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REDUCING GREENHOUSE GAS EMISSIONS FROM DEFORESTATION IN DEVELOPING COUNTRIES: REVISITING THE ASSUMPTIONS

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[1] Any views or opinions presented here are solely those of the author and do not necessarily represent those of the National Institute of Ecology, the Ministry of Environment of Mexico or the Mexican Government.

ABSTRACT

This paper provides a critical perspective to the debate on Reducing Emissions from Deforestation and Degradation (REDD) under the United Nations Framework Convention on Climate Change (UNFCCC). We do this by reviewing a) the science which proves that land-use change is a key contributor of greenhouse emissions globally, particularly in developing countries; b) the assumptions that halting deforestation may be competitive in terms of costs in comparison to other emission reduction options; c) the studies analyzing the complex drivers of deforestation d) the measures that developing countries have undertaken so far to address deforestation and e) the nature of the current policy proposals being discussed. Such review allows us to argue that current REDD policy proposals may become an additional source of funding to build technical and institutional capacities and to provide incentives to reduce emissions from deforestation in some developing countries, but will not be able to solve the deforestation issue at a large scale in the short term. However, ensuring synergies between international processes and sources of funding for development and environment, and promoting tools for the exercise of private authority in global forest governance, may help to speed up this process.

1. INTRODUCTION

Climate change is gaining importance in the environment and development agendas of all countries at all levels. The findings of the Fourth Assessment Report (FAR) of the Intergovernmental Panel on Climate Change (IPCC) underline –as its predecessors– the need for immediate action to reduce the amount of anthropogenic greenhouse gases (GHG) emitted to the atmosphere in order to avoid a dangerous human interference with the climate system. The FAR also recognizes that no single technology or mitigation option has the potential to achieve this goal by itself; instead, a portfolio of alternatives –offering enough flexibility to accommodate different national circumstances and interests– will be required. Moreover, global participation will be paramount to effectively address climate change, which implies creating incentives and designing new avenues for developing countries (and possibly non-Kyoto Parties) to facilitate their participation in the international mitigation effort post-2012.

Reducing GHG emissions from Deforestation and Degradation (REDD)[2] in developing countries through positive incentives under the United Nations Framework Convention on Climate Change (UNFCCC) has been recently considered as an opportunity to deal with many of these concerns. Indeed, deforestation in the tropics generates about a fifth of global GHG emissions (Houghton, 2005). And, since project activities to reduce emissions from deforestation were excluded from the Kyoto Protocol's Clean Development Mechanism (CDM), obtaining support to address this source of emissions has been among the top priorities of developing countries in discussions about the future of the international climate regime. Furthermore, this option is seen as a new door for a "meaningful participation" from these countries -one of the main demands of the United States to consider joining any international treaty imposing binding emissions reduction targets[3]-, thereby providing Annex B countries with a political argument to both urge non-Kyoto Parties to join the international mitigation effort and advocate for deeper national reduction targets in the post-2012 framework.

The Conference of the Parties (COP), at its 11th session, requested the Subsidiary Body for Scientific and Technological Advice (SBSTA), to "consider issues relating to reducing emissions from deforestation in developing countries, focusing on relevant scientific, technical and methodological issues, and the exchange of relevant information and experiences, including policy approaches and positive incentives"[4], thus initiating a two-year process under the Convention aimed at producing a recommendation to the COP at its 13th session (December 2007). As a result of this process, many Parties, Non Governmental Organizations (NGOs) and research institutions, have made specific proposals on approaches to address GHG emissions from deforestation in developing countries. This article provides a brief overview of current and predicted deforestation rates in developing countries, their causes and associated emissions, as well as mitigation potential and costs. Moreover, it reviews the existing proposals under the UNFCCC in order to identify the main scientific, technological, methodological, economic and institutional challenges associated to their implementation, as well as their equity implications, thus providing a preliminary assessment of their feasibility and effectiveness. Finally, a critical analysis of the potential of such proposals to significantly reduce deforestation and contribute to mitigate climate change is provided.

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[2] The acronym REDD has been used in think-tanks and Parties' proposals to the UNFCCC. However, official negotiations have not yet convened on an official acronym, as there is not an agreement on whether forest degradation will be included in a scheme of this kind.

[3] On July 25, 1997, during the negotiations of the Kyoto Protocol, the U.S. Senate unanimously passed by a 95–0 vote the Byrd-Hagel Resolution (S. Res. 98), which stated the sense of the Senate was that the United States should not be a signatory to any protocol that did not include binding targets and timetables for developing as well as industrialized nations or "would result in serious harm to the economy of the United States".

[4] FCCC/CP/2005/L.2, 6 December 2005.

2. GHG EMISSIONS FROM DEFORESTATION IN DEVELOPING COUNTRIES

According to FAO's 2005 Global Forest Resource Assessment, deforestation - mainly conversion of forests to agricultural land - continued at an alarmingly high rate at the global level during the period 1990–2005, about 13 million hectares per year, with few signs of a significant decrease over time. The highest deforestation currently occurs in tropical America (4.5 million hectares per year) and Africa (3.1 million hectares per year), whilst tropical Asia has about 2.9 million ha per year. Nevertheless, rates of deforestation vary greatly from one source of data to another depending on the methods used to estimate them. Rates from inventories and surveys (FAO, 2006) are generally higher than estimates based on remote sensing, although this is not always the case (Table 1). For instance, Hansen and DeFries (2004) used satellite data and reported rates higher than those reported by FAO (2001) in 5 out of 6 countries. These differences are difficult to resolve because the accuracy of ground-based estimates (such as FAO data) is not assessed, and estimates based on remotely sensed data are sensitive to the spatial variability of deforestation - the size of clearings may be too small for a change in tree cover to be recognized in a 30-m resolution Landsat image. Consequently, it will continue to be difficult to accurately determine deforestation rates, at least until standard and validated methodologies exist which can be applied at a range of spatial scales (UNFCCC 2006a).

Table 1. Average annual rates of deforestation (106 ha yr-1) in tropical regions*

	1980s DeFries et al. (2002)	**1990s FAO (2006)**	**1990s DeFries et al. (2002)[1]**	**1990s Achard et al. (2004)[2]**	**2000-2005 FAO (2006)**
Tropical America[3]	4.426	4.165	3.982	4.41	4.482
Tropical Africa[4]	1.508	3.362	1.325	2.35	3.058
Tropical Asia[5]	2.158	2.578	2.742	2.84	2.851
Total	8.092	10.105	8.049	9.60	10.391

* 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.

[1] Rates from DeFries et al. (2002) refer to gross rates of forest loss (not counting gains in forest area).

[2] Rates from Achard et al. (2004) do not include areas of forest increase.

[3] Tropical America refers to South America, Central America and Caribbean subregions in FAO estimates; to Bolivia and 9 states in the Brazilian Amazon in DeFries et al. (2002) and to humid tropical forest biome of Latin America excluding Mexico and the Atlantic forests of Brazil in Achard et al. (2004)

[4] Tropical Africa refers to Eastern and Southern and Southern and Western subregions in FAO estimates, to parts of the Democratic Republic of Congo in DeFries et al. (2002); and to the humid tropical forest biome of Guinea Congolian zone of Africa and Madagascar in Achard et al. (2004).

[5] Tropical Asia refers to south and southeast Asia subregion in FAO estimates; to 4 Indonesian islands in DeFries et al. (2002); and to the humid tropical forest biome of Southeast Asia and India in Achard et al. (2004), including the dry biome of continental Southeast Asia.

Source: UNFCCC (2006)

Forests account for almost half of the global terrestrial carbon pool, and if vegetation is considered alone (excluding soils), they hold about 75% of the living carbon. The total carbon content of forest ecosystems in 2005 was estimated at 638 gigatons (Gt) (FAO 2006). Thus, tropical forests play a particularly important role in the global carbon budget (Melillo *et al*. 1993; Dixon *et al*. 1994; Field *et al*. 1998) because they contain about as much carbon in their vegetation and soils as temperate-zone and boreal forests combined. Per unit area, tropical forests store on average about 50% more carbon than forests outside the tropics. Deforestation is typically associated with large immediate reductions in forest carbon stocks, through land clearing. Forest degradation – a reduction in forest biomass through non-sustainable harvest or land-use practices - can also result in substantial reductions of forest carbon stocks from selective logging, fire and other anthropogenic disturbances, and fuelwood collection (Asner *et al.*, 2005).

Estimates of the magnitude of emissions from deforestation are uncertain due to several reasons such as a lack of resources, lack of standard methods, lack of capacity at national levels, and lack of data (WRI, 2005). The IPCC estimates that, during the 1990s, global land use change and forestry (LUCF) emissions averaged 1.6 gigatons of carbon (GtC) per year ±0.8 GtC. The 1.6 GtC figure amounts to 20 percent of global CO_2 emissions. Taking uncertainties into account, CO_2 from land-use change may be as little as 0.8 GtC (12 percent of world emissions) or as high as 2.4 GtC (28 percent), a difference of a factor of three. Houghton and Hackler (2002) and Houghton (2003) estimated emissions of 2.2 GtC per year (26 percent of CO_2 in the 1990s), which is in the upper range of IPCC figures (WRI, 2005). According to Houghton (2005), considering CH_4 and N_2O and other chemically reactive gases that result from subsequent uses of the land, annual emissions from land-use change during the 1990s accounted for about 20-25% of the total anthropogenic emissions. The FAR points out that global emissions from LULUCF[5] grew 40% between 1970 and 2004, lower than the increase experienced in that period in the energy supply sector (145%), the transport sector (120%), and industry (65%).

