INTERNATIONAL SUBMISSION TO THE UNFCCC/SBSTA
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Reduction of GHG emissions from deforestation in developing countries

By the

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In this document, the Amazon Institute for Environmental Research (IPAM)[3], a Brazilian NGO conducting scientific research that was founded in May 1995, as a credentialed observer to COP-08, puts forth its considerations and contributions to COP/SBSTA related to the topic of emissions originating from deforestation[4] in developing countries (UNFCCC/CP/2005/L.2). We consider this to be a unique opportunity for a significant part of global greenhouse gas (GHG) emissions to be addressed in a definitive manner by the Parties to the Convention on Climate Change and the Kyoto Protocol. By doing so, mechanisms can be sought that will result in a reduction of emissions from deforestation in developing countries. In particular, IPAM requests that SBSTA consider the submission of a specific proposal for treatment of deforestation emissions, which has been called "compensated reduction of deforestation" (Santilli et al. 2005, Moutinho & Santilli 2005). Through this mechanism, developing countries, where most standing forests are located, could receive international financial compensation for emissions reductions from avoided deforestation. They would therefore be able to promote said reductions (using agreed historical deforestation rates as base periods) from their deforestation-related national emissions. We believe that this proposal is capable of promoting substantial reductions in carbon emissions from deforestation and can facilitate significant participation of developing countries in relevant activities to mitigate global climate change.

GENERAL CONSIDERATIONS

To interrupt or drastically decrease GHG emissions is both necessary and urgent to avoid "dangerous interferences" in the global climate system (primary objective of the UNFCCC, Article 2). Said interferences can only be avoided if the threshold of atmospheric CO_2 concentration remains around 450 ppmv (current concentration is at

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[4] In this document, deforestation is defined as the complete removal of forest cover, that is, so-called clear cutting. This is therefore distinct from logging that is characterized by selective removal of trees and consequently of only part of the forest cover.

368 ppmv – for the year 2000.) or temperature rises no more than at most 2 ^{o}C above pre-industrial levels (IPCC 2001, goal established by the European Union). The Kyoto Protocol is an important step in this direction (GHG emissions reduced by at least 5% in relation to 1990 levels by the period between 2008 and 2012). Substantially larger reductions, however, are necessary. Estimates are that to ensure CO_2 concentrations below 450 ppmv by 2100, annual global emission reductions must be greater than 2% per year starting in 2010 (Oneill & Oppenheimer 2002).

Given the inertia of the global power consumption system and costs to change the power grid, both for developed as well as developing countries, it is likely that emission reductions from the burning of fossil fuels at high annual rates (>2%/year), although necessary and urgent, are not realistic in the short term. Reductions in tropical deforestation, which contributes roughly 20% of global GHG emissions (Houghton 2005a, 2005b, Achard et al. 2002, DeFries et al. 2002), however, may be a more rapid and lower cost solution to aid in stabilizing concentrations of these gases, avoiding dangerous interferences in the land climate system.

From a technical-scientific standpoint, in order to avoid said dangerous interference, the following must be considered:

- all sources of (GHG) emissions must be addressed for the earliest possible reduction of total emissions;
- emissions from deforestation are sufficiently high to justify direct actions for their reduction;
- a delay in beginning reductions will make it more difficult to maintain atmospheric CO_2 concentrations below 450 ppmv, therefore, the more rapidly the reductions occur, the less costly they will be.
- there are several technical-scientific aspects (leakage, permanence or compensation for deforestation reductions) to be considered, but these should not serve as an obstacle to a more ambitious agreement that engages developing nations in a positive manner,
- a reassessment of deforestation emissions volume must be conducted, since several models that estimate future emissions, including some of the most well-known, underestimate emissions from deforestation; more recent studies of deforestation indicate substantially higher emissions.

From the political standpoint, the sustainability of current and future agreements on climate must be based on the principle of "common yet differentiated responsibilities". Parties should also acknowledge the following:

- it will only be possible to sustain obligatory and successive increases of emission reductions for rich countries, along the lines of Kyoto, or to have a robust market for ecosystem services, if a mechanism that addresses deforestation is established;
- without a mechanism that addresses emissions from deforestation, developed country participation in actions to mitigate global climate change will necessarily remain limited;
- voluntary reductions of emissions in developing countries (currently with no obligations to reduce) should be encouraged.

CARBON STORAGE, DEFORESTATION AND GHG EMISSIONS

Forests may be considered as huge warehouses of carbon. Some 200 billion tons of this element (200 PgC) are stored in the tropical vegetation that covers the planet (IPCC 2001). Photosynthesis performed by forest vegetation absorbs a huge quantity of carbon from the atmosphere each year. The Amazon forest alone is capable of absorbing six billion tons, the equivalent of 10% of the photosynthesis in all lands around the world. Most of this absorption is offset, however, by release of carbon through decomposition of organic matter and respiration of the forest itself. The remaining portion may be absorbed by the forest and thus transforms them into carbon sinks. Although this is still a controversial issue in academic circles, recent studies (Malhi et al. 2004, Philips et al. 1998; Grace et al. 1996; Maine et al. 1997) demonstrate that the quantity of carbon absorbed by the Amazon forest, for example, may be on the order of 0.4 PgC/year (Malhi et al. 2004). In other words, the forest is still growing.

Despite the role of tropical forests as sinks being still under discussion, it is their degradation and felling that generates large impacts on the climate. Tropical deforestation has resulted in large GHG emissions, especially of carbon gas (CO_2) (Table 1). Estimates are that between 10 and 35% (0.8± 0.2 to 2.2± 0.8 PgC per year during the 1990s) of global emission of these gases is from tropical deforestation (Houghton 2005a, 2005b, Achard et al. 2002, DeFries et al. 2002). A recent analysis, however, estimates that these emissions may be on the order of 3 PgC/year (Lewis *et al*. 2006).

The felling of forests in the tropical portion of Latin America alone produced a net carbon flow into the atmosphere on the order of 0.3 PgC/year during the 1980s. This amount rose to 0.4 PgC/year throughout the 1990s, as a result of deforestation of over 4 million hectares/year (Defries et al. 2002, Table 2). Just as a comparison, the combined deforestation rates of Indonesia and Brazil alone would result in GHG emissions equivalent to 4/5 of the annual reduction goals for the Annex I (industrialized) countries of the Kyoto Protocol (Santilli et al. 2005, Moutinho & Schwartzman 2005, Table 3). This proportion could be even greater if emissions from forest fires and logging activities in the tropics is calculated (Alencar, et al. 2005, Asner et al. 2005). Recent estimates also attribute carbon emissions to the atmosphere that took place during El Niño 1997/1998, on the order of 2.1 ± 0.8 PgC (van der Werf et al., 2004), with emissions from Central and South America having contributed the most (30%) to this amount. During the same period, it is calculated that forest fires in Brazilian Amazonia, for example, produced emissions on the order of 0.2 Pg of carbon/year (Mendonça et al., 2004). An equivalent amount is estimated for Indonesia caused by forest fires in that country (Siegert et al., 2001; Page et al., 2002).

