Forest Resources Assessment Working Paper 156

CASE STUDIES ON MEASURING AND ASSESSING FOREST DEGRADATION

COMMUNITY MEASUREMENT OF CARBON STOCK CHANGE FOR REDD

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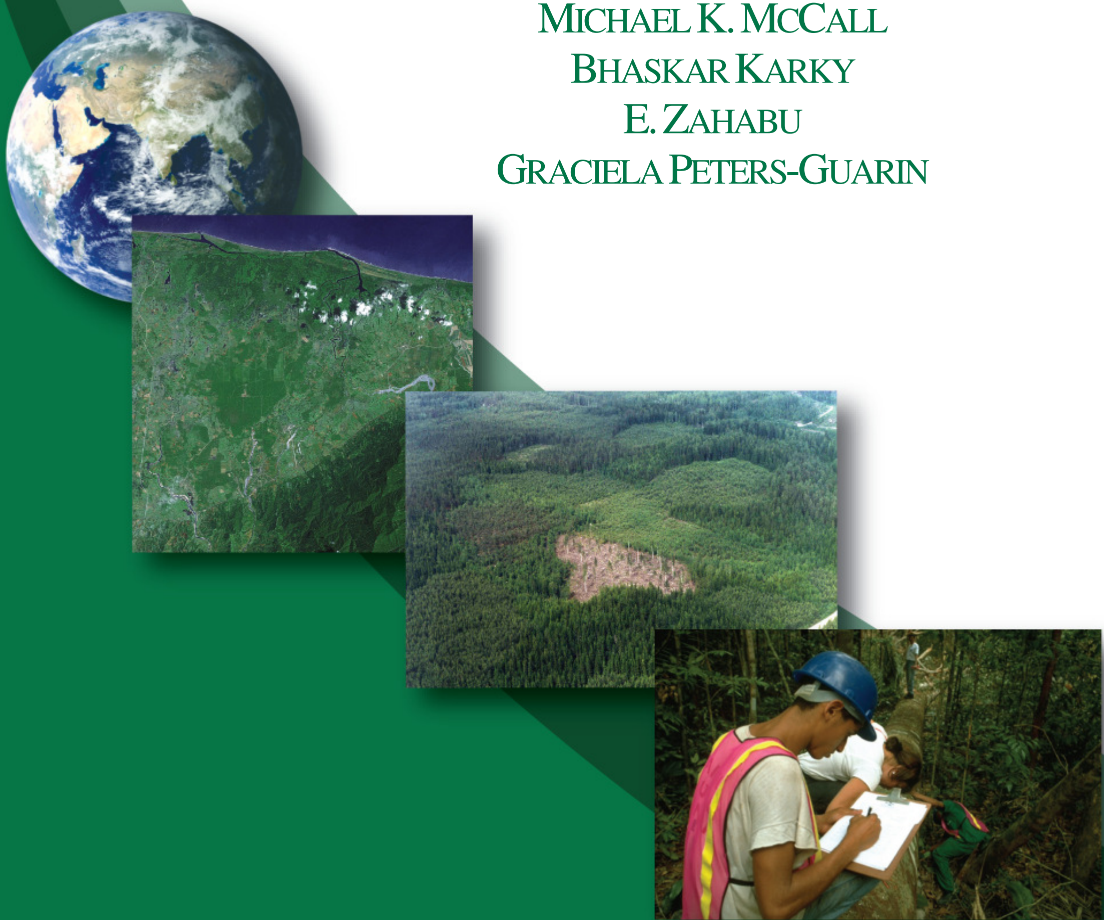

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Sustainably managed forests have multiple environmental and socio-economic functions which are important at the global, national and local scales, and they play a vital part in sustainable development. Reliable and up-to-date information on the state of forest resources - not only on area and area change, but also on such variables as growing stock, wood and non-wood products, carbon, protected areas, use of forests for recreation and other services, biological diversity and forests' contribution to national economies - is crucial to support decision-making for policies and programmes in forestry and sustainable development at all levels.