For developing countries collectively, CO_2 from LULUCF constitutes an estimated one-third of their total emissions (WRI, 2005). The countries with the largest amount of emissions from land use change are Indonesia and Brazil, with 34 percent and 18 percent, respectively, of the global total (Houghton 2003). It has been estimated that continued deforestation at current rates in these two countries alone would equal four-fifths of the annual reductions targets for Annex I countries in the Kyoto Protocol (Santilli *et al*, 2005). Some countries like Malaysia, Myanmar, and the Democratic Republic of Congo, which are not among the largest overall GHG emitters, also account for significant shares of the global total emissions from land-use change and forestry (WRI, 2005). However, it must be noted that uncertainties for national-level figures are very high, on the order of ±150 percent for large fluxes, and ±180 $MtCO_2$ per year for estimates near zero. The World Resources Institute compared data from Houghton (2003) with the official data submitted by governments to the UNFCCC and found that for large emitters and absorbers the estimates are significantly different, most notably in Indonesia and Brazil. In some cases, such as China, India and Argentina, the data submitted by governments show a negative source (that is, a net sink) of CO_2, whereas other sources report a positive emissions source (Figure 1).

Assumptions of future deforestation rates are key factors in estimates of GHG emissions from forest lands and of mitigation benefits, and vary significantly across studies. Sathaye *et al.* (2007) foresee that deforestation rates will continue in all regions, particularly at high rates in Africa and South America, for a total of just under 600 million ha lost cumulatively by 2050. Forests are most likely to be eliminated first in tropical Asia, where the rates are high and forest areas small, and then in West Africa (Houghton, 2005).

Using a spatial-explicit model coupled with demographic and economic databases, Soares-Filo *et al.* (2006) predict that, under a business-as-usual scenario, by 2050 projected deforestation trends will eliminate 40% of the current 540 million ha of Amazon forests, releasing approximately 117,000 ± 30,000 $MtCO_2$ of carbon to the atmosphere (IPCC FAR, 2007). Moreover, Santilli *et al*. (2005) estimate that, at today's rates, another 85 to 130 PgC will be released over the next 100 years, the emissions declining only as tropical forests are eliminated. Furthermore, if droughts become more severe through more frequent and severe El Niño episodes (Trenberth and Hoar, 1997; Timmermann *et al*., 1999), or the dry season becomes lengthier due to deforestation-induced rainfall inhibition (Nobre *et al*., 1991; Silva-Dias *et al*., 2002), or there are rainfall reductions due to global warming (White *et al*., 1999; Cox *et al*., 2000), then substantial portions of the 200 Pg of carbon stored globally in tropical forest trees could be transferred to the atmosphere in the coming decades.

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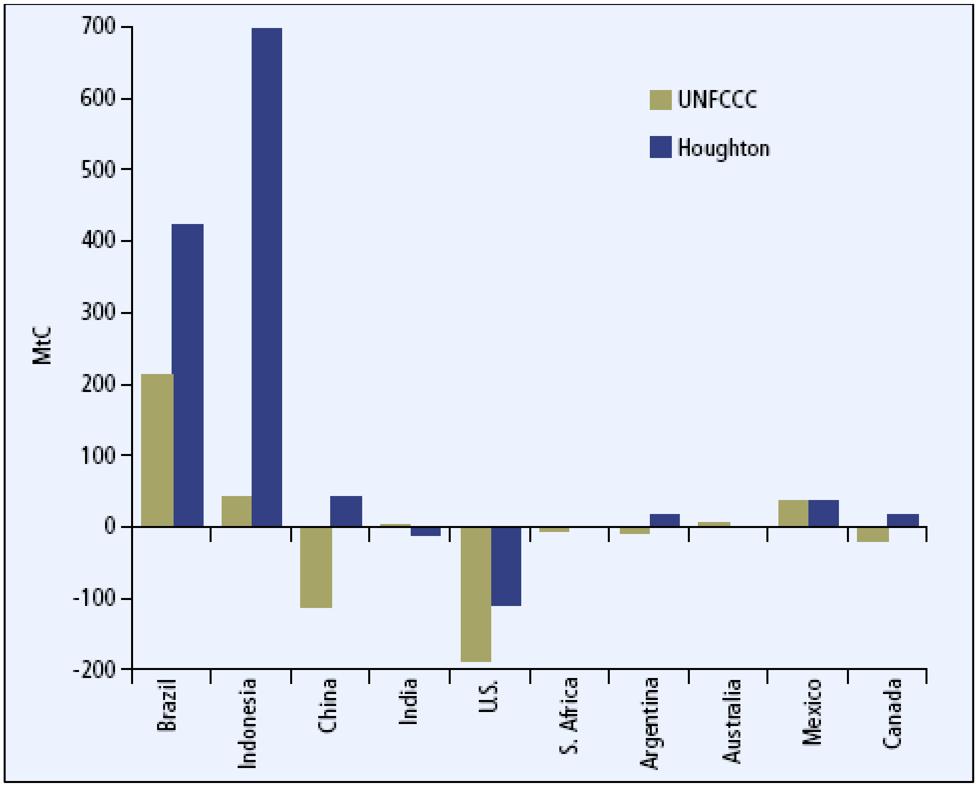
[5] The term "land use, land use change and forestry" is used by the IPCC's AR4 to describe the aggregated emissions of CO_2, CH_4, N_2O from deforestation, biomass and burning, decay of biomass from logging and deforestation, decay of peat and peat fires. This is broader than emissions from deforestation, which is included as a subset. The emissions reported do not include carbon uptake (removals).

Figure 1. Comparison of national LUCF estimates



Notes: Houghton (2003); CAIT-UNFCCC. UNFCCC data is taken from national communications (developing countries) and national inventories (industrialized countries). Estimates from U.S., Canada, and Australia are for 2000; Mexico is from 1990, and others are from 1994.

Source WRI (2005)

3. DRIVERS OF DEFORESTATION

The land-use change and forestry sector is closely connected with poverty and human development in developing countries, since it represents a potential source of food, income and energy for some of the most marginalized communities and individuals in these countries. The practice of converting forest land to agriculture is widespread, whereas wood energy - usually in the form of fuelwood or charcoal - is the most important source of energy for 2 billion people, mostly the poor that lack access to modern energy services (WRI, 2005). Additionally, forests directly influence livelihoods in developing countries through, for instance, eco-tourism and harvesting of forest products— such as timber, rubber, coconuts, bamboo and palm oil for both local use and export (WRI, 2005).

The act of clearing forested land and, subsequently, changing its use, is rooted in a set of complex social, economic, cultural and environmental realities, which operate over different spatial and temporal scales and vary in importance among nations and regions. According to Grainger (1993), tropical deforestation, in particular, is not a forestry problem but one of land use, as most causes originate outside the forestry sector. Some consensus has thus been reached that deforestation usually results from a combination of factors (also referred to as causes, drivers or forces), although the quantification of these factors remains difficult. The literature classifies them into three levels: indirect or underlying causes; direct, immediate or proximate causes; and other factors (Geist and Lambin 2001; Kaimowitz and Angelsen 1998). In addition to these, individuals, corporations, government agencies or development projects that directly clear forested lands have been categorized as agents of deforestation (CFAN 1999; Kaimowitz and Angelsen 1998).

Geist and Lambin (2001) define underlying causes as broad forces that underpin proximate or direct causes. They include macro-level variables and policy instruments that are beyond the control of deforestation agents, and are divided into economic factors, policy and institutional factors, technological factors, cultural factors and demographic factors (Geist and Lambin, 2001). Proximate causes of deforestation are those human activities that directly remove forest cover (e.g., agriculture, logging, infrastructure development), whilst the group of other factors associated with deforestation is composed of pre-disposing environmental factors (land characteristics, features of the biophysical environment), biophysical drivers and social trigger events.

Geist and Lambin (2001) conducted a frequency analysis of the occurrence of underlying driving forces and direct causes of tropical deforestation and their interlinkages as reported in 152 subnational case studies. They analyzed the information on proximate causes, underlying drivers and other factors associated with deforestation in terms of single factor causation, chain logical connection of several factors, and concomitant occurrence of factors involved. The results revealed that tropical deforestation is driven by identifiable regional variations of synergetic cause/driver combinations in which economic factors, institutions, national policies and remote influences are prominent. Regarding underlying forces, Geist and Lambin (2001) found that economic factors are most prevalent in (some) single and multi-factorial combinations (81% of cases reviewed) as compared to policy and institutional (63%), technological (59%), socio-political or cultural (56%), and demographic factors (51%).

