Critical Need for New Definitions of "Forest" and "Forest Degradation" in Global Climate Change Agreements

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Abstract

If global policies intended to promote forest conservation continue to use the definition of "forest" adopted in 2001 by the United Nations Framework Convention on Climate Change (an area of >0.05–1 ha with >10–30% cover of plants >2–5 m tall at maturity), great quantities of carbon and other environmental values will be lost when natural forests are severely degraded or replaced by plantations but technically remain "forests." While a definition of "forest" that is globally acceptable and appropriate for monitoring using standard remote-sensing options will necessarily be based on a small set of easily measured parameters, there are dangers when simple definitions are applied locally. At the very least, we recommend that natural forest be differentiated from plantations and that for defining "forest" the lower height limit defining "trees" be set at >5 m tall with the minimum cover of trees be set at >40%. These changes will help to reduce greenhouse gas emissions from what is now termed forest "degradation" without increasing monitoring costs. Furthermore, these minor changes in the definition of "forest" will promote the switch from degradation to responsible forest management, which will help mitigate global warming while protecting biodiversity and contributing to sustainable development.

Introduction

Forest degradation and deforestation are distinctly different processes. While deforestation involves the conversion of forests to another land cover types, degradation results when forests remain forests but lose their ability to provide ecosystem services or suffer major changes in species composition due to overexploitation, exotic species invasion, pollution, fires, or other factors (Millennium Ecosystem Assessment 2005). Over the past decade, tropical deforestation globally resulted in the release of an estimated 1.1–2.2 PgC yr^{-1}(Achard *et al*. 2004, Gullison *et al*. 2007, Houghton, 2003) (1PgC = 10^{15} gC); forest degradation is thought to have resulted in similar emissions (Gaston *et al*. 1998), but the data are more limited (but see Asner *et al*. 2005, Gibbs *et al*. 2007, Nepstad *et al.* 1999). Unfortunately due to political instability and governance failures, wildfires as well as the uncontrolled and often illegal logging that result in forest degradation continue unabated in much of the tropics (Hembery *et al*. 2007, Meyfroidt & Lambin 2008). Our concern is that while forest degradation is recognized as a major problem, it is mostly being disregarded by the United Nations Framework Convention on Climate Change (UNFCCC) partially because of the way they defined "forest."

The possibility of compensating developing countries for reduced emissions from deforestation and degradation (REDD) was proposed in 2005 by the governments of Papua New Guinea and Costa Rica at the 11th Conference of Parties of the UNFCCC. As the roles of tropical forests in sustainable development and global warming become increasingly apparent, progress is being made towards including REDD in the post-Kyoto Protocol climate change agreement (Miles & Kapos 2008, IISD 2008). Negotiations on this agreement are scheduled to be completed by December 2009 (UNFCCC 2008), which means that discussions about the broader issue of defining forests and debates over the inclusion of forest degradation need to be resolved very soon.

Here, we discuss the problems regarding the definition of "forest" adopted in 2001 under the Marrakesh Accord of the Clean Development Mechanism (CDM; see UNFCCC 2002), lack of a consensus definition of "forest degradation," and the potential exclusion of forest degradation in the post-Kyoto agreement (Neeff *et al.* 2006). We also provide explicit and readily implemented suggestions for addressing these problems so that the outcomes of the new agreement are more likely to include real carbon emission reductions while promoting sustainable forest management and contributing to the welfare of forest-dependent people.

Current definition of "forest" and the need for a new or revised definition

According to the CDM of the Kyoto Protocol, a "forest" is an area of >0.5–1.0 ha with a minimum "tree" crown cover of 10–30%, with "tree" defined as a plant with the capability of growing to be >2–5 m tall (UNFCCC 2002). Participating countries can chose from the specified ranges for a "forest" definition tailored to their needs. While we recognize that any definition suitable for global application will necessarily be comprised of a very few easily measured parameters, we fear that continued use of this particular definition will jeopardize many forest values, including carbon. Furthermore, the CDM forest definition inadvertently allows continued unsustainable exploitation of forest resources principally because natural forests and plantations are not differentiated (about which we have no more to say) and because thresholds for crown cover are so low that the carbon consequences of continued indiscriminate extraction of commercially valuable tree species are not officially recognized (Figure 1).