To have an idea of the estimated contribution of forest fires to Amazonian GHG emissions, during 1998 El Niño alone some 30% of the forests in the region recorded high fire risk (Nepstad et al. 2004, Alencar et al. 2004a). In the same year, an area of 1.3 million hectares of standing forest burned in the state of Roraima and another 2.5 million hectares were affected by fire in southern Pará and northern Mato Grosso (Alencar et al. 2004a).

More recently, it has been estimated that 0.1 PgC/year is released by logging activities (Asner et al. 2005), although there is still no clear idea of carbon volumes absorbed by regeneration of vegetation after selective logging. In addition to all of this, deforestation may be eliminating part of the sink function of the forest.

TABLE 1. Average annual rates of deforestation (10^6 ha yr^{-1}) in tropical regions.*

	1980s		1990s		
	FAO**	DeFries et al.***	FAO**	DeFries et al.***	Achard et al.****
	(1995)	**(2002)**	**(2001)**	**(2002)**	**(2004)**
America	7.4	4.426	5.2	3.982	4.41
Asia	3.9	2.158	5.9	2.742	2.84
Africa	4.0	1.508	5.6	1.325	2.35
Total	15.3	8.092	16.7	8.049	9.60

The FAO rates are based on forest inventories, national surveys, expert opinion, and remote sensing. The estimates of DeFries et al. (2002) and Achard et al. (2004) are based on data from remote sensing.

** Reproduced from Houghton 2005.*

*** The FAO rates of deforestation are not the net changes in forest area reported by the FAO (1995, 2001). Rather, they are gross rates of deforestation, excluding increases in plantation areas. Natural and plantation forest areas for 2000 were obtained from FAO (2001). Natural forest area for 1990 was calculated as the difference between total forest area in 1990 (from FAO 2001) and plantation area in 1990 (from FAO 1995) (Matthews (2001) used the same approach).*
**** Rates from DeFries et al. (2002) refer to gross rates of forest loss (not counting gains in forest area).*
***** Rates from Achard et al. (2004) do not include areas of forest increase.*

Impacts on tropical biodiversity are also great and not only in function of the direct effects of deforestation. Calculations estimate that 15-35% of species from land environments on the planet may be at risk of extinction by the year 2050 through effects of climate change (Thomas et al. 2004) and a large part of these are from the tropics.

DEFORESTATION AND EMISSIONS: THE AMAZONIAN EXAMPLE

High GHG emissions resulting from deforestation should, if we assume continuation of past trends (the last few decades), continue high over the next several decades. Estimates are that by 2012, emissions will remain around 2.1 PgC/year, with a subsequent reduction as forested areas available for logging diminish. By 2100, between 80-130 PgC will have been released into the atmosphere by tropical deforestation (Houghton 2005, 2005), an amount equal to or greater than, for example, the entire carbon stock stored in the Amazon forest (ca. 60-80 PgC).

In Brazilian Amazonia, deforestation increased 30% from 2001 (18,165 km^2) and 2002 (23,266 km^2) and 2004 (23,750 ± 950) generating emission on the order of 0.2 PgC/year (3% of global total) or more (Houghton et al. 2000, Houghton 2005), discounting the quantity of carbon absorbed by vegetation that grows in cleared areas. Emissions from deforestation, therefore, are must higher (70% of the total) than those produced by burning fossil fuels (0.09 PgC/year; reference year 2002, Santilli et al. 2005). A 30% reduction in rates for the year 2005 was, however, achieved by the

TABLE 2. Annual emissions of carbon (PgC/yr) from tropical deforestation during the 1990s

	Achard et al. (2004)	**DeFries et al. (2002)**	**Houghton (2003)**
America	0.441	0.43	0.75
Asia	0.385	0.35	1.09
Africa	0.157	0.12	0.35
Total	0.983	0.91	2.20

Differences among estimates are largely a result of using different rates of deforestation, in this case, the estimate used by Houghton 2003. However, given the uncertainty of biomass, the central value of about 1.5 PgC/yr for the tropics may be an overestimate (Houghton, 2005), because estimates of biomass reported by the FAO (2001) are lower than the estimates used by the three analyses shown in this table.

Brazilian government. Implications of this reduction and its causes are discussed hereinafter.

Recent studies demonstrate that in Brazilian Amazonia alone, some 32 PgC will be emitted into the atmosphere by 2050 if deforestation follows the trend of the last two decades (Soares et al. 2006, Figure 1). The scenarios for increasing emissions in other tropical countries are similar. In Indonesia, 17,000 km^2 of forests were cut down between 1987 and 1997 and 21,000 km^2 in 2003 and another 0.2 PgC/year was emitted (Houghton et al., 2003).

WHAT ARE THE CAUSES OF DEFORESTATION?

Tropical deforestation results from the complex interaction of many (direct and indirect) factors that vary along an annual geographic and temporal axis. General causes of deforestation, however, seem to be the same in different tropical regions of the planet. Briefly stated, causes may be direct and indirect, as follows:

Indirect

- subsidies for agribusiness,
- investment in infrastructure
- land tenure issues,
- absence of adequate surveillance by the government
- demand for forest products (timber and other forest products)
- markets favorable to products from areas previously occupied by forests (grains and cattle, for example).

Direct:

- conversion of forest areas for plantation crops or cattle ranching
- mining
- logging

Taking the Amazon forest as an example, factors that induce deforestation are those mentioned above. The modern phase of occupation of the basin began in the

*Table 3. Carbon emissions from fossil fuel, tropical deforestation, forest fires (Brazil and Indonesia), fires and emission reductions targeted by the Kyoto Protocol**.

Country/Source	**Source**	**Carbon Emission** (PgC yr^{-1})	**Reference**
Brazil	Fossil Fuel (year: 2002)	0.09	**
	Deforestation	0.2 ± 0.2	Houghton et al. 2000
	Forest Fire (El Niño year – 1998)	0.2 ± 0.2	Mendonça et al., 2004
	Forest Fire (Non El Niño year -1995)	0.02 ± 0.02	Mendonça et al., 2004
Indonesia	Fossil Fuel (year: 2002)	0.08	**
	Deforestation	0.2 ± 0.2	Siegert et al., 2001; Holmes 2000; Pinard and Cropper 2000
	Forest Fire (El Niño year – 1997/8)	0.4 ± 0.5	Page et al., 2002
	Peat Fire (El Niño year – 1997/8)	0.2 ± 0.2	Houghton et al., 2001
Global	Fossil Fuel	6.3 ± 0.4	Prentice et al., 2001; Marland, et al., 2003
Tropical	Land Use Change	(0.8 ± 0.2) to (2.2 ± 0.8)	Houghton, 2003; Clini et al., 2003; Achard et al. 2002
Global	Fire (El Niño year – 1997/8)	2.1 ± 0.8	van der Werf et al., 2004
Kyoto Target		0.5	***