Under the umbrella of the Global Forest Resources Assessment 2010 (FRA 2010) and together with members of the Collaborative Partnership on Forests (CPF) and other partners, FAO has initiated a special study to identify the elements of forest degradation and the best practices for assessing them. The objectives of the initiative are to help strengthen the capacity of countries to assess, monitor and report on forest degradation by:

- Identifying specific elements and indicators of forest degradation and degraded forests;
- Classifying elements and harmonizing definitions;
- Identifying and describing existing and promising assessment methodologies;
- Developing assessment tools and guidelines

Expected outcomes and benefits of the initiative include:

- Better understanding of the concept and components of forest degradation;
- An analysis of definitions of forest degradation and associated terms;
- Guidelines and effective, cost-efficient tools and techniques to help assess and monitor forest degradation; and
- Enhanced ability to meet current and future reporting requirements on forest degradation.

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Case Studies on Measuring and Assessing Forest Degradation

Community Measurement of Carbon Stock Change for REDD

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Abstract

This working paper suggests that degradation is a form of (unsustainable) forest management and that measures to counter degradation, in particular Community Forest Management (CFM) lead not only to reduction in degradation but to forest enhancement as well. While reduced degradation is to be credited and rewarded under a Reduced Emissions from Deforestation and Forest Degradation in Developing Countries (REDD) mechanism, it may in fact be more important to measure and reward the increases in carbon stock due to the enhanced growth than the decreases in emissions due to reducing the degradation. Communities are well able to make measurements of changing stock using standard forest inventory methods and mapping techniques based on handheld Information and Communications Technologies (ICT). A field manual developed by the Kyoto: Think Global Act Local project is freely available for use by Non Government Organisations (NGOs) or project developers who wish to promote this. The paper describes results from community forest management projects in 6 countries in Asia and Africa in which communities were trained to map their forests and measure carbon stock over a period of 3 to 5 years. The costs, reliability and ownership advantages of community based measuring and monitoring are also discussed.

1 Introduction: Degradation is forest management

Most people, if asked, would probably say that degradation[1] is more or less the opposite of forest management, indeed that it occurs because there is no effective forest management. We argue in this case study that from the point of view of dealing with degradation under the new United Nations Framework Convention on Climate Change (UNFCCC) climate mitigation mechanism REDD, it is essential that forest degradation is considered not as a minor form or variant of deforestation but as (unsustainable) forest management. We will first explain the reason for this and then describe how in a series of sites in six countries across Africa and Asia, we developed a methodology that would allow communities, which are reversing degradation and bringing their forests under sustainable management, to measure this and potentially to claim carbon credits under REDD.

Clearly there are different drivers behind degradation, but particularly in the dry forests and savanna woodlands of the tropics a major factor is the increasing exploitation of forest products by local communities for subsistence purposes, which include livelihood cash income. Growing population pressure and growing needs for cash for health and education for instance, mean that shifting cultivation cycles have been shortened, reducing the time available for affected forest to regenerate, while at the same time increasing numbers of cattle graze in the forest and there is increased off-take of woodfuels and other non-timber products. When the annual losses of biomass due to these activities exceed the Mean Annual Increment (MAI), forests start to degrade, and from a climate point of view, they become emitters rather than sinks of carbon.

Community or collaborative forest management (CFM), as carried out under various programmes in a large number of countries including Tanzania, India, Senegal and Nepal, has in general proved to be an effective way of dealing with degradation. Different CFM schemes exist, but by and large they all operate by giving local communities greater rights and entitlements over forests in their vicinity provided they follow a management plan which aims for sustainable off-take for forest products (Arnold, 1991). Such plans may involve sustainable harvesting of timber, as in the case of many Mexican rural communities (Bray et al., 2005), or of non-timber forest products such as firewood and fodder, as in Nepal and India (Hobley, 1996; Springate-Baginski and Blaikie, 2007), and some include an eco-tourism component. Almost all focus also on local control of farming encroachments, over-grazing, illegal extractions and fires, but they very rarely involve complete conservation. Basically they help communities to create functional common property management systems to replace open access use. CFM policy gives incentives for forest management and conservation by defining and supporting usufruct rights over forest to local communities.

