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COMMENTARY

The fate of the tropical forest: Carbon or cattle?

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ABSTRACT

Small-scale afforestation/reforestation projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol will sequester atmospheric carbon and facilitate carbon trading but they face significant implementation challenges among the rural poor households and communities that are meant to adopt and benefit from them. Avoiding deforestation – a controversial carbon reduction option now under climate policy discussion – shows promise though for both forest conservation and poverty alleviation among indigenous forest peoples.

1. Commentary

In May of 2007, the scientific and technical advisory body to the UN Framework Convention on Climate Change (UNFCCC) met in Bonn to pursue discussions of a controversial policy option for reducing atmospheric carbon dioxide emissions — the implementation of initiatives to Reduce Emissions from Deforestation (RED) in developing countries (Gullison et al., 2007). The Kyoto Protocol established the Clean Development Mechanism to enable countries to trade carbon as Annex I countries seek to meet emission reduction targets during the first commitment period (2008–2012). Recognizing the important potential sink represented by land use (IPPC, 2000; Montagnini and Nair, 2004; Brown, 2002), the CDM includes small-scale afforestation/reforestation (CDM-AR) projects developed or implemented by low-income communities as valid means for carbon sequestration and trading (19/CP.9) as well as, more broadly, sustainable development (Smith and Scherr, 2003; Lipper and Cavatassi, 2004; Aune et al., 2005). Whereas the high potential for AR projects in tropical forest environments to serve as important carbon sinks has been demonstrated (De Jong et al., 2005; Kraenzel et al., 2003; Olschewski and Benítez, 2005), the micro-level feasibility of small-scale CDM-AR projects and their potential to deliver

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Table 1 – Net changes in land use and carbon stocks under the proposed CDM-AR involving 39 landowners in Ipeti Emberá, Panama

Land-use type	Current land-use (Ha)	Future land-use (Ha)	Land-use net changes (Ha)	Carbon net changes (in tons C)
Teak plantations	11.0	433	422	52,750
Fruits orchards	45.3	169	124	8804
Old fallow	322.5	30	−292.5	−12,080
Young fallow	119.5	20	−99.5	−2537
Silvopasture	0.0	146	146	2190
Pasture	397.0	130.5	−266.5	−1119
Mechanized rice	148.5	69.5	−79	−324
Plantain	6.63	5	−1.5	39
Other cropped land	50.7	88	37	1018
Intact forest	839.1	839.1	0	0
Total				48,741 tC

C inventories allowed calculating the C stored under the different land uses by multiplying surface area of the various land-uses by the C content of that land use (Kirby 2005; Tschakert et al., 2007; Kraenzel et al., 2003).

benefits beyond carbon sequestration is a subject of growing speculation (Gundimeda, 2004; Locatelli and Pedroni, 2006; Minang et al., 2007; Pfaff et al., 2007).

We argue that a careful assessment of small-scale CDM-AR projects is needed – from the perspective of rural households and communities meant to adopt and benefit by them – before concluding that CDM-AR projects provide a viable path for carbon sequestration, forest restoration and poverty alleviation. To illustrate our argument, we present the findings of a three-year project in an indigenous community in eastern Panama that sought to develop and implement a collective CDM-AR project on their homeland. Our results indicate that although reforestation would sequester significant quantities of carbon and enable the community to trade in Certified Emission Reductions (CERs), the economic costs and risks are prohibitive, particularly when compared to the best alternate land use, under prevailing economic conditions and the terms of the CDM.

If such CDM-AR projects fall short of their promise, then alternate and perhaps complementary means for carbon sequestration in the land-use sector will be needed. One alternate option would be to consider avoided deforestation as a legitimate carbon dioxide emissions reduction strategy, providing compensation for offset carbon through tropical forest protection (Niles et al., 2002; Asquith et al., 2002; Santilli et al., 2005; Laurance 2007; Gullison et al., 2007; Mollicone et al., 2007; Tavoni et al., 2007). Since the Montreal Conference of Parties Meeting (COP 11) of the UNFCCC in late 2005, this option has received growing attention in both scientific and climate policy circles, and observers expect that a key policy recommendation will be delivered to UNFCCC at a future Conference of Parties. Our results suggest that, if small-scale farmers were compensated for deforestation avoided, then land use management and carbon sequestration become more attractive for the rural poor and may be more likely to be adopted in low income communities.