The dominance of economic factors relates to their frequency of occurrence, i.e., as single, chain-logically connected or concomitant cause (when considering chain-logical connections only between the underlying and proximate levels, it appears that policy and institutional factors are more important). Economic and policy/institutional factors tend to be strongly interrelated and appear to be strong drivers of all other underlying forces, while cultural, demographic and technological factors are less so (Table 2).

Table 2. Frequency of broad underlying driving forces*

	All cases (N=152)			Asia (n=55)		Africa (n=19)		L. America (n=78)	
	abs	rel	cum	abs	rel	abs	rel	abs	rel
Single factor causation									
ECON	13	9%	9%	0	-	0	-	13	*17%*
INST	4	3%	12%	0	-	1	5%	3	4%
TECH	0	-	-	0	-	0	-	0	-
CULT	0	-	-	0	-	0	-	0	-
POP	0	-	-	0	-	0	-	0	-
2-factor term of causation									
POP-ECON	5	3%	15%	0	-	3	16%	2	3%
POP-TECH	4	3%	17%	2	4%	1	6%	1	1%
POP-INST	1	1%	18%	0	-	0	-	1	1%
POP-CULT	1	1%	18%	0	-	0	-	1	1%
ECON-TECH	1	1%	19%	0	-	0	-	1	1%
ECON-INST	5	3%	22%	0	-	0	-	5	6%
INST-CULT	5	3%	26%	4	7%	0	-	1	1%
3-factor term of causation									
POP-ECON-TECH	5	3%	29%	0	-	4	*21%*	1	1%
POP-ECON-INST	1	1%	30%	1	2%	0	-	0	-
POP-ECON-CULT	2	1%	31%	0	-	1	5%	1	1%
POP-TECH-INST	4	3%	34%	1	2%	1	5%	2	3%
ECON-TECH-CULT	1	1%	34%	0	-	0	-	1	1%
ECON-INST-CULT	6	4%	38%	0	-	0	-	6	8%
TECH-INST-CULT	5	3%	42%	5	9%	0	-	0	-
4-factor term of causation									
POP-ECON-TECH-INST	8	5%	47%	5	9%	2	11%	1	1%
POP-ECON-TECH-CULT	1	1%	47%	0	-	1	5%	0	-
POP-ECON-INST-CULT	2	1%	49%	1	2%	0	-	1	1%
POP-TECH-INST-CULT	5	3%	52%	4	7%	0	-	1	1%
ECON-TECH-INST-CULT	19	13%	64%	12	*22%*	0	-	7	9%
5-factor term of causation									
All	54	36%	100%	20	36%	5	26%	29	37%
Total	**152**	**100%**	**-**	**55**	**100%**	**19**	**100%**	**78**	**100%**

* POP = Human population dynamics, ECON = Economic growth or change, commercialisation, development,
TECH = Technological change, INST = Policy and institutional factors, or change of political-economy institutions,
CULT = Cultural or socio-political factors.

Source: Geist and Lambin (2001)

Underlying factors related to economic growth (or, similarly, to economic change, commercialization or economic development) motivate most (81%) of cases, mainly in combination with other drivers (91%). In just 9% of all cases, economic factors operate as single underlying forces as reported from several cases in mainland South America. There is not significant variation across regional cases, and economic factors could thus be labeled as the most important and robust underlying forces of tropical deforestation. Policy and institutional factors exert the highest impact upon proximate causes. They drive, in particular, agricultural expansion (in 65% of all cases), wood extraction (41%), and the expansion of infrastructure (19%). Similarly, economic and cultural (or socio-political) factors underlie agricultural expansion (in 38% and 41% of the cases, respectively), wood extraction (41 and 32%, respectively), and the development of infrastructure (22 and 15%, respectively). To a lesser degree, technological factors exert impact upon proximate causes, especially agricultural expansion (in 43% of all cases) and wood extraction (28%). Human population dynamics drives only agricultural expansion to an extent worth to be considered (in 47% of all cases). Even though the expansion of cropped land and pasture was found to be the most frequently reported proximate cause of tropical deforestation, shifting cultivators are not always the key agents of deforestation. Rather, it is the expansion of permanently cropped land for food production that drives deforestation. Moreover, two main tandems (defined as 2-factor combinations) relate to agriculture driven deforestation: the development of infrastructure as a strong cause of agricultural expansion (and, to a far lesser degree, of wood extraction), and wood extraction impacting upon agricultural expansion (Table 3) (Geist and Lambin, 2001). Further, in cases with high rates of annual deforestation, pre-disposing biophysical factors are at work or shape the pattern of deforestation. Namely, these are low relief and flat topography in combination with good soil quality and high water availability. In contrast, proximate causes that cannot be assimilated to biophysical conditions are more associated with cases featuring considerably lower rates of annual deforestation.

In addition to these findings, recent literature has studied the link between deforestation and economic development indicating an inverse relationship. Decreasing deforestation with increasing wealth happens because, as economies develop, they tend to invest more in environmental quality. Moreover, less developed economies offer less employment opportunities and force people to convert forested land. Conversely, as the wealth of nations increases, high tech services draws people away from activities that clear land and, hence, usually forest cover increases (Ewers 2006). The literature refers to this process as "forest transitions", which are long-run processes in which economic development drives a pattern of forest loss followed by forest recovery (Ewers 2006; Rudel *et al*. 2005). Overall then, taking into account the multiple factors intervening in tropical deforestation and their complex interactions, it is particularly difficult to develop generic and widely applicable policies that best attempt to control the process, thus any universal policy or global attempt to control deforestation is doomed to failure.

Table 3. Frequency of broad proximate causes*

	All cases (N=152)			Asia (n=55)		Africa (n=19)		L. America (n=78)	
	abs	rel	cum	abs	rel	abs	rel	abs	rel
Single factor causation									
AGRO	6	4%	4%	2	4%	1	5%	3	4%
WOOD	2	1%	5%	0	-	2	11%	0	-
INFRA	1	1%	6%	0	-	0	-	1	1%
OTHER	0	-	-	0	-	0	-	0	-
2-factor term of causation									
AGRO-WOOD	22	15%	20%	12	22%	2	11%	8	10%
AGRO-INFRA	30	20%	40%	3	6%	2	11%	25	*32%*
AGRO-OTHER	5	3%	43%	1	2%	3	*16%*	1	1%
WOOD-INFRA	1	1%	44%	0	-	0	-	1	1%
WOOD-OTHER	1	1%	45%	0	-	1	6%	0	-
3-factor term of causation									
AGRO-WOOD-INFRA	38	25%	70%	21	*38%*	2	11%	15	19%
AGRO-WOOD-OTHER	6	4%	74%	4	7%	1	5%	1	1%
AGRO-INFRA-OTHER	8	5%	79%	0	-	0	-	8	10%
WOOD-INFRA-OTHER	1	1%	80%	0	-	0	-	1	1%
4-factor term of causation									
All	31	20%	100%	12	22%	5	26%	14	18%
Total	**152**	**100%**	**-**	**55**	**100%**	**19**	**100%**	**78**	**100%**

AGRO = agricultural expansion, WOOD = wood extraction, INFRA = infrastructure extension, OTHER = land characteristics, biophysical drivers and social trigger events.

Source: Geist and Lambin (2001)

4. ADDRESSING DEFORESTATION: EXPERIENCES SO FAR

The approaches most commonly followed by countries to reduce deforestation rates are supporting conservation initiatives and promoting sustainable forest management (SFM). While the first focuses on preserving forest ecosystems and limiting exploitation activities, the second acknowledges the need for communities to directly benefit from goods and services from these ecosystems in a way that it can be sustained into the future. The institutional framework of each country to implement these approaches responds to its economic, socio-political and environmental situation and, therefore, arrangements vary considerably country by country. Almost all countries have in place a mixture of policies and incentives for this purpose, which combine setting aside lands for conservation purposes, with programs promoting forest conservation and sustainable agriculture, logging and forest management (UNFCCC 2006b). Table 4 provides a review of policies that have been used to prevent forest clearance through the promotion of conservation and sustainable forest management, as well as their effectiveness based on the experience on their implementation to date.

The International Tropical Timber Organisation (ITTO) estimates that about 36.4 million hectares (4.5 percent) of the total natural permanent forest state is considered to be under Sustainable Forest Management (SFM) (including 7.1 percent from production forests and 2.4 percent from protection forests). According to this organization, the main constrains to SFM are, in first place, that this activity is in most cases less profitable to the various parties involved than alternative uses. The second one is land tenure, including the lack of long-term security of land title and the problems in the process of land allocation. The third constrain is illegal logging and trade which needs to be tackled through law enforcement in consumer and producer countries. Finally, institutional capacity is also a major constrain, further worsened by shortage in staff, equipment, vehicles, research facilities, training centers and others (ITTO 2005).

