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Crediting carbon in dry forests: The potential for community forest management in West Africa

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ABSTRACT

Policy on Reduced Emissions from Deforestation and Degradation in Developing Countries (REDD) is currently being debated under the auspices of the UNFCCC. The paper reviews developments in this, particularly as regards potential crediting for reduced forest degradation in places such as the Sahel, given that degradation in the tropical dry forests and savanna woodlands is a considerable source of carbon dioxide emissions. It then presents field data from sites in Guinea Bissau, Mali and Senegal where the Kyoto: Think Global Act Local project has been working for a number of years. In these sites, the local communities had been managing their forests under a variety of different programmes before KTGAL started. The purpose of KTGAL was to record the carbon outcomes of typical community forest management regimes, and to assess whether local communities were capable of making carbon stock measurements themselves. The results indicate that carbon savings range from 5 to 14 tons carbon dioxide per hectare, if both avoided degradation and increased biomass due to forest enhancement are included. They also show that communities can be trained relatively easily to make stock (and thus carbon) assessments, at a much lower cost than employing professional forest surveyors. It is not clear yet whether both reduced degradation and enhanced stock will be rewarded under REDD, nor is it sure how much of the financial reward might potentially be claimed by the communities, but even if only 10% of the financial value of the carbon were to filter back to the communities, this would still represent a considerable incentive for participation.

1. Introduction

In this paper we look at a forestry strategy that many developing countries might build on and employ under forthcoming international climate change arrangements. It seems likely that REDD (Reduced Emissions from Deforestation in Developing Countries) will be adopted as a policy under United National Framework Convention for Climate Change (UNFCCC) in the near future, following positive developments in this respect at UNFCCC's Conferences of Parties, CoP13 in Bali (December 2007) and at CoP14 in Poznan (December 2008). Many of the rainforest countries which are currently suffering from deforestation are optimistic that this will provide a source of funding to enable them to take action to reduce their deforestation rates, whether by strengthening their capacity for enforcement of forest law, or through direct payments to forest users to adopt more sustainable management regimes. Dry forest countries have not been in the forefront of the negotiations on REDD, because of the perception that this new policy concerns humid forests. Dry forests by nature have much less biomass above-ground per hectare than humid forests, and thus proportionally less above-ground carbon stock on an area basis (for the case of sub Saharan Africa, 17–70 tons carbon/ha compared to 193–200 in equatorial forest, Gibbs et al 2007) , although the carbon pool in the soil may be much greater. Their human population densities are much higher than those of humid forests (Campbell et al., 2008) , which means they are more subject to forces causing degradation and they are likely to represent a considerable source of emissions, although the quantity of these emissions is not accurately recorded or known (Achard et al., 2002; Fearnside and Laurance, 2003). This paper proposes that countries with largely dry forests might therefore be able to participate in and benefit from REDD, in addition to countries in the Congo Basin and the Amazon, and Indonesia, Malaysia, etc. In particular we consider what role community forest management (CFM) might play under REDD, taking cases from three West African countries to illustrate the potential.

1.1. REDD policy

Following a major decision made at UNFCC CoP13 in Bali in December 2007, the Parties to the UNFCCC are now discussing a policy known as REDD (Reduced Emissions from Deforestation and Degradation in Developing Countries UNFCCC, 2007). Recognizing that emissions of CO_2 from deforestation in tropical countries account for 20–25%

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of total global emissions (IPCC 2007), REDD policy is designed to reward countries that are able to reduce their rates of deforestation, probably in proportion to the amount of carbon that is thus saved (Gullison et al., 2007; Tollefson, 2008) . The details of how the mechanism would work are still unclear, but in principle it will probably operate at national level, unlike CDM which is project based (Moutinho and Schwartzman, 2005). A reference scenario for each participating country, based for example on past rates of forest loss, would be constructed, against which achievements in reducing deforestation could be measured. Countries would have to commit to retain forests, and not to let their deforestation rates increase in periods that follow. The policies and strategies that a country selects and promotes to achieve its reductions in deforestation would be of its own choice. Carbon credits would be issued on the basis of the net reductions in rate of loss of forest biomass over the relevant accounting period, across the whole country, compared to the reference scenario. Participation would be voluntary, and funds would derive either from sale of carbon credits in a global market, or from a special fund managed by a multi-lateral organization.

A very important issue still to be decided is what, exactly, will be eligible for carbon credits. A distinction is made between deforestation and degradation. Deforestation implies that a forest area is cleared of trees, becoming non-forest (canopy cover falls to below a threshold level, which has been selected by countries themselves in the range 10–30%). Degradation refers to decreased biomass density of biomass in forests which remain forests. Both will be included. However, exactly how degradation is to be defined and measured is unclear. Foresters often use the term interchangeably with 'deforestation', or imply that it is a first step on the road to deforestation, but in reality many forests that are degraded never become fully deforested. A clear definition is greatly needed (Lanly, 1982; Gyde Lund, 1999). An official advisory team to IPCC was not able to fully resolve the question (Penman et al., 2003), although some interesting suggestions relating to 'carbon carrying capacity' of forest have since been made (Cadman, 2008).