Our findings are based on a participatory study conducted among the Emberá people in the community of Ipeti-Emberá (78°30′–78°34′ W, 8°55′–9°00′ N), 120 km east of Panama City, along the Pan-American Highway (Dalle and Potvin, 2004). The community holds collectively 3198 ha of land (Tierra Colectiva) and is comprised of 81 households who live primarily by a mix of subsistence and market-oriented agriculture, forest product extraction, livestock raising, handicrafts and off-farm wage labor. Households are both income and asset poor, earning in 2004, $1,100 US/year (range: $967–3495) and holding 38.8 ha of land (0–140 ha) and $1236 of non-land assets ($293–5091) (Tschakert et al., 2007). Of community land, 46% remains in humid tropical forest, 26% in forest fallow, 18% in pasture and the remainder in annual and perennial crops (Potvin et al., 2007). Rapid population growth in the community and a drive for improved living conditions, have lead community leaders to seek new opportunities for income generation while protecting their limited forest land base.

The concept of a CDM-AR project was introduced to Ipeti-Emberá in 2002, as part of an on-going research project on resource use and biodiversity, and welcomed by community leaders and a local NGO (Organisación para el Desarollo y la Unidad de la Comunidad de Ipetí-Emberá). Between 2002 and 2005, workshops, household surveys and farm/forest inventories were conducted to provide data required to develop land use management scenarios and a CDM-AR proposal with the community. The proposal entails the collaboration of 39 households, each contributing between 1.7 and 70 ha of land, for a total of 692 ha (22% of community land) targeted for carbon sequestration. Such land would be reforested mainly in teak and fruit tree species, increasing significantly the area under forest cover (Table 1). Land use change would enable the sequestration of an estimated 48,741 t carbon (tC) over a project life of 25 years without jeopardizing food production since tree plantations would increase at the expense of pasture and fallowed land rather then cropland.[1] In addition to carbon sequestration, reforestation could provide a stream of benefits in marketable teak and fruit as well as ecological services. The project would be managed by the local NGO, under a 25 year contract, with the benefits from CER sales divided among participants and with the community.

[1] Residents rely on fish and minor livestock rather than beef for protein so that pasture loss would not result in decreased local consumption. Households reported holding sufficient land to secure subsistence agricultural products even with a reduction in fallow land and many envision (realistically) a shift away from subsistence agriculture with increased incomes from non-farm activities (including CDM-AR).

The costs of implementing the CDM-AR in Ipeti-Emberá are substantial, estimated at $628,964 (Net Present Value, discount rate: 5%). The labor required to establish the project is 35,418 days during the first three years. In fact, almost 50% of the costs is incurred during these first years with project establishment, including technical studies, fencing, land preparation, seedling procurement and planting, weeding, and substantial administrative fees/transaction cost fees for marketing of CERs. Transaction costs include preparation of a Project Idea Note, a Project Design Document (PDD), validation of the PDD by an independent organization, and periodic monitoring to determine the true amount of emission reduction (EcoSecurities, 2005). We assume that such costs would be on the order of $50,000, given the small area to be reforested and the fact that most data for the planning documents is already in hand (see Cacho et al., 2004; P. Moura Costa pers. comm.); one half of the transaction costs are assumed to be incurred in the first year, the other half in the tenth year. The discounted 'break-even' value of stored carbon (i.e., where costs, including labor, equal benefits) would be $12.90 tC^{-1}, at the beginning of the project, when accounting for implementation over the project's lifetime.

The main land use decision for villagers regarding the CDM is whether to engage in cattle ranching or commit to carbon sink activities. Table 2 presents the benefits and costs per hectare for carbon, through teak plantations, and cattle for an average farm in the community over 25 years. Labor is valued at the prevailing rural wage ($6 day^{-1}) for both family and non-family labor. In terms strictly of total net revenue over the life of the project, the carbon project is more profitable than cattle raising; the net returns for carbon including the sale of teak ($13,985, NPV, discount rate: 5%) far exceed returns for cattle which are actually negative ($–420) (Table 2). The substantial returns from the CDM-AR are due less to carbon than to the high value of the teak (the planting of which would be necessarily financed by carbon payments in year 1) sold at the end of year 25. Not only does this represent a very long 'wait period' for farmers but the benefit (revenue) stream from cattle in most years (except for year 1, with partial payment for the CERs and at the end of year 25, with teak harvesting) exceed those from the CDM-AR project. As such, in terms of net present value, a farmer should adopt carbon instead of cattle; the returns, however, are distant and the investment a risky one for asset-poor farmers.