Protected areas represent, in extent and financing, the largest policy intervention for conservation and active management of tropical forests. FAO (2001) estimates that 3.46 million square kilometers of tropical and subtropical forest have protected status - about a seventh of the world's forest and approximately equivalent in area to India. A full accounting on spending to establish protected areas in tropical forests is unavailable, but during 1992–2002 the Global Environment Facility financed $3.6 billion in projects for protected areas, covering about a quarter of the world's protected areas (UNFCCC 2006b). Across the developing world, total annual spending (including recurrent spending) on protected areas is roughly $800 million (Chomitz 2006). However, these areas are usually under funded, their effectiveness is limited due to insufficient staffing and their long-term effectiveness is subject to the nature of multi-stakeholder and institutional arrangements, management leadership and enabling political environments (Stoll-Kleeman et al. 2006).

According to experiences so far, the success of forest conservation and SFM activities is determined by institutional frameworks that recognize the multiple values and uses of forests, and take into account the longer term. Such vision requires that economic sectors which have an impact on deforestation consider environmental costs from deforestation (UNFCCC 2006b). Likewise, the effectiveness of such frameworks is determined by a set of conditions which include information availability and access, institutional capacity building and public participation, including local and indigenous communities, in the policy process (OECD 1999a). Grainger (1993) suggests that policies to reduce deforestation rates in developing countries have generally encompassed those which make attempt to make agriculture and forestry more sustainable, to raise the political status of forest conservation, and to modify social and economic development policies. In fact, governments have generally implemented a package of policies and incentives rather than a single one. However, studies on their medium and long term effectiveness are scarce or non-existing at all. This scarcity is due to the complexity in assessing the individual effect of incentives and policies, to lack of data and to the fact that countries themselves, first, do not undertake periodic evaluations and, second, that these evaluations are not compatible or comparable among countries (OECD 1999b).

Table 4. Review of policies to prevent forest clearance

Policy	Description	Effectiveness
1. Reducing prices and demand for tropical agriculture and forestry products		
Policies for economic growth	Evidence suggests that economic growth policies that concentrate less on agriculture and forestry are more likely to be effective on reducing deforestation rates. However, this is the case only when economic growth is accompanied by an equitable distribution of wealth (Ewers 2006).	Moderate (Kaimowitz et al. 1998)
Policies to devaluate currency	They increase the relative price of tradable goods, thus making agriculture more profitable. Policies to control exchange rates could decrease deforestation rates if the export of agricultural goods is a major underlying cause of deforestation. Governments are unlikely to adopt them as a means to control deforestation. .	Moderate (Kaimowitz et al. 1998)
Policies that control the price of tropical goods	They apply to local production and consumption and include price ceilings and quotas, import restrictions and guaranteed minimum prices. A policy could, for example, prohibit imports of goods that cause deforestation. Regarding national production and consumption, quotas of goods can limit agricultural output although the impact on deforestation depends on whether such goods would have been produced in newly cleared lands. Experiences in Central America show that price controls and other restrictions are likely to affect producers on lands that have already been converted and not to those on the agricultural frontier as these last have fewer alternatives to agriculture (Kaimowitz et al. 1998). The same situation applies to logging, with the addition that decreasing prices and demand for wood can have negative effects on sustainable forest management.	Ambiguous (Von Amsberg 1998) Moderate (Kaimowitz et al. 1998)
Policies that set export bans and taxes	They could be implemented with the intention of decreasing supply and demand of agricultural products by increasing prices. However, such policies are likely to have negative side effects as they would discourage sustainable production, increase national consumption and increase illegal activities in countries with weak law enforcement.	Moderate in the short run (Kaimowitz et al. 1998)
2. Increasing the costs and risks associated with deforestation		
Policies that reduce subsidies for certain agricultural inputs	In an interest to promote agricultural activities, governments provide subsidies on fertilizers, pesticides and fuel, and credit for farming as well as for logging in the form of low stumpage prices and logging concessions. The literature has largely criticized these subsidies for the effects on forest cover. In general terms, market distortions that artificially make agricultural or logging activities more profitable have proven to be less economically efficient in the longer run as a consequence of ignored environmental costs (Grainger 1993; Kaimowitz and Angelsen 1998).	Moderate in the medium term. However, effectiveness is questionable (see examples from Brazil cited by Lele et al. 2000 and Faminow 1998)
Policies to reduce technical support for agricultural activities that deforest	They could decrease deforestation, however, they may be difficult to implement given the political difficulties of stopping technical support for agricultural development in general. Some countries have effectively implemented policies that target lands not belonging to the agricultural frontier, as well as labor intensive practices, natural resource management and intensification of agricultural production.	Low (Kaimowitz et al. 1998)
Incorporating deforestation concerns into road and transport policies	The development of new roads increases deforestation in many different ways, for example, by opening new areas of forests and by increasing the profitability of agriculture through eased transport. For this reason, analyzing the implications of road construction for forest cover should be an essential component of any transport policy. This does not necessarily imply that fewer roads should be developed but rather changing their location, type and nature.	Moderate in the medium term (Kaimowitz et al. 1998), while, the longer term is determined by underlying causes of deforestation

Policy	Description	Effectiveness
Establishing protected areas	Although there are examples of efficiently managed protected areas, a report by IUCN reveals the lack of sustainable funding and shortage of funds to effectively manage them. It concludes that current levels of funding are inadequate, thus requiring the identification of new sources (IUCN 2006). Kaimowitz et al. 1998 argue that deforestation has also been encouraged by restricting access to natural resources and by neglecting traditional management and protection of forested areas. For this reason, policies on land use zoning should provide for the involvement of local and indigenous communities. Only a couple studies explore reasons for variations in the effectiveness of protected areas. Bruner and others (2001) and Dudley and others (2005) survey such areas, correlating management practices with self-reported measures of park conditions. The clearest result is a correlation between staffing and effectiveness, suggesting that guards are an important part of the transformation between "paper parks" and working parks, though staff may also be important in working with local residents (Chomitz 2006).	Variable (Kaimowitz et al. 1998)
Policies to reduce support for colonization	Few countries still support the colonization of forested areas.	Generally moderate (Kaimowitz et al. 1998)
3. Addressing land tenure		
Changes in land titling	In Latin America, some countries deny land title to farmers that have undertaken deforestation. There are also policies in place which require that a portion of natural forest in newly acquired lands be preserved. For example, the Brazilian government requires that, in the Amazon, public lands that become private shall preserve at least 60 percent of forest cover.	Low, or even negative, resulting from weak implementation (Kaimowitz et al. 1998)
Policies to establish common property regimes	They are applicable to indigenous and forest-dependent people and can have positive effects on deforestation as they transfer the management responsibility to a group of individuals that is in closer contact with the resource.	Moderate (Kaimowitz et al. 1998)
Zoning	Zoning has a sensible premise: efficient land allocation and management. There are at least two strands of technical planning, though in practice they may be combined (Chomitz 2006). One is rooted in agricultural science and forestry. The second approach comes from systematic conservation planning (Margules and Pressey 2000; Cowling and others 2003; Stoms, Chomitz, and Davis 2004). The legitimacy and effectiveness of zoning are closely linked to land tenure and depend on securing landholder consent and cooperation. Poor people can suffer if zoning is imposed on them without consent or compensation, while wealthier or more powerful interests may ignore the rules with impunity—or there may be no political will to impose zoning on anyone. For this reason, zoning has been problematic at the national level (Hoare 2006). There has been an efflorescence of participatory land use planning, often used to help demarcate indigenous lands (Chomitz 2006). For instance, it is being used to resolve conflicts between forest dwellers and plantation interests in Papua province, Indonesia, and to delineate community boundaries in Vietnam. Successful applications have also been reported in Cameroon (Lescuyer and others 2001) and Madagascar (Cowles and others 2001).	Variable (Chomitz 2006)
Taxes	They could be used to decrease deforestation by establishing tax concessions and exemptions on protected lands. Land taxes and capital gain taxes can discourage land speculation as they raise the cost of holding land as a mechanism to decrease inflationary risk. Related information is not available, however, Kaimowitz et al. 1998 suggest that negative tax mechanisms are difficult to implement and enforce due to the high information requirements as well as the potential for tax evasion or avoidance.	Variable/unknown (Kaimowitz et al. 1998)