* Reproduced from Santilli et al. 2005.
*** Energy Information Administration, EIA; (http://www.eia.doe.gov/pub/international/iealf/tableh1.xls).*
**** Carbon emissions forecast for 2010 for industrialized, Eastern European and Former Soviet Union countries (4.610 billion tons) (http://www.eia.doe.gov/oiaf/ieo/tbl_a10.html) minus the total annual reduction target established by the Kyoto Protocol for the same year (3737 billion tons) (Energy Information Administration-EIA, DOE/EIA-0573/99, DOE/EIA 0219/99).*

1960s with the building of roads connecting the Central and Southern parts of the country with the North. Over the following two decades, deforestation was a reflection of the model of development and integration of countries. In Brazil, this integration was characterized by the deployment of large-scale colonization and mining projects (Northwest Complex, Carajás and the construction of hydro power plants and

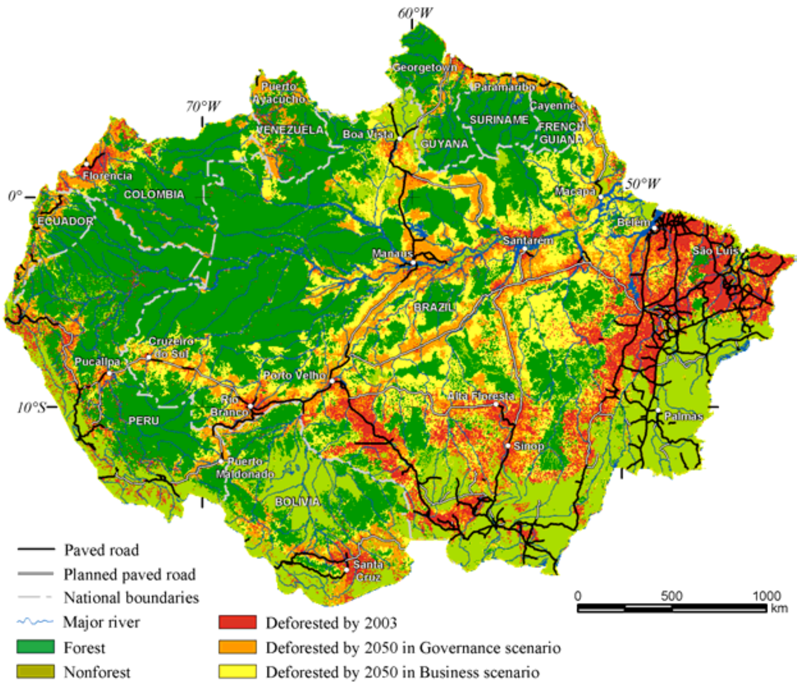

Figure 1. Estimated area deforested in Brazilian Amazonia by 2050 under two scenarios: governance and business-as-usual (Soares Filho et al. 2006). Under a business-as-usual scenario, 45% of current Amazon forest cover will be deforested by 2050. Additional information: www.csr.ufmg.br/simamazonia.

highways). Tax incentives for large-scale agriculture/ranching projects also played an important role, making feasible the conversion of large forested areas into extensive pasturelands (Mahar 1989, Becker 1989, Sampaio 1997, Nepstad et al. 2000, 2001, Carvalho et al. 2001, 2002). Currently the Amazon is undergoing a second phase of colonization, where tax incentives play less of a role and the profitability of extractive activities (logging) and agriculture/cattle-raising are driving expansion and transformation of the frontier (Mattos and Uhl 1994, Margulis 2003, Alencar et al. 2004b). This process is being reinforced by government and bilateral investment programs in infrastructure works (Carvalho et al. 2001, 2002, Nepstad et al. 2000, 2001). Roads connect the region to the central and southern parts of the country, to the Pacific Ocean, the Caribbean and, through the Amazon River, to the Atlantic Ocean. Perhaps the difference between this new phase and former occupation phases is the existence, for the first time, of economic, demographic and political conditions for definitive occupation of the region within the next few decades.

Deforestation in Brazilian Amazonia may also be seen as a reflection of the national economy and, more recently, the international economy as well. For example, its dependence on investments from outside the region has made the advance of deforestation, over the years, follow the dynamics of the economy of the country as a whole. A good indicator of this fact is the close and positive relationship between deforestation and growth of Brazilian GDP (Alencar et al. 2004b, Fearnside 2003). Therefore, the more capital available in the national economy, the greater the investments made in Amazonia that require deforestation. More recently (2001-2002), the increased deforestation rate is no longer explained solely by increased growth of the GDP. A new economic order in the region, by which deforestation rates are no longer tied solely to the state of the national economy, is underway. In this case, the increased rate may reflect the growth of the international market for "new" Amazonian products such as beef and soy. Moreover, other factors leverage this demand of new lands for agriculture. The development of better grain cultivation and cattle-raising technologies for the tropics and the occurrence of diseases such as mad cow in Europe have provided favorable conditions for beef raised extensively (especially in Amazonia) to gain market share (Nepstad et al. 2005; http://www.ipam.org.br/noticias/Amazonia_no_caminho.pdf). In the case of soy, used to make animal feed to supply the Chinese market (where consumption of pork and poultry is high) adds further pressure for new croplands. This increased demand for soy is also the result of the recent prohibition of the use of cattle cadavers in feed manufacture due to the outbreak of mad cow disease. Complementary to this, the reduction of farm subsidies in the US and Europe intensify the search for new croplands. Lastly, in this context, currency exchange fluctuations play an important role in generating deforestation. Deforestation increases with the devaluation of the Brazilian 'real', as has occurred over the last four years. With a stronger currency or with international soy and beef prices lower, deforestation should retract, as it did in 2005. On the margins of this process are the small farmers that depend on their own labor and produce to satisfy their basic needs and therefore contribute to the base deforestation rate to a much lesser degree.

Increasing value of the forest, avoiding deforestation: the role of the carbon market

Global economic dynamics related to agro-industry and even to small-scale farming indicate that forest will only remain standing when felling costs (maintaining the forest standing, from this standpoint, is expensive) become greater than the potential gain from converting it to some other use. Unless this relation is changed, conserving large areas of tropical forests will be very difficult. Although the federal government has had some recent success in combating factors that cause deforestation, command and control efforts are insufficient to control deforestation throughout the basin. Therefore, preservation of large areas of forest will only be possible if there is a mechanism capable of attributing monetary value to a standing forest besides those conferred on it from its forest and non-forest resources. This is the greatest challenge to establishing a sustainable and environmentally sound economy in Amazonia and in other tropical regions. The most powerful economic mechanism to finance policies that seek to conserve large expanses of tropical forests is perhaps based on non-visible yet real commodities, such as the environmental services provided by a standing forest. Along these lines, the current carbon market created by the Kyoto Protocol is perhaps the most promising mechanism for valuing tropical forests, such that maintaining them becomes economically advantageous to tropical countries and forest peoples. Means such as those suggested by Compensated Deforestation Reduction may bring relatively significant economic benefits that, if invested in policies to increase the value of forest resources, could result in significant reductions in deforestation rates and associated GHG emissions. Certainly conditions for reducing deforestation exist in several countries, but only the adoption of mechanisms to enhance the value of standing forests will result in paradigm shifts regarding the development to be chosen for tropical regions.

