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Preparing Community Forestry for REDD+:

# *Engaging Local Communities in the Mapping and MRV Requirements of REDD+*

**Abstract**
Based on fieldwork carried out over the last five years, this article presents the case for communities being permitted to make their own forest carbon inventories for the purposes of monitoring under national REDD+ programmes, following brief training. Modern technology, particularly PDAs (small, handheld computers), can provide the platform both for mapping and for storing data, and can easily be used by people with only a few years primary education, although a technical agency will be needed to back up such systems. There are many advantages to this approach: costs are much lower than when professionals do the work, while the data are equally accurate. 'Ownership´ of the data may be important in legitimising communities´ claims to carbon credits in the forests they manage.

## 1. Introduction

In her plenary speech on Forest Day 3, 13th December 2009, during UNFCCC COP 15 in Copenhagen, Elinor Ostrom highlighted the importance of creating clear local livelihood incentives to ensure the sustainable management of forests and woodland resources. Citing meta-analysis studies – for example, that by Chhatre and Agrawal (2009) – Ostrom noted that the local monitoring, management and control of forest and woodland resources create a sense of local ownership and value in forests that is crucial to their long-term acceptance and sustainability.

In this article, we argue the case for communities to monitor those forest lands with which they are already engaged through their own

direct management for the sake of valorising the carbon services provided. Such a strategy should be valuable in national REDD+ programmes within forests under community control, although the strategy has less relevance for forests which are being logged or degraded by external public or private entities. We explore the notion of community-based forest carbon monitoring (CBFCM) as a means of creating local employment opportunities and local values in forests. We first focus on the ability of CBFCM to meet project- and national-scale monitoring, reporting and verification (MRV) requirements in REDD+. Our material and evidence for these skills is based on field research undertaken by the authors during the last five years in Africa and in Asia. Then a comparison is made of the advantages and disadvantages of forest monitoring undertaken by local residents as compared to external consultants, also based on field measurements. We conclude by discussing the livelihood benefits and skills-development opportunities created through CBFCM, as well as its potential to reduce the transaction costs of carbon forestry as a climate change mitigation and adaptation option.

*The aim is to provide a practical assessment of the capacities of communities to become involved in MRV, and to propose recommendations to develop these capacities. Equally important, we look at the potential benefits for communities, and what real interest communities themselves might have in involvement in MRV for REDD+.*

### 1.1 Objective

The objective of this paper is to review the experiences of local community people's involvement in MRV-type activities in REDD+ projects, or in community carbon forestry in general. There are not as yet many examples of communities being actively involved in REDD+ MRV, so we refer also to experiences and findings from other community carbon forestry initiatives or 'traditional' community forestry projects.

The aim is to provide a practical assessment of the capacities of communities to become involved in MRV, and to propose recommendations to develop these capacities. Equally important, we look at the potential benefits for communities, and what real interest communities themselves might have in involvement in MRV for REDD+.

### 1.2 Context: what are the likely future scenarios of REDD+?

Although there is still much uncertainty about the form REDD+ will take, in this paper we assume it will be implemented at the sector level across whole countries, or (for large or physically disjointed countries) sectorally across major administrative regions, rather than consist of individual projects as in the CDM process. The technical reason for this is to avoid leakage from treated areas to untreated areas, but there are political reasons too. Only 14 forestry CDM projects have been approved to date by the UNFCCC, partly because of the difficult conditionalities imposed. Current negotiations at the UNFCCC level indicate that many countries prefer to treat REDD+ as a national programme rather than as piecemeal projects carried out by project developers. This is demonstrated by the 35 national REDD Readiness proposals submitted to the World Bank's Forest Carbon Partnership

Facility and the 28 submitted to the UN-REDD programme. These documents, which result from participatory processes in each country, are all committed to the national REDD approach, although, given the difficulties of start-ups on a national scale, a likely scenario is that programmes would begin with individual pilot projects.