Policy	Description	Effectiveness
4. Increasing the profitability of sustainable forest management		
Policies to promote the marketing of forest products	They include forest certification and ecolabelling and use market forces to increase the profitability of SFM. In most cases, such programs need government support because sustainable exploitation of forests would not pay for the opportunity costs of land. At the international level, forest certification has been promoted by ITTO and the Forest Stewardship Council. Certification through ITTO includes about 96.2 million hectares (27%) of "production" permanent forest estates (3.0%) and 1.77 million of plantations (3.9%).	Variable/moderate (Espach 2006)
Enhanced security of tenure	Such policies apply to forest dwellers as well as to long term logging concessionaires as they can reduce perverse incentives to clear cut as well as create incentives for the implementation of SFM. Transferability of tenure could encourage positive practices in forests as licenses for resources that are kept in better shape can be sold for higher prices in the future.	High, however, depends on political changes, length of concessions and transferability of licenses. (Kaimowitz et al. 1998)
Payment of environmental services	They are schemes to support the conservation of forests and SFM through transferring a payment from a beneficiary of a specific environmental service (e.g. watershed protection or carbon storage) to the provider of that service. The basic principle of PES is that beneficiaries are compensating forest owners because protecting forests entails a cost. Wunder (2005) defines PES as a voluntary, conditional transaction with at least one seller, one buyer, and a well-defined environmental service. Mayrand and Paquin (2004) indicate that, by 2004, more than 300 PES schemes had been implemented globally. Most of these were designed for watershed and water conservation purposes, followed by biodiversity and carbon.	Variable (Kaimowitz et al. 1998)
Integrated Conservation-Development Projects (ICDPs)	These projects aim to boost development in forest communities, often those in or near protected areas. ICDPs have, however, some limitations (Chomitz 2006). First, they won't reduce deforestation if targeted communities are not to blame for deforestation. Second, there is no strong reason to expect that unconditional provision of alternative livelihoods will automatically reduce a community's pressure on forests and other natural resources. Finally, while ecotourism and non-timber forest products can motivate conservation and raise incomes, it can be difficult to set up these businesses. Some researchers have concluded that ICDPs can succeed only if there is a specific *quid pro quo* bargain —such as periodic payments to communities based on measured conservation outcomes (Ferraro and Kiss 2002). A recent review by the Global Environment Facility examined the impact on local incomes of 88 biodiversity projects, mostly in protected areas (but not all forests). Less than half of projects for which information was available succeeded in boosting incomes but financial success did not guarantee environmental success when the new business was unrelated to the natural resource at risk.	Low (Chomitz 2006)

Source: Adapted from UNFCCC (2006b), Chomitz (2006) and other sources

5. MITIGATION POTENTIAL AND COSTS

5.1. Top-down and bottom-up mitigation potential estimates

Reducing deforestation and degradation is the forest mitigation option with the largest carbon stock impact in the short term per ha and per year globally, because large carbon stocks (about 350-900 tCO_2/ha) are not emitted when deforestation is prevented (IPCC FAR, 2007). Curbing deforestation is considered a highly cost-effective and immediate way of reducing greenhouse gas emissions at a significant scale because it does not imply the development of new technology, except perhaps for monitoring (Stern 2006). Moreover, it is assumed that forest-related mitigation options can be designed and implemented to be compatible with adaptation, and can have substantial co-benefits in terms of employment, income generation, biodiversity and watershed conservation, renewable energy supply and poverty alleviation (Stern 2006). However, climate change can affect the mitigation potential of the forest sector and is expected to be different for different regions, both in magnitude and direction (IPCC FAR, 2007).

Recent bottom-up studies have been conducted at national, regional, and global scales to estimate the mitigation potential (areas, carbon benefits and costs) of reducing tropical deforestation. In a short-term context (2008-2012), Jung (2005) estimates that 93% of the total mitigation potential in the tropics corresponds to avoided deforestation. For the Amazon basin, Soares- Filho *et al.* (2006) estimate that by 2050 the cumulative avoided deforestation potential could reach 62,000 $MtCO_2$ under a "governance" scenario[6] (IPCC FAR, 2007). Furthermore, Sohngen and Sedjo, (2006) argue that, looking at the long-term, for 27.2 US$/$tCO_2$, deforestation could potentially be virtually eliminated. Over 50 years, this could mean a net cumulative gain of 278,000 $MtCO_2$ relative to the baseline and 422 million additional hectares in forests. For lower prices of 1.36 US$/$tCO_2$, only about 18,000 $MtCO_2$ additional could be sequestered over 50 years. The largest gains in carbon would occur in Southeast Asia, with nearly 109,000 $MtCO_2$ for 27.2 US$/$tCO_2$, followed by South America, Africa and Central America, which would gain 80,000, 70,000, and 22,000 $MtCO_2$, respectively (Figure 2).

Global (top-down) models show a large potential for climate mitigation through forestry activities. The global annual potential in 2030 is estimated at 13,775 $MtCO_2$/yr (at carbon prices less than or equal to 100 US$/$tCO_2$), 36% (~5000 $MtCO_2$/yr) of which can be achieved under a price of 20 US$/tCO2. Reducing deforestation could contribute with 3,950 $MtCO_2$/yr, most of which (54%) could be achieved at prices equal or lower than 20 US$/$tCO_2$. Most of this potential is found in Central and South America with 1,845 $MtCO_2$/yr, and Africa (1,160 $MtCO_2$/yr), and to a lesser extent, in Asia (Table 5).

The emissions reduction estimates from bottom-up assessments are higher than those found in top-down studies, particularly at higher cost levels. This can be explained by the fact that this sector (as well as the agricultural sector) is often not well covered by top-down models due to its specific character. Moreover, data from top-down estimates include additional deforestation (negative mitigation potential) due to biomass energy plantations, which is not included in bottom-up analyses. Moreover, global models often do not address implementation issues such as transaction costs (likely to vary across activities and regions), barriers, and carbon market rules, which tend to drive mitigation potential downward toward true market potential. Political and financial risks in implementing afforestation and reforestation by country were considered by Benitez-Ponce *et al.* (2007), who found that the sequestration potential was reduced by 59% once the risks were incorporated (IPCC FAR, 2007).

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[6] By a governance scenario, these authors refer to a situation in which Brazilian environmental legislation is implemented across the Amazon basin through the refinement and multiplication of experiments regarding the "enforcement of mandatory forest reserves on private properties through a satellite-based licensing system, agro-ecological zoning of land use, and the expansion of the PA network" (ibid.: 540).

Table 5. Mitigation potential of global forestry activities. Global model results indicate annual amount sequestered or emissions avoided, above business as usual, in 2030 for carbon prices 100 US $/t$CO_2$ and less

Region	**Activity**	**Potential at costs equal or less than 100 US$/ton CO2, in MtCO2/yr in 2030**[1]	**Fraction in cost class: 1-20 US$/ton CO_2**	**Fraction in cost class: 20-50 US$/ton CO_2**
USA	Afforestation	445	0.3	0.3
	Reduced deforestation	10	0.2	0.3
	Forest management	1,590	0.26	0.32
	TOTAL	2,045	0.26	0.31
Europe	Afforestation	115	0.31	0.24
	Reduced deforestation	10	0.17	0.27
	Forest management	170	0.3	0.19
	TOTAL	295	0.3	0.21
OECD Pacific	Afforestation	115	0.24	0.37
	Reduced deforestation	30	0.48	0.25
	Forest management	110	0.2 0.	0.35
	TOTAL	255	25	0.34
Non-annex I East Asia	Afforestation	605	0.26	0.26
	Reduced deforestation	110	0.35	0.29
	Forest management	1,200	0.25	0.28
	TOTAL	1,915	0.26	0.27
Countries in Transition	Afforestation	545	0.35	0.3
	Reduced deforestation	85	0.37	0.22
	Forest management	1,055	0.32	0.27
	TOTAL	1,685	0.33	0.28
Central and South America	Afforestation	750	0.39	0.33
	Reduced deforestation	1,845	0.47	0.37
	Forest management	550	0.43	0.35
	TOTAL	3,145	0.44	0.36
Africa	Afforestation	665	0.7	0.16
	Reduced deforestation	1,160	0.7	0.19
	Forest management	100	0.65	0.19
	TOTAL	1,925	0.7	0.18
Other Asia	Afforestation	745	0.39	0.31
	Reduced deforestation	670	0.52	0.23
	Forest management	960	0.54	0.19
	TOTAL	2,375	0.49	0.24
Middle East	Afforestation	60	0.5	0.26
	Reduced deforestation	30	0.78	0.11
	Forest management	45	0.5	0.25
	TOTAL	135	0.57	0.22
TOTAL	**Afforestation**	**4,045**	**0.4**	**0.28**
	Reduced deforestation	**3,950**	**0.54**	**0.28**
	Forest management	**5,780**	**0.34**	**0.28**
	TOTAL	**13,775**	**0.42**	**0.28**

[1] Results average activity estimates reported from three global forest sector models including GTM (Sohngen and Sedjo, 2006), GCOMAP (Sathaye et al., 2007), and IIASA-DIMA (Benitez-Ponce et al., 2007). For each model, output for different price scenarios has been published. . The authors were asked to provide data on carbon supply under various carbon prices. These were summed and resulted in the total carbon supply as given middle column above. Because carbon supply under various price scenarios was requested, fractionation was possible as well. Two right

columns represent the proportion available in the given cost class. None of the models reported mitigation available at negative costs. The column for the carbon supply fraction at costs between 50 and 100 US$/tCO2 can easily be derived as 1- sum of the two right hand columns.