FIGURE 1 HERE

By setting the lower limit of tree crown cover at 10 or even 30%, degradation leading to substantial reductions in standing stocks of carbon will be allowed to continue without causing deforestation (point A to points C and C' on Figure 1). The consequences are worse if the minimum height to which "trees" must grow is set at only 2 m rather than 5 m (Table 1), but in any case, the loses of both carbon and other forest values are substantial. These losses have attendant negative impacts on about 2.7 billion forest dependent people (Koopmans 2005) as well as the rest of the planet. Furthermore, the permitted practices that lead to these losses (e.g., illegal, unsupervised, and unsustainable logging as well as rampant wildfires) also subvert the UNFCCC's goal of reducing net emissions from developed countries while promoting sustainable development in the rest of the world.

In defense of the UNFCCC negotiators' choice of tree crown cover as one of the principal parameters describing "forest," it is worth noting that this forest feature plays a vital role in biosphere and atmosphere interactions (Ozanne *et al.* 2003), that canopy cover can be readily monitored using standard remote sensing techniques, and, finally, that it is a major component of the definition of "forest" that has been used for decades by the Food and Agricultural Organization (FAO) of the United Nations. Nevertheless, it is important to note that whereas the FAO uses a minimum threshold of 40% tree crown cover to define "closed forest" (and 10–40% for "open forest"; FAO, 2000), the

UNFCCC left it to each country participating in the CDM to select a minimum threshold of only 10–30% (for the minimum canopy covers and tree heights selected to define "forest" by signatory countries see Table 1). Although by selecting the UNFCCC's higher minimum (i.e., 30%) to define "forest" a country would potentially have more land area eligible for reforestation or afforestation under the CDM (Verchot *et al*. 2007, Zomer *et al*. 2008), many chose a lower option. We suggest that in keeping with the FAO and in recognition of the fact that open forests (10–40% tree crown cover) are generally more fire-prone than more closed canopy forests (e.g., Cochrane *et al*. 1999) and are otherwise ecologically different, the UNFCCC should differentiate the two in the agreement being designed to replace the Kyoto Protocol during the second commitment period starting in 2012.

Table 1

These changes in the "forest" definition used by the UNFCCC are critical because, unlike the first commitment period (2008–2012) during which compensation is only available for increased carbon stocks resulting from afforestation and reforestation, the post-Kyoto REDD approach is intended to provide compensation for the protection of forest carbon stocks. If REDD becomes a reality, then the question "what type of forest do we want as an outcome of the agreement?" remains to be addressed. If we want functioning forest ecosystems with their full complement of biodiversity, then forests should not be allowed to be converted into plantations or to otherwise lose large proportions of their carbon stocks or species. Avoiding these forms of degradation will be promoted by adopting a new definition of "forest."

Current definition of "forest degradation" and the need for a consensus definition

Forest degradation greatly affects social, cultural, and ecological functions. It is a silent killer of sustainable development insofar as its consequences are often subtle and become apparent only slowly. Lack of a universally agreed-upon definition of forest degradation will cause complications when REDD projects are implemented. Unfortunately, the FAO, the International Tropical Timber Organization (ITTO), the United Nations Environmental Program (UNDP), and the Intergovernmental Panel on Climate Change (IPCC) all define forest degradation differently (Schoene *et al*. 2007).

At the global level, a consensus definition of forest degradation is needed for sound implementation of REDD as well as for the Convention on Biological Diversity, but that definition needs to take into account the full range of biophysical and social conditions under which forests develop and the variety of ways they can be degraded. This definition will necessarily continue to focus on readily monitored parameters (i.e., canopy cover and tree heights). In contrast, at the national-level, implementation guidelines should consider other ecosystem services upon which many poor people in developing countries depend (Brauman *et al*. 2007, Koopmans 2005). These other ecosystem services would include but not be limited to non-timber forest products, genetic resources, biogeochemical processes, recreation, and cultural practices. This detail in local policies is needed to avoid conflicts with efforts to protect biodiversity, to encourage sustainable forest use, and to promote regional development.