This paper assumes that REDD+ will incorporate measures for enhancing removals of atmospheric carbon dioxide as well as reducing emissions. The detailed policy discussion on REDD+ at COP15 (UNFCCC, 2009) strongly suggest that incentives should be offered for emission reductions from lowered national deforestation and degradation rates, and also for increases in forest carbon stock (forest enhancement). In addition, there would be some kind of compensation for conservation of forest that is intact, although how these carbon savings will be rewarded is not clear (UNFCCC, 2009; RECOFTC, 2010).

Many of the national REDD Readiness proposals specify community forest management as a central component of their national plans to reduce deforestation and degradation and enhance forest growth. Many forest departments have recognised that community forest management is a cheap and relatively effective strategy for sustainable forest management, particularly in low-value forests, although local communities have rarely been able to protect forests of high timber value, which are subjected to stronger commercial forces. Many national REDD+ programmes therefore envisage a system of payments for carbon services in which communities would receive some financial or in-kind reward for positive changes in carbon stocks. This would be financed from a public purse filled by national level sale of international carbon credits.

Another uncertainty revolves around where the money for carbon credits will come from, and whether the carbon credits can be used for offset or not; in other words, whether there will be a carbon market or a carbon fund. However, from the point of view of developing countries this distinction may not be so important because the criteria, such as those for designing systems to monitor environmental integrity, and probably also for monitoring social equity, are likely to be equally restrictive under either approach. More important, though going beyond the scope of this paper, will be the size of the demand for credits, since this will determine the price at which carbon can be sold.

## 2. Information needs in REDD+

### 2.1 MRV (monitoring, reporting and verification) requirements under probable REDD+ scenarios

If REDD+ is run as a sectoral, national-level programme rather than at project level, it will create immediate difficulties for MRV, since what has to be measured includes not only the areas subject to special treatment under REDD+, but all forest areas within the national territory. Moreover, in the past individual REDD-like projects, whether financed in the voluntary carbon market or simply to combat deforestation as in PES (payment for environmental services) projects, have used different monitoring and reward systems. A national REDD+ programme would have to set standard procedures for both data-gathering and the payments, which will require additional major efforts in public administration. For example, the standards of forest inventory would have to be acceptable internationally. They may be required to follow procedures recommended by the IPCC in its Good Practice Guidance for LULUCF (IPCC, 2003), which provides protocols for calculating sample size based on a pilot inventory. It also proposes that a randomised system of permanent plots should be used.

Measurement of change in national forest area (to detect changing rates of deforestation) can be carried out reasonably easily and cheaply through remote sensing, but this will not be sufficient for REDD+. Quantifying the density of biomass (i.e. the level of the carbon stock) in different categories of forests is much more difficult, but it is essential firstly for estimating the stock in the forests, both remaining and lost, and secondly, also for claiming for reduced degradation, forest enhancement and sustainable forest management, for which the changes in biomass density must be measured accurately. In many countries the majority of losses and gains in forest carbon will be in these three categories, rather than through deforestation. Therefore the ability to gather reliable data on forest density change may be the key to countries' participation in REDD+. It is essential to find cheap, reliable methods for establishing rates of degradation and forest growth: this includes setting baselines or reference levels for these processes. The REDD+ concept is hardly concerned with changes in forest composition per se because it is the changes in carbon stock that count for valorisation, but obviously forest composition affects ecological quality, biodiversity, local forest services and thus local welfare, and therefore is a vital factor in overall national forest policies, as well as in community land-use decisions.

Different measurement methods produce data at different levels of accuracy (Tiers 1 to 3 in IPCC terms),[1] and it may be assumed that when a low level of accuracy is implied, a greater proportion of the estimated carbon savings will be discounted from the crediting on the principle of financial conservatism. A method which produces data of greater accuracy (i.e. small standard error) should in principle generate more confidence in the results, and hence leverage rewards in terms of eligibility for a higher proportion of the estimated carbon savings (Wise et al. 2009) For a national REDD programme this presents a trade-off between the additional costs of increased accuracy of estimates of changes in forest density and the financial benefits of the additional carbon credits that can be generated. The parameters for these calculations have not yet been defined, and the margins for conservatism have not been set, though experience from the Voluntary Carbon Standard (VCS) of using a percentage of the credits as insurance against the risks could be adapted for REDD+. It is very evident anyway that governments will look for methods that generate maximum accuracy at minimum cost.

