The value and the feasibility of community monitoring of biomass under REDD+[1]

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Synopsis

- Communities in forest areas can be trained to carry out forest mapping and standard forest inventory, though an intermediary organisation is needed for technical support in some tasks.
- Costs of community carbon monitoring are likely to be much lower than professional surveys, and accuracy appears to be relatively good. The precision levels depend on the size of the sample and there is an important trade-off between costs of increasing sample size and the amount of carbon that communities could claim as a result.
- Entrusting forest inventory work to communities could have other advantages within a national REDD programme, such as transparency, and could highlight the value of community forest management in providing carbon services.

1 Introduction

The inclusion of degradation and forest enhancement (´negative degradation´) in REDD+ implies that countries will need to carry out forest inventories on a regular and systematic basis in order to quantify forest carbon stock changes. This would be an expensive undertaking if professional surveyors are employed, and there may be serious manpower shortages. One possibility is that communities in forest areas

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[1] This chapter is largely based on work done in the Kyoto: Think Global Act Local project (www.communitycarbonforestry), which was financed by Netherlands Development Cooperation. All views expressed in the chapter are however the responsibility of the authors. Parts of Section 4 are taken from Skutsch et al. 2009. A more technical account of procedures and options for community based monitoring can be found in the GOFC-GOLD Sourcebook, 2009 version (Chapter 3.4, Van Laake and Skutsch).

undertake some of the necessary forest inventory work, particularly those communities that are involved in carbon PES programmes or other forest management (CFM) schemes.

The chapter explores the potential for community carbon monitoring. It first explains the need for detailed ground level data if communities and countries are to be rewarded for (negative) degradation. It then presents very briefly the steps involved and the experience with community carbon monitoring. It continues by discussing the reliability and costs, and how community monitoring might be integrated into national REDD systems, before presenting some conclusions. The chapter is mainly based on the authors' experience of the Kyoto: Think Global Act Local programme.

2 The importance of ground level stock change data for claiming degradation and forest enhancement credits

Most programmes for community forest management (CFM, see Chapter 16) are in practice not directed primarily towards reducing large-scale deforestation (land use change), but to reducing the kind of degradation or loss of biomass within the forests that is related to local over-exploitation for firewood and charcoal production, clearance for temporary farming plots by fire, fodder collection and grazing in the forest. Successful CFM not only halts this degradation but also brings about forest carbon enhancement (which can be seen as ´negative degradation´). Reduced degradation and forest carbon enhancement are both now included in REDD+, and both could therefore potentially be rewarded. But the implications for monitoring, reporting and verification (MRV) are important, and have not been fully appreciated in the current debates.

The kind of degradation that CFM attempts to reverse tends to be slow, on the order of one or two tons per hectare per year. The forest enhancement that results from CFM is also relatively slow. Such small changes cannot be identified, let alone measured in mass terms, from remote sensing over a time span as short as a carbon accounting period (yet to be defined, but perhaps 1-2 years, and in any case not more than 5). Claims in the literature that degradation can be measured using a combination of high tech remote sensing procedures (e.g. Souza 2003) do not concern this type of degradation, but selective logging in rainforests, which tends to take place as episodic, highly localised events, which are much more visible from above. Though difficult to measure through remote sensing, the small but positive gains per hectare that are associated with CFM are important from a climate change perspective, not least because they could potentially be won over very large areas.

In order to make credible claims internationally for reduced degradation and for forest carbon enhancement resulting from CFM, countries will therefore need to carry out carbon monitoring to gather Tier 3 level data (Box 1 and Chapter 7) through sequential ground level inventories over the quite large areas of forest that are under CFM. If generalised non-local data (Tiers 1 or 2) are used, the error margin may be so great that the small quantity that could be claimed per hectare might make the effort not worthwhile. Since the costs of forest inventory are essentially the same per hectare whatever the biomass level, it may not be cost effective for governments to invest in regular surveys of forests which are only changing slowly. The danger is therefore that the efforts of communities through CFM may go unrewarded under REDD+ because of the economics of MRV under a compliance regime.