Potential exclusion of forest degradation

The REDD program will involve developed countries (Annex I) compensating developing countries for activities that result in carbon retention in natural forests (Figure 1). REDD is attractive because it explicitly recognizes the value of natural forests, as opposed to plantations, and because the associated costs for project developers are expected to be low (Kindermann *et al*. 2008, Putz *et al.* 2008a, but see Potvin *et al*. 2008). Unfortunately, the frequent failure to consider forest degradation in several prominent recent studies (e.g., Kindermann *et al*. 2008, Gullison *et al.* 2007, Aldy & Robert, 2008) causes concern that only deforestation-avoidance credits will be allowed under the new protocol. Given that the uncontrolled selective logging by untrained and unsupervised crews commonly practiced in tropical natural forest doubles the amount of avoidable damage and wood waste relative to planned or reduced-impact logging (i.e., RIL; planned timber harvesting by trained and supervised crews; Table 2), the avoidable emissions from switching from exploitation to management are substantial (Asner *et al*. 2005, Putz *et al*. 2008b). Furthermore, given the rapid expansion of logging activities in central Africa (Laporte *et al*. 2007) and elsewhere in the tropics, carbon emissions resulting from forest degradation by uncontrolled logging are likely to increase.

If forest degradation is disregarded in the implementation of the REDD agreement, forests could lose much of their carbon, not to mention biodiversity and other ecosystem services, when valuable trees are harvested without regard to the ecological consequences (Broadbent *et al*. 2008). These loses will not be accounted for because the exploited areas still remain forest, as defined by the Marrakesh Accords of the

UNFCCC. To illustrate this phenomenon, we use inventory data for trees >5 cm DBH (diameter at breast height, DBH) in 23 clusters of plots (each cluster contains 9 plots of 20 × 60 m) collected in natural evergreen forest in central Cambodia. We estimate that this evergreen forest in this region holds average above-ground carbon stocks of 121.2 MgC ha^{-1} (see Supporting Information for calculation method), of which 71.4 MgC is in trees ≥45 cm DBH (Table S1). If all these large trees are harvested, the forest would still be categorized as 'forest' by the UNFCCC definition. In Cambodia and other countries where loggers often operate without management plans or supervision, the highest valued timbers are exploited first (So 2004, McKinney 2002). Even the stumps and large roots of "luxury grade" trees are used for manufacturing furniture. This sort of exploitative harvesting results in rapid disappearance of these highly valued tree species—a form of degradation by biodiversity loss. In fact, many species of Cambodian trees being illegally exploited for their luxury-grade timber (*Dalbergia oliveri, Aquilaria crassna, Dalbergia cochinchinensis, Gardenia ankorensis, Afzelia xylocarpa, Pterocarpus marcrocarpus, Dysoxylum loureiri, Diospyros cruenta, Lasianthus kamputensis*) are already classified as *Critically Endangered* on the International Union for Conservation of Nature's "Red List" (So 2004; www.iucnredlist.org). Technological capacities notwithstanding, at least some of these trees need to be protected to ensure the long-term sustainability of forest resource production as well as the maintenance of the ecosystem functions necessary for sustainable development.

Table 2 here

Fortunately, with recent advancements in remote sensing technology, international concerns over the economic feasibility and monitoring costs of the REDD projects are declining rapidly. Remote sensors can already detect and monitor minor changes in forest canopy cover (Asner *et al*. 2006), which makes it possible to monitor forest degradation by illegal and unplanned logging operations.

Conclusion and Recommendations

To ensure that biologically rich natural forests are not severely degraded in ways that remain unrecognized, in addition to differentiating natural forests and plantations, the new and improved definitions of “forest” and “forest degradation” should set the minimum crown cover at 40% and the minimum height for a “tree” at 5 m. These changes will help reduce greenhouse gas emissions from what is now termed forest “degradation” without increasing monitoring costs. Furthermore, these changes will promote the switch from degradation to responsible forest management, which will help mitigate global warming while protecting biodiversity and contributing to sustainable development. We also recommend that to avoid conflicts between conservation goals, global agreements that pertain to the fates of forests include requirements for more detailed definitions of “forest” in national-level implementation guidelines. Given the variety of ways that forests are perceived and valued, the adopted definitions are likely to vary among countries and could include a variety of components, but explicit and appropriate definitions are nonetheless of paramount importance at the country level.

At least in regards to standing stocks of forest carbon, recent advances in remote sensing technology that allow cost-effective monitoring of forest degradation coupled with the substantial and increasing emissions from poor logging and forest fires, continued disregard of the second “D” in REDD is not justified. Including forest degradation in the new climate change agreements will help ensure the sustainability of ecosystem services and protect the livelihoods of forest-dependent people while providing a low-cost option for reducing carbon emissions.

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Supporting Information

Additional Supporting Information may be found in the online version of this article: Supporting Information.