Source: IPCC FAR (2007)

Figure 2. Cumulative carbon gained through avoided deforestation by 2055 over the reference case, by tropical regions under various carbon price scenarios

Source: IPCC FAR (2007)

5.2. Costs of avoiding deforestation

Grieg-Gran (2006) estimated the costs of avoiding deforestation for eight countries with large areas of tropical forest responsible for 70% of the global emissions from land use: Bolivia, Brazil, Cameroon, the Democratic Republic of Congo, Ghana, Indonesia, Malaysia and Papua New Guinea. Annual net forest loss in these eight countries equals 6.2 million ha, which, if avoided, would result in a 46% reduction in global deforestation. The total costs of avoided deforestation in the form of the net present value of returns from land uses that are prevented as a result of controlling deforestation for these eight countries are approximately US$5 billion per year[7] - taking into account the legal, practical and market restrictions on logging. According to these results, direct yields from land converted to farming, including proceeds from the sale of timber, are equivalent to less than 1 US$/t$CO_2$ in many areas currently losing forest, and usually well below 5 US$/t$CO_2$. The opportunity costs to national GDP would be somewhat higher, as these would include value added activities in country and export tariffs (Grieg-Gran, 2006).

Costs would be higher if governments are not able to identify and target the areas with highest deforestation risk or are unable to prevent displacement of deforestation to other areas, as this would mean that a larger area would need to be compensated to achieve the desired reduction in deforestation. Vera Diaz and Schwartzman (2005) calculated the carbon price at which conservation of standing forests becomes financially attractive for loggers and ranchers in the Brazilian Amazon (referred to as break even price). Their results indicate that benefits from deforestation captured by logging and cattle ranching come to $1,699 per hectare, which translates into 11 US$/tC (3 US$/tCO_2), assuming a high timber potential scenario and 3 US$/tC (0.8 US$/tCO_2) in a low timber potential scenario. When deforestation benefits come from logging following cattle ranching, the break even price ranges from 1 US$/tC (0.3 US$/tCO_2) to 14 US$/tC (4 US$/tCO_2), whilst in the case of soybean cultivation it could go from 6 US$/tC (less than 2 US$/tCO_2) to almost 30 US$/tC (around 8 US$/tCO_2).

Moreover, Chomitz (2006) compared, for selected land uses, profitability versus the carbon lost in creating the land use, finding a tremendous variability in the potential cost of conserving carbon. At one extreme, traditional pasture management in the Brazilian state of Acre entails a loss of 145 tons of carbon per hectare, but creates only 4 US$/ha in land value and 11 days/ha/year of employment. So the cost of conserving carbon, in principle, is just 0.03 US$/tC (or less than 0.01 US$/tCO2). Rubber agroforestry in Sumatra, as traditionally practiced, also yields virtually no land value, just managing to repay the opportunity cost of labor. The most profitable land use, oil palm in Cameroon, entails a carbon loss of 150 tons per hectare, confers a land value of US$1090, and provides 150 days of employment; here the theoretical cost of conserving carbon is 7.27 US$/tC (near 2 US$/tCO_2). Chomitz concludes that, at very low carbon values, it is socially preferable to keep land under forest rather than convert it to typical low-productivity pasture or annual cropping. At moderate values, carbon competes even with relatively high value plantation crops.

In addition to compensation payments, reducing emissions from deforestation would imply the costs of putting in place and operating compensation schemes. These costs would vary depending on a number of

[7] It is assumed that the alternative to deforestation is forest conservation without any exploitation of timber and corresponding revenues.

factors, for instance, the scale of the scheme (i.e., project based, municipality, state, regional or national), its characteristics, the existing capacities and the level of accuracy required in the measurement of emissions reductions. Based on the experience of existing payment for environmental services schemes in Central and South America[8], Grieg-Gran (2006) estimates that annual administration costs associated with payment schemes compensating for 6.2 million hectares of avoided deforestation (the annual average net forest loss in these eight countries over the period 2000-2005) would range from US$25 million to US$93 million. To maintain this reduced rate of global deforestation over time will require substantial increases in administration costs every year. In the second year, compensation payments would need to be initiated for another 6.2 million ha and payments made for the 6.2 million ha from the first year. By year 10, annual administration costs would range from US$250 million to just under US$1 billion. Fixed costs of monitoring deforestation (but not at a level of accuracy to monitor carbon), and considering an estimate of US$2 million per country (estimated by Chomitz, 2006), would be at least US$16 million.

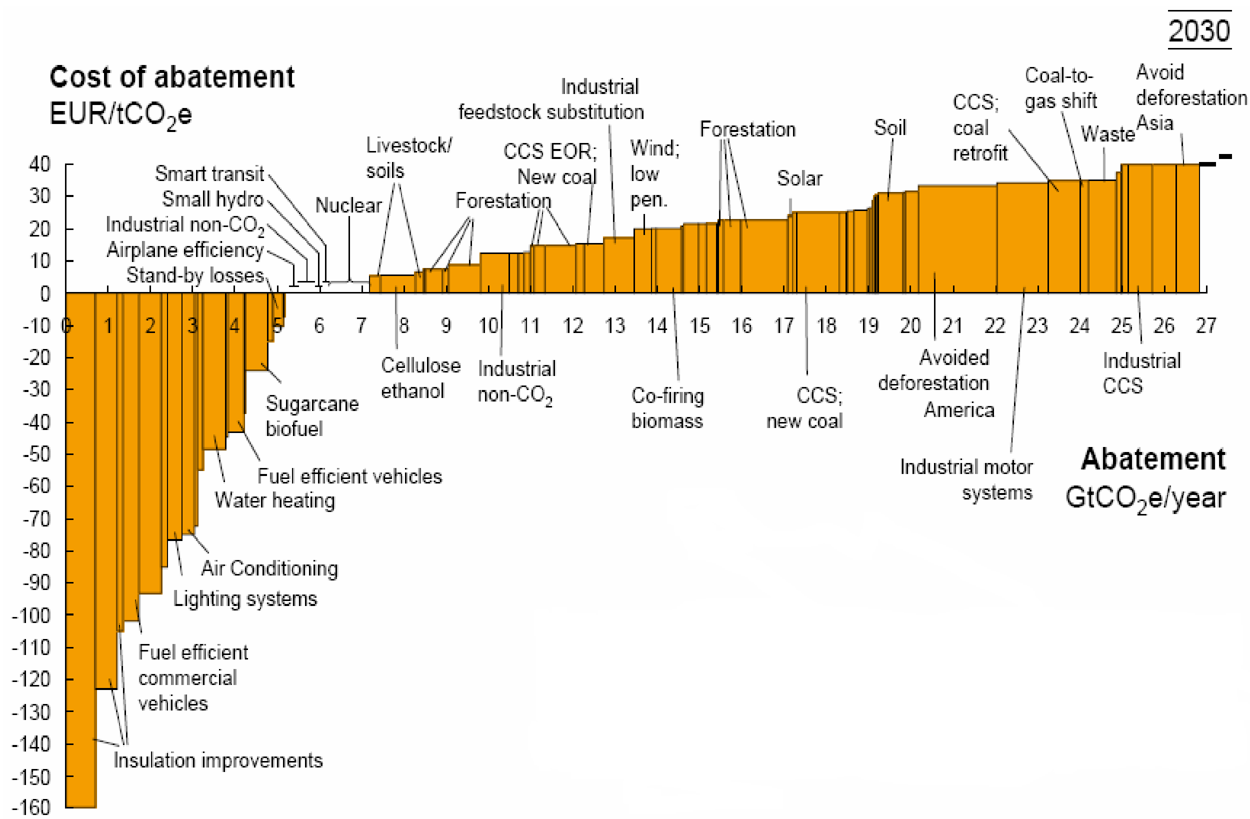
Measures to avoid emissions from deforestation look feasible when their cost per avoided ton is weighed against the observed prices in the international carbon market, which, in the case of the allowances of European Emissions Trading Scheme fluctuated from 24.70 US$/t$CO_2$e in 2005 to 22.10 US$/tCO_2e in 2006, whilst the Certified Emissions Reductions from the CDM saw average prices of 10.90 US$/t$CO_2$e (World Bank 2007). The costs of reducing emissions from deforestation are also reasonable when compared to those of other mitigation options. For instance, they compete with the incremental costs of the technologies identified in the Energy Technologies Perspective (ETP) of the International Energy Agency (IEA)[9], which are not expected to exceed – when these technologies are fully commercialized – 25 US$/t$CO_2$e in all countries, including developing countries.

Nevertheless, avoiding emissions from deforestation is not among the cheapest options in the mitigation portfolio available to 2030 (Figure 3). As can be observed, around 7 GtCO2e are achievable at zero or negative costs through e.g., energy efficiency measures, biofuels and nuclear energy. Likewise, some industrial technologies, reforestation activities and CO_2 capture and storage options may result cheaper than reducing emissions from deforestation (Vattenfall, 2007). This, together with the difficulties of implementing effective actions to avoid deforestation may question the potential of RED credits to “flood” the carbon market, a concern commonly raised by some Parties and NGOs. Furthermore, it could be argued that the fears regarding LULUCF activities “flooding” the market were the result of a “procedural failure” in the negotiations of the Kyoto Protocol, given that the emission reduction commitments (the demand) were defined before the activities eligible to meet them (the potential offer) were decided – something that may not happen in the post-2012 discussions.

Figure 3. Mitigation options and costs to 2030

[8] From these schemes, a lower bound figure for annual administration costs of US$4 per ha and an upper bound of US$15 per ha were derived. These represent the likely range of operational costs of a compensation scheme employing a system of payments.