1 Tier 1 estimates carbon stock using regional or even continental averages. Tier 2 uses averages from national secondary data in areas similar to the site under consideration. Tier 3 uses measurements made at the site itself.

### 2.2 Information and meta-data requirements at international level

REDD+ adds carbon sequestration through forest enhancement, sustainable management of forests and forest conservation to the avoidance of deforestation and degradation envisaged under REDD+. Protocols for REDD+ have yet to be developed, but to make claims internationally a Reference Emissions Level (REL) will have to be drawn up by each country and approved by an international body. As with baselines for CDM projects, it is likely that several methodologies will be made available to meet different circumstances. Countries wishing to claim for both reduced degradation and forest enhancement will have to provide credible RELs for this – no easy task, since few have much data on changing forest density over time. Since most forest departments currently lack enough skilled staff, additional technical assistants (government, NGO, or

private sector) are likely to be needed, who would have to be funded out of the sales of carbon credits. Countries must declare what monitoring methodologies they are using, as this is essential for transparency of metadata. Probably they will develop and implement their internal verification methodology, and independent, external verification will then be implemented. Table 1 sets out the likely requirements.

**Table 1.** *Capacities likely to be required for national REDD programmes*

| | |
|---|---|
| **Measurement of carbon** | Site-level field data on carbon stock changes to indicate:<br>• Reduced deforestation and degradation compared to local baseline (Reference Emissions Level, REL)<br>• Increases in carbon stock sequestration/forest enhancement |
| **Scales of functioning** | • Measurement skills at community level<br>• Capability to scale up to region and country<br>• Accessible central database for uploading data from decentralised projects |
| **Verification and certification** | • Transparent and independent verification system<br>• Information availability from independent sources<br>• Leakage estimated and included |
| **Management Capability** | Leadership; participation, resource rules, and enforcement<br>• At local levels<br>• At national level |
| **Acceptability** | Acceptability to states, regions and local communities, of the management and participation rules |
| **Externalities** | Damaging effects to environment and society and e.g. equilty are dealt with to an acceptable degree |

### 2.3 Information and meta-data likely to be required at national and community level

For communities to credit and register the carbon sequestered in their forest, two levels of accurate and geo-referenced information are required for REDD+. First, a meso or 'landscape' level that involves information at 'community' scale will be needed to establish the initial forest management scenario (year 0). The second level represents a more intensive collection of detailed plot-level information (biomass sample plots within management strata), and some at tree level. Accurate data on the size and location of every measurable tree and bush in sample plots are required for monitoring and to facilitate re-measurement in subsequent years (see Table 2).

**Table 2**. *Information for Community Forest Management and Carbon Sequestration*

| **Level 1: Spatial and other information for establishing the initial management scenario (year 0)** |
|---|
| • Boundaries of the community, and of its forest areas which are intended for a carbon payments project.<br>• Community's land claims, if necessary<br>• Community Forestry Management Approaches, land-use plans<br>• Location of activities contributing to forest degradation, such as illegal logging, grazing, marginal agriculture, illegal settlements<br>• Location of areas potentially affected by hazards (e.g. fires, erosion, ecosystem degradation, flooding, strong winds)<br>• Conflict areas (spatial information about competing land uses and boundaries) |
| **Level 2: Information for forest biomass inventories (year 0 and later)** |
| • Delimitation of forest ecotype strata (zones)<br>• Location and geo-referencing of the sampling plots for measuring different carbon pools<br>• Geo-referencing trees and other features for future location of the sample plots<br>• Field measurement and storage of tree data: DBH (diameter at breast height), tree heights, species, status, etc. in databases |

For communities, particularly in developing countries, finding most of the forest management information in Table 2 is not easy. Non-existence, unavailability or inadequacy of forest information, lack of technical knowhow, and deficient support from government institutions to produce or handle information are drawbacks commonly faced. Therefore, for measuring and monitoring their forest resources, communities are likely to be dependent on external professionals and technical assistants, whose services would claim a big share of any income from carbon payments.