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Table and Captions

Table 1 Forest definition parameters adopted by tropical countries*[1] for participation in the UNFCCC

Country	Minimum tree crown cover (%)	Minimum area (ha)	Minimum tree height (m)	Forest Area (2005)*[2] (`000 ha)
Brazil	30	1.0	5	477,698
Indonesia	N/A	N/A	N/A	88,495
Peru	30	0.5	5	68,742
India	15	0.05	2	67,701
Mexico	30	1.0	4	64,238
Colombia	30	1.0	5	60,728
Malaysia	30	0.5	5	20,890
Paraguay	25	0.5	5	18,475
Thailand	30	0.16	3	14,520
Ethiopia	20	0.05	2	13,000
Viet Nam	30	0.5	3	12,931
Madagascar	30	1.0	5	12,838
Ecuador	30	1.0	5	10,853
Cambodia	10	0.5	5	10,447
South Africa	30	0.05	2	9,203
Ghana	15	0.1	2	5,517
Nicaragua	20	1.0	4	5,189
Honduras	30	1.0	5	4,648
Morocco	25	1.0	2	4,364
Panama	30	1.0	5	4,294
Uganda	30	1.0	5	3,627
Kenya	30	0.1	2	3,522
Costa Rica	30	1.0	5	2,391
Uruguay	30	0.25	3	1,506
Niger	30	1.0	4	1,266
El Salvador	30	0.5	5	298
TOTAL				**987,381**

Note:

*[1]: countries whose parameters of forest definitions are available on http://cdm.unfccc.int/DNA/index.html

*[2]: FAO (2005)

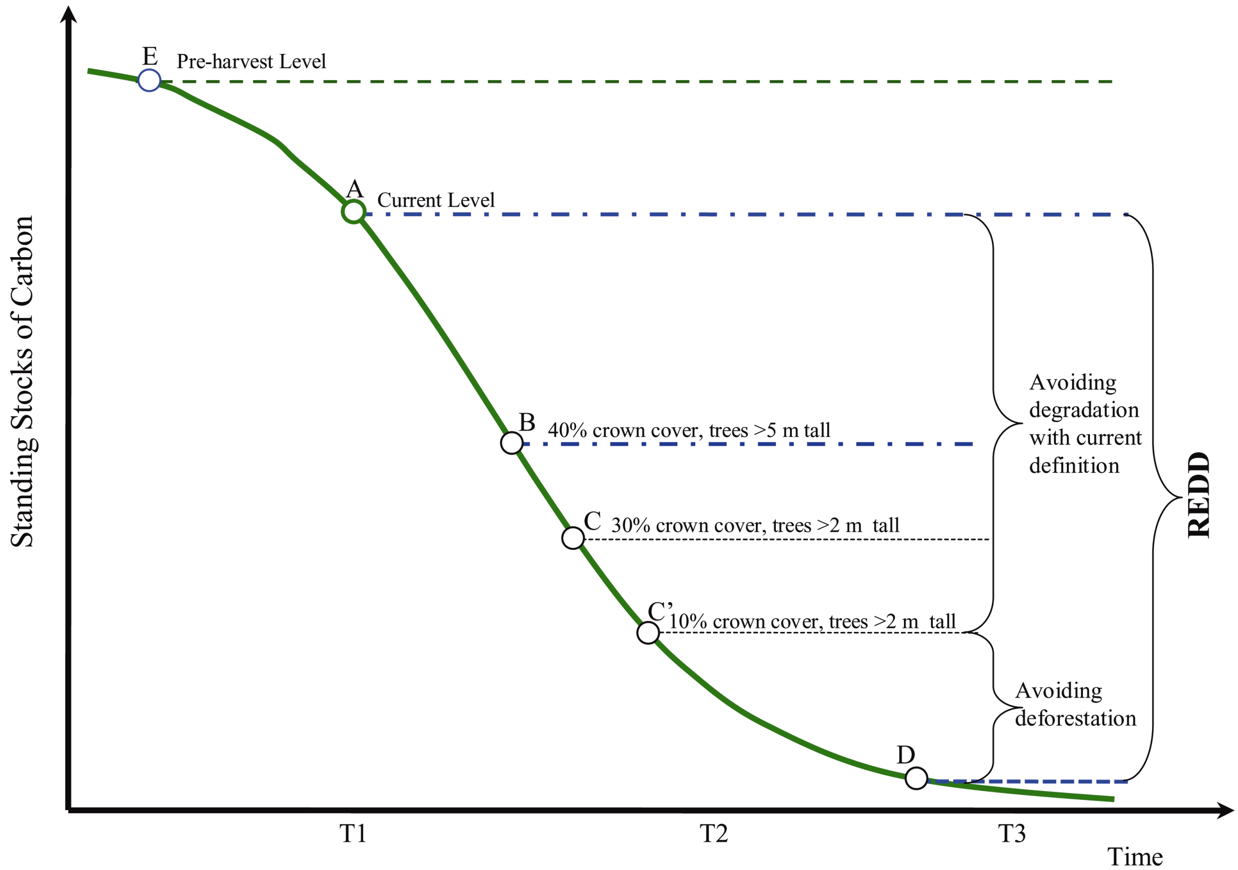
Table 2 Damage associated with conventional selective logging of tropical forests compared with similar intensities of timber harvesting by trained and supervised crews using reduced-impact logging (RIL) techniques.