There are other aspects of forest biomass change that may also be included in the REDD, such as Sustainable Forest Management (SFM) and forest enhancement. SFM is usually understood to mean a form of timber extraction, for example low impact logging, which, by replacing current wasteful processes, would conserve more of the forest biomass, and reduce emissions (sustainable yield management). Forest enhancement refers to any management regime which results in increased forest biomass as a result of natural regeneration or enrichment planting, that is, it would increase the size of the forest sink. This implies a rather different approach, as it would involve credits for increased sequestration rather than for avoided emissions. Both are briefly mentioned in Decision 2/COP13, as well as in the Chairman's summary of the SBSTA[2]29 discussions on REDD in December 2008. In addition, a few countries, led by India, argue that credits should be given for past conservation efforts or even for total carbon stock through 'Compensated Conservation' (Republic of India, 2007).

1.2. The difficulty of obtaining data on degradation

Population pressure is higher in dry forests and savanna woodlands than in humid forests (Campbell et al., 2008), and degradation in these forests is usually the result of activities of the local people who depend on the forest for a variety of livelihood supports, rather than commercial logging processes. Shifting cultivation cycles have shortened and requirements for grazing have increased, while wood products such as firewood and charcoal once used solely for local subsistence are increasingly being extracted from the dry forests for export to the cities (Kigomo 2003). The results of extraction rates above the capacity for natural regeneration are visible at ground level in the deteriorating condition of the forest but, unlike deforestation, cannot generally be detected from satellite imagery, because the activities responsible are de-concentrated, that is to say, spread out over large areas and long time periods (DeFries et al, 2007). Most developing countries do not have comprehensive forest inventory data, particularly in dry forests which are not very attractive from a commercial logging point of view, so there is almost no ground based data on degradation rates (Achard et al 2004; FAO, 2006), which raises the question of how to create a reference scenario for degradation under REDD and how to monitor REDD efforts to reduce it.

1.3. Community forest management as a carbon conservation strategy

'Community forest management' (CFM) is a general term which describes a variety of programmes in which forest land, usually officially property of the state, is handed over to local communities for management (Arnold, 2001; Padgee et al., 2006). Examples are India's Joint Forest Management programme , Nepal's Community Forest User Groups (Springate-Baginski et al, 2003), and Tanzania's Community Based Forest Management programme, now re-named Participatory Forest Management (Blomley and Ramadhani 2006, Blomley, 2006). The details of each programme vary, but in most cases the community signs an agreement with the Forest Department in which a management plan is drawn up for a given area of forest. The community will be given rights to certain quotas of forest products (firewood, fodder, in some cases also timber). In return, some activities to protect the forest are taken on by the community, most often maintenance of fire-lines and patrol duties. By-laws regarding grazing of cattle and hunting may be established and a community organisation is empowered to manage all this, often including the distribution of benefits among community members and the handling of community funds that are derived from sales of produce and from fines imposed on transgressors (Hobley, 1996). If communities are able under such programmes to manage forests in a sustainable way, then they are in principle protecting them from degradation and reducing the rate at which carbon dioxide is emitted into the atmosphere. As such, CFM could be one weapon in the arsenal that a country might use to participate in REDD.

2. Community forest management in dry forest in West Africa

West Africa has a range of forest ecosystems; we focus only on dry forests and savanna woodlands, which have been subject to widespread degradation. These types of forests account for almost 10 m sq km or 22% of Africa´s land area (FAO 2000). Earlier reports indicate that open forest (foret claire, >40% tree cover) and woody savanna (savanne boisée, 30–40% cover) account for around 170 m hectares in African south of the Sahara, while tree savanna (savanne arborée, 10–30%) covers 282 m ha and schrub savanna (savanne arbustive, <10%), 444 m ha (FAO, 1983). In many cases, degradation of dry forests is thought to be connected to fuel use, particularly to supply major cities with firewood and charcoal. This has led some countries, such as Senegal, to enact national legislation which strictly controls the production of charcoal. In Mali decentralized territorial communities or 'Marchés Ruraux' were given the right to exploit the forest areas within their territory for firewood and charcoal, under sustainable management plans approved by the Forest Department. In Guinea Bissau the official situation is rather strict, although not enforced everywhere. Customary rights to gather non-timber forest products are recognized, but exploitation and sale of wood is officially prohibited.

These efforts were intended to control off-take of wood for commercial purposes (particularly for charcoal). However, it has proven difficult to control the anarchic use of forest products by local populations for their own subsistence. Shifting cultivation and burning during hunting impede the recovery of the dry forests. Over the last 15 years efforts have been made in almost all countries in the region to

[2] Subsidiary Body for Scientific and Technical Advice.

