects of payments for biodiversity

Method for channeling willingness-to-pay for forest biodiversity	Scale effect?	Composition effect?	Subsidy effect?

Biodiversity buyers pay for additional REDD+	YES	NO	NO
Existing REDD+ buyers pay a premium for abatement from biodiverse forests	YES* (*but increased funding for biodiversity contingent upon increased demand for carbon abatement)	YES	NO
Biodiversity buyers contribute funds to site-level interventions; countries and communities sell REDD+ to market	YES	YES	YES
Biodiversity buyers buy REDD+ from biodiverse forests above market price; sell to market at market price	YES	YES	YES
Countries and communities sell carbon abatement to REDD+ mechanism: extinction abatement to stand-alone biodiversity mechanism	YES	YES	YES

This subsidy effect is illustrated in Figure 2. With REDD+ carbon payments alone, avoided deforestation occurs only in forests where carbon payments can outcompete alternative land uses (Rectangle A). When bundled payments for biodiversity are added, additional avoided deforestation occurs in forests where biodiversity payments can outcompete alternative land uses (Rectangle B). But due to the subsidy effect, avoided deforestation also occurs in forests where alternative land uses are not outcompeted by either carbon payments or biodiversity payments in isolation, but are outcompeted by biodiversity payments and carbon payments combined (Triangle C).

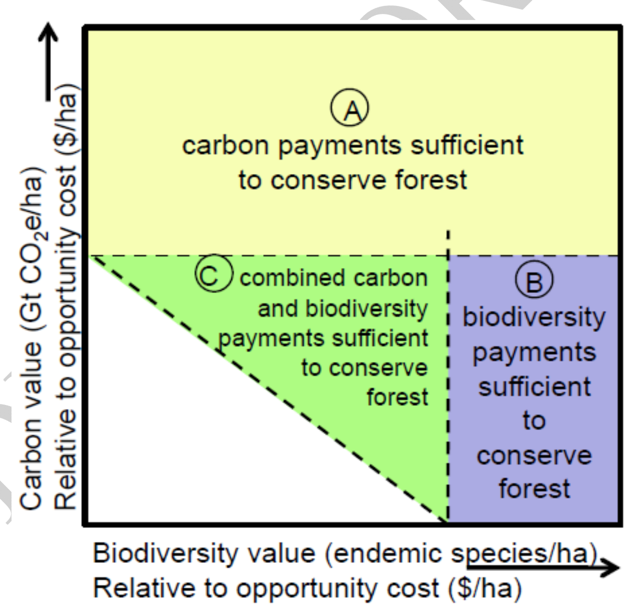

Figure 2 – Biodiversity payments subsidize carbon payments, reducing deforestation beyond what either can accomplish in isolation

These results for biodiversity can be generalized to other mappable ecosystem services such as water provision or land and soil stabilization, where services provided are a function of location only. In the case where services provided are a function of management and production technique as well, a richer model would be needed to estimate the impact of payments. For example, a system of payments for social co-benefits would not only affect the spatial composition of REDD+ consumers' purchases, but also the manner in which REDD+ was produced.

Practical discussion of payment methods

Forests' climate regulation service has been estimated to comprise between 35% (Torras, 2000) to 90% (Adger et al, 1995) of forests' total indirect use and non-use value. With the emergence of a global REDD+ mechanism, it is anticipated that countries and communities will be able to recover a large share of international willingness-to-pay for their forests' climate regulation service. Once the institutional infrastructure is put in place to compensate standing forests, which methods provide greatest potential to channel willingness-to-pay for forests' other services?

Additional purchases of REDD+ carbon abatement from biodiversity buyers require no new mechanisms. A precedent for such purchases exists in the form of environmental NGO purchases of pollution rights and fishing rights. Yet it seems unlikely that the additional scale of finance from such purchases would be large, due to the indirect nature of achieving the desired biodiversity benefits through this method.

Buyers of REDD+ carbon abatement could be willing to pay a price premium for carbon abatement originating in forests known to be valuable for biodiversity. One market research survey (Neeff et al, 2009) indicates that current buyers of REDD+ on the voluntary market could be willing to pay a considerable premium for credits from forest carbon projects meeting social and environmental standards. Enabling the emergence of this price premium requires only a standard for differentiating the biodiversity value of forests, that is, BD_i in equation (6) above. But the magnitude of funding available through price premiums will be fundamentally limited by the scale of demand for carbon abatement among existing REDD+ buyers.

Bundling provides a more direct payment route for biodiversity than additional purchases of REDD+, and is likely to capture more willingness-to-pay than premiums by drawing upon a new pool of buyers. Facilitating the bundling of payments requires both new buyers and a system for differentiating the biodiversity value of forests. A standardized system for differentiating biodiversity value would remove the cost of information-gathering on biodiversity value from individual consumers. In combination with a standardized system for differentiating biodiversity value, a baseline from which to measure reductions, RBL_i in equation (5) above, would open the door to offset-quality biodiversity credits. But with or without standardization, identifying the spatial origin of abatement would allow consumers of forest biodiversity to exercise their own judgment about which abatement locations are so desirable for biodiversity as to merit a price premium. These consumers could make *ex ante* (up front) payments for such reductions. Or, they could buy reductions *ex post* (after the fact) from biodiverse forests above market price, and then sell these reductions back to the carbon market at market price.

The payment systems described above rest upon differentiation of forests' biodiversity value, BD_i, and in some cases a reference level for biodiversity, RBL_i. The simplest reference level for biodiversity would be derived using the same reference deforestation rate as for emissions, but this would not need to be the case. Arriving at such values would not need to be the burden of the UNFCCC. Appropriate and accurate metrics for biodiversity value and biodiversity baseline would need to result from a transparent and scientific process, but would not need to be consensus-driven. This analysis has considered national measurements of biodiversity value—endemic species per hectare of forest—but efficiency in reducing extinctions would likely be improved through the development of a finer measurement.

The recoverable international willingness-to-pay for forests' biodiversity is potentially very high. Historically, payments for biodiversity have comprised a large share of recoverable international willingness-to-pay for forests, in the form of conservation projects and bilateral and multilateral budget support for protected areas. The estimated current international expenditure on biodiversity conservation of $1.5 billion (Halpern et al, 2006) is dwarfed by the anticipated potential scale of finance for REDD+. We hypothesize that funding for forest services such as biodiversity will increase when REDD+ pays the start-up costs of an efficient global system of payments for forest conservation. Thus, the infrastructure put in place for paying to conserve forests may in the end be at least as important as the carbon payments themselves.

V Conclusion

We find that carbon payments would be subsidized by payments for forests' other services. Thus the goal of the UNFCCC—reducing emissions from deforestation—would be furthered by payments for "reducing extinctions from deforestation" or "reducing erosion from deforestation." Because such payments can be facilitated through extra-UNFCCC institutions at no cost or burden to the UNFCCC, all REDD+ stakeholders have an interest in facilitating the emergence and development of systems to supplement REDD+ with payments for forests' other services.

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