Moving Ahead with REDD

Issues, Options and Implications

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Chapter 10

How do we measure and monitor forest degradation?

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10.1 Why REDD has two D's

Forest degradation is a major source of greenhouse gas emissions (GHGs). In the Brazilian Amazon forest, degradation is responsible for 20% of total emissions (Asner *et al*. 2005). In Indonesia, the forest stock is decreasing by 6% a year and forest degradation is responsible for two thirds of this, whereas deforestation is responsible for only a third (Marklund and Schoene 2006). In Africa the annual rate of forest degradation is almost 50% of the annual rate of deforestation (Lambin *et al*. 2003).

In 2007, the Thirteenth Conference of the Parties (COP 13) to the United Nations Framework Convention on Climate Change (UNFCCC) acknowledged the importance of forest degradation by making it part of the proposed mechanism for reducing emissions from deforestation and forest degradation (REDD). Addressing degradation has other important benefits. Less degradation will mean that forests will have higher capacity to adapt to climate change and to provide more and better ecosystem and livelihood services.

Often, the driving forces for forest degradation and deforestation are different. Also, degradation is not necessarily a precursor to deforestation. Forests can remain degraded for a long time and never become completely deforested. So, addressing deforestation does not automatically reduce rates of forest degradation. In addition, failing to include degradation in a REDD agreement would mean that considerable amounts of forest-based emissions would not be accounted for. For example, if a healthy primary forest with a crown cover of 70% degraded to a state where it only had a crown cover of 15%, it would still be classified as 'forest' and the increase in emissions from degradation would not be accounted for.

This chapter focuses on the methods used to measure and monitor forest degradation. It complements and elaborates on Chapter 9, which focuses on both Ds – deforestation and forest degradation. The methods to measure and monitor forest degradation are discussed in terms of effectiveness in accounting for emissions, cost efficiency, and international equity issues. The discussion takes account of differing country circumstances.

10.2 Definition and causes of forest degradation

As adopted at COP 9 in 2003, forest degradation is defined as 'direct human-induced long-term loss (persisting for X years or more) of at least Y% of forest carbon stocks (and forest values) since time (T) and not qualifying as deforestation' (IPCC 2003a). However, reaching agreement on an operational procedure for monitoring, reporting and verifying (MRV) forest degradation has been problematic (Penman 2008). This is because X (human-induced long-term loss), Y (% of forest carbon stocks) and the minimum area of forest to be measured are difficult to define. Each factor is influenced by the activities causing degradation and the ecology of the particular forest.

Common activities causing forest degradation in the tropics include (GOFC-GOLD, 2008):

- Selective logging
- Large-scale and open forest fires
- Collecting non-timber forest products and wood for fuel
- Producing charcoal, grazing, subcanopy fires and shifting cultivation

Apart from selective logging, there have been few analyses of the impacts of these activities on the loss of forest biomass and how long forests need to regenerate. Further, almost all studies have focused on humid tropical forests. However, extracting fuelwood from dry forests often causes more degradation than commercial timber harvesting (Skutsch and Trines 2008). This is important since dry forests are generally more heavily populated than rainforests. While the carbon content of dry forests is much lower than that of humid forests, dry forests account for 42% of tropical forests (Murphy and Lugo 1986).

10.3 Methods for estimating emissions from forest degradation

The IPCC (2003b) identifies five carbon pools that should be monitored to estimate emissions from deforestation and forest degradation: aboveground biomass, belowground biomass, litter, dead wood and soil organic carbon. The most practical method of estimating emissions is to monitor only aboveground biomass. However, degradation processes such as logging and burning can significantly influence emissions from other carbon pools such as dead wood and litter.

