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Monitoring, reporting and verification for national REDD+ programmes: two proposals

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Abstract

Different options have been suggested by Parties to the UNFCCC (United Framework Convention on Climate Change) for inclusion in national approaches to REDD and REDD+ (reduced deforestation, reduced degradation, enhancement of forest carbon stocks, sustainable management of forest, and conservation of forest carbon stocks). This paper proposes that from the practical and technical points of view of designing action for REDD and REDD+ at local and sub-national level, as well as from the point of view of the necessary MRV (monitoring, reporting and verification), these should be grouped into three categories: *conservation*, which is rewarded on the basis of no changes in forest stock, *reduced deforestation*, in which lowered rates of forest area loss are rewarded, and *positive impacts on carbon stock changes in forests remaining forest*, which includes reduced degradation, sustainable management of forest of various kinds, and forest enhancement. Thus we have moved degradation, which conventionally is grouped with deforestation, into the forest management group reported as areas remaining forest land, with which it has, in reality, and particularly as regards MRV, much more in common. Secondly, in the context of the fact that REDD/REDD+ is to take the form of a national or near-national approach, we argue that while systematic national monitoring is important, it may not be necessary for REDD/REDD+ activities, or for national MRV, to be started at equal levels of intensity all over the country. Rather, areas where interventions seem easiest to start may be targeted, and here data measurements may be more rigorous (Tier 3), for example based on stakeholder self-monitoring with independent verification, while in other, untreated areas, a lower level of monitoring may be pursued, at least in the first instance. Treated areas may be targeted for any of the three groups of activities (conservation, reduced deforestation, and positive impact on carbon stock increases in forest remaining forest).

Keywords: REDD+, forest carbon, monitoring, UNFCCC, verification

1. Introduction

With the outcomes of the United Framework Convention on Climate Change (UNFCCC) Conference of the Parties sixteenth session in November and December 2010 in Cancun, the policy and mechanisms for implementing REDD have been further specified and agreed in the process of long-term

collaborative action (LCA, UNFCCC 2010). In conjunction with text on methodological issues for REDD+ produced by SBSTA31 in December 2009 (UNFCCC 2009a), it is now clear that not only reduced emissions from deforestation and degradation, but also conservation of forest carbon stocks, sustainable management of forest (SFM) and enhancement of forest carbon stocks are now proposed to be tackled by

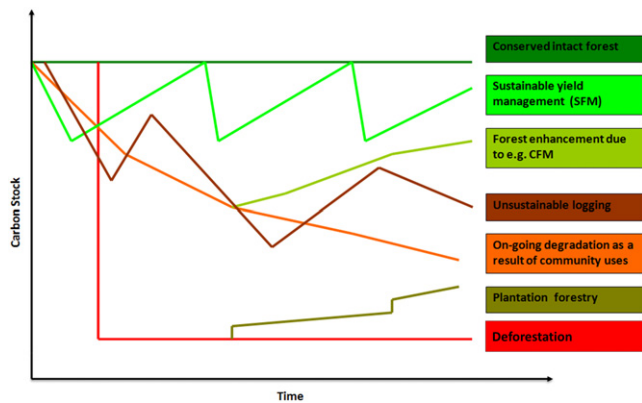


Figure 1. Conceptual overview of processes leading to carbon stock changes in forests.

countries and implementing bodies. These three elements are included in what is now known as ‘REDD+’. The UNFCCC decision text (UNFCCC 2009a) refers to the need to establish monitoring systems that use an appropriate combination of remote sensing and ground-based forest carbon inventory approaches with a focus on estimating anthropogenic forest-related greenhouse gas emissions by sources, removals by sinks, forest carbon stocks and forest area changes. All estimates should be transparent, consistent, as accurate as possible, and should reduce uncertainties, as far as national capabilities and capacities permit. It is further indicated that these monitoring systems and their results will be open to independent review as agreed by the Conference of the Parties (COP). Particular reference is made in the UNFCCC (2009a, 2010) text to the need to involve local communities in the implementation and measuring and monitoring carbon stocks.

This creates some idea about the contours of the agreement and what will be credited, as well as opportunities to use a variety of approaches to measuring and monitoring (UNFCCC 2009b). It is also clear that most Parties are generally in favor of a national, or near-national approach, rather than one based on projects like CDM. This follows the valid reasoning that real reductions in loss of forest carbon can only be ensured if there is monitoring and reporting at the national level (i.e. dealing with leakage, at least within national boundaries). However, considerable uncertainties remain before the necessary modalities for this interesting and progressive policy can be implemented and operationalized in specific country circumstances. One of the important challenges, for example, is the development of reference emission levels (RELS). This has already been discussed (e.g. by UNFCCC 2009c, Olander *et al* 2008). Permanence is another important and contested concern (Dutschke and Angelsen 2008, Skutsch and de Jong 2010, Skutsch and Trines 2010), but these issues are not pursued further here. The aim of this paper is instead to explore two new proposals that may simplify MRV requirements associated with national REDD+ programmes.

The first proposal consists of a re-grouping of the various elements that have been included in REDD+ into more logical categories, which may make REDD+ activities both easier

to implement and easier to monitor; the second suggests that monitoring, verification and reporting do not need to be carried out at equal levels of intensity throughout a whole country, but could be more rigorous (say, Tier 3) in areas where REDD+ activities are being carried out and more generalized in other parts of the national forest estate, at least in the short run. This could provide a bridge to help countries upscale procedures that have been used in the past at project level, and provide a means of transitioning to a full forest accounting system.

The structure of the paper is as follows. In section 2 we present the case for the re-grouping of the different elements within REDD+ (proposal 1), both from the point of view of logic of implementation and their MRV requirements. In section 3 we present the case for allowing MRV at different intensity levels in different parts of a country (proposal 2). Section 4 explains the need to start early in the REDD process and how the proposals we have made will assist in this. Section 5 is a general discussion.