Experience with community-based forest management has been widely reviewed (Arnold, 2001; Carter and Gronow, 2005; Dubois and Lowore, 2000) and will not be discussed further here. Suffice to say that it is not always successful and there are sometimes distribution and equity issues, but in general it works because it legitimises

[1] The term degradation is widely used in forestry literature as a synonym for deforestation. In the context of REDD and climate change, however, degradation is understood as the reduction of carbon stock (biomass) within a forest, while the forest remains forest, whereas deforestation refers to a change of land use from forest to e.g. agriculture or pasture. The threshold value for forest is selected by each country individually in the range 10-30% canopy cover.

the uses of forest by local communities, helps to exclude use by casual exploiters who have no long term interest in the local area, and regulates the off-take so that the biological systems are able to regenerate optimally. Basically the effect is to halt the processes of degradation that are commonly related to subsistence and livelihood uses of forest. Moreover it stimulates natural regeneration, allowing the biomass stock to increase from year to year (forest enhancement) and there is evidence of improving biodiversity. This can lead to improvements in a variety of environmental services as well as to potential economic benefits.

Under REDD, countries which are able to reduce their rates of carbon losses from deforestation and degradation compared to a reference scenario which represents business-as-usual will be able to claim and sell the corresponding carbon credits internationally. Changes in rates of deforestation will be established largely by comparing areas of forest cover over time, from remote sensing images. But changes in rates of degradation – for example, the reductions in rates of degradation that result from CFM – cannot be measured in this way. Even if areas that are subject to degradation by relatively large scale events such as selective logging in rainforests can be identified from remote sensing (and there is some doubt even about this), making quantitative assessments of the changing stock – and thus of the carbon emissions - within forest which is under the types of community management described above, is simply not possible using remote sensing (deFries et al., 2007). Measurements will have to be made on the ground, using traditional forest biomass inventory methods in time series.

In areas where forest management is unsustainable, over time a loss in biomass will be recorded. In areas where a sustainable management regime has been successfully introduced into degraded forest units, as in CFM, there will be an increase in forest biomass over the same period. The biomass level may still be far below that of the original, intact forest, but it will be moving in the ´right´ direction. Degradation and forest enhancement thus represent the two opposite directions on the scale of forest management and for the case of REDD need to be measured in the same terms: change in carbon stock.

2 Methodology: Community carbon inventories

Most developing countries do not have inventory data for the vast majority of their forests so there is very little historical data on past rates of degradation. In particular, no value was seen in carrying out inventories in dry forests and savanna woodlands with low timber potential, as there was, and still is, a shortage of skilled manpower in the government forest departments. Our project has however demonstrated that local people with as little as 4 to 7 years of primary education, particularly those who are already involved in CFM, can easily be trained to carry out forest inventories employing the standard methods used in forestry and recommended by e.g. the IPCC Good Practice Guide (IPCC, 2003). If the carbon savings can be credited, this could act as an incentive the communities for carrying out management and conservation activities.

In most cases we sampled all above ground biomass (trees, shrubs and herb layers, and litter) but did not take soil carbon measurements, both because of 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 a standard expansion factor.

The field manual that we developed for this can be freely downloaded from the project website (www.communitycarbonforestry.org). This material is designed for use by an NGO with some basic computer skills, which will be able to train a team of people from the community and maintain the equipment. It is a ´participatory´ method, but like all participation, the question of who actually participates is always problematic. In the cases covered by this research, the community teams in general represented the community forest committees that already existed.

The method is presented here in summary only.