The IPCC (2003b) also provides three tiers for carbon accounting. Each tier requires more data and more complex analyses and, therefore, is more accurate:

- Tier 1 applies default emission factors (indirectly estimates emissions based on the loss of canopy cover) to data on forest activities ('activity data') that are collected nationally or globally
- Tier 2 applies country specific emission factors and activity data
- Tier 3 applies methods, models and inventory measurement systems that are repeated over time, driven by high resolution activity data and disaggregated subnationally at a fine scale

Monitoring, reporting and verifying (MRV) deforestation and degradation has two components: (i) monitoring changes in forest area by forest type; and (ii) monitoring average carbon stocks per unit area and forest type (carbon densities) (IPCC 2003b). Thus, the simplest approach (Tier 1) keeps track of changes in the area of each category of forest, and calculates carbon stocks in each forest category using global default values for carbon densities. In Tier 2, the accuracy improves because carbon densities are estimated using country specific data instead of global default values. In Tier 3, models and inventories are tailored to the particular country and repeated over time. Thus Tier 3 also measures changes in carbon densities within the accounting period.

Changes in forest area can be monitored by remote sensing, at least in part, or by systematic forest inventories. Inventories need to be based on a sample large enough to detect significant changes in forest area by forest type. Monitoring forest degradation (i.e. the change from intact forest to disturbed forest) by remote sensing is much more challenging than monitoring deforestation. Deforestation is easily detected by remote sensing, particularly when it occurs on a large scale. However, it is much more difficult to detect degradation because remote sensing does not clearly show, for example, the removal of a few trees (selective logging) or loss of undergrowth (by fire) or disappearance of branches and small trees (for fuelwood). These activities have little effect on the canopy cover but can affect the forest stock significantly (DeFries *et al.* 2007). Even with high resolution optical imagery it is hard to detect changes under the canopy: advanced methods such as radar, which do have this potential, are currently only available in small areas.

One way of dealing with this problem is to use a probabilistic approach. This involves stratifying forest by risk of degradation, based on past trends and proxy variables such as accessibility (e.g. density of roads, distance from settlements) (Schelhas and Sanchez-Azofeifa 2006). The parameters in the models would be different for different types of degradation activities (e.g. selective logging, collecting fuelwood) (Iskandar *et al.* 2006).

Changes in average carbon stocks per unit area per forest type can be monitored by various methods. These include making use of secondary datasets and estimates from IPCC (2003b), as well as carrying out *in situ* forest inventories and monitoring sample plots. To measure changes in carbon stocks caused by forest degradation, IPCC (2006) recommends two methods: the stock-difference method and the gain-loss method (see Figure 9.1).

The *stock-difference* method builds on traditional forest inventories to estimate sequestration or emissions. The *gain-loss* method builds on an understanding of the ecology of forests: how forests grow, and how natural or anthropogenic processes produce carbon losses. The stock-difference method measures the actual stock of biomass in each carbon pool at the beginning and end of the accounting period. The gain-loss method estimates biomass gains as mean annual increment (MAI) in biomass minus estimated biomass losses from activities such as timber harvesting, logging, collecting fuelwood and overgrazing, as well as from fire. If the forest is stratified into areas subject to different kinds of degradation, and these are well understood, it may be possible, for example, to estimate the quantity of wood products extracted in a given period quite accurately.

Table 10.1 compares the stock-difference method with the gain-loss method. Both methods could be used for assessing forest degradation in IPCC Tiers 2 and 3. The choice of method will depend largely on what data are available and what resources are needed to collect additional data (GOFC-GOLD 2008). Countries experiencing significant forest degradation may wish to develop their own national and local databases and models in order to use the gain-loss method to estimate changes in different carbon pools. Estimates by Hardcastle and Baird (2008) suggest that adding degradation to the Tier 3 reporting set-up would cost the Democratic Republic of the Congo an additional 10%, Indonesia an additional 11% and Brazil an additional 13%. The percentage increases in recurrent costs would be similar. However, these calculations assume that these countries are already reporting in Tier 3 and will therefore have robust sampling systems (covering a minimum of 3% of land surface and 6 strata) in place.