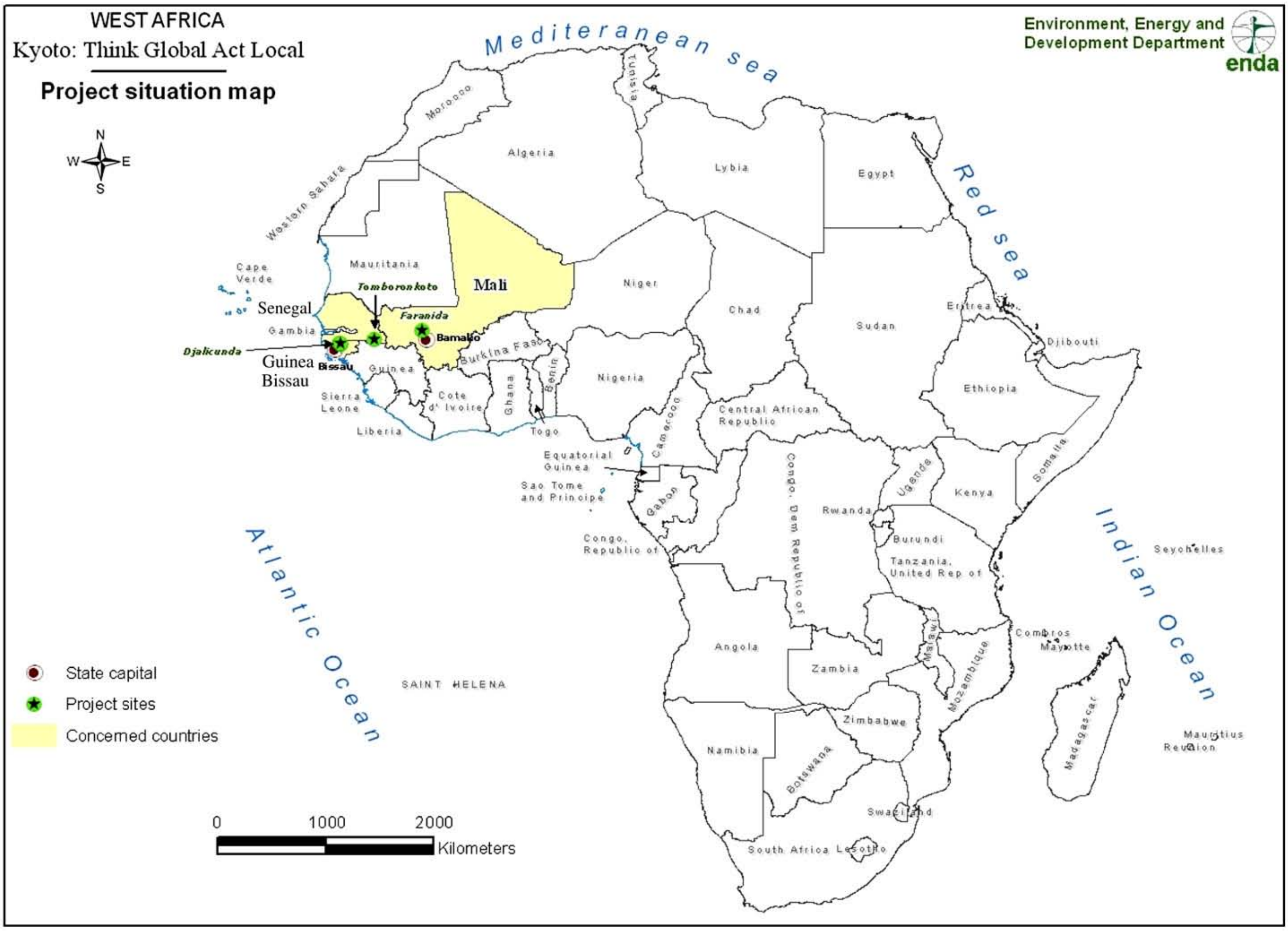

Fig. 1. Location of the K:TGAL project sites.

improve this situation by supporting community forest management in various forms (Kerkhof, 2000; ESMAP, 2001).

2.1. Participatory research to measuring the carbon impacts of CFM

Under Kyoto: Think Global, Act Local (K:TGAL)[3], a research programme financed by the Netherlands Development Cooperation, communities in seven countries in Africa and Asia that have been involved for some years in CFM, have been trained to make biomass (carbon stock) inventories (Murdiyarso and Skutsch, 2006; Banskota et al., 2007). The purpose of the project is to measure the impacts of typical CFM practices on carbon stocks in forests and to test the feasibility of data collection by the local people. The overall aim is to assess whether communities could earn supplementary income by trading carbon if and when REDD policy is adopted internationally.

In West Africa the research is in the hands of ENDA (Environnement et Developpement Tiers Monde), and covers sites in Guinea Bissau, Senegal and Mali. All the carbon assessments were carried out by the local communities themselves, after training by local NGOs. Details concerning the nature of the training and the costs of making the carbon inventories in similar sites in Tanzania, as well as the reliability of community estimates compared to those of professional teams of foresters are reported elsewhere (Skutsch et al., 2009).

[3] http://www.communitycarbonforestry.org.

2.2. Characteristics of the study sites and their management

The forests studied represent four dry vegetation zones: open canopy forest, woody savanna, tree savanna and shrub savanna. The locations of the research sites are shown in Fig. 1 and their vegetation characteristics are presented in Table 1.