3 Community self-monitoring of carbon stocks

Given these monitoring problems, one option is to entrust the forest inventory work to the local community that is managing the forest; this could indeed provide the basis for any payments they receive for carbon. Although there have been several studies on the capacity of local people to make forest biodiversity or disturbance assessments (Holck, 2008; Topp-Jørgensen et al 2005), there are currently only a few projects in which local people have been trained to make detailed carbon stock measurements, . These include the Scolel Té project in Mexico, from which carbon credits are sold in the voluntary market (Box 2), and the Kyoto: Think Global, Act Local (K:TGAL), which is a research project designed specifically to experiment with this idea and to assess whether local people could make forest carbon inventories reliably and cost effectively (Skutsch 2005; Tewari and Phartiyal 2006; Karky 2008; Zahabu et al. 2008). The results, some of which are presented in this chapter, are based on field findings in CFM projects in around 30 sites in 8 countries in Africa, Asia and Latin America, over 3 to 5 years.

K:TGAL has demonstrated that local people with as little as 4 to 7 years of primary education, who are already involved in CFM, can easily be trained to carry out forest inventory employing the standard methods used in forestry and recommended by, for example, the IPCC Good Practice Guidance (IPCC, 2003). The methodology used in the project is summarised in Box 3. This involves sampling all above-ground biomass (trees, shrubs and herb layers, and litter), but not soil carbon. The reasons for this exclusion are the technical difficulties of estimating changes in soil carbon over time, and because it is not yet clear whether soil carbon will generate carbon credits under REDD+. Below ground biomass is calculated using standard expansion factors (secondary data on the typical ratio of below ground to above ground tree biomass).

In 24 of the 28 K:TGAL sites for which data is available for between 3 and 5 years, steady annual increases in carbon stock have been recorded. In the remaining 4, there were losses in one year because of encroachments, but the overall trend was for increasing biomass levels, indicating the general success of CFM in building up carbon stocks. Moreover, the research under K:TGAL showed that forest enhancement accounted for around three times as much carbon gain as the estimated reduced degradation in the sites that had been brought under CFM (Skutsch et al. 2009a, 2009b), meaning that it is the dominant process.

While monitoring of carbon stocks systematically over time can be used to estimate forest carbon enhancement, calculating emission reductions from reduced degradation is not so straightforward. The reference level for carbon enhancement is zero change, whereas the reference level for degradation is a hypothetical construct of the counterfactual development, i.e., what would have happened without REDD+ in a business as usual scenario. Historical data on degradation is not available in most areas where CFM has been started. One option could be to select a conservative nominal rate (such as one ton per hectare per year) to reflect past degradation rates, but this would always be open to question.

To resolve this difficulty, a simple option is to reward *only* the measured forest carbon enhancement and treat the avoided degradation as an additional, unpaid contribution. From a carbon buyer's perspective, this would have the additional advantage of making the carbon claims conservative. Rewarding the forest enhancement rather than the avoided degradation makes sense because in most cases of CFM, degradation is quickly reversed and forest carbon enhancement sets in (Figure 1), which as noted may be the dominant process.

4 Reliability of community monitoring in forest carbon inventories

How reliable is community monitoring? Are the results comparable to forest inventories carried out by professionals? Data from the K:TGAL project in community forests in Tanzania and the Himalayan region show that the estimates of mean biomass made by the community in 2008 were in no case more than 7% different, and mostly less than 5% different from those of the independent experts who carried out control surveys that year (Table 1). In all cases, the measurements by the community were lower than those of the experts, which might seem to imply a more conservative approach to the measurement, but in reality probably reflects the fact that the experts' measurement was done some months after the communities', and that the trees had grown during the interval. This also indicates that the real difference in community and expert estimates is almost certainly less than that shown in the table. However, in some cases the variance of the data is higher for the case of the community measurements, implying that through the accuracy is good, the precision was weaker. The difference in precision levels however can be traced to the fact that in these locations, the consultants used slightly different sampling method (e.g. larger plot sizes), and not to any lack of measurement skills on the part of the community team.

Reliability can also be increased by ensuring regular sampling over time. Ideally the surveys should be done in the same season. Even though carbon gains may be calculated and rewarded over a full accounting period, annual surveys are recommended. Growth rates fluctuate owing to variations in annual rainfall and temperature, and a data series may smooth and average these natural effects out. Further, if data is gathered on an annual basis there is also more chance of catching errors, simply from statistical examination. Annual surveys are also important in terms of continuity, so that the community remains aware of this task and the team trained to do it will not forget so easily the monitoring procedures, reducing re-training costs.