Table 10.1. Comparison of stock-difference and gain-loss methods for estimating emissions from different types of degradation

Type of degradation	Stock-difference method	Gain-loss method
Selective logging	• Legal harvesting usually requires measurement of biomass after harvesting, thus necessary data should be available • Illegal harvesting would require additional data collection • Data on undisturbed forest can be used as a proxy if pre-harvesting data for particular sites is not available	• Uses estimates of MAI and centralised records on timber extraction activities • Reliability depends on honesty of timber companies in reporting rates of extraction
Large-scale forest fires	• Reference data from undisturbed forest can be used for pre-fire biomass, but forest inventory would be needed to measure post-fire biomass	• Losses due to fire can be estimated from the area burned. Emission factors can be used to estimate emissions based on the biomass lost
Harvesting of fuel wood and non-timber forest products	• Pre-harvesting biomass levels could be estimated from typical levels in undisturbed forest. But, in practice, much of the forest subject to these uses will already be partially degraded at the start of the accounting period • In areas already under individual or community management, pre- and post-period forest inventories can be carried out by forest users	• Data on losses, e.g. registers of commercial wood-based products, estimates of fuelwood use, may be available • Fuelwood off-take could also be calculated using population and data on average household fuelwood consumption • Data on gains are available from standard MAI statistics
Subcanopy fire, grazing and shifting cultivation (using forest for agricultural production)	• Pre-harvesting biomass levels could be estimated from typical levels in undisturbed forest. But, most forest subject to these changes will already be partially degraded at the start of the accounting period • Communities can measure changes. This can help establish local 'ownership' of the process	• Data on gains are available from standard MAI statistics • Data on losses are rarely available in national statistics

10.4 Cost implications for countries

The cost of measuring and monitoring forest degradation depends on the circumstances in each country, such as:

- The extent of forest cover
- The level of forest stratification (for example, the Democratic Republic of the Congo has only one major forest type whereas Indonesia and Mexico have four or more forest ecotypes)
- The tier of carbon accounting applied

Countries' forests are at different points on the forest transition curve (Figure 10.1), reflecting the changes in agriculture and forest rents over time (Angelsen 2007). As a result, degradation is a more critical issue in some countries than in others. For example, some countries may have halted deforestation but may still be losing biomass from the forests that remain. Thus, the state of a country's forests will influence to what extent it invests in forest degradation accounting systems and which measurement and monitoring option it chooses.

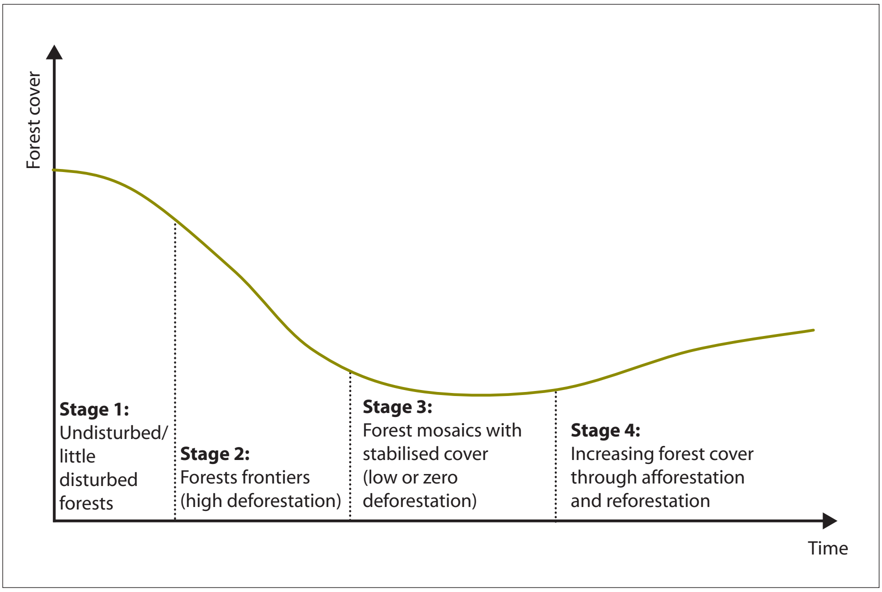

Figure 10.1. Stages in forest transition (adapted from Angelsen 2007)