2. Proposal 1: clarifying and re-grouping the terms used in REDD+

In the policy texts currently in discussion under the UNFCCC, REDD is understood to include reduced deforestation and degradation, while REDD+ includes these but also forest enhancement, sustainable management of forests and forest conservation. It is evident that between them, these five concepts cover three different principles with regard to climate change mitigation; reduction of emissions, increasing the rate of sequestration within existing forests, and maintaining existing forest stocks (Benndorf *et al* 2007). The grouping as it currently stands reflects the history of the policy debate in which first ‘avoiding deforestation’ was recognized as an important goal, to which ‘avoiding degradation’ was quickly appended. The additional elements making up REDD+ entered the debate more recently, at the insistence of countries which have low deforestation rates but nevertheless feel that their forests may play an important role in the global carbon balance. ‘D and D’ are always seen as being closely related, and rather different from the other three elements. However, as we shall show in this section, both from the point of view of instituting actions and MRV perspective, this may not be the most suitable grouping of concepts. We propose a simpler grouping that should help clarify the issue for many technical experts and practitioners.

A definition of deforestation was agreed in the Marrakech Accords (Boyd and Schipper 2002) in terms of tree canopy cover, height and area thresholds. Countries may select a canopy cover threshold of between 10 and 30%, with a height minimum of between 2 and 5 m (of trees at maturity), and an area criterion with a minimum of 0.1 hectares. Any area of woody vegetation (regardless of whether it is locally defined as forest or woodland or wasteland) that drops below the threshold is considered to have been deforested, in other words, it has undergone change from forest to non-forest (i.e. to agriculture, pasture, urban development etc). Deforestation is indicated in figure 1 by abrupt drop in the red line. Loss of forest related to a change in land use that prevents the

natural forest re-growth usually results in considerable carbon emissions, and preventing deforestation from happening is therefore a primary objective of REDD (De Jong *et al* 2010, Eva *et al* 2010).

Degradation. While there are more than 50 definitions of forest degradation (Lund 2009, Simula 2009), from the point of view of climate change policy and the IPCC national estimation and reporting guidelines, it refers to loss of carbon stock within forests that remain forests (UNFCCC (2008); this is illustrated in figure 1 by the dark brown line)³. More specifically, degradation represents a human-induced negative impact on carbon stocks, with measured forest variables (i.e. canopy cover) remaining above the threshold for definition of forest. Moreover, to be distinguished from (sustainable) forestry activities, the decrease should be considered persistent. This is a specialized use of the term degradation, which in normal forestry terminology is an umbrella concept relating to loss of a variety of forest values (Simula 2009). It is in fact often loosely used as synonymous with 'deforestation', as a cursory internet search of images of 'degradation' makes clear. A group convened by IPCC to resolve the definition of degradation (Penman *et al* 2003) was unable to produce a clear definition because losses of biomass in forest may be temporary or cyclical and therefore essentially sustainable, even if on average the carbon stock remains below that of intact forest (figure 1, bright green line). Realizing that in addition to the variables used to define deforestation, a time element was also required, the IPCC expert group also recognized that selecting such a threshold is very difficult. This is in part because forestry cycles are usually much longer than commitment or accounting periods under climate change agreements. A special UNFCCC workshop on degradation convened in 2008 discussed various methodological issues relating to degradation, but although some interesting suggestions were made (e.g. Cadman 2008), the meeting did not result in a clear definition (UNFCCC 2008).

The IPCC report however does make clear that there are different forms of degradation relating to different human uses of forest (Penman *et al* 2003). In much of the REDD discourse, references to 'degradation' refer to locationally specific attacks on otherwise intact forest, which occur episodically, as in selective commercial logging in rain forest (Souza *et al* 2009). This type of degradation may or may not be followed by clearance for agriculture, i.e. deforestation; a study in the Amazon suggests that full clearance only occurs in 30% of the area which has been logged over (Krug 2008); a further 30% re-grew within four years, while the fate of the remaining 40% could not be determined as the logging was very recent. This is however not the only, and not necessarily the most important type of degradation which affects tropical forests. Other forms of degradation are less visible in place and time, but may be much more widespread, as they are caused by gradual processes which continue year after year, primarily as

a result of community uses of forest products where population densities are increasing, for example in dry forests and savanna woodlands of sub-Saharan Africa (figure 1, orange line). These processes may, in fact, never lead on to full deforestation, but the forest may remain in a degraded state for years. It is important to understand that while the UNFCCC concept of degradation is related to carbon stocks, and will be defined in these terms, degradation in everyday terms refers to the anthropogenic processes which drive the carbon losses, and an understanding of these processes will be essential to quantify and forecast these carbon losses in the long run as well as to design policies to combat it.

Measuring forest degradation and related forest carbon stock changes is more complicated and less efficient than measuring deforestation since the former is based on changes in the structure of the forest that do not imply a change in land use, therefore it is not always easily detectable through remote sensing (GOFCC-GOLD 2010). There is not one method to monitor forest degradation. The choice of different approaches depends on a number of factors including the type of degradation, available (historical) data, capacities and resources and the potentials and limitations of various measurement and monitoring approaches (Asner *et al* 2005, Laporte *et al* 2007, Souza *et al* 2005, Baccini *et al* 2008).

Although degradation has been grouped with deforestation as far as REDD is concerned (it forms 'the second D' in REDD), IPCC LULUCF procedures for estimation and reporting on 'forests that remain forests' (e.g. for National Communications) make the more logical link of degradation to forest management, since this reporting requires estimation of net carbon change in forests remaining forest (increase in carbon stocks in some locations minus degradation losses in others). Increases—forest enhancement—may be achieved through a number of human activities such as enrichment planting, but also by regulation of off-take to levels which can be more than supported by the rate of natural increment (this might be thought of as negative degradation). Sustainable management of forests (SMF) generally means bringing the rate of extraction in line with the rate of natural increase. The linking of degradation to deforestation rather than to these new elements in REDD+ is partly the result of the (in many cases false) idea that degradation just a step on the path to full deforestation. In reality, deforestation is usually the result of a one-off decision by a particular actor to change land use, while degradation is usually a gradual process, resulting from decisions of many actors over time as regards extraction of forest products. But the conventional link between deforestation and degradation is partly because degradation, like deforestation, is responsible for emissions, while the new elements under REDD+ have to do with increasing or stabilizing sinks.