At all sites the primary use of the wood from the forest by local people is for firewood for cooking. In the past, over-exploitation for firewood and charcoal, related to export to cities, had been responsible for steady forest degradation (reduction in density of biomass resources), although no data is available on what annual rates of loss prevailed. At all three sites there was in the past some clearance for agriculture and at the site in Senegal there has also been some wood

Table 1
Vegetation characteristics of the sites studied.

	Senegal	Mali	Guinea Bissau
Location of the site	Tambacounda	Bougoula	Djalicounda
Rainfall at the site	1250 mm	1000 mm	1200–1500 mm
Composition of the forest			
Open canopy forest (foret claire) ha (40–60% tree cover)	222		2198
Woody savanna (savane boisée) ha (30–40% tree cover)	8695		
Tree savanna (savane arboree) ha. (10–30% tree cover)	7660		
Shrub savanna (savane arbustive) ha (<10% tree cover)	3670	226	

removal for timber. At all the sites, grazing of cattle and forest fires reduced the ability of the forest to regenerate, and at the site in Mali, hunting had in the past been a major economic activity for the local populations, often with the use of fire. In this forest, the degradation had gone so far that considerable soil erosion was taking place with gullying and significantly reduced fertility.

2.2.1. Guinea Bissau

In Guinea Bissau the project sites are in the forests of Djalicunda, in the northern, drier part of the country. Forest management started in this area in 1994 under the Programme Agri-Sylvi-Pastorale (PASP) in cooperation with Kafo, a rural training centre. An area of 2399 ha (20% of the whole forest) was designated as a 'community reserve forest' in 1995, and is managed by the 1290 inhabitants of five villages, each of which has its own part of the forest to take care of. The agreement gives limited rights to the local people as regards use of forest products; they are permitted to collect dead wood, wild fruits and medicinal plants. Management activities include creation of a team of local forest guards which patrols and monitors the reserve. Fire-lines have been cut round the borders of the forest. These also serve as paths and are cleared annually. Controlled fires are used to reduce the impacts of wild fires. PASP supports alternative means of income generation such as rice cultivation, horticulture and honey collection to make up for income loss when charcoal production was stopped.

2.2.2. Mali

In Mali, the site is in the forest of Faranida, between the villages Nianzana–Safecoro in the rural commune Bougoula, around 75 km of south of Bamako, and Kaka which is in the Siby-Keniero administrative area. The area is 226 ha and has a population of 8603 inhabitants. The forest had been very heavily degraded partly due to fires lit for hunting purposes. In 2004, with the help of the Mali Folkecenter, a local environmental NGO, the villagers have formed forest management committees which organise conservation work and enforce fire control. As a result the population is now able to meet its entire subsistence needs for firewood, building poles and timber from the protected forest, which has meanwhile greatly improved in terms of rate of regeneration. They are also able to gain an income from collection of shea nut (karité or *Vitellaria paradoxa*, used for its butter), néré (*Parkia biglobosa*, edible fruits), medicinal plants and honey.

2.2.3. Senegal

In Senegal, the sites are in the department of Tambacounda in the south–east of the country. The forest borders on to the Nikolo Koba National Park to the north and covers an area of around 20,000 ha, managed by 11 villages with a total population of 3492. The sites fall within a much larger area which is covered by the PROGEDE project, earlier financed by the World Bank under a trust fund. A major provision states that local people are still allowed to extract firewood both for themselves and for sale, provided they have a permit from the chief of the village, but no outsiders (i.e. traders) are allowed to do this. Cutting trees to use as fodder is not permitted, but income generating projects such as horticulture, vegetable processing, guineafowl production, fruit cultivation and bee-keeping have been started as an alternative. Some native forest products are sold commercially ensuring some income to the population.

3. The effects of CFM on carbon stocks

3.1. Measured increases in carbon stock

Villagers mapped their forests (boundaries and strata) and took annual forest inventories using methods outlined in the IPCC Good Practice Guide for LULUCF, and stratified random sampling. Despite the low level of education (0–7 years of primary education) these tasks were quickly mastered by the village forest committees or persons appointed by them, after training by local NGOs (Murdiyarso and Skutsch, 2006). As a result of this work, detailed statistics on forest area and of carbon stocks have been recorded, as shown in Table 2. In almost all cases there appears to have been slow but steady increases in biomass density of the forests under CFM. This is a measure of forest enhancement.

In a number of cases however there have been dramatic losses, for example at Bafatandim in Guinea Bissau. Here despite community management, it is known that there was some incursion and clearance for agriculture, possibly by outsiders, a pressure which is often difficult for many communities to withstand even though this land use change is not legal. The statistics appear to indicate that an area of about 5 ha (out of the 17 under management) was affected in this way. The effect of a small clearance of this nature would show up very strongly in this case because the total forest area allocated to Bafatandim is so small; in a larger forest, the 5 ha would be averaged out and the effect absorbed over a larger total area. But the fact that only one sample plot was used in Bafatandim's forest also means that the results may be misleading when taken on their own, and highlights the importance of using statistical sampling procedures which give known levels of certainty (confidence intervals were not recorded systematically across the case study sites and have therefore not been reported here). More intensive sampling will generally be required in small areas to obtain a given level of confidence, meaning that the costs of measurement in small areas will be much higher on a per hectare (and ton carbon) basis. This case thus indirectly illustrates an important underlying reality relating to

Table 2
Dynamics of carbon stock in the community managed forests.