**2.3 Monitoring additional variables complementary to improved land management.**

While assessing carbon stocks and fluxes is crucial to the MRV, it is only one of several components that will need to be measured in developing REDD+ activities. There are additional metrics to be monitored under the current project-scale standards, such as the VCS and the Climate, Community and Biodiversity Standard, and these are likely to be included in future national-scale REDD+ frameworks:

- Socio-economic information: documentation of stakeholders, social governance structures, household income, biomass energy use, food and cash crops production, and benefit flows,
- Quantification and explanation of land use and land-use change: understanding the nature of deforestation drivers so as to model deforestation scenarios and develop appropriate responses. Monitoring

changes in land-use types and accessibility (especially roads) is thus an additional requirement.

- Biodiversity: the majority of REDD verification standards currently require quantification of project effects on biodiversity, especially threatened species – hence the need for adequate assessment of biodiversity, including in the forest surroundings.

## 3. The capacity and potential of community-based forest monitoring to meet information needs

### 3.1 Comparative advantages and benefits of community-based monitoring

***Required skill-sets and expertise***

Most activities related to carbon monitoring are regarded as technically highly demanding and therefore in the realm of professionals. However, experiences in Africa and Asia show that, with adequate training, key activities such as forest inventories, assessing and measuring forest resources, tree measuring and quantification of the current carbon stock and changes can be carried out by local residents, as demonstrated in the K:TGAL programme[2] (Skutsch, ed. 2010).

Under K:TGAL, a 'participatory geographical information system (PGIS)' was implemented in which local communities became conversant with the use of IT for carbon forest data capturing and geo-referencing. When trained, local people were able to map forest reserves rapidly and with precision, locate permanent sampling plots with accuracy, and record measurement data for trees and other vegetation in the plots. Local residents with a basic level of education could be trained in approximately two weeks to conduct surveys. If they have used cell phones before the work can proceed more quickly because of their similar handling characteristics to GPSs and handheld computers. A basic premise is that even people unfamiliar with computers (including the illiterate and innumerate) can learn to follow the inventory protocols used by professionals if suitable translation methodologies are developed and made available. Results in several tested areas were within the desired levels of precision and reliability of those produced by professionals (Box 1; Zahabu 2008; Skutsch (ed.) 2010).

2 The K:TGAL programme, which ran from 2003 to 2009, worked at 39 sites in 7 countries and trained communities to make their own forest inventories to assess carbon stock changes for the purposes of REDD+. The training manual developed by the project can be downloaded from www.communitycarbonforestry.org

**Box 1**. *Costs and reliability of community versus professional carbon-monitoring*

In the K:TGAL programme, costs of community measurements were made at several sites, including the costs of training by an intermediary organisation and a daily wage rate for the community members undertaking the forest inventory. These are compared with the costs of professionals at two sites. The variations in cost between communities reflect variations in the size of forests (considerable economies of scale), their accessibility (to the intermediary organisation) and their carbon productivity. As indicated in the following table, the costs of professional measurement appear to be at least double the costs for local measurement.

| Location | Cost per hectare, community ($) | Cost per tonne carbon, community ($) | Cost per hectare, professional ($) | Cost per tonne, professional ($) |
|---|---|---|---|---|
| Nepal site 1 | 2.4 | 0.2 | | |
| Nepal site 2 | 4.7 | 1.5 | | |
| Nepal site 3 | 5.1 | 2.5 | | |
| Tanzania | 3.1 | 2.3 | 10.0 | 7.4 |
| Uttarakhand (India) | 5.4 | 0.8 | 11.0 | 1.6 |
| Papua New Guinea | 3.8 | 0.4 | | |

Comparing the results of professional and community inventories at the Tanzanian and Indian sites indicates that the two sets of estimates are similarly reliable; there were no statistically significant differences in their estimates of mean biomass.

Both the professionals and the communities measured diameter at breast height and tree height, identified the species and applied the relevant allometric equations to reach the estimate of above ground woody biomass (from Skutsch ed. 2010).

