REDD payments as incentive for reducing forest loss

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region where forest has been and continues to be lost to cocoa production. Ghana receives support for developing early REDD activities from the World Bank's Forest Carbon Partnership Facility. Using simulation modeling, we examine whether REDD payments to farmers would provide the necessary incentives for farmers to opt for reducing deforestation and forest degradation instead of cultivating their land. We also examine some of the socioeconomic implications of REDD, given that many policy makers are driven by development issues rather than environmental issues.

Methods

The landscape

The Wasa Amenfi West district in southwestern Ghana covers an area of 34,646 km^2 of which 25% is natural forest. The district experienced heavy in-migration by farmers growing cocoa, the most important cash crop, resulting in a population of 156,260 inhabitants in 2000 (District Report 2005, unpublished). Forest reserves account for 12% of the total landscape and are largely

Table 1

Table 1 Continued

Model sector	Contents	Assumptions and data	Information source
Carbon	The carbon stock is calculated for the land-uses on the off-reserve area which is currently covered with old growth forest (for scenario 2) and with old growth and secondary forest (for scenario 3)	Average carbon contents (ton C/ha) per land-use: Urban, bare soil = 0; nonforested fallow = 15; food crops = 30; food crops intercropped with young cocoa = 50; 3–8 year old cocoa = 70; productive cocoa = 100; forested fallow = 130; timber and rubber = 135; secondary forest = 160; old growth = 200	Mediated estimations from Swallow *et al*

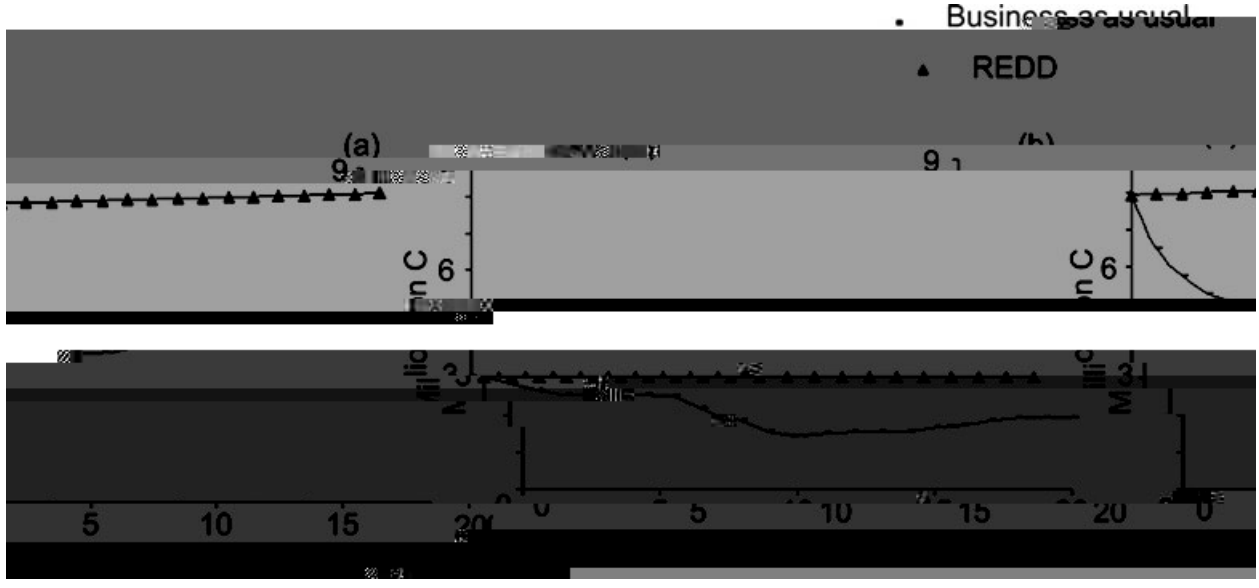

Figure 1 Total carbon stock in the off-reserve area for (a) area currently covered with old-growth forest under "business as usual" (scenario 1) and "avoided deforestation of old-growth forest" (scenario 2); and (b) area now covered with secondary and old-growth forest under "business as usual" and "avoided deforestation of standing secondary and old-growth forest" (scenario 3).

and at what carbon price this would not happen (Appendix S1). In general, discount rates are high among low-income farmers (Campbell *et al.* 2006). However, Richards & Asare (1999) argue discount rates to be low among Ghanaian cocoa farmers, since many see cocoa farming as a type of old age pension, suggesting a discount rate of 6%. We used discount rates of 6 and 20%.

Three scenarios were modeled. Scenario 1 explores business as usual: old-growth and secondary forest are converted into cocoa plantations extrapolating the linear trend for the period 2000–2007. Scenario 2 explores avoided deforestation of old-growth forest. In this scenario, we assume all large landholders with old-growth forest on their land opt to receive REDD payments and no old-growth forest is converted into cocoa plantations. Scenario 3 explores avoided deforestation of all forest. In this scenario, we assume all farmers with standing old-growth and secondary forest on their land opt to receive REDD payments and no forest is converted into cocoa plantations. Only degraded cocoa plantations and non-forested land is used for new cocoa plantations.