	Area (ha)	No. of sample plots	Carbon stock/ha 2005	Carbon stock/ha 2006	Carbon stock/ha 2007	Carbon stock/ha 2008	Annual increase in carbon stock tons/ha	Annual CO_2 equivalent (tons)
Senegal, Tambacounda (11 villages)								
Foret claire	222	31	31.99	27.85	nd	29.24	−0.92	−3.31
Savanne boisee	8695	28	17.11	21.50	nd	23.83	2.24	8.06
Savanne arboree	7666	43	18.15	17.77	nd	19.14	0.42	1.51
Savanne arbustive	3670	81	8.80	8.03	nd	9.41	0.20	0.72
Total	20,253						Weighted average[a] 1.15	Weighted average 5.4
Mali, Bougoula (3 villages, 1 forest)								
Savanne arbustive	226	20	13.09	15.79	17.54	nd	2.2	8.3
Guinea Bissau, Djalicounda (5 villages, all foret claire)								
Djalicunda	467	16	nd	nd	88.20	89.65	1.49	5.36
Buro	723	8	nd	nd	57.40	65.06	7.70	27.72
Ga-Quebo	191	9	nd	nd	63.90	64.98	1.10	3.96
Bafatandim	17	1	nd	nd	94.82	68.00	−25.99	−93.56
Sitato	800	13	nd	nd	36.44	40.37	3.88	13.98
Total	2198						4.14	14.90

[a] Weighted on basis of relative areas of the different sites involved.

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economies of scale, as well as the need for full statistical reporting including standard error.

Despite observed losses in some areas, the overall effect of management is clearly positive in carbon terms. Data for these sites is admittedly sketchy, as we have measurements only for a few years in each case; more years of measurement, reporting on standard error, and in some cases, a higher intensity of sampling would be necessary to establish the trends and the size of carbon increments with more certainty. The starting carbon stocks vary considerably, being particularly low for the sites in Senegal, where degradation had been very severe prior to initiation of the management regime. The growth rates reflect both the management regime employed and the rainfall. Preliminary indications are that over the areas of dry forest and savanna woodlands which are under community management, even though there are losses of biomass in some parts, net growth rates of carbon stock are in the range 1.0 to 4 tons/ha/year, which is equivalent to 5 to 15 tons of carbon dioxide. This is more than the growth rates (0.63 tons carbon/ha/year) measured in rainforest areas (Lewis et al., 2009), and reflects the fact that these areas, unlike the rainforest, are heavily degraded with 'room to grow'. Given the fact that relatively much larger areas of dry forest than of rainforest are degraded, it is clear that dry forests represent a major opportunity for carbon savings if degradation can be reversed.

3.2. Carbon emissions from avoided degradation

These estimates do not, however, include the 'avoided degradation'—carbon that would have been lost, if management had not been carried out. To estimate this, either a historical baseline, or contemporaneous measurements at control sites would be necessary (i.e. sites which are similar in type, but which have not been brought under management). Data was not available for establishing the historical pattern of degradation, and a major problem with using control sites in the vicinity of the managed areas is that they would most likely be affected by 'leakage' from the managed sites. Since the permanent plots were not visibly marked however, it is unlikely that there was leakage within the managed area, as this would have been picked up in the annual measurements.

Indeed there is always an underlying risk that management simply displaces the degrading activities to different forest areas, in which case there may be no net saving of carbon at all. The extent to which this is the case, will depend on the type of activities that are introduced. In all three cases, there has been considerable emphasis on replacing firewood and charcoal as trade products with other, potentially more sustainable activities (horticulture, bee-keeping, etc). These activities will not result in leakage, to the extent that they are successful in changing people's way of earning money, and there has been some decrease in woodfuels trade, but impacts have not been carefully assessed yet. There has also been emphasis on fire control, which should not lead to leakage.

Thus for a number of reasons we do not have accurate data on the rate of degradation that would be expected if management had not taken place. We have therefore used an estimate of 5% of total woody biomass per year in each of the forests to create a typical scenario, for purposes of illustration only. Table 3 shows the combined impacts, in carbon terms, of the avoided degradation and the enhanced sequestration at the three sites.

3.3. The value of the carbon savings

Carbon may be valued at around $5 per ton in today's markets and the final column in Table 3 indicates what the value of the carbon savings would be at this rate. It would be an illusion to expect that the calculated values (ranging from $25 per ha in the Senegal sites to nearly $100 in Guinea Bissau) would be available to the communities concerned. In practice, there will be large overheads and transaction costs, which would be deducted, and each country will have to decide what portion of the earnings per ton would be distributed to those immediately responsible for the savings (the communities, in this case) and what part would be retained by the state or by the intermediary organisations that would certainly be necessary to assist communities in managing, measuring the carbon, and registering their claims. However even if only 10% of the financial value of the carbon were to be returned to the communities, this still represents a considerable earning for them, given the low returns on agriculture and the lack of alternative employment opportunities. It might even be sufficient to encourage many more communities to involve themselves in forest management. The balance might be sufficient to incentivize the state to expand its efforts as regards implementation of community forest management activities.