Interest in CBFCM has encouraged the emergence of new techniques and technologies to improve the collection of data. Hand-held electronic data-entry hardware (PDAs) and software products developed as field survey equipment are being applied to CBFCM to reduce sampling error and loss of data. The hardware unit, typically including a GPS receiver, records location and vegetation metrics in predefined fields to improve data quality and completeness. The data are then uploaded into a database system that automatically verifies them and flags potentially incorrect values for the attention of the field team. The Tropical Ecology Assessment and Monitoring Network (www.teamnetwork.org) is an example. Data are either uploaded from a PDA unit or entered into a predefined spreadsheet. Data are systematically backed-up, and additional analysis can be performed immediately.

Local people often have a good basic knowledge of local tree species, the distribution of spe-

cies and forest products, and an understanding of the local ecology. Moreover, residents have a good understanding of local logistics of access, permissions, role players and the local and traditional authorities. In comparison, external consultants have to go through lengthy introduction and permission processes, as it is usually frowned upon simply to start surveying on communal or private lands. Permissions can absorb much valuable time, and even then local residents are often suspicious of outsiders. External consultants therefore require a local facilitator to manage logistics, deal with permissions and communicate with local residents. Knowledge of local languages and traditional structures is especially advantageous in monitoring the non-carbon metrics. Stakeholder engagement and the monitoring of socio-economic metrics take considerable care and time, requiring frequent engagements with individuals and groups. In such cases, external consultants may be prohibitively expensive as well as impractical.

**Cost efficiency**

The financial viability of REDD ventures relies on cost-efficient monitoring of carbon stocks across landscapes. While technological advances allow deforestation to be measured with a reasonably high level of accuracy through satellite-borne sensors, experiences in assessing carbon stocks in the tropical forests of the eastern DRC and Miombo woodlands of Zambia indicate that the cost of the advanced imagery and processing is often more than the monetary value of the change in carbon stocks.

Relatively inexpensive remote sensing data such as MODIS or LANDSAT imagery have been used until now to assess forest cover for REDD projects. Although significant progress has been made in the processing and analysis of MODIS and LANDSAT data, intensive ground-truthing is still required to estimate carbon stocks to an adequate level of certainty, as well as to verify land-uses changes such as food and cash-crop farming, pasture, roads and exotic plantations (Trodd and Dougill 1998). In addition, the ground-truthing is required over vast, inaccessible areas demanding lengthy investments of time. Empowering local people to undertake such monitoring, as opposed to external consultants, saves significant costs and maybe also time when the additional flights, local mobility and accommodation for external consultants are factored in.

Concerning the precision of carbon estimates, there is always the possibility of sampling errors creeping in, whether residents or consultants undertake them. While monitoring effort should be proportional to the improvement in the certainty of the estimate (Wise et al. 2009), based on the central limit theorem, it is generally prudent to invest in increasing the number of replicates (plot measurements) per stratum rather than the accuracy of each sample in order to increase the precision per unit cost. The number of replicates is key, not necessarily the accuracy of each replicate. Since local wages for field staff are typically a fraction of external consultant costs, by incorporating local people it is economically feasible to undertake many more replicates in each stratum, thereby reducing the variance in the carbon estimates of each stratum. This is often crucial to project financial viability, especially in woodland and savanna systems (Wise et al. 2009) (Box 1). Moreover, if communities take the measurements themselves, measurements could be taken annually, which would increase reliability by increasing the number of replicates and by allowing a trend line to be established within the crediting period, rather than just at each end of the period..

**Required capacity for national-scale REDD+**

In practical terms of capacity, there may not be enough external consultants to undertake all the carbon, socio-economic and biodiversity surveys required for national REDD+ initiatives (Burgess et al. 2010). The few consultants available are in high demand and charge high fees. Although monitoring procedures, techniques and technologies are becoming more efficient, it will require a vast number of monitors to cover all the metrics across all countries entering REDD+. Moreover, it is proposed that REDD projects have a lifespan of at least twenty years. The Noell Kempff Mercado Project in Bolivia, for example, is planned for 99 years, and forest monitoring and verification need to cover the project lifespan. A system based on external consultants is likely to be financially unviable under REDD+, which is an important rationale for local residents to undertake the monitoring, using external consultants only for the necessary third party independent verification.