What could allow low-income farmers such those in Ipetí-Emberá to engage in CDM-AR or other C sequestrating activities? One possibility is to give the full amount of CERs at the onset of the project to offset the establishment cost, even though this may lead to incentive compatibility problems in the long-run. Alternatively, an NGO or a business partner could subsidize the costs of plantation establishment, effectively reducing the investment required by participants, or an annuity could be offered on timber to be harvested in final year (25) of the project. However, these options to reduce initial costs and realize earlier returns are few and fraught with high risk and moral hazard problems. In all cases, the threat of fire or disease or pest outbreaks, premature cutting, and the continuous need to monitor local conditions and enforce appropriate behavior would reduce their attractiveness to external organizations. Moreover, unlike the carbon project, cattle offer – regardless of negative long term returns – certain significant economic advantages, including low time demand, high liquidity (for insurance and investment), limited sunk costs, lower price risk (cattle vs. carbon) and limited co-ordination/administrative costs.[2] Despite a strong interest in the CDM-AR project by the community and the promise of positive financial returns, villagers recognize that the economic barriers are substantial and perceive the best alternate land use – deforestation for pasture creation and cattle raising – as a clearly a superior option.

A distinct land use policy strategy would be to aid villagers in protecting the tropical forest and avoiding forest loss in return for carbon sequestration payments. Currently under the Kyoto CDM, only projects that convert non-forested lands to forest qualify for CERs. Recognizing that some 20% of global greenhouse gas emissions arise from tropical deforestation (Houghton 2005), Parties to UNFCCC have begun discussions on policy directions and incentives for emission reductions from deforestation in developing countries. The World Bank is currently discussing a new initiative, the Forest Carbon Partnership Facility, and a voluntary carbon market, established in parallel with the Kyoto protocol, could possibly accept RED credits. In Ipeti-Emberá we predict, based on baseline scenarios developed by our team with residents, that without the CDM-AR project, carbon stocks will decrease from 301,859 tC in 2004 to 155,730 tC in 2024 (Potvin et al., 2007). Without positive incentives, forest cover will likely fall over the next 20 years from 1432 ha to 416 ha of the community land area, representing a loss of 1016 ha and 182,400 tC. As such, in terms of carbon, conserving only 269 ha of tropical forest in Ipeti would be the equivalent the current 692 ha CDM-AR proposal.

Our financial analyses reveal that avoided deforestation — whereby residents would be compensated in return for forest preservation is a promising alternative compared to pasture and cattle raising. Consider the case for subsidizing the average farmer to preserve a hectare of existing forest (Table 2, final column). We assume that the annual cost of subsidy is represented by the gross benefits (ha^{-1}) that a farmer would receive should he choose to farm plus the cost of implementing and monitoring forest preservation, resulting in a total (non-discounted) subsidy over the 25 years of $1597 ha^{-1}. As the existing stock of trees is maintained, the farmer does not encounter additional labor and other input costs while receiving an annual payment. Thus, the farmer is not affected by the same 'lumpiness' problems as with the reforestation project and the existing trees are used as carbon sinks. Importantly, the option value and insurance function of the mature trees and land is preserved, should the farmer or the 'buyer' break the contract; a clear advantage over the CDM-AR option during the first 10 years. Community leaders opine that avoided deforestation also would be preferred over CDM-AR in terms of ecological integrity (i.e., by protecting extant

[2] In frontier environments elsewhere in Latin America, negative rates of return on investment in pasture creation and land-extensive cattle raising by colonists are also often offset by rising land values and access to government 'frontier development' subsidies (see Hecht, 1985; Ledec and Goodland, 1989; Mattos and Uhl, 1994); neither of which are likely to be strongly influential in the case of Ipeti as an Emberá homeland.

Table 2 – Annual benefits and costs of CDM-AR activities and cattle raising, with costs of deforestation avoidance, per hectare for an average farmer, Ipeti Emberá, Panama