Sustainable management of forests (SMF) is related to sustainable forest management, a term usually used in the context of commercial timber operations, better described as sustainable yield management (figure 1, bright green line). But there are other ways in which forest could be managed sustainably, for example through community forest management (CFM). There are many different forms

³ It is important here to distinguish between the concept of a degraded forest, which has a reduced carbon stock which could remain stable or increasing below the level of a primary forest for years, not contributing any further CO₂ emissions, and the process of degradation, which implies a continuing loss of stock.

of community management; some communities (usually indigenous groups) live in the forest in such a way that they have very little impact on forest stocks at all, and may be considered to be managing the forest in an essentially passive, but conservationist manner (remote tribes in the Amazon for example). At the other end of the scale there are communities, for example many in Mexico, which manage their forests for timber on a commercial basis (which may or may not be sustainable). Other common forms of 'active' community forest management (CFM) are less concerned with timber than with firewood, fodder and non-timber products. Such programmes have been operating in Nepal and India for 20 years already and have also become popular in other countries (Arnold 2001, Hopley 1996, Schreckenber 1998). Basically these involve bringing degraded state-owned forest lands under community control through a legal process, in which communities gain rights to the products by accepting responsibility for management. The K:TGAL programme (Zahabu 2008, Karky 2008, Skutsch 2010; www.communitycarbonforestry.org) has demonstrated that in practice this kind of management usually results not only in halting of degradation (figure 1, orange and brown lines), but also in forest enhancement, that is to say, a long run increase in forest stocks (negative degradation, figure 1, lime green line). Work by the IFRI programme (Chhatre and Agrawal 2009, Coleman 2009; <http://www.sitemaker.umich.edu/ifri/home>) indicates that improved forest health occurs in community managed forests when key institutional factors are present, particularly when communities have a degree of autonomy over their forests and are secure in their tenure. It may be noted in passing that reductions in degradation and enhancement of forests through these kinds of approaches may be easier to achieve in a national REDD/REDD+ programme than reductions in rates of deforestation, as CFM is generally a popular and low cost initiative. Deforestation on the other hand is often driven by powerful commercial interests, which are politically more difficult to combat.

From a practical, action-oriented point of view it would therefore seem to make more sense to consider degradation as a form of (unsustainable) forest management which can best be tackled through improved management and strengthened institutional arrangements, rather than as a minor form of deforestation, as it is seen at present. This is because degradation is a manifestation of the way that people use forest which remains forest, rather than a complete change of land use. From a monitoring perspective also, degradation, like forest enhancement and SFM, requires sequential stock change measurements, which is rather different from what is needed for monitoring deforestation. For assessing reductions in degradation, as in assessing forest enhancement and SFM, what matters is the change in the rate at which carbon stock had been changing in the REL. Reduced degradation is a reduction in the rate at which degradation (loss of stock) has been taking place; forest enhancement is an increase in the rate at which forest stock has been increasing. SFM could result in either of these two effects.

The remaining item under REDD+ is forest conservation (indicated in the dark green line in figure 1). This concept

is new to the UNFCCC discussions in the sense that no similar forest-related concept has been agreed upon before by the parties. The following considerations are important in understanding the role of forest conservation under REDD+:

- it is an effort to decrease the threat that the forest may become a source of carbon emissions in the future and to ensure permanence by establishing long-term commitments to preserve forest,
- it implies that human activities in such areas are minimal, and in sum, will result in a net zero carbon balance in the near and long-term,
- it may refer to any types forests within a country, but in particular to those not considered at risk of disturbance or carbon stock loss through human activities,
- it will result in the continued supplies not only of carbon but also of other ecosystem services, provided the ecosystem is kept intact.

Following IPCC good practice guidance, forest conservation is understood as a specific type of forest management and is already covered under the aegis of 'forest remaining as forest'. The monitoring objective is to verify that in the forest labeled 'conservation forest' (i.e. through a policy), the carbon stocks remain stable and intact. How to credit this carbon under REDD+ remains in question, since credits for deforestation, degradation, forest enhancement and SFM will all be based on changes in the rate of change of carbon stock in a given area of forest (reduced rates of loss, increased rates of gain), while the aim of forest conservation is for a zero rate of change. Conservation may therefore require instruments rather different from those used for all the other elements of REDD and REDD+, but many Parties to the UNFCCC are clear that all forests, including those in which there are no changes in carbon stocks, should be considered, even the ones where no anthropogenic drivers are posing a particular risk to lose forest carbon. It is important to understand that maintenance of intact forests through forest conservation is a separate matter from reducing national rates of deforestation, and needs to be treated differently both in crediting and in MRV. A number of countries, for example Guyana, have a very low deforestation rates, and if REDD is simply geared to compensating for reduced deforestation they will have no incentive to maintain the stocks. In countries which have some intact forests and other areas which are being deforested, such as in the Amazon Basin, it is also important to separate these two under REDD, so that the areas which are really under threat of deforestation are dealt with as priority, while non-threatened areas are also rewarded if they are sustained. In this context, the idea of carbon reserves has been proposed (Prior *et al* 2007), although these might have to be rewarded on a lump sum or flat rate per hectare basis rather than per tonne of carbon as there should be no change in the carbon stocks⁴. MRV then needs only to establish that the intact forests are still in place.