In countries with entrenched bureaucratic governance, officials may balk at handing over a function to local residents that is traditionally seen as a government responsibility and prerogative. Moreover, currently some REDD+ projects are being developed by external NGOs that are unfamiliar with local government structures. This can result in important actors being left out of the development and officials feeling alienated and not buying into the CBFCM concept.

**Table 3**. *Comparison of monitoring components undertaken by external consultants and by teams from the local community*

| Monitoring component | External Consultants | Local Community Residents |
|---|---|---|
| **Cost** | High professional fees, travel and accommodation costs | High initial set-up and training costs followed by substantially lower salary, travel, accommodation costs over time |
| **Local knowledge** | Usually poor. Local guides and translators usually needed | Good. Residents typically know the area well in terms of access, logistics, local authorities, laws, and species names |
| **Data quality** | Good | Good, but dependent on appropriate training and data verification |
| **Consistency** | Potentially low if same consultants cannot continue with monitoring over lifespan of project | Potentially high if same team members or at least the same coordinators can be maintained |
| **Intensity** | Usually low. Too costly to spend long periods in field. | Good. Even if sampling is done part-time, substantial travel and set-up time is saved |
| **Value addition** | Low. Usually limited to technical input and PDD compilation | High. Project success depends on local resource users. Monitoring by locals creates ownership. |
| **Spin-offs** | Maybe for consultants' business, not for community. | Participation adds to the skills levels and capacity of local residents. Possible spin-offs to other community PES activities |
| **Management** | Expected to be good | Potential area of concern in many communities. |
| **Logistics** | Consultants' flights, vehicles and accommodation costs are high. In remote areas, costs escalate when vehicles are needed. | If locally organised is cheaper and more appropriate, e.g. working by foot or animal can be effective because field surveys are spread over time. |
| **Initial inputs, e.g. time** | Low. Assumption is that professional teams need relatively little preparation time | High. Takes more time to identify, train and equip teams |
| **Collection of other important data, e.g. socio-economic information** | Generally poor. Very challenging to understand local socio-economy and culture, time-consuming to collect the data. | Good. In-built knowledge of local economy and culture; easy to collect initial information and monitor changes |

Where there is funding to contract-in external monitoring consultants, it is common practice in certain countries also to take on local officials to act as national facilitators. These posts are often paid at lucrative international rates. When local community monitoring is proposed in place of external consultants, some officials may be apprehensive that it could jeopardise future facilitation contracts.

Management of monitoring teams is a key issue. In remote areas people often do not have access to the internet, and there is limited accessibility. This means it is often infeasible to remotely manage monitoring teams from, say, the capital city or a foreign-based NGO. It is highly recommendable that teams have a permanent local manager, especially a CBO or local NGO, who can be readily contacted for reporting and who will deal with technical matters.

Resistance to monitoring by the communities who are managing their forests may also come from people within the community who may view it as restricting their use of natural resources. To avoid this, the REDD+ process needs to be open and transparent right from the outset through a process of public participation. However, this in itself will not ensure long-term buy-in from local residents. Community-based participatory projects by governments and NGOs are common today in rural areas, and there is often increasing reluctance by local people to become involved. Participation is time-consuming, and more importantly these projects have often brought no real, lasting benefits. These realities are frequently observed by development practitioners, but not so often recorded (though see, e.g., Hickey and Mohan 2004). For REDD+ to succeed, there have to be long-term financial, material and empowerment benefits for local residents. Employing community residents as monitors is one way of achieving this.

## 4. Creating value in forests for local communities through implementing carbon projects

***Creating rural employment opportunities and income flows***

A key component of the long-term acceptance and sustainability of REDD+ initiatives is the creation of a sense of local ownership and value in intact forest and woodland systems (Chhatre and Agrawal 2009). Moreover, income flows and value added by REDD+ activities need to be greater than the foregone opportunity costs of deforesting or degrading the area for timber, charcoal, livestock or agriculture.

Clear, substantive incentives, such as employment, direct cash incentives, sustainable livelihood opportunities and community development projects, are essential to ensure the appropriate management of forest resources over the long term. The authors' experiences in developing REDD activities in sub-Saharan Africa indicate that creating the incentives in the forms of employment and alternative livelihoods is particularly challenging in remote rural areas where access to communications, and especially to markets, is limited.