4. Discussion: implications for participation in REDD

The research carried out at the sites demonstrates a number of points which may be useful to consider in the design of national strategies under REDD and the role of CFM within this.

1. Local communities are able to manage forests
   The effects of the three programmes described are visible in terms of the improving health of the forests concerned. Regeneration rates have improved and biomass is increasing slowly but surely

Table 3
Total carbon that might be eligible for crediting.

	CO_2 sequestered per hectare per year due to management	Estimated CO_2 saved per hectare per year through avoided degradation	Total CO_2 per hectare per year that might be credited	Value per hectare per year at $5 per ton	Annual value over whole forest area at $5 per ton
Senegal, Tambacounda					
Foret claire	−3.3	5.8	2.5	12.5	2775
Savanne boisee	8.1	2.8	10.9	54.50	473 878
Savanne arboree	1.5	3.2	4.7	23.50	180 151
Savanne arbustive	0.7	1.4	2.1	10.50	3853
Total value over all					660 657
Forest					Av per ha = $32.6
Mali, Bougoula					
Savanne arbustive	8.3	2.5	10.8	54.0	12,204 (av $54/ha)
Guinea Bissau, Djalacounda (all foret claire)					
Djalacounda	5.4	15.8	21.2	106.0	49 502
Buro	27.7	10.4	38.3	192.5	139 177
Ga-Quebo	4.0	11.2	14.2	71.0	1356
Bafatandim	−93.6	18.3	−75.3	−376.5	−6400
Sitato	14.9	6.5	20.5	102.5	82 000
Total value over all					265 635
Forest					Av per ha = $120

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(Table 2). By and large local people have been able to bring about these improvements by the way they interact with the forest, albeit with the guidance of the Forest departments and NGOs. There exists enough solidarity, cohesion or social control within the villages to ensure that the rules, once made, are largely adhered to.

2. The carbon stock increases are considerable.
The management plans were originally put in place without any view to increasing carbon sequestration; they were instigated for other environmental and social reasons. However, there have been steady increases in carbon stock (Table 2) and in addition it is reasonable to assume that there are further carbon savings as a result of reduced degradation. The incentive to participate in a crediting scheme will be higher if both the forest enhancement and the avoided degradation are credited. It would therefore be advantageous, and provide a greater incentive, if REDD policy were to be formulated to include both reduced degradation and forest enhancement.
3. If carbon were to be valued on a per ton basis, this could act as an incentive to government to initiate, and communities to participate in, much more extensive CFM programmes.
CFM programmes involve considerable costs to set up and donor funding is frequently necessary, as in the cases described. If carbon savings due to CFM were to be credited, this could provide a source of funds to promote CFM on a much greater scale. Financial benefits would clearly need to be shared between government, intermediary organisations and local communities, to reflect the costs involved to these stakeholders.
4. Measurement of carbon stock can be done by local people
In all three communities, local people with minimal education were trained to map the forest boundaries including the strata, and to do standard forest inventory work (estimation of diameter at breast height (dbh) and tree height, in sample plots). While the initial setting out of the sample plots and the calculation of tree mass per hectare, which uses allometric equations, need professional assistance from e.g. local NGOs, the annual work involved in data collection was carried out by community members themselves to reasonable degrees of accuracy at the plot level. The results of the community measurements need to be compared against professional measurements before reliability can be assessed, but data from sites in Tanzania and the Himalayas (Skutsch et al., 2009) demonstrates that such community carbon assessments are typically no more than 5% different from those of professionals. The idea that communities are capable of making forest assessments is further supported by a number of studies which relate to biodiversity and disturbance inventories (Topp-Jørgensen, 2005; Holck, 2008; Danielsen et al., 2009). It is too early to assess what further impacts community forest inventories might have on management and the relationship of the community to the forest, but it is quite possible that it may raise awareness of the effectiveness of different management strategies and increase understanding of forest dynamics. Independent verification of community assessments would of course be required, as in any payment for environmental services system.
5. The cost of carbon measurement is low
Since the bulk of the work lies in the measuring of trees in sample plots, the costs are much lower than those of a professional survey, lowering overall transaction costs. For Tanzania, Zahabu (2008) estimates the long run costs would be about one quarter of those of professional surveys. If participating communities make their own forest inventories and record their own stock change data, more of the financial rewards from the carbon credits would be available for distribution.
6. Economies of scale in sampling
It is clear that considerable care is required in calculating the necessary sample size to ensure reliable results. Standard statistical procedures are necessary, and were evidently not always followed by participating communities (e.g. as detected in the case of Bafatandim). Provided the forest is relatively uniform, the general rule is that the larger the area being surveyed, proportionately the fewer samples plots will be required. This would imply that villages with relatively small forest areas would do much better if they were willing to combine their efforts.
7. Leakage needs to be accounted for
It is not clear in our studies how much leakage is occurring (displacement of activities from the managed forest areas to other locations); measurement of leakage is not a simple matter. It is probably higher for the case of Guinea Bissau, where there is adjacent unmanaged forest, than in the sites in Mali and Senegal, but we are not able to quantify this. It is probable that in order to account for leakage, the crediting system would apply a conservative rule of thumb to represent leakage losses, and deduct a portion of the credits from the total claimed to counterbalance it.