Variables	Locations	Uncontrolled Logging	RIL	Sources
Logging damage to residual stands as percentage of commercial stem density	Sarawak, Malaysia	54.0 (DBH ≥10 cm)	28.0 (DBH≥10 cm)	FAO (2001)
	Sabah, Malaysia	60.0 (DBH ≥1 cm)	30.0 (DBH≥1 cm)	Tay *et al.* (2002)
	East Kalimantan, Indonesia	48.4 (DBH ≥10 cm)	30.5 (DBH≥10 cm)	Bertault & Sist (1997)
Logging damage to residual stands per one commercial tree harvested	Eastern Amazon	50.9 trees (DBH ≥10 cm)	34.7 trees (DBH≥10 cm)	Johns *et al.* (1996)
Waste as percentage of harvested wood	Sarawak, Malaysia	20.0	0.0	FAO (2001)
	East Kalimantan, Indonesia	46.2	26.2	Sist & Saridan (1999)
	Easter Amazon	24.0	8.0	Holmes *et al.* (2002)
Vulnerability to forest fires	Brazilian Amazon, Indonesia	Yes due to large logging gaps, huge wood wastes, and forest drying[1,4]. About 5.2 million ha burned in 1997-1998 in Indonesia[2], 27 million ha burned in 1998 in Brazilian Amazon[3]	Unlikely because of less logging gaps and less wood waste	[1]: Holdswoth & Uhl (1997) [2] Siegert *et al.* (2001) [3] Nepstad *et al.* (1999)
Selective logging leads to deforestation and carbon emissions	Brazilian Amazon	More than 32% of logged areas were deforested within 4 yrs[4]	Unlikely because of well-planned logging and well-trained personnel.	[4] Asner *et al.* (2006)
Carbon retention	Tropical	0	0.16 PgC yr^{-1}	Putz *et al*. 2008b

Figure and Captions

Figure 1. Differences in forest carbon stocks to be credited that result from different definitions of “forest.”

Under the current definition of “forest” agreed upon in the Marrakesh Accords of the Kyoto Protocol, carbon stocks in the tropics could continue to decline without recognition from point A until a point corresponding to a crown cover of 10–30% (either C or C’), which defines the forest threshold. Depending on the adopted definition of a country, deforestation is likely to be credited by the REDD agreement only from point C or C’ onward. A REDD agreement based on 10% or 30% crown cover definitions would therefore halt deforestation and prevent carbon stock losses from dropping below C’ or C, respectively; carbon released above these limits would be from forest degradation. Forest degradation losses would be much reduced (points A to B) if the “forest” definition is based on a higher canopy cover requirement (40%). Also, if improved forest management is also included in the agreement, healthy tropical forest as well as increased carbon stocks could be achieved (point A to E) as logging damage and wood waste are reduced. T1 to T2 is the next commitment period after 2012, and T2 to T3 is the “ensured” period for the post-Kyoto agreement. Carbon stored in the forest equivalent to point A (assuming that REDD is included in the post-Kyoto agreement) during the T2 to T3 period should not drop below that in the T1 to T2 period, otherwise the forest would be logged or converted to other land uses shortly at the end of the next commitment period (T2).



Standing Stocks of Carbon
E
Pre-harvest Level
A
Current Level
B
40% crown cover, trees >5 m tall
C
30% crown cover, trees >2 m tall
C'
10% crown cover, trees >2 m tall
D
Avoiding degradation with current definition
Avoiding deforestation
REDD
T1
T2
T3
Time