IS IT POSSIBLE TO CONTROL DEFORESTATION?

One of the main points often raised by those contrary to the inclusion of measures to control tropical deforestation as a valid mitigating action on global climate change is the "complete lack of capacity of countries in controlling the felling of the forest". Tropical deforestation, although with its peaks and low points, has continued its trend of continuous growth, as the driving factors of deforestation (see previous section on causes of deforestation) were not duly considered and enforcement power of governments is weak and often hindered by lack of adequate environmental legislation. Moreover, the total lack of a monetary value attributed to standing forest (that is, outside those obtained from timber and non-timber products) compared to other land uses (pasture, grain farming – Americas – and palms for oil production – Asia) is perhaps the main problem to obtain consistent reductions in tropical deforestation rates (see previous section). From all indications being worthless, the forest will continue to lose ground in favor of other land uses. Current lack of lands for expansion of agro-industry in countries in the Northern Hemisphere, for example, is increasing pressure on abundant lands in the South and, obviously those with tropical forests.

Tropical deforestation may be, however, gradually reduced if there are necessary resources and proper investments in support of sustainable development. Taking Brazilian Amazonia as an example, several attempts to contain the advance of deforestation over the last two decades have failed. Although some may feel that current Brazilian legislation represents a straight-jacket that strangles and hinders even legitimate economic activities, the major problem for controlling deforestation has been the weak performance of the government in its enforcement (Alencar et al. 2005) and the lack of monetary incentive to maintain the forest standing. There are, however, a number of potentially effective mechanisms to control deforestation. The deforestation monitoring system (PROARCO) in Amazonia is one of the best in the world and may serve as a model for other tropical countries. Brazilian monitoring capacity is being further enhanced by deployment of the SIVAM project (Amazonian Surveillance System), with the release of deforestation data in digital format initiated by the current government and through new methods able to monitor logging activities (Asner et al., 2006).

The major problem has continued to be enforcement capacity "on the ground", that is, where deforestation, fires and logging take place. Budget cutting policies of the federal government over the last decade progressively reduced funds for agencies responsible for surveillance and control of deforestation, reducing their capacity to maintain inspectors effectively present in the field and in major urban centers. Currently, lack of qualified personnel, basic equipment and funds for field activities has limited the capacity of these institutions to perform their activities in a minimally adequate fashion. Nevertheless, the fundamental elements necessary to control deforestation are available. These are:

- regional development plans (avoid creation of new economic corridors – roads – before a regional plan has been established and agreed upon by local society);
- mapping of critical areas where emergency intervention is possible (for example, frontiers in an explosive growth phase);
- application of different types of intervention (moratorium on deforestation, implementation of a regional development plan, enforcement of environmental legislation and other instruments to control land tenure and use;
- involvement of society in regional planning (fundamental to integrate interests of different social and political groups in defining the future of any region).

Implementation of a governance process in deforestation frontiers could result in significant reductions in deforestation. A recent study simulating the effects on the pace of deforestation in Brazilian Amazonia demonstrate that implementing a number of governance activities in the region would reduce deforestation by 40% (Soares-Filho et al. 2006). The difference between one governance scenario (increased network of protected areas and improved law enforcement) and the norm represents, if converted to carbon, avoided emissions of 16 billion tons of carbon by 2050 (16 PgC, Figure 2).

A recent attempt by the federal government to control deforestation was conducted with the launch of "Deforestation Control and Prevention Action Plan for Legal Amazonia", launched in March 2004[5]. In an unprecedented manner, the plan involved 13 ministries and, different from previous initiatives, was coordinated solely by the Ministry of the Environment.

Actions in the plan focused on four fundamental activities: Land and Land Tenure Organization (Instruments for organizing confused property rights focusing on land tenure, conservation units and local sustainable development strategies), Monitoring and Control (Instruments for monitoring, licensing and deforestation, burning and logging surveillance), Support for Sustainable Productive Activities (Rural Credit and Tax Incentives; Technical Assistance and Rural Extension services; Scientific and Technological Research), Infrastructure (Infrastructure policies, focusing on transportation and energy sectors). Execution of the plan was, for the most part, deficient, due to lack of funding or disbursements of funding so that the goals could be achieved. Among the actions most compromised by lack of funding were those for land regulation and registration. Furthermore, involvement of some ministries (Ministry of Agriculture, for example) was practically non-existent. On the other hand, some actions apparently exerted significant influence on the advance of deforestation.

Monitoring activities were among these, with the creation of DETER (real time deforestation detection in Amazonia, updated every 15 days), providing greater agility in identifying and preventing deforestation. More intense actions, albeit of an emergency nature, were also conducted and involved the Federal Police and Army working in an unprecedented relationship. The government also created over 7 million ha in new protected areas between 2004 and 2005 in active frontiers, in an attempt to establish barriers to the advance of the deforestation and, at, in the case of extractive reserves (~2 million ha) also address local social demands. The government plans to create a further 15 million hectares of conservation units.

The cost of maintaining and protecting these units and the incentives to provide support to extractivist reserves for their sustainable development is still an obstacle that needs to be overcome. Also along the lines of organization and public policies, the government made progress in increasing the area under certified forest management from 300,000 to 1.4 million hectares and the Congress recently approved the legislation creating a system of forestry concessions, or Management of Public Forests. Increased rigor in legal requirements to obtain documentation to legalize rural properties was established with the publication of Ordinance no. 10 of the Ministry of Agrarian Development/INCRA, which was also an important step.

[5] (https://www.presidencia.gov.br/casacivil/desmat.pdf, in Portuguese).