1. Boundary mapping. Since many forest areas managed by communities are not marked on maps, but simply set out on the ground with fences or painted stones, their areas are not accurately recorded and their boundaries are not geo-referenced. Both of these will be essential if carbon credits are to be issued. A hand held computer (iPaq or PDA – 'personal digital assistant') linked to a GPS was programmed with a standard GIS programme (ArcPad), and a geo-referenced base map or satellite image (O.S. or similar) was uploaded. A team of villagers can be trained in a day in the basic use of this equipment. Boundary mapping requires walking around the edge of the forest area with the hand-held computer with map and GPS function on. Provided contact with the satellites is not impeded, the trajectory of the walk appears on the map as you move (in cases where dense forest interferes with reception, a separate GPS works better). At points of interest along the route, including corners, the screen is clicked with a stylus, and notes can be recorded. When the circuit is completed, the boundaries will be fixed on the map and geo-referenced, and the area automatically calculated.
2. Identifying strata. Most community forests are heterogeneous and need to be stratified for the purposes of carbon counting. The team walks through the forest and identifies areas which are clearly of different types, on the basis of: dominant tree species, stocking density, age, and aspect (slopes, orientation). Similarly, areas with different types of community management can be identified and located. The boundaries of the strata 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. Several circular pilot plots (their size will depend on density of forest) are set out in each stratum and the first training on how to do the biomass inventory is carried out on these plot. The team is first taught how to mark the central point and lay out the sampling circle; data are then collected from each sample plot on the dbh ('diameter at breast height'), and in some cases height, of all trees over 5cm dbh, and either recorded in a notebook or entered directly into the PDA using a tailor-made database. Each tree is identified by species name, using local terminology. Quadrats may be used for the shrub and herb layers and for litter. This inventory protocol follows standard procedures in basic forestry practice as presented e.g. in the Winrock field manual (MacDicken, 1997) and as recommended in the IPCC Good Practice Guidance (IPCC 2003), and the exercise will take a maximum of 2-3 days. Local suitable allometric equations, ideally species specific, are required to convert dbh (and height) variables into biomass mass estimates. For each stratum the variance in biomass in each of the carbon pools (trees, shrubs and herbs, litter) is calculated

and from this, the sample size needed to achieve a maximum of 10% error in the estimate of the mean, using standard statistical equations.

4. Permanent plots are laid out. Once the number of plots required in each stratum is known, the central points are marked in the field, and their locations are marked on the computer base map using parallel transects running across the area to spread the plots as evenly as possible over the stratum. The start point of the first transect is established at a random point on the boundary so that the sample is random though systematically structured. This work will usually be done by the supporting NGO with the help of the village team.
5. Re-finding the permanent plots and measuring biomass in each of them. The village team carries out this work, once per year, possibly with some supervision from the NGO for the first samples. The locations of the plots are found using the hand-held computer with GPS (this will bring the team within a few metres of the plot; they can then find the centre visually from the marker). The biomass inventory is carried out as described in step 3. Data are recorded either in a notebook (and then transcribed into the database by the NGO), or directly into the PDA in the field, depending on how well the village team can work with the equipment. 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. Most community teams found no difficulty in using the PDA in this way. 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. Allometric equations are linked to the database for each species to facilitate calculations, and statistical manipulations (means, standard deviations, confidence interval) are pre-programmed.
6. Weight of shrubs and herbs, and litter layers. The samples taken from the quadrats are dried and weighed to estimate the total weight over the whole plot site.
7. Below ground carbon. Carbon in tree roots is estimated using a locally appropriate expansion factor.

The reliability of the carbon estimates made by communities was tested by hiring independent professional foresters to re-survey three of the sites we used in the research (one each in India, Nepal and Tanzania). The results of these inventories were within 5% of the communities´ estimates in every case.