Payments are simulated only for forest outside reserves since the forest reserves are already under a national forest conservation strategy and are not available to local farmers. We assume an international carbon price of US$10/ton CO_2 to be paid by investors (Table 1), of

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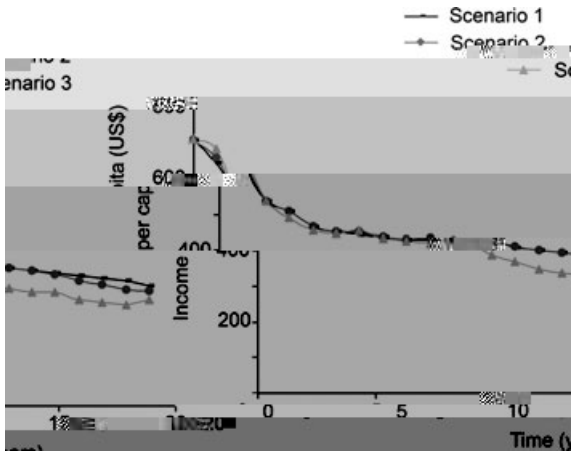

Figure 2 Income per capita for the rural population in the district under three scenarios: (1) business as usual, (2) no conversion of old-growth forest, and (3) no conversion of standing secondary and old-growth forest.

secondary forest after 6 years. Under scenario 2, 1.2 million ton C is prevented from being emitted compared to business as usual (Figure 1a).

Under scenario 3, after 1 year, all nonforested fallow land has been converted to cocoa plantationsc2ualhas77-antation192S(Figur4(m76.9(aximum76.3(ad)-ov297(U77on)-354.4(TJio)-(

Table 2 Net present values (US$) for 20 year income flows under the three scenarios with current and alternative model assumptions applying a 6 and 20% discount rate

	Net present value – 6% discount rate					Net present value – 20% discount rate				
		Alternative assumptions					Alternative assumptions			
		Cocoa price for farmer fixed at US$1.46/kg (price 2009)	Cocoa price increasing with 40% over 20 years	Carbon price paid by investors US$15	Carbon price paid by investors US$20		Cocoa price for famer fixed at US$1.46/kg (price 2009)	Cocoa price increasing with 40% over 20 years	Carbon price paid by investors US$15	Carbon price paid by investors US$20
Scenario 1	5,169	7,455	8,677	5,169	5,169	2,405	3,270	3,608	2,405	2,405
Scenario 2	5,170	7,437	8,641	5,186	5,202	2,419	3,283	3,619	2,428	2,437
Scenario 3	4,922	7,013	8,092	4,974	5,026	2,377	3,198	3,512	2,405	2,432

conversion to cocoa. This scenario results in some delay in carbon emissions but not in net emission reduction or conservation of old-growth forest over 20 years. To stop the deforestation of old-growth forest, a carbon price of at least US$ 55–60/ton CO_2 is needed. Deforestation of old-growth and degraded forest is stopped at a minimum of US$ 70–75/ton CO_2.

Discussion

Assuming an annual REDD payment, farmers are likely to accept REDD initiatives, especially if a large up-front pay-

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Full description of the method, model structure and dynamics.

Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting materials supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.

References

Angelsen, A. (2008) *M r AJ EAD RED: , B*
ar d l car . CIFOR, Bogor, Indonesia.

Bellassen, V., Gitz V. (2008) Reducing emissions from deforestation and degradation in Cameroon—assessing costs and benefits. *Ecol Econ* **68**, 336–344.

Butler, R.A., Koh L.P., Ghazoul J. (2009) REDD in the red: palm oil could undermine carbon payment schemes. *Conserv Lett* **2**, 67–73.

Campbell, B.M, Gordon I.J., Luckert M.K., Petheram L., Vetter S. (2006) In search of optimal stocking regimes in semi-arid grazing lands: one size does not fit all. *Ecol Econ* **60**, 75–85.

Capoor, K., Ambrosi P. (2008) *State and Trends of the Carbon Market 2008*. World Bank, Washington, DC.

CarbonPositive. (2009) Indonesia reveals REDD revenue shares. Available from: URL http://www.carbonpositive.net/viewarticle.aspx?articleID=1602. Accessed 17 September 2009.

De Bruijn, A. (2005) *Carbon dr c lar M ad r ar Re ar c F , B r d* Thesis, Wageningen University, The Netherlands.

Förster, J. (2009) *T r ad c r d ar f d f ar ar d d ad ar (REDD) r r ar* Thesis, University of Bayreuth, Germany.

HPS (High Performance Systems). (1996) *STELLA and STELLA ar c ar* . HPS, Hanover, NH.

Kanninen, M., Murdiyarso D., Seymour F., Angelsen A., Wunder S., German, L. (2007) Do trees grow on money? The implications of deforestation research for policies to promote REDD. Center for International Forestry Research (CIFOR), Bogor, Indonesia.