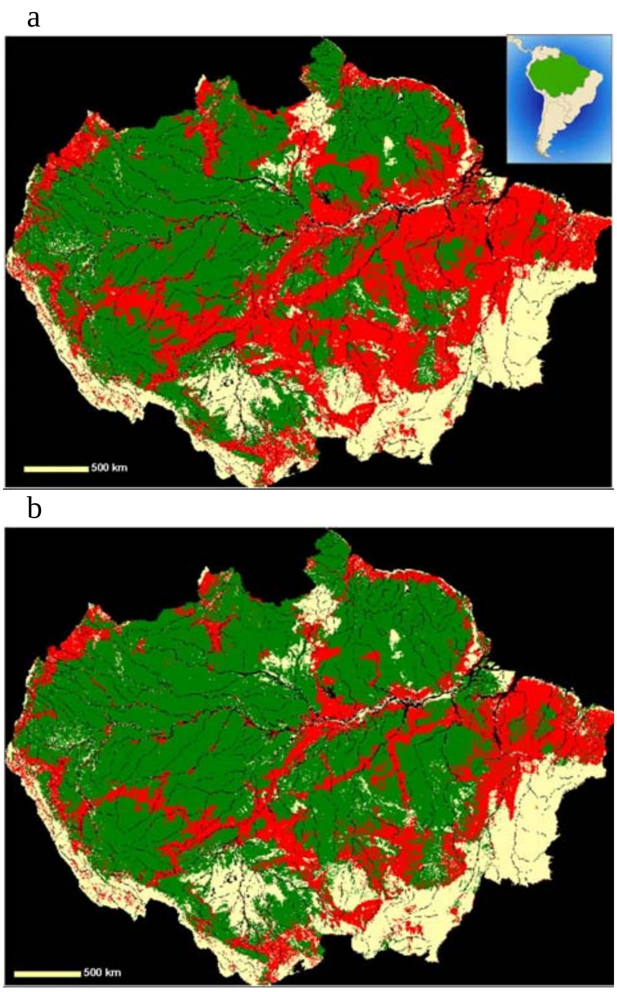

Figure 2. Two deforestation Scenarios for Amazonia (Soares et al. 2006) by 2050. Under a business-as-usual scenario (a) historical trends of deforestation are reproduced in the future, producing emissions of 32 PgC by 2050. Under a governance scenario (b) environmental legislation is fully implemented, and protected areas are 100% protected through strict law enforcement. Emissions of 16PgC would be avoided under governance scenario.

As a consequence, the Brazilian government has credited the plan for the recent reductions in the deforestation rates in Amazonia. The rate in 2004 (2.72 million hectares) fell in 2005 (1.89 million ha): a 30% reduction. Of course, a good part of this drop may be conditioned by factors outside the plan, especially those linked to the international beef and soy markets. Prices of these commodities dropped during this period, reducing demand for new forest areas to be converted into plantations and pastures. In any case, one cannot deny that in some areas the decrease in deforestation was on the order of 90%, a reduction difficult to explain solely by variations in soy and beef prices. This argument is reinforced by reductions observed in illegal deforestation rates inside conservation units. Long-term sustainability, however, of these reductions will only be ensured if there are financial mechanisms that attribute value to the forest and its role as a carbon reservoir, since only then forested areas can become as economically attractive as other land uses.

IS IT POSSIBLE TO MONITOR DEFORESTATION ON A GLOBAL LEVEL?

Despite routine monitoring through satellite data analysis (Defries et al. 2005; INPE 2005), doubts have been raised about the practicality, reliability and even the existence of a monitoring system broad enough to assess the advance of deforestation in all tropical regions on the planet. Uncertainties regarding the deforested area lead are proportionally compounded by uncertainties regarding the corresponding volume of carbon emitted into the atmosphere. Advances in the field of remote sensing and technological transfer agreements among countries, however, can address the numerous barriers to more precise measurement of tropical deforestation (Defries et al. 2005) for the purposes of agreements such as the Convention on Climate Change and its Protocol.

Difficulties such as the high cost of and failure to obtain regular images from high resolution sensors due to frequent cloudiness that occurs in the tropics (Asner, 2001) can now be overcome. For example, the creation of the Long-Term Acquisition Plan (LTAP) to collect data from Landsat 7 greatly increased cloud-free data acquisition in tropical areas and several research groups have conducted analyses of national data through systems such as Landsat Multispectral Scanner (MSS) and Thematic Mapper TM from the 1970s and 80s (Defries et al. 2005). Currently, the Geocover Landsat database is made available by NASA, providing national analyses during the 1990s (Defries et al. 2005). Moreover, a growing number of satellites with high spatial resolution are providing routine access to coverage of limited regional areas (< 40,000 km2) per image. Satellite sensors, such as of Landsat TM and ETM+ (US), Land ASTER (US-Japan), CBERS-2 (China-Brazil), SPOT MSS (France) and IRS-2 (India) for example, provide data required for high resolution mapping of deforestation, logging and other forest disturbances (Table 4). New processing techniques are now also enabling the mapping of forest disturbances on a scale of 2-5 million square kilometers per year (INPE, 2000; Asner et al., 2005).

Tropical countries with capacity to adequately monitor deforestation have overcome these difficulties by acquiring and processing data directly at the reception station (for example, Brazil) and launching national satellites (for example, CBERS, IRS). With the launch of the NOAA AVHRR, CNES SPOT, NASA Land, Water and ESA ENVISAT satellites and the freely available data from sensors aboard these rough resolution platforms (from 250 km to 1 km), one can now monitor large deforestation events on a routine basis. In particular, the Moderate Resolution Imaging Spectroradiometer (MODIS) on board Land and Water satellites enable precise identification of deforestation events larger than roughly 10 hectares (Anderson et al., 2005; Morton et al., 2005).

Among the most successful monitoring methods in the world are those of PRODES established by the Brazilian Space Research Institute (INPE). PRODES annually produces estimates of yearly deforestation for the entire Brazilian Amazon. More recently, INPE established DETER[6] that identifies deforestations larger than 25 hectares each two weeks.

Access to large volumes of data have recently improved through NASA and the capacity of associated data distribution made available through the Global Land Cover Facility (GLCF) and by the Tropical Rainforest Information Center (TRFIC) - respectively, (http://glcf.umiacs.umd.edu/index.shtml e http://bsrsi.msu.edu/trfic/data_portal.html) (DeFries et al. 2005). Methods for analyzing large volumes of data have also become more achievable due to information technology advances. A variety of automated approaches have been developed that greatly reduce processing time and increase accuracy (Asner et al., 2005; Shimabukuro et al., 2005).

For a monitoring system in developing countries to have potential for future use in remuneration of countries for reducing their deforestation rates, certain fundamental principles must be observed:

What is deforestation? The report by the Intergovernmental Panel on Climate Change, Land Use, Land Use Change and Silviculture includes several definitions (Watson et al., 2000). The definition to be adopted should be the most direct - "permanent removal of forest cover".

[6] http://www.obt.inpe.br/deter/

*TABLE 4. High and moderate resolution satellite data for pan-tropical deforestation monitoring**

Spatial	Temporal	Overall Status Resolution (ground sample distance)	Resolution (days)	Status
High Resolution (< 50 m)				
Landsat 5	TM	30 m	16	Aging
Landsat 7	ETM+	30 m	16	Crippled by sensor component failure
IRS-2	Resource SAT	6-56 m	5-24	Unknown availability
CBERS-2				Unknown availability
Terra	ASTER	20 m	26	Acquired on a task by task basis
SPOT	MSS	20 m	26	Acquired on a task by task basis
ERS	Synthetic Aperture Radar	30 m	35	Acquired on a task by task basis
Radar SAT	Synthetic Aperture Radar	8-100 m	24	Acquired on a task by task basis
Moderate Resolution (> 50 m)				
Terra/Aqua	MODIS	250 m 500 m 1000 m	Up to daily	Highly available
TIROS	AVHRR	> 1100 m	Up to daily	Highly available
SPOT	VGT	1000 m	Up to daily	Highly available
IRS	AWiFS	60 m	5	Available
EnviSAT	MERIS	300 m	3	

Reproduced from Defries et al. 2005.