⁴ It is usually assumed that in intact forests, the carbon stocks will be stable and neither increase nor decrease. In practice there are likely to be increases in soil carbon in some types of forest (for example in savanna forests) and there is some evidence of slow above ground stock increases in intact humid forests (Lewis *et al* 2008).

This analysis of the elements of five elements of REDD+ suggests that the logical way to group them is in three categories; *reduced deforestation*, which is measured on the basis of forest area change over time, multiplied by an estimated average factor for carbon density, such that reductions in the rate of loss are credited in terms of tons of carbon; *conservation*, which is measured on the basis of fixed areas of forest remaining forest, and probably not rewarded on a ton-carbon basis since there is no flux, but using some other per hectare or lump sum payment; and *positive impact carbon stock changes in forests remaining forests*, in which reduced levels of degradation and increases in forest stock within the forest (due to community forest management or sustainable management of forest for example) are credited. This grouping into three categories also very much simplifies and streamlines the approach to MRV, as will be shown in the section 3. It also suggests that the national RL or REL might consist of separate RLs representing these different processes.

Given the suite of REDD and REDD+ options proposed in policy drafts so far, the options for real world forest interventions for climate change mitigation form a continuum as shown in figure 2. The potential contribution of the different elements will vary between countries. In some, deforestation is the main source of carbon losses, but in many others, particularly countries which have large areas of dry forests with widespread human habitation, steady degradation is a greater cause. Efforts to reduce degradation (through SFM, CFM etc) are likely, as mentioned above, to yield a forest enhancement effect in addition, thus crossing the boundary from reduced emissions to increased sequestration. In figure 2 we have, for the sake of completeness, also included the creation of new plantations (as e.g. under CDM afforestation/reforestation projects). Although this is not a strategy that is included in current draft texts on REDD and REDD+, from a carbon point of view such projects are a logical part of the overall picture. However it is not yet clear exactly how carbon stocks in newly created forests will be balanced against any losses in natural forests in REDD accounting, nor how double counting with any existing CDM A/R projects will be avoided.

3. Proposal 2: flexible geographical tailoring of MRV intensity

A national monitoring system provides the foundation for estimation and reporting and to verify that the sum of all forest-related or REDD+ activities have a positive effect as regards human impact on forest carbon (Gibbs and Herold 2007). Thus, a systematic and continuous national monitoring effort is clearly essential and fundamental for all countries. However any country contemplating a REDD/REDD+ programme will need to decide where to place its major efforts, based on what policies and programmes are considered to be most effective in its own context. Here the main consideration will be not only what drivers and processes can be realistically and effectively tackled, and with which carrots or sticks; but also what would be the likely benefit, in terms of carbon credits that would result? It is clearly in the interest of the country to tackle the low hanging fruits first; the easiest, and most profitable options. Not that it is immediately clear

Mitigation option	Mitigation objective	Policy instrument	Forest management options
Reduce forest CO2 emissions	Reducing deforestation	REDD (the first D)	Committing forest for carbon conservation, using law enforcement, new protected areas, PES contracts on area basis etc.
	Reducing degradation	REDD (the second D)	A broad range of forest management strategies could be used to replace unsustainable uses of forest with sustainable ones: sustained timber yield management, community forest management, enrichment planting, PES on a per ton carbon saved basis. Such instruments will reverse degradation and result in enhanced forest stock.
Increase CO2 sequestration	Enhancing forest growth (restoring stock lost earlier)	REDD Plus	
	Creating new forests and tree cover	CDM A/R	New planted forest, new agroforestry, rehabilitation of degraded lands with woody species etc.

Figure 2. Grouping of forestry approaches in climate change mitigation (adapted from Blaser et al 2009).

what these best options would be, nor whether the easiest are necessarily the most profitable. First of all, a clear understanding of drivers and processes affecting forest carbon stocks on the national scale will be essential (Lambin and Geist 2003, Benndorf et al 2007, Herold and Johns 2007, Herold and Skutsch 2009). Such an analysis will lead to characterization of the forest land or estate into distinct areas suited to different approaches, such as commercial SFM legislation, areas which would be placed under conservation orders and all necessary support and infrastructure to enforce this, areas that might be placed under community management with the primary aim of reducing degradation, perhaps with associated payment for carbon services, etc. Thus, the aim is to have a national stratification by human activities affecting forest carbon through typical forest processes, and to relate this to different policy options and opportunities for improvements in carbon impacts. These might be operationalized as sub-national implementation within a national programme, enabling the country to get started with pilot REDD+ activities quickly. In addition however there may be large parts of the forest which are not assigned specific REDD activities, probably because on-going process are more difficult, or more expensive, to curtail. These areas will in the long run have to be monitored, as it is only the aggregate improvement over the national REL that will be credited, and if losses in non-treated areas are greater than they were in the REL level, these would have to be deducted from the gains made elsewhere. In this way leakage will be dealt with.

Figure 3 illustrates this. Here the hypothetical country's entire land area is schematically considered to be made up of non-forest land (gray), forests in which specific REDD and REDD+ activities are to be carried out (pale green), conservation forests (dark green) and other forests (mid green). Changes may occur from forest to non-forest land or vice versa through deforestation and reforestation, as indicated by

Table 1. Data requirements for measuring and monitoring of REDD and REDD+ actions within a national REDD programme⁵.