This also enabled us to estimate the cost differences. The cost of the local inventory was between 50% and 30% of the cost of the professional survey, and would be expected to decrease rapidly over time, since the major fixed cost is the time investment in training. The costs include: the time for the community members involved (around $2 per day), the time and expenses of the NGO during training and supervision, and a proportional share of the costs of the equipment and software (based on expected lifetime and the sharing of PDAs by a number of communities. It is noticeable that economies of scale play a considerable role in the costs of the community-based inventory. Depending on the growth conditions (wetter versus drier sites); we estimate the cost per ton of CO_2 would be between $0.33 and $0.2 in a large forest unit (500ha) and between $0.83 and $0.45 in a small forest (50ha).

It may be noted that storing the data in the electronic database has the advantage that they can be communicated anywhere in the world, meaning that in principle it may be possible to reduce overhead costs associated with intermediaries.

3. Results: Degradation and forest enhancement under CFM

The project worked at a total of 34 sites in six countries (India, Nepal, Tanzania, Senegal, Mali, and Guinea Bissau), of which 28 were under community management and the remaining 6 were control sites; that is, similar forest within the ambit of the villages but not being part of the CFM area. The control sites were measured in exactly the same way as the others, with the aim of estimating the ´business-as-usual´ degradation rate in the absence of forest management, since no such data were available from the managed sites themselves before they were taken into management. In selecting the 28 sites we tried to avoid sites at which there was the risk of leakage (i.e. the possibility that activities such as firewood or poles harvesting, formerly causing degradation in the now-managed areas, have simply shifted to what we selected as control areas). Data were collected at most sites for four or five years, though in some cases only three. In 24 of the 28 managed sites, there were steady gains in biomass over the years in which they were measured. In the remaining 4, not degradation, but deforestation was the reason for losses: parts of the forest area were encroached and cleared, usually by actors from outside the community. The community was apparently not in a position to prevent this. In each of these cases the ´attack´ occurred only in one year, causing a drop in the total biomass, after which steady growth resumed. It should be noted that the observed increases in biomass are net increases after the off-take by the communities of allowed quotas of forest products such as firewood, fodder and poles, since these forests are managed on the basis that sustainable off-take of such products is permitted. The estimates of degradation avoided are based on the losses in biomass measured in the control sites. Biomass levels have been converted into tons of carbon dioxide equivalent (table 1).

	Observed increase in biomass (tons/ha/year), net of off-take of fuelwood and poles	**Annual increase in CO_2 stock (tons/ha) due to growth of stock**	**Estimated annual CO_2 emissions saved (tons/ha) by preventing degradation**	**Total CO_2 benefit tons/ha/year**
Dry forest and savanna woodlands	0.8 – 3.0	1.5 – 5.5	1.5 – 3.5	3.0 -9.0
Temperate woodlands and mountain forest	3.0 – 6.5	5.5 – 11	1.5 – 3.5	7 – 14.5

Table 1: Carbon impacts of community forest management in the research sites

The results indicate that in dry forests and savanna woodland, improved community management results in a CO_2 benefit of between 3 and 9 tons per hectare per year and in temperate woodland and montane forest, between 7 and 14.5 tons. One important observation is that the gains due to increased stock in the forest are in general higher than the gains due to avoiding degradation. This has serious implications for the way a reward system (payment for carbon credits) is set up. If only the reduced degradation is credited, as was first proposed under REDD, the community would ´earn´ on only a small part of the real carbon benefit. In order to provide a stronger incentive to communities, it would be advisable to credit also the increase in carbon stock (forest enhancement).

New technological opportunities for community carbon inventories: smart phones and cyber tracker

Since the data were gathered in the six countries mentioned, new technological opportunities have been investigated with a view to simplifying the work at the community level. We are currently working in Mexico on re-aligning the community stock assessment and monitoring of biomass carbon by using Google Earth and Cyber Tracker software, in place of expensive and complicated satellite imagery and GIS software (this would result in considerable reductions in the cost estimates presented above). The method we are developing involves firstly downloading Google Earth[2] images from the Web whenever possible, as source material for the forest maps. This is combined with new mapping software applications for forest and carbon, using the user-friendly interface and icons of Cyber Tracker.