Year	Benefits and costs per hectare						Costs		
	CDM-AR: carbon, with timber			Cattle raising			CDM-AD: avoided deforestation		
	Benefits	Costs	Net	Benefits	Costs	Net	Gross opportunity costs	Costs	Total costs of subsidy
1	$784	$524	$260	$0	$259	−$259	$0	$12	$12
2	$0	$108	−$108	$0	$59	−$59	$0	0	$0
3	$0	$108	−$108	$0	$59	−$59	$0	0	$0
4	$0	$36	−$36	$0	$59	−$59	$0	0	$0
5	$0	$36	−$36	$92	$114	−$22	$92	0	$92
6	$0	$36	−$36	$25	$59	−$34	$25	$12	$37
7	$0	$36	−$36	$25	$59	−$34	$25	0	$25
8	$0	$36	−$36	$46	$59	−$13	$46	0	$46
9	$0	$36	−$36	$67	$59	$8	$67	0	$67
10	$0	$72	−$72	$196	$114	$82	$196	0	$196
11	$0	$36	−$36	$25	$59	−$34	$25	$12	$37
12	$0	$36	−$36	$25	$59	−$34	$25	0	$25
13	$0	$36	−$36	$46	$59	−$13	$46	0	$46
14	$0	$36	−$36	$67	$59	$8	$67	0	$67
15	$0	$36	−$36	$196	$114	$82	$196	0	$196
16	$0	$36	−$36	$25	$59	−$34	$25	$12	$37
17	$0	$36	−$36	$25	$59	−$34	$25	0	$25
18	$0	$36	−$36	$46	$59	−$13	$46	0	$46
19	$0	$36	−$36	$67	$59	$8	$67	0	$67
20	$0	$36	−$36	$196	$114	$82	$196	0	$196
21	$0	$36	−$36	$25	$59	−$34	$25	$12	$37
22	$0	$36	−$36	$25	$59	−$34	$25	0	$25
23	$0	$36	−$36	$46	$59	−$13	$46	0	$46
24	$0	$36	−$36	$67	$59	$8	$67	0	$67
25	$784	$36	−$36	$196	$114	$82	$196	$12	$196
End: Timber harvest	$47061								
Total	$48,629	$1,568	$47,061	$1,525	$1,938	−$413	$1,525	$72	$1,597
NPV (5%)	$15,107	$1,122	3,985	$736	$1,156	−$420			$776

Carbon price computed for CDM-AR scheme: $12.54 tC^{-1}.
Carbon price computed for CDM-AD scheme: $8.82 tC^{-1}.
Notes:
This table presents the hypothetical case of a farmer contemplating two land use options: (1) cattle raising or (2) carbon (trees for 25 years, with timber harvest at the end of the period). It does not consider potential costs related to additionality, leakage or permanence, nor potential benefits from the provision of other ecosystem services than carbon sequestration. The figures are presented in dollars per hectares. The assumptions upon which the calculations are based are as follows.
1. For the CDM-AR calculations, we considered a low establishment cost including only the purchase of planting bags, fertilizer, pesticides, and herbicides at $94.00 ha^{-1} in year 1 and $45.00 ha^{-1} yr^{-1} in years 2 and 3 and no other input in following years. In Panama, seedling prices range between $0.20 (timber) and $1.00 (fruit trees). At a standard planting density of 700 seedlings ha^{-1}, the villagers would need $59,080 for the 422 ha of timber plantation and $86,800 for the 124 ha of fruit trees. The 146 ha under Silvopastoral use would be established with a density 10 times lower then both timber and fruit plantations, at a cost of $2044. The estimates for labor requirement come from personal experience (C. Potvin) and discussion with the, at the time, Executive Director of PRORENA (M. Wishnie). Land preparation would take between three days person^{-1} for a pasture and 9 days person^{-1} if the land is in old fallow. Planting would necessitate 6 days person^{-1}. Cleaning the plantation would require 15 days person^{-1} in year 1 and 10.5 days person^{-1} in both years 2 and 3. We assumed yearly long-term maintenance to be equivalent to 6 days person^{-1}. For simplicity, the CDM-AR figures in Table 2 are for an average farm holding of 12 ha with only teak planted; benefits and costs related to fruit orchards are not included in Table 2. A teak plantation is assumed to sequester 125 tC per hectare over 25 years (see Kraenzel et al, 2003).
2. Cattle raising. Net returns over the 25 years are negative and based on the assumption that both family and non-family labor are employed at equal wage rates. We expect that peasant households in the community consider only paid (non-family) labor in their analyses of expected net returns.
3. Deforestation avoidance entails two types of costs — the opportunity cost of the next best alternative (cattle), and the cost of monitoring and enforcement of an agreement to protect the forest. We assume that the monitoring and enforcement cost is the same as with CDM-AR over the 25-year period, except that farmers pay it over shorter intervals to reflect more visits. The opportunity cost the farmer receives is the annual gross benefits one would obtain from cattle.
4. The value of the funds received through the CER scheme must exceed the sum of these two costs to be viable. The financing of the subsidy to the farmer for avoided deforestation would be the market value of the carbon stored in the extant forest, delivered as an annual payment to the farmer. The break-even CER value is the price per ton generating enough revenues to cover the total subsidy cost of the average hectare. Table 2 assumes that the farmer would only cultivate teak, not tree fruit crops. A one-hectare plot of primary forest is assumed to store 181 tC aboveground (Kirby, 2005). The break-even CER value was computed without discounting; using a 5% discount rate, the carbon values would be $8.97 tC^{-1} and $4.27 tC^{-1} for CDM-AR and CDM-AD schemes, respectively.