Essence of carbon credit claim under REDD/REDD+	Forest stock remaining intact (no increases or decreases)	Reduction of rate of loss in forest area	Positive carbon stock changes in forest remaining forest
Identified in policy as:	Forest conservation	Reduced deforestation	Reduced degradation, SMF, forest enhancement
What needs to be measured	Any changes in area of forest cover (to be multiplied by estimates of associated carbon stocks)		Changes (increases) in biomass density in forests under management
Primary data sources for measurements	Remote sensing with any available some carbon inventory data from secondary sources		Ground level forest inventories at beginning and end of accounting period
What needs to be monitored/controlled	Degradation within the forest (displacement of emissions)		Area change and affected
Additional (secondary) data required for calculations	Carbon density of any areas of forest lost		
Verification	Consistent long-term monitoring and independent validation	Consistent long-term monitoring and independent accuracy assessment of area changes	Long-term re-measurements, independent validation and error analysis

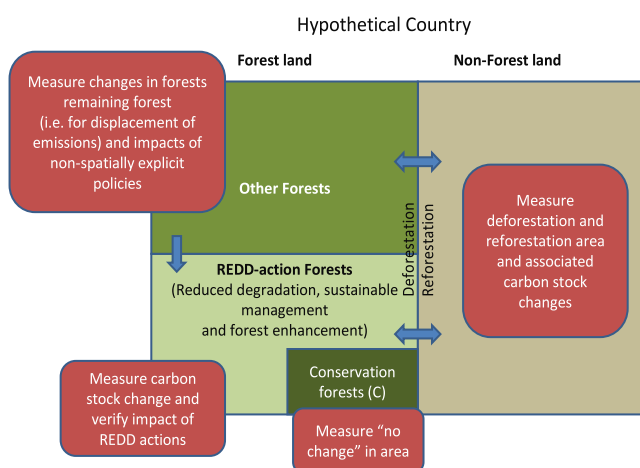


Figure 3. Different types of land use, their potential role in the national REDD/REDD+ programme and associated MRV tasks.

the blue arrows. Within the forest land, monitoring would be carried out at greater intensity in the ‘REDD+ action forests’ where the positive impact of dedicated activities needs to be verified. These types of forests may also include conservation forests where the aim is to verify no significant carbon stock changes from human activities. The forest land not under specific REDD+ activities should be monitored to account for possible displacement of emissions (leakage) and to measure the impact of non-spatially explicit policies. Once a forest has become a REDD+ action forest it is assumed it will remain in this category for verification. Hence land from the ‘other forest’ might gradually move into the ‘REDD+ action forests’ category as REDD activities become more widespread (blue arrow) but a reverse movement would not be permitted.

In terms of the carbon cost–benefit of different approaches: reductions in rates of deforestation will yield high carbon benefits per hectare over relatively small areas (only those that are under real threat of deforestation at present). Reductions in rates of degradation, and associated forest enhancement, will yield much lower carbon gains per hectare, but could potentially be achieved over much larger areas. Estimates of likely carbon savings per hectare in each of these situations would clearly need to be balanced against the expected costs of implementing the necessary measures to achieve them. But there are also very important implications as regards the MRV requirements, and the costs of these.

Table 1 presents the different approaches to MRV that would need to be taken in areas subject to different treatment under REDD/REDD+. Conservation forests and deforestation will be primarily defined and measured in terms of area changes (or no area change in case of conservation), which can be assessed rather efficiently using remote sensing technology with some ground truthing, while degradation, SFM and forest enhancement should all be primarily defined and measured on the basis of localized changes of stock within the forest. Of paramount importance in this regard is the fact that changes in levels of biomass in forests remaining forests (i.e. for the cases of reduced degradation, forest enhancement etc) will, over any accounting or commitment period, be small relative to the standing stock, and therefore require much more emphasis on ground level forest inventory. This tends to be more expensive and difficult to organize than remote sensing analysis, but will

⁵ Afforestation and reforestation have not been included in the table since these are not mentioned under REDD/REDD+ but instead fall under CDM. However, in principle and in the long run any increases in forested area due to A/R should be deducted from decreases due to deforestation, using similar MRV procedures.

be essential at least in the transitional period before more sophisticated remote sensing becomes available. For example, radar technology, and airborne Lidar may have the potential to generate good data on stock change in the future (Asner 2009), but the costs, particularly of interpretation, are still large, but results from new large area experiments suggest more efficient approaches in the future (Asner *et al* 2010). At the same time, the areas which might be treated with strategies aimed at reducing degradation and promoting forest enhancement could be enormous.

The gathering of ground level data for degradation and forest enhancement may thus seem a daunting task, particularly as it would appear that the areas likely to produce relatively low per hectare carbon gains (reduced degradation, forest enhancement) will cost more in terms of MRV than areas which might return higher carbon gains per hectare (reduced deforestation). However, this apparent difficulty may in fact turn out to be an advantage. There is growing evidence that local monitoring of carbon stocks is a task that can be carried out easily, reliably and at very low cost by the local stakeholders (Zahabu 2008, Karky 2008, Skutsch 2010, Danielsen *et al* 2010); regular data collection on woody biomass levels in the forest could be made a condition for participation in national REDD/REDD+ activities (Van Laake and Skutsch 2009, Murdiyarto and Skutsch 2006). Periodic (e.g. annual) community level data collection (and inventories by private landowners for example) could thus result in good level data for those areas where management is actively practiced. Communities are well able to collect data, but they will require support from intermediary agencies for various tasks, in particular for reporting. In passing it may be noted that stakeholder monitoring of carbon stocks brings with it many other advantages. There is evidence that communities that systematically monitor their forests manage them better, because of the higher levels of information available (Coleman 2009), and if communities gather the necessary data themselves, this will give them legitimacy and a stronger claim to financial benefits from the carbon market or fund. Such a system could in fact provide the basis for an equitable distribution of rewards to stakeholders within a national REDD+ programme. There would of course still be a requirement for independent verification, but this is necessary for all claims of carbon savings under REDD+. More research is needed to determine whether community data collection is more efficient than other approaches in the long run, and what kind of sampling frame and intensity would be required.