[9] The ETP was produced in response to the G8 leaders at the Gleneagles Summit in July 2005, which called for the IEA to develop and advise on alternative scenarios and strategies aimed at a clean, clever and competitive energy future. The technologies assessed included energy efficiency in buildings, industry and transport, clean coal and CO2 capture and storage, electricity generation from natural gas, nuclear power and renewables, and biofuels and hydrogen fuel cells in transport.



Source: Vattenfall, (2007)

6. POLICY APPROACHES TO REDUCE EMISSIONS FROM DEFORESTATION IN DEVELOPING COUNTRIES UNDER THE UNFCCC

As a part of the two-year process launched by the Conference of the Parties (COP) at its 11th session, Parties have reviewed and shared experiences on past and ongoing efforts to reduce deforestation (including different policy approaches and incentives), scientific and technical challenges of monitoring deforestation and quantifying the ensuing changes in carbon stocks. As a result, they have recognized the need for urgent action through capacity building and pilot activities. Additionally, many Parties have submitted proposals on the design of potential arrangements to reduce emissions from deforestation in developing countries (Table 6). Generally speaking, it can be argued that the arrangements proposed consist of two basic elements, namely i) sources of funding for incentives[10] and ii) mechanisms for the allocation of such incentives. These should be complemented by methodologies and accounting rules to be agreed by Parties, whilst the design and implementation of activities reducing emissions on-site are left to each developing country according to its particular circumstances and interests.

6.1. Sources of funding for incentives to reduce emissions from deforestation

Reducing emissions from deforestation will require the identification of sources of funding able to provide sufficient, long-term and predictable resources, which should be additional to the support that developing countries already receive from developed ones. As shown in Table 6, Parties have proposed a number of potential sources of funding, which can be divided into three groups: a) voluntary contributions; b) the

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[10] All Parties have referred to economic incentives. Capacity building, technology transfer and exchange of experiences have also been widely mentioned by Parties in their submissions, but as supporting elements for the implementation of incentives mechanisms and not as incentives themselves.

carbon market and c) levies and taxes. To what extent could these options generate sufficient, long-term and predictable resources?

Based on the estimates by Grieg-Gran (2006) presented in the previous section, it could be argued that, in order to be considered as "sufficient", a source of funding would have to provide at least US$5 billion per year to achieve a substantial reduction in emissions from deforestation. Taking into account that the total funding of the Global Environment Facility (GEF) - the financial mechanism of the UNFCCC – devoted to climate change activities from 1991 to March 2005 reached only US$ 1.75 billion (China GEF Office, 2005), and that the whole fourth GEF replenishment to fund operations between 2006 and 2010 amounts to merely US$3.13 billion[11], it becomes clear that voluntary contributions have historically been far below the necessary level of funding. Moreover, Official Development Aid (ODA) fluctuates considerably over time and is unpredictable. On average, ODA volatility is four times higher than the Gross National Product of developing countries. This volatility stems mainly from budget procedures in donor countries, changes in priorities and policy-making or implementation delays. In most cases, it cannot be linked to objective and identifiable causes, hence it cannot therefore be anticipated (Mission Permanente de la France, 2006).

The carbon market could thus be seen as the most important new and additional source of development finance, potentially exceeding USD$50-120 billion/year in the long term (IEA, 2005). In 2006, developing countries generated nearly 450 $MtCO_2e$ of CDM credits, representing an increase of 32% from 2005 volumes, for a total market value of US$5 billion (World Bank, 2007). However, for the carbon market to become a sufficient and predictable source of funding, an agreement on stringent emissions reductions beyond 2012, the inclusion of other project typologies under the CDM while maintaining adequate carbon prices, and the establishment of a long-term carbon goal will be essential. Additionally, simple rules and a broad market access for activities reducing emissions from deforestation will also be indispensable, taking into account that in 2006 carbon assets from LULUCF remained at merely 1% of the total volumes transacted in the CDM mostly due to these two factors (i.e., complex modalities, procedures and methodologies and the exclusion of CERs from sinks projects from the EU Emissions Trading Scheme) (World Bank, 2007).

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[11] http://www.gefweb.org/replenishment/replenishment.html

Table 6. Summary of proposals by Parties on mechanisms to reduce emissions from deforestation in developing countries

Proposal	Source of funding for incentives	Incentives mechanism	Scale	Main features
Bolivia - joint submission[1]	Carbon and non-carbon market	REDD Mechanism - a system of positive incentives to support voluntary policy approaches	National	Incentives would be determined by calculating the estimated reduced **gross** emissions from deforestation and degradation (REDD), over an agreed upon past time period, evaluated against the Reference Scenario (RS) RS will be made by estimating a reference emissions rate (RER) and taking account of a Development Adjustment (DA) factor The RER could be updated periodically REDD would be estimated in accordance with existing IPCC Guidance & GPG
Brazil	Financial incentives provided by Annex I countries that voluntarily engage in the arrangement	Arrangement under the UNFCCC aimed at providing positive incentives for the **net** reduction of emissions from deforestation in developing countries that voluntarily reduce their greenhouse gas emissions from deforestation in relation to a rate of emissions from deforestation (RED)	National	The positive incentives system is based on a comparison between the rate of emissions from deforestation (RED) for a certain past time period with the reference emissions rate (RER) RER is calculated on the basis of the emissions from deforestation in the last **10 years**. in order to estimate the RER, a minimum of **4 representative years** need to be assessed. RER shall be recalculated every three years, only if it falls below the previous RER, as the average of the three last RED values If emissions from deforestation have increased, the difference is converted into a **debit** from future financial incentives The amount of the incentive per carbon tonne is to be calculated by a set amount to be agreed and to be reviewed periodically All the reduced emissions of a country are added together for an agreed period, and are converted into a monetary sum, divided among the participating developing countries in the same ratio as the emissions reductions they have achieved The monitoring of the reduction in emissions shall be based on a transparent and credible system that reliably provides estimates of the annual emissions by **biome**

Table 6 cont'

Proposal	Source of funding for incentives	Incentives mechanism	Scale	Main features
Costa Rica – joint submission[2]	Levy on ERUs or AAUs, tax on carbon intensive commodities and services in Annex I countries and voluntary contributions	An Avoided Deforestation Carbon Fund (ADCF) to provide resources for the implementation of specific activities that directly reduce emissions from deforestation, and for activities in countries which have very low rates of deforestation.	From project to national	A possibility is proposed that emissions reduction activities financed through the ADCF could generate credits and provide participants with an entry to the carbon market (e.g. CDM), which would in turn entail additional funds and incentives.
	Carbon market	CDM and other market instruments		Builds on the institutions and experience of the CDM
Congo Basin Countries[3]	Share of proceeds on REDD credits[4], taxes on products and services with a high carbon footprint and voluntary contributions	Stabilization Fund to support developing countries which have very low rates of deforestation and want to maintain their forest cover	National	The share of proceeds among the countries could use advantageously a distribution key based on national criteria, such as: • total forest area, • deforestation rate, • forest area managed sustainably, with approved management plan, • certified forest area (based on sustainable management criteria), • protected areas. The selected criteria will especially recognize any effort in sustainable management beyond the forest cover conservation. Weighting systems could be applied in order to put special emphasis on some of the above criteria
India	Not specified	A mechanism of "Compensated Conservation" intended to compensate the countries for maintaining and increasing their forests as carbon pools as a result of conservation and increase/ improvement in forest cover backed by verifiable monitoring systems.	National	The incentive would be provided to developing countries for effecting expansion, increment or enrichment of their forests from a previously set baseline, that may be fixed at 1990 or other appropriate level. This incentive would not only be granted on the incremental stock from the baseline, but also on the baseline stock

Table 6 cont'

Proposal	Source of funding for incentives	Incentives mechanism	Scale	Main features
Vanuatu	Carbon market	A Carbon Stock Mechanism that extends the principles of a voluntary emission trading to forest carbon reserves in developing countries. It is an approach that promotes private and public participation on all levels (local, regional, international) while avoiding the need for project specific baselines.	National and project	The Carbon Stock Mechanism involves: 1. Calculating the amount of carbon stock that exists in a country's forests; 2. Issuing credits representing the carbon stored in the above ground biomass of national forests; 3. Establishing a reserve over part of the national forest area - the size of the reserve will be negotiated by the countries participating in the mechanism either as part of the overall post 2012 negotiations or as a separate mechanism; 4. Approving eligible projects that commit to protecting forest area outside the reserve (but included in the national forest stock) and periodically verifying the quantity of carbon stock being protected; 5. Issuing a corresponding amount of tradable (temporary or permanent) credits to the approved projects. If a country fails to maintain the agreed amount of reserve carbon or compliance with the participation criteria, the country will not longer be eligible to approve new projects. Existing projects already approved should still be able to have its carbon stock re-verified as individual projects or communities that are performing as planned should not be penalized by events in another part of the country outside of their control.
	Carbon market	A Sectoral Crediting Baseline Approach: covers carbon stock management activities within a geographic area defined by the country. In practice, this 'programme management area' would represent those areas of the country where there is a significant risk of reductions in carbon stock by deforestation or forest degradation.	Sector	The country voluntarily proposes a commitment of a C stock level in its programme management area at the end of the management period, and this is accepted in the international negotiation process as the crediting baseline C stock. The country achieves a higher C stock than the baseline C stock at the end of the management period and is awarded carbon credits equal to this difference. Project proponents would enter into a contract with the host government where they would commit to a minimum carbon stock level at the end of the management period within an identifiable project boundary inside the programme area. They would receive tradable carbon credits upon achieving a higher carbon stock than the project baseline stock. With a firm contract in place with the government, the project proponents could then enter into a forward contract sale of compliance-grade (temporary or permanent) credits to international carbon market buyers.