Cyber Tracker (www.cybertracker.org) was originally developed for wildlife monitoring in Southern Africa by Louis Liebenberg. Its salient advantages are that the software was originally designed to be especially user-friendly for indigenous people unfamiliar with computers, even illiterates and innumerates. The interface is relatively straightforward to use, and the development of new applications is clearly sequenced by adapting from exiting applications. The front end has been designed for ease of understanding, e.g. with a wide range of existing icons, thus relatively little need for programming skills.

Cyber Tracker provides for the field mapping steps in the inventory above: mapping the community and forest boundaries, and mapping the forest strata in the field. It also provides menus and screen templates to ease the process of data acquisition on the pilot and permanent sample plots, carbon pools and on the community forest management systems and types and sources of degradation, which are essential to the REDD approach.

Cyber Tracker is open source for further development and freely available. When combined with free satellite imagery from Google Earth and an open source free GIS software (we use ILWIS [3]), there are considerable financial advantages over relying on expensive (Ikonos, SPOT) or low resolution (e.g. Landsat) remote sensing products and on standard GIS software such as ArcPad (Arc View).

We are also experimenting with using 3G Smart cell phones such as HTS Diamond Touch, as an alternative to the use of GPS + iPaq. The Smartphone has an in-built GPS, very large storage with a chip for images and software, web-accessibility for uploading

[2] Google Earth 5.0, Google Earth Pro. http://earth.google.com/

[3] ILWIS 3.6 Open. .52ºNorth, Münster, Germany, and, ITC, Enschede Netherlands. http://52north.org/index.php?option=com_content&view=category&layout=blog&id=33&Itemid=67

& downloading, camera and video capability for adding photos, other functionalities, and is simpler to handle. We contend that as the technology develops and the scale economies of volume production emerge, Smart phones should lead to lower costs, as well as to greater simplicity and ease of use (especially by young people) in rural communities. This could lead on the one hand to the production of much needed geo-information (including forest carbon data) at local level at very low cost and on the other hand to many local employment opportunities related to carbon measuring.

4 Discussion and Conclusions

The most recent draft proposal by UNFCCC SBSTA for methodology for REDD (UNFCCC 2009) explicitly recognises the need for full and effective engagement of indigenous people and local communities in, and the potential contribution of their knowledge to, monitoring and reporting of activities related to REDD. It also calls for the development of guidance for the engagement of such groups in monitoring and reporting. We have shown that community carbon forestry inventories are possible, feasible, reliable and cost effective. We suggest that it makes little sense to measure degradation for its own sake, but rather that this should be tied to programmes and interventions, like CFM, that are designed to reduce degradation and enhance forest stock. If reductions in degradation and increases in forest stock are one day to be rewarded under climate policy such as REDD, this may provide a stimulus and an incentive for more communities to involve themselves in sustainable management to combat the processes of degradation that are so common today.

Much will depend on the market price of carbon credits, and even more so, on the share of the financial reward that may be received by the community. For as the policy proposals stand at the moment, countries will be rewarded centrally for the average reductions they achieve in their deforestation and degradation rates across the whole country (and possibly in the increases in their stocks). How the financial rewards will be distributed among the various actors and stakeholders, who use and manage the forest, is a matter of national sovereignty; a large proportion of the rewards will certainly be required to cover overheads at national level. There have been doubts expressed as to whether anything will actually trickle down to the communities.

This is a question of governance, and one that needs to be taken seriously. We would argue, however, that by enabling local communities to make their own carbon inventories, their claims to a share of the rewards would gain in legitimacy, and also in practicality, because the data are in their own hands. Moreover, without the involvement of communities in these inventories, it is unlikely that the state will be able to garner sufficient data to make any claims for carbon credits for the case of reduced degradation. For more effective and robust monitoring system, communities could monitor their neighbour's forest, leaving their own to be monitored by another. The bottom line is however that the involvement of communities in this kind of exercise is not merely a technical possibility, but an efficient option for states wishing to participate in REDD, and a progressive political choice.

Figure 1. Community members measuring forest trees.

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