Table 3 – Criteria for acceptability of alternate land use options for low-income households, Ipeti-Emberá, Panama

	CDM-AR	Cattle	Avoided Deforestation
Net returns	+ +	–	+
Financing	– –	–	na
Production risk	– –	–	–
Market risk	–	+ +	?
Labour demands	– –	+	+ +
Liquidity/sunk costs	– –	+	– –
Insurance value	–	+ +	+
Implementation modalities	– –	+ +	?
Perceived equity	– –	–	+ +
Ecological integrity	+	– –	+ +

NB: A positive score indicates that the option is attractive to the household on that criterion. na: not applicable. ?: unascertainable at present.

forests and ecosystem services over reforestation) and of distributional equity within the village (i.e., by rewarding those who have protected their forests over those who benefited by deforesting and then are subsidized to reforest). Avoided deforestation would still need to be, nevertheless, more economically attractive than cattle raising.

The relative advantages of each land use option, from the perspective of asset-poor households in a low-income community such as Ipeti-Emberá, are summarized qualitatively in Table 3. The CDM-AR option is attractive to households for the high potential net financial returns, if credit financing becomes available to enable them to overcome high set-up costs and production as well as market risk. The advantages of cattle are more economic than financial — although long run returns are low (even negative), households face low market risk, low sunk costs, high insurance value (by selling off cattle in times of need) and relatively straightforward implementation (i.e., pasture creation and cattle raising). Avoided deforestation – a hypothetical option, for which market risk and implementation modalities are as yet unknown – has the potential advantages for households of positive financial returns, low labor investment, positive insurance value (sell trees if contact fails) and high perceived equity as well as conserved ecological integrity.

Avoided deforestation is likely to face similar challenges to those of a small-scale CDM-AR scheme in terms of high transaction (including monitoring and verification) costs; however, leakage and additionality are less of a concern than might be expected. Leakage is unlikely to occur beyond Ipeti or within the community because – in contrast to colonists who 'move on' – Emberá residents are strongly tied socio-culturally to their community homeland and payments for avoided deforestation would cover all forest in the community so as to avoid internal leakage. As such additionality is likely to be achieved with forest conservation in Ipeti. Further, because carbon sequestration through avoided deforestation is more land efficient than by reforestation, payments per ton of carbon would be lower for avoided deforestation than under a CDM-AR scheme. Assuming that a one-hectare plot of primary forest stores 181 tC aboveground (Kirby, 2005), the break-even CER value for a farmer to avoid deforestation is about 30% less than that for reforestation, i.e., \$8.82 tC^{-1} versus \$12.54 tC^{-1}. In February of 2007, the international market price of unissued CERs (buyer assumes risk) was reported to be 4–9 Euros tCO_2e (5.4–12.2 \$US) (Carbonpositive, 2007). As such, our CERs values for forest preservation and reforestation, corresponding respectively to \$2.41 tCO_2e and \$3.43 tCO_2e, are well below current CER market prices.

Our results suggest that CDM-AR projects aimed at low-income communities in tropical regions of the developing world face – from the perspective of poor rural households – significant obstacles to adoption and they are not likely to meet their ancillary objectives of restoring forest cover and reducing rural poverty. The primary impediments for adoption by asset-poor households are more economic in nature than financial – high labor demands, sunk costs and illiquidity, and production and price risk – in absolute terms and, importantly, relative to the best alternate land use, i.e., pasture and cattle raising, which remains a primary cause of large-scale tropical deforestation in tropical Latin America (Wassenaar et al., 2007). As such, the current terms of the CDM and prevailing cost-price environment are shaping incentives for continued forest conversion for cattle raising over reforestation for carbon sequestration.

Whereas significant innovations in credit markets may help overcome some obstacles (though not all) to adoption of CDM-AR projects by low income communities, it would seem timely to explore other potentially complementary approaches. A possible alternate land use policy does exist – one that would allow efficient carbon storage, increased incomes for the rural poor, forest conservation and associated ecosystem services – that is to accept forest conservation as a basis for carbon emission reduction and trading. Such a policy promises significant benefits for conservation and the rural poor, and merits much closer attention by researchers and policy-makers as the debate over the potential role of avoided deforestation in the carbon economy unfolds.

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