The sound forest management practices needed for REDD+ sustainability demand much labour from the community, for fire prevention, livestock grazing controls, water and soil erosion management, defence against illegal felling and encroachments, and so on. The PES model assumes that the real costs of this local employment are accounted for

and compensated within the carbon payment levels. Furthermore, the carbon monitoring itself presents an additional opportunity to create employment and income flows. While the monitoring only takes a portion of the year, the trained team can also be involved in surveillance, fire control and other management tasks.

***Local skills development and creating the human and institutional capacity needed for national scale REDD+ implementation***

In impoverished rural areas, formal educational levels are low, thus training people as REDD+ monitors adds a set of life skills that potentially spill over to other spheres. The involvement can lead to social and institutional strengthening in the community. There is not only an expanded understanding of local natural resource management and values, but the skills such as data capture and mapping empower people and bring at least some of them into decision-making processes. When the skills are developed and retained or passed on to others and new technical knowledge is acquired, then, importantly, the ability to deal with powerful government agencies, NGOs and commercial capital is greatly strengthened. There is great potential for utilising the participatory survey and mapping skills for other community purposes, such as making land claims, resolving land conflicts, collaborative land use planning, and applying for other PES finance such as hydrological or biodiversity services.

***Ability to respond from an empowered, informed position to REDD+ developments***

Currently, local communities have little say in REDD+ developments, due to their limited policy knowledge and lack of institutional support. Whilst participating in monitoring and mapping activities, residents can be learning about the functioning of climate change policy, REDD mechanisms and payments for climate change mitigation. This increased awareness would allow people to respond to national REDD+ agencies and the global carbon project developers from a more informed and confident position. Moreover, it should allow communities to engage with REDD+ initiatives if they wish, with 'free, prior and informed consent'.

***Lower transaction costs are essential for the economic viability of community REDD+***

The actual price of carbon credits will ultimately determine whether REDD+ activities are worthwhile or not for the country as a whole, as well as for communities that may participate. At this moment there is little information on what this price will be. However, it is clear that cost efficiency and reducing the transaction costs of crediting carbon will be crucial to achieving financial feasibility. Their importance is amplified where the volume of emission reduction units produced is relatively small, whether this is because of the small size of the management units or because the carbon stock growth rate is relatively low (Cacho et al. 2004). Thus, reducing monitoring costs is essential in small community projects in dry forest and savannah areas, for example, in the miombo woodlands of sub-Saharan Africa,

Community-based monitoring greatly reduces the transaction costs of monitoring and management, as the operational costs are a fraction of those of external professionals (Box 1). The key is to develop the protocols, mechanisms and associated training, so that community residents can perform monitoring and reporting with sufficient accuracy and reliability to be acceptable in a formal carbon finance mechanism.

## 5. Conclusions

Community management is currently being promoted in many national REDD+ programmes, but the full implications of the range of the data collection is not always considered. While changes in forest area (relating to deforestation) can be measured relatively accurately using remote sensing, the changes in forest density, related to reduced degradation and forest enhancement, must make use of decentralised field measurements. We have argued above that, for many reasons, communities that are already involved in the management of their forests should be empowered and mobilised to carry this out. Some authorities may view this idea with scepticism, but our and others' experiences show that, given a clear protocol and appropriate training, communities are able to gather data as accurately as professionals, and at a fraction of the cost.

The protocols used, such as those in the K:TGAL programme, need to be based on internationally accepted methodology to ensure confidence in the data, and independent verification will be essential. Detailed guides are available from various sources (Bhishma et al. 2010, Theron 2009, Verplanke and Zahabu, 2010; see also van Laake et al. 2009; Peters and McCall 2010)

´What is in it for communities?` This depends crucially on the financial margins that communities would receive as a result of their participation in REDD+ activities, and how these are distributed. At present it is very difficult to estimate either the market price of REDD+ carbon or the transaction costs that will be incurred in running the national programmes. These issues will become more visible as national programmes get started. In any case, we argue that the low cost and high effectiveness of community monitoring offers the hope that communities will one day be able to measure and sell credits for the increases in carbon in their forests as a form of livelihood diversification.

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