Associated with questions of reliability, carbon estimates are normally subject to verification before any payments are made. It is possible that some elements of verification could be carried out through local community measurement. The experience of the Scolel Té project (Box 2) in using a combination of ´neighbours´ and technical staff to check measurements is interesting and could be explored further.

5 Costs of community monitoring

A second important question is how the costs of community monitoring compare with professional forest inventory. In the K:TGAL experiment, the cost of the community inventories was recorded in detail for four sites in Tanzania (Table 2). First year costs for community survey (which are high because of initial training and setting up of the permanent plots) were found to range between 70% and 30% of the cost of the professional survey (Table 2). Costs decreased rapidly over time, since with annual surveys, only a limited amount of time has to be invested in re-training each time. The average cost of community inventories over four years is only about one quarter of that of professional surveys. The costs of community monitoring include: the time for the community members involved ($2 per day, the typical local day rate for unskilled labour), the time and expenses of the intermediary organisation during training and supervision, and a proportional share of the costs of the equipment and software used. The costs of the professional survey were the actual payments made to the survey team based on normal local rates, including travel costs.

The main reason for the very high variation in costs between sites, as shown in Table 2, is that economies of scale play a considerable role, both for community-based and for professional surveys. Relatively fewer sample plots are required for the same level of precision in large tracts of forest than in small forests, assuming the same level of homogeneity. In addition, training is a fixed cost, and is thus in per hectare terms more expensive for smaller forests. This has important consequences for carbon emission reduction claims, implying that it might be more economic to bundle the claims of several communities.

For the case of Dhaili in Uttarkhand, India, with a forest in 3 strata totalling 58 hectares, the community manpower involved in the first year work was estimated at around $3 per hectare, while the professional team costs were around $5.5 per hectare. From the second year onwards costs would be about half of this for both teams, since boundary mapping and setting out of sample plots would not be repeated.

An important trade-off exists between increasing the amount of carbon that could be claimed through achieving a higher level of precision, and the cost of doing this by increasing the size of the sample, that is, size and number of plots measured, as is illustrated by the difference in the consultants' and community approach as mentioned above. It would certainly be possible for the community to increase the precision of its estimates by increasing the size of the plots, but this would involve more man-days of work. It is difficult to estimate the optimal choice in this regard until the sales value of a unit of carbon is known. Moreover, no rules have yet been developed concerning whether the estimate of the mean itself will be used in rewarding carbon reductions, or the lower side of the confidence interval, or some other discount factor to represent uncertainty. In the Scolet Té project for example, only 90% of the measured carbon stocks are credited. Clearly it will be difficult for the community itself to make the calculation for this, but once the rules are settled, this cost-benefit trade-off will be much clearer to the supporting intermediary.

6 Community monitoring within the national REDD programme

Under REDD+, countries are likely to have to make far more forest inventories than they typically have in the past, if they have to attain the level of accuracy that the IPCC has proposed for other reporting under the UNFCCC: maximum 10% error at the 90% confidence level. Community monitoring appears to be a straightforward option for dramatically increasing the intensity of the monitoring. Within a national REDD+ programme community monitoring could potentially present a relatively cheap way to generate accurate, ground level data (Tier 3). Countries could start to use community monitoring methodology in areas where communities are close to the forests, especially where they already are active in management, while still using gain-loss (Tier 2) or other methods of estimation in areas where this is not yet possible.

A national electronic database into which communities directly upload the results of their inventories is well within today's technical possibilities, and simple statistical analysis can be used to detect suspicious reporting, although some form of verification (such as random spot checking using very high resolution remote sensing techniques) would also be necessary, as in all carbon reduction schemes.

Data from community inventories could potentially be used:

- To directly assess biomass and biomass change over time.
- To support stratification of the forest resources into homogeneous units based on resource type, resource condition, management regime and temporal dynamics.
- To support independent validation of carbon emission reduction claims by correlating individual inventories against satellite imagery, ex-ante and ex-post. This may obviate the need for extensive field visits and thus reduce transaction costs.
- To raise the accuracy of data estimates, reducing uncertainty and error margins, thus allowing the country to claim more carbon credits, particularly on reduced degradation and forest enhancement
- To provide a transparent basis for the distribution of financial benefits under national carbon PES or PES like systems (Peskett and Harkin, 2007; Luttrell et al., 2007; see also Chapter 17)

Further, community inventories will serve to highlight the importance of community management in provision of carbon services and legitimise community claims to a share of the financial benefits. They will also strengthen the negotiating position of communities in assessing the relative value of forests versus other land uses in the case of land disputes.