What is forest? Within the framework of the Kyoto Protocol, forests are defined by the host country within variations of "an area of at least 0.05 to 1 hectare of trees, with a crown cover of at least 10 to 30% and with trees capable of reaching 2 to 5 m". For a monitoring system and possible quantification (for credit purposes) of GHG emission reductions, the definition of what is to be considered as a forest is fundamental. Without this it will be difficult to assess the proper dimensions of areas covered with tropical forest (and with different types) to be included in a monitoring system to calculate emissions and especially to attribute credit for reductions achieved

(Defries et al. 2005). For example, should a monitoring system be only for tropical rainforests or should it include dry tropical forests? Data sources to determine the initial extent of the forest to be analyzed can generally be identified by maps, global remote sensing products or even national analyses to determine deforestation rates in previous decades (Hansen et al., 2003). Moreover, the use of a reduced (< 10%) threshold of tree cover (Hansen et al. 2004) from plant cover density of forests around the world can individually identify forests that are typically tropical and therefore eligible to be included in an emissions assessment and compensation mechanism with carbon credits.

For existing monitoring methods to be useful in negotiations within the scope of the UNFCCC and for possible quantification of carbon emissions, it is necessary that:

- the methods be appropriate to the type of forest, deforestation process, clearings size and sensor used in the monitoring;
- the area to be monitored is delimited, using a previously established forest expanse baseline;
- verification be conducted of a representative sample of sites with onsite data or high resolution images;
- base periods be established for forest expanse and area deforested in previous decades. This will require the combining and harmonizing of previous results and additional analysis to develop baselines where they do not currently exist;
- a monitoring strategy be set up that combines approaches to identify deforestation hotspots and high resolution coverage within hotspots, where computation, data storage and data availability limit complete coverage analysis (Defries et al. 2005);
- countries where monitoring systems do not exist must receive support to establish their own specific programs of international assistance.

Briefly stated, the technological advances achieved over the last few years are perfectly capable of providing the basis for the establishment of a global tropical deforestation monitoring system and for the use of standardized calculation methods and procedures, thus avoiding variations and uncertainties heretofore attributed to said systems. This was the main conclusion of several remote sensing and forestry experts gathered recently in a workshop held in March 2006 in Germany with support from the "Global Terrestrial Observing System's Global Observations of Forest Land Cover Dynamics" (GOFC/GOLD). These experts are ready to provide guidelines and protocols to monitor deforestation in developing countries and should release a technical report on the topic soon.

HOW CAN CARBON EMISSIONS ORIGINATING FROM DEFORESTATION BE MEASURED?

Simply put, C emissions originating from tropical deforestation can be calculated by multiplying the area deforested (estimates from satellite images) by forest biomass. For calculations of net emissions, deduct from the previous calculation the quantity of C sequestered by vegetation growth (Houghton 2005). Many forest inventories and remote sensing techniques provide estimates on forest biomass in the tropics, which vary as a function of the type of land use (pasture or agriculture) and forest (humid, dry or transition) and geographic region (Asia, America or Africa). Changes in different reservoirs (live vegetation, soils, remains, woody vegetation and timber products) determine the net carbon flow between the earth and atmosphere

(Houghton et al., 1983; Houghton et al. 2001; Defries et al. 2002; Houghton, 2003, 2005a, 2005b). These variations in the quantity of tropical forest biomass, as well as variations among calculations of areas deforested in the tropics, have been the source of uncertainties regarding carbon flow to the atmosphere resulting from deforestation. To a large extent, these uncertainties result from the use of forest inventories, which are few in number or at times inexistent, depending on the region or country (Houghton 2005). The results are variations in estimates of carbon flows into the atmosphere.

Such uncertainties have often been used as an argument against including deforestation reduction as a valid means to control climate change. Without good estimates, it is impossible to accurately account for possible emission reductions and therefore these reductions become useless for mechanisms such as those provided for by UNFCCC and the KP. These uncertainties exist. Nevertheless, despite these, it is undeniable that carbon emissions resulting from tropical deforestation are significant in terms of volume. There is, therefore, no justification, due to methodological calculation uncertainties, for concrete actions against tropical deforestation not to be considered by international climate agreements. A step forward along these lines would be the following:

- agreements, backed by the IPCC, on the value of plant biomass per hectare to be assumed for a determined macro-region;
- if this value is lower than existing estimates for that macro-region, then there will be clear benefits to the atmosphere.

Furthermore…

- standardization in methods for estimating deforestation, as mentioned in the previous section, could be adopted to reduce variations in flow estimates;
- agreements to this end could be scientifically informed by the IPCC and vetted by SBSTA;
- efforts to obtain forest carbon stock estimates or deforestation rates in countries where these are unavailable, using, for example, rapid estimate technologies, such as those based on remote sensing, should be encouraged (Houghton 2005; see also considerations in previous section and in Defries et al. 2002 and Houghton 2006).

COMPENSATED REDUCTION: MAKING GHG EMISSION REDUCTION FEASIBLE THROUGH A DECREASE IN DEFORESTATION

During COP-9 in Milan a group of scientists from various institutions (Amazon Institute for Environmental Research-IPAM, Instituto Socioambiental-ISA Environmental Defense, CPTEC/INPE and Woods Hole Research Center) proposed a new mechanism for addressing emissions from tropical deforestation: Compensated Reduction of Deforestation (Santilli et al. 2005). Through this mechanism, developing countries, the main repositories of tropical forest stocks, would receive international financial compensation for emissions avoided from deforestation. They would therefore be able to promote said reductions (using agreed historical rates, e.g the annual average of 1980s as base periods) from their deforestation-related national emissions. This compensation would be pursuant to the average value of carbon on the market during the year 2012 (certificates, similar to Certified Emission Reductions – CERs –

could be issued and sold to governments or private investors) (Santilli et al. 2005, Moutinho & Schwartzman 2005, Figure 3).

Once compensation had been received, the countries would agree to not increase, or to further reduce deforestation in future commitment periods (under the condition that Annex I countries fulfill their obligations). On the other hand, if these countries were to increase their deforestation rates during the first commitment period, this additional amount would become an obligatory reduction goal for the second period, without right to compensation. After the goal is achieved, they would again be eligible for financial compensation for additional reductions. If they continued increasing deforestation, these countries would become subject to the same sanctions that developed countries would be subject to for failing to fulfill their emission reduction goals. To ensure proper control, the IPCC could establish common criteria for establishing base periods in interested countries and set calculation parameters for carbon stocks in tropical forests. This proposal would thus incorporate developing countries into the international process to reduce GHG emissions. National deforestation rates, calculated using common and robust technical criteria (see previous sections) would establish compensation parameters. This would not be a mechanism, like the CDM, linked to the execution of specific projects, but rather a commitment between countries. Compensation would come a posteriori, with technical verification of effective emissions reductions, regardless of where the reduction had come from.

A mechanism such as CR could not only provide means for developing countries to take action to mitigate climate change, it would also encourage developed countries to raise their goals. For example, if a group of tropical nations offered Annex I countries a given amount of emission offsets for the second commitment period, a proportional or even greater increase in the goals of these countries could be required.