It may be more difficult to organize REDD+ in other areas (e.g. large, under-populated areas, where there is no community or commercial actors are present to carry out management, or areas in which no attempts to reduce deforestation are being made), but data will be needed from these areas too, as accounting has to be nation-wide. Here secondary data and modeling techniques (gain-loss methods, generally Tier 2, or using conservative default values) might be used to monitor stock change, with much less accuracy. The aim of this measurement however would be mainly to check for increase in activities against the degradation REL, rather than to directly claim credits. This assumes that it

will be relatively straightforward to identify those areas which are undergoing hardly any change, moreover policy priorities might change over time and different areas might be targeted for REDD+ activities. What we propose is therefore a rather rough and ready, pragmatic approach to address the most important and relevant activities today to cover the interim period before more solid data can be gathered systematically over the entire land area.

4. Early participation and interim performance

Current interest by Parties in promoting REDD and REDD+ is high, as indicated for example by national REDD readiness plans submitted to the World Bank's Forest Carbon Partnership Facility and the UN-REDD programme, even though there is very limited information on how this international mechanism will work, what the value of REDD carbon will be, and what MRV requirements will be imposed. While expectations are high, a note of caution is important, particularly as regards capacities and costs related to MRV. Full implementation unlikely to be a near-term possibility in many countries which do not have the manpower or capital resources for this at present, not only for MRV but indeed also as regards implementation of REDD+ activities, which means that in practice it may have to be carried out on a pilot or project basis in the short-term for until capacity for a truly national approach develops. Existing MRV systems are imperfect (Herold and Johns 2007, Herold 2009), and costs and capacity building effort needed for a fully national REDD+ programme are significant. Adequate levels of institutional capacity may be years away in some countries, particularly those which start from a position of limited data availability.

Nevertheless, the process of REDD participation needs to get started as soon as possible and early actions should be encouraged, both in terms of pilot activities and in terms of MRV. With regard to the latter, it is particularly important that countries with currently limited capacities are able to enter into this process now, and not fall behind those with the advantage of better data infrastructure. While assistance from funds like FCPF and UN-REDD will go some way to building the necessary capacity, this may not be sufficient and in any case will not work overnight. Thus, it is important to elaborate what could reasonably be used as proxy methods in the absence of a fully developed MRV system.

A useful concept providing flexibility in dealing with uncertain or incomplete data in the REDD+ process is conservativeness (Grassi *et al* 2008). Conservativeness is a concept that has also been used in the Kyoto Protocol. In the REDD+ context, conservativeness may mean that when completeness or accuracy of estimates cannot be achieved, the reduction of emissions or increases in carbon stock should not be overestimated and the risk of overestimation should be minimized. We have already suggested that conservative values should be used in estimation of stock change in areas where low levels of MRV intensity are used. While the MRV system is improving and moving away from incomplete, uncertain estimates, the need for using conservative estimates may be replaced by the use of 'best estimates', which, like all

Table 2. A set of suggested indicators that may be used to assess the performance of near-term REDD+ activities on the national level in absence of a fully developed MRV system (adapted from Herold and Skutsch 2009).

REDD+ objective	Justification	Interim performance indicator
Reduced deforestation	Emissions from the loss of forests are among the largest per hectare losses in terrestrial carbon	Total area under current forest cover (as defined by the Marrakech accords) shall not decrease as monitored by satellite data
Conservation of intact forests	Continued supply not only of carbon but also of other ecosystem services; incentive to maintain natural forests in their natural state	The total area of intact forests within the country should remain constant as monitored by satellite data
Reduced degradation of forests	Very large areas, particularly dry tropical forest, are subject to carbon losses as a result of unsustainable extraction for livelihood purposes; such emissions have probably been underestimated as data on this kind of degradation is very scarce	Community and individual forest land owner programmes for improved management in place and expanding; case studies carried out to assess typical annual impacts
No increase in emissions from forest management (i.e. selective logging) activities	Forest management should work towards sustainable forest use with net zero or positive carbon balance in the long-term	All areas under forest management should be monitored and activities documented as far as practicable using existing capacities (i.e. concessions, harvest estimates etc, satellite data). Observed changes in forest management activities should spur estimations of forest carbon impacts
No increase in emissions resulting from anthropogenic forest fires	Forest fires result in direct emissions of several greenhouse gases	Area of forest burnt each year should decrease compared to current amount, verifiable by satellite data
Encouragement of increasing carbon sink capacity of non-forest and forest land	All changes from non-forest land to forest (i.e. through plantations, land use change) or within forest land (sustainable forest management, enrichment planting) increase the sequestration of atmospheric carbon	Not considered relevant in the interim period before a proper MRV system is in place but any dedicated activities should be documented as far as practicable

measurements under REDD, would be subject to independent assessment.

A set of such simple and interim indicators or verifiable proxies that could be used to assess the performance of REDD+ actions in cases of incomplete and uncertain data on the national level is presented in table 2. These would provide justification and prioritization for early implementation of REDD+ actions, and build on the principle of conservativeness while encouraging the development of a more accurate MRV system over time. Monitoring using suitable satellite data, for example, is rather straightforward and just the fact that satellite data are systematically acquired for a whole country would give some level of certainty that key activities (forest area change) can be observed and activities verified even later in time using archived data. In this context, the area change data are important and for some interim indicators no actual carbon data would be needed initially. This could be understood as a Tier 0 or simple Tier 1 approach at the national level, i.e. to agree on a standard but conservative average carbon stock in the absence of sufficient information. In areas where stock change data are required to assess reduced degradation and forest carbon stock enhancement, typical (conservative) estimates based on a limited number of detailed case studies

within the country might be used while the communities and other stakeholders are being trained to make their own Tier 3 level inventories.

It is important to assume that all actors will make best use of available data and internationally accepted methods following the IPCC reporting principles of completeness, consistency, transparency, uncertainty, comparability, and encourage independent international review of results. The idea would be to replace the indicators suggested in table 2 as soon as the performance can be measured, reported and verified using the IPCC GPG methods.