5. Conclusions

The fact that CFM can be demonstrated to be a cost-effective means of reducing degradation rates in dry forest areas does not necessarily mean that CFM can easily be stimulated or supported by direct payments from REDD policy in the future. Nor is it sure, even if it is supported by REDD, that communities will be able to earn from the carbon credits they generate. International funds for REDD will almost certainly be paid centrally to the state on the basis of average reduction in deforestation and degradation rates, not to individual projects. Setting up a national institution to administer a payment for carbon services system for communities will not be simple at all, given that it may require full carbon accounting across the whole country, a monitoring system to verify carbon claims and a complicated formula and infrastructure for making payments. The opportunities for fraud, and the associated risks of corruption, should not be underestimated.

There are however other ways of creating incentives. The alternative income generating activities promoted by the CFM programmes examined here are all funded by donor organisations at the moment, and are therefore undertaken on relatively small scale. With the promise of carbon funds, the state itself could take the financial lead and organise these kinds of shifts in the economic base of village life on a much larger scale. Part of the enterprise might include paying local communities to measure their forests—to carry out forest inventories on a regular basis, using the kinds of techniques which the K:TGAL has demonstrated to be feasible. This way, the community would not be paid for the carbon as such, but for their services in monitoring it. Although this might appear at first sight to remove the incentive, in reality it might be a much more manageable approach.

Whether the funds for REDD come from a carbon market or from a voluntary multi-lateral fund, the side benefits of this approach, including the fact that it could improve the lives of some of the poorest people in West Africa, make it a very attractive option for countries to explore. For the participation of communities in dry forests areas however it is vital that degradation is defined and measured in such ways that communities may stake their claim, and self-assessment of carbon stock change is an important means of achieving this. UNFCCC negotiators need to recognise that both policy questions (what types of carbon savings are allowed for crediting) and methodological questions (preference for locally measured stock change assessments) will be very important in determining whether communities will be able to participate in REDD.

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References

Achard, F., Eva, H.D., Stibig, H.-J., Mayaux, P., Gallego, J., Richards, T., Malingreau, J.-P., 2002. Determination of deforestation rates of the world´s humid tropical forests. Science 297 (5583), 999–1002.

Achard, F., Eva, H.D., Mayaux, P., Stibig, H.J., Belward, A., 2004. Improved estimates of net carbon emissions from land cover change in the tropics for the 1990s. Global Biochemical Cycles 18, GB2008.

Arnold, J.M., 2001. Forests and People: 25 Years of Community Forest Management. Rome, FAO.

Banskota, K., Karky, B.S., Skutsch, M., 2007. Reducing carbon emissions through community managed forest in the Himalaya. ICIMOD, Kathmandu.

Blomley, T., Ramadhani, H., 2006. Going to scale with participatory forest management; early lessons from Tanzania. International Forestry review 8, 93–100.

Blomley, T., 2006. Mainstreaming participatory forestry within the local government reform process in Tanzania. Gatekeeper series 128. IIED, London.

Cadman, S. 2008. Defining forest degradation for an effective mechanism to reduce emissions from deforestation and forest degradation (REDD). Paper prepared for SBSTA Workshop on Degradation, Bonn. http://unfccc.int/files/methods_science/redd/application/pdf/seancadman2_11nov8.pdf

Campbell, B.M., Angelsen, A., Cunningham, A., Katerere, Y., Sitoe, A., Wunder, S., 2008. Miombo woodlands—opportunities and barriers to sustainable forest management. CIFOR, Bogor, Indonesia.

Danielsen, F., Burgess, N.D., Balmford, A., Donald, P.F., Funder, M., Jones, J.P.G., Alviola, P., Balete, D.S., Blomley, T., Brashares, J., Child, B., Enghoff, M., Fjeldså, J., Holt, S., Hübertz, H., Jensen, A.E., Jensen, P.M., Massao, J., Mendoza, M.M., Ngaga, Y., Poulsen, M.K., Rueda, R., Sam, M., Skielboe, T., Stuart-Hill, G., Topp-Jørgensen, E., Yonten, D., 2009. Local participation in natural resource monitoring: a characterization of approaches. Conservation Biology 23, 31–42.

DeFries, R., Achard, F., Brown, S., Herold, M., Murdiyarso, S., Schlamadinger, B., de Souza, C., 2007. Earth observations for estimating greenhouse gas emissions from deforestation in developing countries. Environmental Science and Policy 10, 385–394.

FAO, 2006. Global Forest Resources Assessment 2005. FAO, Rome.

FAO, 2000. Global Ecological Zoning for the Global Forest Resource Assessment. Rome, FAO.