Several possible models present themselves for the institutional linking of community inventories into national REDD programmes. Clearly, local responsibility for biomass inventory could be made an integral requirement of all carbon PES programmes, such that payments would be result based, and the costs to the community of making the inventories would be recouped from the financial flows they receive for the carbon. However in the short term this could lead to high transaction costs and inter-community conflict as the potential for carbon credits is unevenly distributed both by nature and by earlier management. As an intermediate step, before national REDD systems are fully operational, an alternative could be to pay communities not for the actual carbon gains in their forest, but a flat rate per hectare basis for their services in measuring and monitoring of the stock changes. Although it might seem that this removes the incentive for restoring carbon stock, the payment could be tied to a general management agreement, which then serves as a proxy for reduced degradation and forest carbon enhancement[2]. The country would benefit by obtaining detailed data on stock change which would enable them to claim carbon credits on degradation and forest enhancement, while the community would earn some income for generating the data, not for the carbon itself.

7 Conclusions

Community forestry is a strategy which is likely to be adopted by many countries as part of their national REDD programme. Although other monitoring methods (professional forest inventories, or gain-loss methods based on secondary data) could be used for claiming rewards for the related carbon savings, community monitoring offers a number of advantages. It appears to be cheap and relatively reliable, particularly if carried out annually, and would result in Tier 3 level data. It could potentially be carried out in all forest areas which are within range of rural settlements, particularly those parts of the forest that are already under community management or that will be brought under community management under REDD, and it may in itself provide a stimulus for involvement of local communities in REDD. From a national point of view, it could provide a transparent basis for carbon payments, if these are to be output related. However, until the working rules for REDD carbon accounting are clearer (for example, how avoided degradation will be assessed at local level, and what proportion of the estimated increases in carbon stock may be claimed by a community as 'forest enhancement', not to mention the price that will be paid per ton of carbon), the net benefits to communities of carrying out such monitoring remain unclear.

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[2] Most PES systems currently function on the basis of flat rate payments, and are not output based, mainly because measuring outputs of, for example, biodiversity or water conservation, is very difficult. Carbon is much easier to measure, but nevertheless it may not always be necessary to base rewards on the actual outputs.

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	Estimates by community	Estimates by consultants	% difference of mean
Dhaili village, Uttarkhand, India			
1. Even aged banj oak forest, Mean biomass (tons/ha) Standard deviation	 64.08 25.42	 66.97 25.46	 4%
2. Dense mixed banj oak forest, Mean biomass (tons/ha) Standard deviation	 173.39 59.09	 188.05 62.37	 7%
3. Banj oak chir pine degraded Mean biomass (tons/ha) Standard deviation	 66.29 17.75	 66.87 18.16	 <1%
Lamatar village, Nepal			
Oak forests Mean biomass (tons/ha) Standard deviation	 125.28 72.56	 125.99 50.47	 <1%
Kitulangalo SUA Forest Reserve, Tanzania			
Degraded miombo woodland, Mean biomass (tons/ha) Standard deviation	 42.19 8.65	 43.15 3.75	 2%

Table 1: Biomass estimates by villagers and professional surveyors in Tanzania (source: Zahabu, 2008) and in the Himalaya region (K:TGAL, 2008)

Study site	Forest area (ha)	If carried out by local communities				If carried out by professionals
		Cost ($/ha)				
		1st	2nd year	3rd year	4th year +	Every year
1. Kitulangalo	1020	5	3	2	1	10
2. Handei	156	17	12	8	2	44
3. Mangala	28.5	53	37	24	6	176
4. Ayasanda	550	8	6	5	1	13

Table 2: Costs of carbon assessment by local communities compared to professionals (Source: Zahabu 2008)

Text for Box 1

Tier 1 data is default data provided by the IPCC on carbon stocks and growth rates, representing the average for each of six typical vegetation classes for each of the continents. It is therefore highly generalised and may be very different from the actual situation for any given location on the ground. Tier 2 data is based on national level inventories and studies, and gives typical values for the forest types that are present in the country. It is thus likely to be a little closer to the actual situation, but could still be very inaccurate for specific locations. It is likely that if these kinds of data are used, safety margins will be employed and considerable deductions will be made to ensure conservative estimates and to avoid 'hot air'. Tier 3 data is site specific, usually measured in permanent in situ plots. As the error factors will be much lower, a much larger part of the estimated carbon saving should be claimable.