5. Final remarks

National REDD/REDD+ based on a forest sectoral approach appears to offer the best opportunity for moving ahead as regards forest emissions and this approach has the support of the majority of the Parties debating the post-Kyoto climate agreement today. This is despite the fact that some observers, particularly large international environmental NGOs such as Nature Conservancy, favor an approach in which individual REDD projects may be financed independently of a national programme, by external donors (Parker *et al* 2009). One of the

arguments for this approach (which is sometimes, confusingly, referred to as a ‘nested approach’) is that countries are not ready for full MRV activities at the national level. However, as we have tried to show here, the inclusion of all forests does not mean that all forests have to be measured and monitored in the national programme at an equal intensity.

The alignment of REDD+ strategies into three groups—conservation, reduced deforestation, and positive impacts on carbon stock changes in forests remaining forest (proposal 1)—not only makes sense in terms of operationalizing REDD activities at national level, but also in terms of MRV requirements. In particular, it would allow for varying intensity of MRV over the country to focus more attention on those areas where carbon credits are in fact being generated (proposal 2).

While a systematic national forest monitoring is clearly essential, countries may prefer to focus REDD+ activities in areas where key drivers are most active and threats are highest and/or the possibilities for successful intervention seem greatest, and carry out detailed (Tier 3) MRV activities in these areas while using more simplified procedures in other parts of the country. We have pointed out also that areas which are being treated for degradation through promotion of a variety of sustainable management approaches are likely also to experience forest enhancement, and that this group of strategies will require different types of monitoring procedures and baselines from those which are intended to simply prevent deforestation. The forest areas may be divided strategically to deal with these two processes separately, according to need. We would also like to point out that while most attention in the REDD discourse has been devoted to the issue of reducing emissions, strategies for enhancement and conservation of forest carbon stocks may already be more important for some countries and in the long-term for many more.

A step-wise approach to inclusion of all forests and the build up of detailed carbon information on them is also a step towards a future climate change agreement in which wall-to-wall carbon losses and gains from all land use in all countries and climate zones is included, which would be a much more effective model in the long run. Until then early actions will need to deal with imperfect MRV systems and data, and make best use of existing activities including those on the project level, where we have made a number of suggestions of potentials and limitations.

For actors involved and interested in national REDD MRV planning and implementation we suggest that the recommendations made in this paper are useful to make the national efforts more effective by:

- better linking national REDD strategies policies addressing the key activities and drivers of forest change nationally, and MRV capacity development,
- identifying areas of high priority to focus the majority of the detailed MRV activities in this areas as part of a stratified national approach,
- to understand national MRV capacity development as a process along a roadmap with simple, interim performance targets that can be defined as milestones.

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References

- Arnold J M 2001 *Forests and People: 25 Years of Community Forest Management* (Rome: FAO)
- Asner G P, Knapp D E, Broadbent E N, Oliveira P J C, Keller M and Silva J N M 2005 Selective logging in the Brazilian Amazon *Science* **310** 480–2
- Asner G P 2009 Tropical forest carbon assessment: integrating satellite and airborne mapping approaches *Environ. Res. Lett.* **4** 034009
- Asner G P *et al* 2010 High resolution forest carbon stocks and emissions in the Amazon *Proc. Natl Acad. Sci.* **107** 16738–42
- Baccini A, Laporte N, Goetz S J, Sun M and Dong H 2008 A first map of tropical Africa’s above-ground biomass derived from satellite imagery *Environ. Res. Lett.* **3** 045011
- Benndorf R, Federici S, Forner C, Pena N, Rametsteiner E, Sanz M and Somogyi Z 2007 Including land use, land-use change and forestry in future climate change agreements: thinking outside the box *Environ. Sci. Policy* **10** 283–94
- Blaser J, Robledo C and Skutsch M 2009 Forest landscape carbon management: a vision for GEF *Washington DC; Presentation to Global Environmental Facility* 31 March
- Boyd E and Schipper E 2002 The Marrakech Accord: at the crossroad to ratification *J. Environ. Develop.* **11** 184–90
- Cadman S 2008 Defining degradation for an effective mechanism to reduce emissions from deforestation and forest degradation (REDD) *SBSTA Workshop on Forest Degradation (Bonn, 21–22 October 2008)*
- Chhatre A and Agrawal A 2009 Trade-offs and synergies between carbon storage and livelihood benefits from forest commons *Proc. Natl Acad. Sci.* **106** 17667–70
- Coleman E A 2009 Institutional factors affecting biophysical outcomes in forest management *J. Policy Anal. Manag.* **28** 122–46
- Danielsen F *et al* 2010 At the heart of REDD: a role for local people in the monitoring of forests? *Conserv. Lett.* at press (doi:10.1111/j.1755-263X.2010.00159.x)
- De Jong B, Anaya C, Masera O, Olguín M, Paz F, Etchevers J, Martínez R, Guerrero G and Balbontín C 2010 Greenhouse gas emissions between 1993 and 2002 from land-use change and forestry in Mexico *Forest Ecol. Manag.* **260** 1689–701
- Dutschke M and Angelsen A 2008 How do we ensure permanence and assign liability? *Moving Ahead with REDD: Issues, Options and Implications* ed A Angelsen (Bogor: CIFOR)
- Eva H, Carboni S, Achard F, Stach N, Durieux L, Faure J-F and Mollicone D 2010 Monitoring forest areas from continental to territorial levels using a sample of medium spatial resolution satellite imagery *J. Photogram. Remote Sens.* **65** 191–7
- Gibbs H and Herold M 2007 Tropical deforestation and greenhouse gas emissions *Environ. Res. Lett.* **2** 045021
- GOFC-GOLD 2010 A sourcebook of methods and procedures for monitoring and reporting anthropogenic greenhouse gas emissions and removals caused by deforestation, gains and losses of carbon stocks in forest remaining forests, and forestation *GOFC-GOLD Report version COP16-1* (available at www.gofc-gold.uni-jena.de/redd/)
- Grassi G, Monni S, Federici S, Achard F and Mollicone D 2008 Applying the conservativeness principle to REDD to deal with the uncertainties of the estimates *Environ. Res. Lett.* **3** 035005
- Herold M 2009 An assessment of national forest monitoring capabilities in tropical non-Annex I countries: recommendations for capacity building *Report for The Prince’s Rainforests Project and The Government of Norway* (available at http://princes.3cdn.net/8453c17981d0ae3cc8_q0m6vsqxd.pdf)