Forest transition theory identifies four stages in the transition of forests. Countries can be grouped into four categories according to the stage their forests fall in:

1. Countries and regions with **low deforestation and high forest cover** such as the Congo Basin and Guyana – Here, forests are relatively undisturbed, but may be subject to increasing deforestation and degradation in the

future. These countries and regions are likely to be the most interested in accounting for forest degradation because they are less likely to benefit from 'avoiding deforestation', at least if reference levels are based on historical deforestation. In these countries with intact forests, the stock-difference method with stratified sampling would be the most cost-efficient way of carbon accounting. Proxies could be used if there is no data from before logging or other human interventions (Table 10.1). Countries with large logging concessions could use the gain-loss method cost effectively because the basic data for Tier 2 type of reporting would be available. These countries could be motivated to account for degradation by the expectation that they could obtain financial support to do so.

2. Countries with **high deforestation** such as (parts of) Brazil, Indonesia, and Ghana that have large tracts of forest with high deforestation rates (forest frontiers) – These countries have a strong incentive to engage in deforestation accounting. Unless it requires little additional effort, they are less likely to have a significant interest in accounting for forest degradation. However, excluding forest degradation from national REDD schemes (especially where selective logging predominates) might lead to considerable leakage. These countries would most likely prefer to use the gain-loss method for the same reasons as countries in Category 1 with large logging concessions.
3. Countries with **low deforestation and low forest cover** characterised by forest mosaics and stable forest areas – In these countries, deforestation rates have levelled off, either because forests have already been largely cleared or because they have strong forest protection policies. India may fall in this category and, as indicated in their 2008 submission to the UNFCC, they may be interested in reducing degradation, probably in combination with forest conservation, afforestation and reforestation, and other schemes to enhance forest carbon stocks. These countries could use the stock-difference method in Tier 2. As site-specific data becomes more widely available and cost effective they could progress to Tier 3.
4. Countries with **increasing forest cover** such as China and Vietnam – These countries may not be very interested in accounting for forest degradation unless a REDD agreement includes 'enhancing' carbon stocks (Chapter 2). However, even though new plantations may increase the forest area in these countries, the existing forests may be simultaneously degrading. Countries may prefer to present their success in increasing the area of forest plantations as afforestation/reforestation (A/R) under the Clean Development Mechanism. Whether or not this happens depends on whether or not A/R is integrated into a REDD agreement. Because they may have records of forest management going back some time, these countries may have databases that can provide historical reference scenarios, enabling them to adopt the stock-difference method in Tier 3.

10.5 Conclusion

Forest degradation is more complicated to define, monitor, report and verify (MRV) than deforestation (IPCC 2003a). More proxy factors need to be used. But IPCC stock-difference and gain-loss methodologies (IPCC 2006) and tiers (IPCC 2003b) are useful for carbon accounting in forest degradation. Where data is limited, simple methods, default values (Tier 1), and proxies can be used to account for emissions from different kinds of degradation. The uncertainties inherent in simpler approaches mean that credits would need to be 'discounted'. This would be a direct incentive for countries to upgrade their measuring and monitoring methods.

Overcoming the challenges posed by carbon accounting in forest degradation by using the IPCC stock-difference and gain-loss methodologies, and tiers, means that forest degradation could realistically be included in a REDD agreement. This would make REDD more effective because it would account for a wider range of forest greenhouse gas emissions. The international equity of the REDD mechanism would also improve because a wider range of countries, many of them in Africa, would be encouraged to participate. It is, therefore, important that decisions on the MRV framework for degradation allow for a diversity of circumstances. This can be done by allowing countries flexibility in designing, developing and applying carbon accounting methods for forest degradation.