Text for Box 2

Community Monitoring in the Scolel Té project

The Scolel Té project in Chiapas involves tree planting in a coffee agroforestry system and other agricultural systems as well as sustainable management of surrounding natural woodlands. The project is operated by an NGO, AMBIO, using a system called Plan Vivo, and is financed from the voluntary carbon market. Through a highly participatory process, each individual farmer develops a plan for his own land and has a contract with the organisation as regards carbon sequestration in his/her plots. Following 1-2 days training, the participant carries out annual measurements of increases in the woody biomass stock using standard forest inventory methodology. Each participant has a passbook in which the carbon increments are recorded and payments for the carbon (through ´Plan Vivo certificates´) are listed. The expected increment in carbon is however calculated at the beginning of the process, and farmers receive around 20% of the expected sales value on initiating the plan, to cover the start-up costs; the rest is made over in two later periods (5 years-10 years), this system being to encourage both initial entry in the programme and permanence of the trees. Only 90% of the total carbon recorded can be sold, leaving a buffer of 10% for uncertainties. The carbon measurements of the farmers in one village are independently cross checked by farmers from another participating village, although technical staff of AMBIO re-check 10-15% of all cases. Farmers receive in total approximately 60% of the sales value of the credits in the voluntary market, the rest covering overhead costs of AMBIO.

http://www.planvivo.org

Text for Box 3

Methodology for community forest inventories

The K:TGAL project developed a field manual for community carbon monitoring (www.communitycarbonforestry.org). The material is designed for use by an intermediary (e.g. local forest department or NGO) with some basic computer skills and able to train a team of people from the community and maintain the equipment. It is a ´participatory´ method, although like all participation, the question of who actually participates may be problematic. In brief, the method consists of the following steps:

1. **Boundary mapping.** Geo-referencing of forest boundaries using a hand held computer (or PDA – 'personal digital assistant') linked to a GPS with a standard GIS programme and a geo-referenced base map or satellite image. Boundaries are walked, and immediately appear on base map on the screen. The forest area is automatically calculated (Figure 2).
2. **Identifying strata.** Heterogeneous forests are stratified on basis of: dominant tree species, stocking density, age, and aspect (slopes, orientation), as well as different types of community management. Strata boundaries are added to the base map using the same technique (walking the boundaries of each stratum).
3. **Pilot survey for variance estimation, to determine the number of (permanent) sample plots required.** Circular pilot plots are set out in each stratum. Training on how to do the biomass inventory is carried out on these plots. Central point marked, sampling circle set out; data on dbh (diameter at breast height) and height of all trees over 5cm dbh recorded in database on the PDA. Trees identified using local terminology. A drop down menu opens for each entry, with multiple choice for data such as species and condition, while numeric data are entered using the keyboard. The database is set up such that every tree is recorded separately in a file for each plot, and all the plots in one stratum are held in one file. Protocol based on MacDicken (1997) IPCC Good Practice Guidance (IPCC 2003). Local allometric equations and expansion factors in database in PDA convert dbh and height variables into biomass estimates. Variance in biomass in pilot survey plots is used to calculate sample size needed to achieve a maximum of 10% error. Statistical manipulations (means, standard deviations, confidence interval) are pre-programmed.
4. **Permanent plots are laid out.** Central points are marked in the field and on the computer base map using parallel transects running across the area with a random start point. This work will be done by the supporting intermediary with the help of the village team (Figure 3).
5. **Re-finding the permanent plots and measuring biomass in each of them**. Annual survey by community team. Locations of the plots are found using the GPS. The inventory is carried out as described in step 3.
6. **Sampling of herb and litter layer:** In quadrats within the permanent plots; bagged, dried and weighed.

Figures 1, 2 and 3 are in separate files, which are being resent, as requested.