- Herold M and Johns T 2007 Linking requirements with capabilities for deforestation monitoring in the context of the UNFCCC-REDD process *Environ. Res. Lett.* **2** 045025
- Herold M and Skutsch M 2009 Measurement, reporting and verification for REDD+: objectives, capacities and institutions *National REDD Architecture and Policies* CIFOR book
- Hobley M 1996 Participatory forest management in S. Asia. The process of change in India and Nepal *Rural Development Forestry Study Guide* (London: ODI)
- Karky B 2008 The economics of reducing emissions in community managed forests in Nepal Himalaya *PhD Thesis* University of Twente, The Netherlands
- Krug T 2008 Detection of selective logging for estimating and monitoring forest degradation: methodologies and experiences in Brazil *UNFCCC Workshop on Methodological Issues Relating to REDD (Tokyo, 25–27 June 2008)*
- Lambin E F and Geist H J 2003 Regional differences in tropical deforestation *Environment* **45** 22–36
- Laporte N T, Stabach J A, Grosch R, Lin T S and Goetz S J 2007 Expansion of industrial logging in Central Africa *Science* **316** 1451
- Lewis S L *et al* 2008 Increasing carbon storage in intact African tropical forests *Nature* **457** 1003–7
- Lund H 2009 What is a degraded forest *Forest Information Services* Gainesville, VA
- Murdiyarsa D and Skutsch M 2006 *Community Forest Management as a Carbon Mitigation Option: Case Studies* (Bogor: CIFOR)
- Olander L P, Gibbs H, Steinger M, Svensen J and Murray B 2008 Reference scenarios for deforestation and forest degradation in support of REDD; a review of data and methods *Environ. Res. Lett.* **3** 025011
- Parker C, Mitchell A, Trevedi M and Mardas N 2009 *The Little REDD Book* (Oxford: Global Canopy Foundation)
- Penman J, Gytarsky M, Krug T, Kruger D, Pipatti R, Buendia L, Miwa K L, Ngara T, Tanabe K and Wagner F 2003 *Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types* (Kanagawa: IPCC-IGES) (available at <http://www.ipcc-nggip.iges.or.jp/public/gpplulucf/degradation.html>)
- Prior S, O'Sullivan R and Streck C 2007 A carbon stock approach to creating a positive incentive to reduce emissions from deforestation and forest degradation *Joint Submission to the UNFCCC Secretariat on Reducing Emissions from Deforestation in Developing Countries by Centre for International Sustainable Development Law and Global Public Policy Institute* (available at http://www.climatefocus.com/downloads/CISDL_and_GPPI_UNFCCC_Submission-Carbon_Stock_Approach.pdf)
- Schreckenber K 1998 Rural development forestry *Prog. Phys. Geogr.* **22** 389–97
- Simula M 2009 Towards defining forest degradation: comparative analysis of existing definitions *Forest Resources Assessment* (Rome: FAO) p 57 *Working Paper 154* (available at <ftp://ftp.fao.org/docrep/fao/012/k6217e/k6217e00.pdf>)
- Skutsch M (ed) 2010 Community forest monitoring for the carbon market *Opportunities under REDD* (London: Earthscan) ISBN: 9781849711364
- Skutsch M and Trines E 2010 *Understanding Permanence in REDD+. K: TGAL Policy Note 6* (available at www.communitycarbonforestry.org)
- Skutsch M and de Jong B 2010 The permanence debate *Science* **327** 107
- Souza C, Cochrane M, Sales M, Monteiro A and Mollicone D 2009 Integrating forest transects and remote sensing data to quantify carbon loss due to forest degradation in the Brazilian Amazon *FRA Working Paper 161* (available at <http://www.fao.org/forestry/cpi/forestedegradation/64442/es/>)
- Souza C, Roberts D A and Cochrane M A 2005 Combining spectral and spatial information to map canopy damages from selective logging and forest fires *Remote Sens. Environ.* **98** 329–43
- UNFCCC 2008 Informal meeting of experts on methodological issues related to forest degradation *Chair's Summary of Key Messages (Bonn, 20–21 October 2008)* (available at http://unfccc.int/methods_science/redd/items/4579.php)
- UNFCCC 2009a Methodological guidance for activities relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries *Decision COP 15/4* (available at <http://unfccc.int/resource/docs/2009/cop15/eng/11a01.pdf#page=11>)
- UNFCCC 2009b *UNFCCC/SBSTA Technical Paper on Costs of Monitoring for REDD* (available at <http://unfccc.int/resource/docs/2009/tp/01.pdf>)
- UNFCCC 2009c *Report on the expert meeting on methodological issues relating to reference emission levels and reference level* (available at http://unfccc.int/documentation/documents/advanced_search/items/3594.php?rec=j&preref=600005140#beg)
- UNFCCC 2010 Outcome of the work of the Ad Hoc Working Group on long-term Cooperative Action under the Convention—policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries *UNFCCC COP 16 Cancun* (available at <http://unfccc.int/2860.php>)
- Van Laake P E and Skutsch M 2009 Data collection and national/local level *GOF-C-GOLD: Reducing GHG Emissions from Deforestation and Degradation in Developing Countries: a Sourcebook of Methods and Procedures for Monitoring, Measuring and Reporting. Report Version COP14-2* (Alberta: Natural Resources Canada) chapter 3.4
- Zahabu E 2008 Sinks and sources, a strategy to involve local communities in Tanzania in global climate policy *PhD Thesis* University of Twente, The Netherlands