Reductions in tropical deforestation: higher goals for developed countries and greater benefits for the atmosphere

As stated previously, effective and voluntary emissions reductions through tropical deforestation can and should provide substantial increases in obligatory goals for developed countries while simultaneously providing greater benefits to the atmosphere. This argument can be demonstrated in a simple manner using two scenarios:

- scenario A – Annex I countries decide to simply stabilize emissions at the first commitment period levels (repetition of Kyoto goals). No compensation for deforestation would be viable in such a case.

- scenario – B – Annex I countries agree, for example, to triple their reduction goals for the second commitment period (15% below 1990). Under this scenario, parties might authorize a negotiated amount of deforestation offsets for Annex I countries. As long as Annex 1 countries make deeper cuts than would otherwise have been the case, deforestation offsets do not compromise global emission reduction efforts.

Under scenario B, tropical nations would obtain significant rewards and developed countries would be stimulated to establish higher goals than contemplated before, maintaining the current Kyoto model for the second commitment period. This scenario, in principle, could raise fears over the risk of 'flooding' the current market with cheap carbon. Obviously the limit for compensations authorized to industrialized

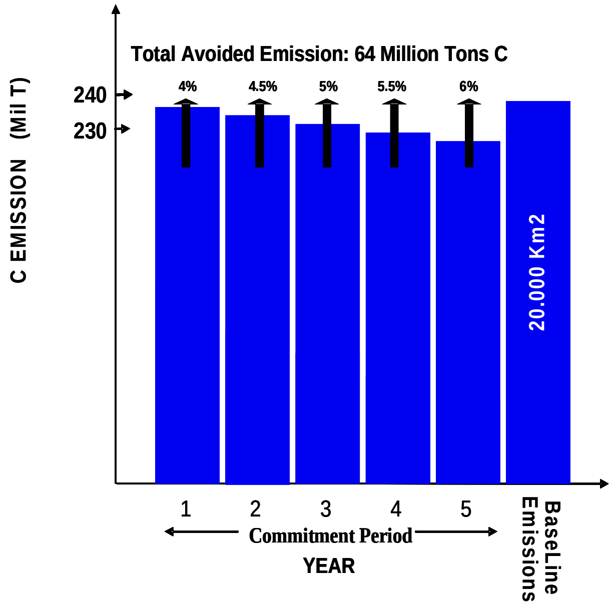

Figure 3. Compensated Reduction Concept. Carbon emission reduction over a commitment period (1-5), assuming a progressive reduction of deforestation rate (4%-6%) relative to base period deforestation. The base period would be the average of annual deforestation in the 1980s (20.000 km^2). The emissions from deforestation were calculated as follows: annual rate (km^2) X 12000 T of C/km^2 (120 T/ha). The annual mean of avoided emission per year is 12.000 (± 2) Million T of C.

countries could be negotiated, but even in the absence of such a limit, it is likely that this 'flood' will not occur. An effective compensated reduction program must necessarily be a national program. Allowing companies and individuals with high historical deforestation to directly enter the market could create a perverse mechanism of compensation to those who deforested in the past (instead of those promoting conservation). Moreover, in all large remaining or future tropical forest frontiers, governments must make substantial and long-term investments in governance frameworks (monitoring and enforcement capability, organization of land tenure, allocation of property rights) before carbon compensation can become an economic alternative for individuals and companies.

A mechanism such as CR agreed upon within the scope of the COP would establish more propitious conditions for continuity of international climate negotiations. Currently, the major obstacle to these negotiations has been the refusal of the current US administration to participate in agreements. The current US administration argues that the KP has no activities that seek to reduce emissions in developing countries. The CR for deforestation would at least eliminate such an argument.

Funds obtained from compensation for deforestation reduction would be invested in public programs and policies aimed at enforcing environmental legislation, providing support to economic alternatives to extensive felling of the forest (including carbon credit). This would promote strengthening of institutional capacity in remote forest regions as recently demonstrated in parts of Brazilian Amazonia (FEMA, 2001; Nepstad *et al*., 2002; Fearnside, 2003), through environmental licensing in the states of Amazonia and also the Deforestation Control Program. Furthermore, a substantial portion of the forest can be protected through conservation units if adequate funding is available (Bruner *et al*., 2001; Pimm *et al*., 2001; Nepstad *et al*., 2006). As a means of addressing the issue to initial lack of funds for reducing deforestation, since remuneration for reduction follows verification, countries that desire advance financing for deforestation reduction could execute agreements with bilateral or multilateral financial institutions or attract investments from the private sector for this purpose. Public financing, however, should not be diverted from existing development assistance, as agreed upon in the Marrakesh Accords. Countries could also issue carbon bonds convertible in subsequent commitment periods, conditioned on verification and certification of reductions.

The issues additionality, base period, leakage and non-permanence pursuant to the concept of Compensated Reduction of Deforestation are addressed below.

Additionality and base periods. Base periods[7] are established according to historical deforestation rates (average rate for the 1980s, Santilli et al. 2005). Since there is no evidence that tropical deforestation will significantly decrease in the short term (decades), "additionality" is not an issue. It is important to consider that, in all regions of remaining extensive tropical forests, the trend is towards maintaining or increasing deforestation, until the forests are exhausted. Therefore, any reduction in relation to recent rates will be a gain to the atmosphere. The procedure for selecting historical base periods (or reduction goals) must take into account the different regional dynamics of deforestation in the tropics. In Amazonia, for example, with ~80% of the original forest cover and high current deforestation rates, the base period of average annual deforestation rates in the 1980s (since 1990 is the reference year for the Kyoto goals) would be adequate. Countries with substantial tropical forests, but with relatively low deforestation to date (for example Peru and Bolivia) should be allowed higher baselines than their recent deforestation rates (on the "growth limit" model of Australia) as an incentive to participate and to avoid future increases. Regions that have been heavily degraded, such as Kalimantan, Sumatra and Sulawesi, for example, where 70-80% of the lowland *Dipterocarpaceae* forest cover has been removed in areas deforested and conversion into oil-producing palm species is underway, a baseline could be expressed in terms of the existence of carbon stocks at some point in time in the past, with credit for any increase over it between 2008-2012, making reforestation or regeneration an alternative to palm plantations. A historical baseline could be revised down in 20 years as an incentive for countries to continue reducing deforestation rates. This is a plausible amount of time for a nation such as Brazil and others to transform their land use practices.