FAO, 1983. Fuelwood Supplies in the Developing Countries. Ch 4: Africa south of the Sahara. FAO Forestry Paper 42: Rome.

Fearnside, P.M., Laurance, W.F., 2003. Comment on ¨Determination of deforestation rates of the world´s humid tropical forests¨. Science 299, 5609.

Gibbs, H.K., Brown, S., Niles, J.O., Foley, J.A., 2007. Monitoring and estimating tropical forest carbon stocks: making REDD a reality. Environmental Research Letters 2, 045023.

Gullison, R.E., Frumhoff, P.C., Canadell, J.G., Field, C.B., Nepstad, D.C., Hayhoe, K., Avissar, R., Curran, L.M., Friedlingstein, P., Jones, C.D., Nobre, C., 2007. Tropical forests and climate policy. Science 316, 985–986.

ESMAP, 2001. Sustainable woodfuel supplies from the dry tropical woodlands. Energy Sector Management Assistance Programme of the World Bank, Technical Paper 13, Washington D.C.

Gyde Lund, H., 1999. A 'forest' by any other name. Environmental Science and Policy 2 (1999), 125–133.

Hobley, M., 1996. Participatory Forest Management in South Asia: The Process of Change in India and Nepal. Rural Development Forestry Study Guide. ODI, London.

Holck, M., 2008. Participatory forest monitoring: an assessment of the accuracy of simple cost-effective methods. Biodiversity and Conservation 17, 2023–2036.

IPCC, 2007. 4th Assessment Report: Climate Change 2007. IPCC.

Kerkhof, P., 2000. Local forest management in the Sahal. SOS Sahel, London.

Kigomo, B. 2003. Forests and woodlands degradation in dryland Africa: a case for urgent global attention. Paper presented at World Forest Congress, Quebec City. Available at http://www.fao.org/DOCREP/ARTICLE/WFC/XII/0169-B3.htm

Lanly, J.P., 1982. Tropical forest resources. FAO Forestry Paper No. 30. Rome.

Lewis, S.L., Lopez-Gonzalez, G., Sonké, B., Affum-Baffoe, K., Baker, T.R., Ojo, L.O., Phillips, O.L., Reitsma, J.M., White, L., Comiskey, J., Djuikouo, M., Ewango, C., Feldpausch, T.R., Hamilton, A.C., Gloor, M., Hart, T., Hladik, M., Lloyd, J., Lovett, J.C., Makana, J.-R., Malhi, Y., Mbago, F.M., Ndangalasi, H.J., Peacock, J., Peh, K., Sheil, D., Sunderland, T., Swaine, M.D., Taplin, J., Taylor, D., Thomas, S.C., Votere, R., Wöll, H., 2009. Increasing carbon storage in intact African tropical forests. Nature 457, 1003–1006.

Moutinho, P., Schwartzman, S., 2005. Tropical Deforestation and Climate Change. Instituto de Pesquiso Ambiental da Amazonia and Environmental Defense, Belem, Brazil.

Murdiyarso, D., Skutsch, M., 2006. Community Forest Management as a Carbon Mitigation Option: Case Studies. Bogor, Indonesia, CIFOR.

Padgee, A., Kim, Y.-S., Daugherty, P.-J., 2006. What makes community forest management successful: a meta-study from community forests throughout the world. Society and Natural Resources 19, 33–52.

Penman, J., Gytarsky, M., Krug, T., Kruger, D., Pipatti, R., Buendia, L., Miwa, K.L., Ngara, T., Tanabe, K., Wagner, F., 2003. Definitions and methodological options to inventory emissions from direct human-induced degradation of forests and devegetation of other vegetation types. IPCC-IGES, Kanagawa, Japan.

Republic of India, 2007. Country submission on reducing emissions from deforestation in developing countries. UNFCCC: Views on the Range of Topics and Other Related Information Relating to Reduced Emissions from Deforestation in Developing Countries. FCCC/SBSTA/2007/MISC.2.

Skutsch, M., Van Laake, P.E., Zahabu, E., Karky, B.S., Phartiyal, P., 2009. Community monitoring in REDD+. Chapter 8. In: Angelsen, A. (Ed.), Realising REDD: National Strategy and Policy Options. Bogor, Indonesia, CIFOR.

Springate-Baginski, O., Dev, O.P., Yadeve, N.P., Soussan, J., 2003. Community forest management in the middle hills of Nepal: the changing context. Journal of Forest and Livelihood 31, 1.

Tollefson, J., 2008. Save the trees. Special report. Nature 452.

Topp-Jørgensen, E., Pousen, M.K., Lund, J.F., Massao, J.F., 2005. Community-based monitoring of natural resource use and forest quality in montane forests and miombo woodlands of Tanzania. Biodiversity and Conservation 14, 2653–2677.

UNFCCC, 2007. Decision 2/CP13: Reducing emissions from deforestation in developing countries; approaches to stimulate action. UNFCCC, Bonn.

Zahabu, E., 2008. Sinks and Sources. PhD thesis, University of Twente, Enschede, Netherlands.

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