Leakage. In contrast to CDM projects, deforestation does not "leak" to energy or transportation sectors (Santilli et al. 2005, Moutinho & Schwartzman 2005, Schlamadinger et al. 2005). Possible leakages (indirect effects of emission mitigation projects outside the project itself or even beyond national borders) to other countries will become apparent when comparing national rates over time. Deforestation can be measured from beginning to end of the commitment period precisely as is done in the case of national emissions from Annex I countries. The so-called international "market leakage" for export timber products, where one participating country stops exporting timber to obtain carbon investments, and another non-participating country correspondingly increases exports, is an issue requires further analysis. This type of leakage, however, can occur under Kyoto rules (sinks and activities that increase carbon stocks in Annex I countries are credited, but forest destruction in developing countries is not debited, Niesten *et al*. 2002). Leakage from deforestation from one country to another (for example, Brazilians who stop deforesting and move to Bolivia) can occur, although participation of several countries in a geographical region (Amazonian countries for example) in a compensated reduction mechanism will

[7] This is therefore different from the concept of baseline, which is defined as a basis for extrapolations in the future for emissions reductions that occur in function of a change in human activity.

decrease this likelihood. Economic modeling of international timber trade may be able to identify international leakage.

Non-Permanence. Considering that the additional from forests maintained standing by reduced deforestation rates (i.e. protected carbon stock) can be felled in the future due to a natural disturbance or through direct human action, proposals such as compensated deforestation reduction must address what has been termed as "non-permanence". Permanence can be ensured in a compensated reduction mechanism through a provision by which participating countries that increase deforestation (emissions) above their base periods will have to assume the surplus emitted as an obligatory reduction goal for the following commitment period. Security of emissions offsets may be enhanced by an insurance system where a portion of the credits from reductions achieved in the first five-year commitment period can be available for emission offsets in the following period. Another part could be negotiated for use in future commitment periods (in contrast to CERs, which are only valid for the first commitment period under the Marrakesh Accords). It is noteworthy that permanence of reductions is also an issue for all sectors – a country that fulfills its commitments in the first period may decide not to participate in the second and increase its emissions. Carbon insurance mechanisms for all emissions compensations should be developed and their costs incorporated in carbon markets.

OTHER CONSIDERATIONS AND CONCLUSION

As we have seen, emissions from tropical deforestation, while not as important as those resulting from the burning of fossil fuels as a cause of greenhouse effect, are of sufficient scale to aggravate it and may compromise a good part of the international efforts to reduce emissions during the first and subsequent Kyoto commitment periods. Moreover, if the Earth's temperature increase provokes drastic reductions in tropical forest stocks, a large additional quantity of greenhouse gases will further compromise the worldwide climate situation. It will therefore not be possible to establish minimum control parameters on global warming without implementing some effective mechanism to reduce deforestation.

Deforestation occurs in developing countries that still possess significant forest stocks and result from several causes. If on the one hand agricultural and forest production has been important to the balance of payments of developing countries, also responding to demand by developed countries for these products, on the other hand it has generated deforestation and large-scale carbon emissions. One cannot therefore attribute responsibility for deforestation solely to the developed countries. Its reduction will provide benefits for global climate and for mankind as a whole. Based on these and other considerations described in different parts of this document, a mechanism such as compensated deforestation reduction (Santilli et al. 2005) is justified.

Positive incentives and Grants for deforestation reduction A consensus that developed countries should provide financial support to efforts to reduce deforestation has been building as a starting point for the discussion on this issue during COP11. Suggestions on the means to render this feasible are many and include compensation through carbon credits issued after proven reduction of emissions from deforestation. Among those using carbon credits is the "Compensated reduction of Deforestation" explained above as well as the proposal presented by Papua New Guinea and Costa Rica.

Other proposals not based on the carbon market. have also been suggested, however. The main one is based on "positive incentive funds" announced by the Ministry of Foreign Affairs of the government of Brazil during COP11. This proposal argues that efforts to reduce emissions must not discriminate against those that do not have forests, that is, those countries whose emissions are from the burning of fossil fuels, such as China and India. Brazil also suggested during COP11 that support to developing countries be provided through grant funds for government projects that seek to reduce emissions, and argued that in this way additionality for the climate would be even greater.

It is evident that any reduction of emissions not linked to offsets (as is compensated deforestation reduction) represents a greater additionality in relation to the climate. Nevertheless, the position of the Ministry of Foreign Affairs did not suggest a secure source of funding for these reduction efforts. It consequently assumes that Annex I countries would provide financial resources for this fund in addition to those already provided through GEF or international cooperation programs. These funds would also be in addition to the cost of efforts they must put forth to reduce their own emissions. Already existing funds, however, targeting the financing of specific programs, have shown themselves to be ineffective in relation to their announced objectives, and the amounts involved are incomparably less than those that could come from a compensation mechanism within the scope of the Kyoto Protocol, if developing countries manage to promote significant reductions in their emissions.

Moreover, there is an Adaptation Fund proposed within the scope of the Protocol, which will receive probably limited funds, from fees charged to CDM projects, and that is unlikely to achieve effective results. It can also be reasonably assumed that, if grant funds from developed countries are available, their priority should be to invest in projects from countries poorer than China, India or Brazil. It is not morally defensible to finance the developing countries that least depends on international cooperation, even though they are among the greatest current emitters of greenhouse gases. Therefore, proposals for international funds for deforestation reduction do not appear sufficiently solid to achieve significant results from the standpoint of supporting tropical deforestation reduction and its corresponding emissions, even though, in thesis, this would represent greater additionality in relation to the climate. On the other hand, a market mechanism such as the "compensated reduction" proposal has the advantage of linking funds to results and favoring the adoption of significantly higher emission reduction goals by developed countries for the next commitment period.

The strategy of providing economic incentives for reducing deforestation, compensating rural landowners that are willing to maintain their forests standing, as implemented in Costa Rica bears mention. In this case, compensation is provided up front, through internal policies that can be adopted by developing countries with tropical forests. Although this proposal is not comparable to the preceding ones, it is an important and complementary element to the idea of "compensated reduction". Clearly, for a developing country to achieve effective reductions in its deforestation rates, making it eligible for compensation, it will have to make investments beforehand, to develop deforestation monitoring systems among others. Using economic and tax-based mechanisms to compensate landowners for ecosystem services as in the Costa Rica case may be one means of addressing this.

Developing countries that require external funding to make these investments to reduce their deforestation rates must have access to concessional funds through the

World Bank or bilateral cooperation. Depending on the situation in each country, these pre-investment funds could be negotiated in the form of subsidized loans or grants linked to their accreditation to participate in a mechanism such as "compensated reduction". The proposal to have funds for incentives with grant resources to government programs will make much more sense if used to make these pre-investments feasible, and not as an exclusive (and dubious) alternative to the market mechanism within the Kyoto Protocol or Convention on Climate Change.

Halting or decreasing deforestation can contribute towards continuity and strengthening of a solid and broad international regime of emissions reductions after 2012 and vice-versa. Furthermore, nothing could be more useful to the preservation of biological diversity on the planet. More hazardous to the global climate system than any issues of leakage or permanence in offsets for reduced deforestation is the prospect of failing to sustain a mandatory international emissions reductions system and robust market for ecosystem services and failing to enlist a growing number of nations in them. As a voluntary mechanism that offers substantial incentives for larger developing countries to reduce emissions through means of their own choice, mechanisms such as compensated deforestation reduction suggested in this document, will be necessary to aid in reverting the global climate crisis while there is still time.

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