Table 6 cont'

Proposal	Source of funding for incentives	Incentives mechanism	Scale	Main features
Vanuatu	Macroeconomic Ecosystem Services Market	A Direct Barter Approach - involves negotiating the exchange of an ecosystem service provided by one entity with something of value that can be provided by another entity. The value to be exchanged in a barter transaction is determined through barter negotiation between negotiating parties and could include cash, debt cancellation, trading opportunities, employment, migration, technology transfer, education, capacity building	National	The eligibility of forests for Direct Barter transactions would depend on the ability of such forests to demonstrably contribute to global carbon stocks protection. Forests that are put forward by nations seeking Direct Barter transactions would register these forests as Direct Barter Assets (DBAs). The eligibility of DBAs and their categorization in a Direct Barter Asset Register could fall into two categories – a mandatory category (DBAm) and a voluntary category (DBAv). The mandatory category would encompass the minimum allowable criteria for eligibility as DBAs, and would provide a verifiable minimum requirement for carbon stock protection and permanence and leakage provisions. The voluntary category would include the DBAm criteria but additionally encompass a list of verifiable ecological, social, economic, or cultural co-benefits that may increase the overall quality of the DBA, which may increase its attractiveness to a buyer and potentially affect its selling 'price'.

Table 6 cont'

Proposal	Source of funding for incentives	Incentives mechanism	Scale	Main features
Tuvalu	• Bilateral ODA • Corporate sponsorship • NGO contributions • Government contributions (including through debt for nature swaps and other similar measures)	A Forest Retention Incentive Scheme: a new funding arrangement under the Convention (alternative to carbon trading) to provide the necessary financial incentives to allow communities in Developing Countries to set aside forests or sustainably manage their forests and avoid economic pressures to lose their forests or see them degraded.	Community	Communities that wish to reduce emissions from deforestation or forest degradation activities would seek funding to establish a Community Forest Retention Trust Account (CFRT Account) The funds received for the forest retention project would be put into the CFRT Account and the community could draw on a prescribed percentage of this Account to establish measures to combat emissions from deforestation and forest degradation. The remaining amount would be set aside in the CFRT Account. A community could then draw upon the interest from the Account on an annual basis, based on the concept of being paid an annual "rent for environmental services". Once the CFRT Account was established communities could apply for Forest Retention Certificates. These Certificates would be estimated based on emission trends calculated at the commencement of the project compared with potential actions to reduce these emission trends. At the end of a prescribed period, possibly 5 years, certificates equivalent to a determined amount of tonnes of CO_2 equivalent of reduced emissions would be issued by national governments. At the end of a prescribed period of time, possibly 10 years, the area of forest originally set aside or sustainably managed by a community would be assessed by an independent assessor. An independent auditor would also assess whether the CFRT Account was still in operation. If the project and the account were endorsed by the assessor and auditor, communities could redeem a prescribed percentage of their Certificates. This process would be repeated every 10 years. The Certificates can only be redeemed to the International Forest Retention Fund (fed by The Special Climate Change Fund, voluntary contributions from governments, International financial institutions, corporate donations and NGO contributions). The fundamental component of this scheme is founded on the principle that the certificates could not be sold, transferred or traded.

[1] Bolivia, Central African Republic, Costa Rica, Democratic Republic of the Congo, Dominican Republic, Fiji, Ghana, Guatemala, Honduras, Kenya, Madagascar, Nicaragua, Panama, Papua New Guinea, Samoa, Solomon Islands, Vanuatu. [2] Costa Rica, Dominican Republic, Guatemala, Honduras, Mexico, Panama, Paraguay and Peru. [3] Gabon on behalf of Central African Republic, Cameroon, Congo, Equatorial Guinea, Democratic Republic of the Congo and Gabon. [4] The Congo Basin Countries also suggested the creation of a REDD mechanism, identical to that proposed by Bolivia in its joint submission. The REDD credits mentioned here refer to those generated through that mechanism

Some Parties have proposed setting a levy (although they have not quantified it) on Emissions Reductions Units (ERUs) issued or Assigned Amounts (AAUs)[12], first traded in the carbon market similar to the one imposed on CERs as well as a tax on carbon intensive commodities and services in Annex I countries to feed an Avoided Deforestation Carbon Fund, which would support activities to reduce emissions from deforestation. In the case of ERUs, Point Carbon estimates that the potential offer in the period 2008-2012 could be around 200 $MtCO_2e$. Conservatively assuming a price of ERUs equal to its 2006 average (US $8.70) (World Bank, 2007), the total market value of ERUs offered in the first commitment period could be around US$1.8 billion (or US$360 million per year). For its part, the potential AAUs supply during that period has been estimated at 6.75 billion, but it is likely that in reality it will be limited to around 2.7 billion (Haites, 2004). Assuming an average AAU price of US$5 per ton[13], the total value of AAUs in the first commitment period could be around US$13.5 billion, equivalent to US$2.7 billion a year. Therefore, under the conditions expected until 2012, not even the sum of the potential annual value of both ERUs and AAUs together could attain the US$5 billion per year required to reduce deforestation estimated by Grieg-Gran (2006). In fact, assuming a 2% levy on Joint Implementation or on Emissions Trading, the total annual market value of ERUs or AAUs would have to be around US$250 billion (nearly ten times the expected AAU market value from 2008 to 2012) in order to generate the required level of resources. Furthermore, a levy of this kind would depend on the existence of a sound long-term carbon market in order to produce a (to some extent) predictable flow of funds. Nevertheless, such levies, if linked to the carbon market by allowing funded projects to generate credits as proposed by Costa Rica[14], could constitute a potentially sufficient source of funding, although politically difficult to negotiate.

Finally, it is not possible to estimate the likely volume of resources that a tax on carbon intensive commodities and services in Annex I countries could raise, since such commodities and services have not yet been specified by Parties. It is worth noting, however, that in the current context no international authority has the power to levy taxes. Consequently, an international tax such as the one proposed would have to be defined as a series of identical or similar national taxes, implemented by governments within a jointly agreed framework that would also cover the use of the revenue raised by each country[15]. This cooperative arrangement would need to be negotiated and legally formalized. Nevertheless, in order to be negotiated under the Convention, the proposed scheme would have to focus on emissions, and not on commodities and services. The selection of sources of funding will affect the technical and methodological requirements of the approaches. Those based on the carbon market will by definition imply more accurate methodologies and monitoring, since the reductions achieved will be used for complying with reduction commitments in the international climate regime.

6.2. Mechanisms for the allocation of incentives to avoid emissions from deforestation

The objective of a mechanism for the allocation of incentives to avoid emissions from deforestation is to allocate the resources identified in the previous sub-section to those actors who have reduced emissions from deforestation complying with both a set of rules and methodologies agreed upon internationally and the applicable laws and regulations of the country where emissions reduction activities take place..

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[12] Each Annex I Party issues AAUs up to the level of its assigned amount. Assigned amount units may be exchanged through emissions trading, Emission reduction units (ERUs) are generated for emission reductions or emission removals from joint implementation project. Certified emission reductions (CER) are issued for emission reductions from CDM project activities. All units are equal to 1 metric ton of CO_2e (UNFCCC Website http://unfccc.int/essential_background/glossary/items/3666.php).

[13] According to the unpublished repot Options for a Green Investment Scheme for Bulgaria (2004), by Charlotte Streck and Varadan Atur *et al*., a price range of $4 to $7 per ton of AAU seems plausible, and a median price around $5 or $6 per ton could be realized based on current market indications.

[14] In a joint submission with the Dominican Republic, Guatemala, Honduras, Mexico, Panama, Paraguay and Peru (see Table 6 for more details on this proposal)..

[15] A similar scheme has recently been proposed by France for the International Air-ticket Solidarity Contribution, aimed at addressing the public health challenges facing developing countries.

The scale of the mechanism has direct implications on the technical, methodological and institutional requirements for its application, as well as on the scope of eligible land use changes (e.g., including/excluding degradation) and on aspects related to equity, efficiency and environmental integrity. According to the scale at which carbon benefits are assessed and awarded, mechanisms proposed by Parties can be divided into two main groups: i) exclusively national and ii) from project to national. What follows describes the main implementation opportunities and challenges for each of these two approaches.

6.2.1. Institutional capacities required

A number of Parties (e.g., PNG, Bolivia and Brazil) have proposed approaches that base incentives exclusively on the achievement of quantified emissions reductions from deforestation vis-à-vis national baselines or reference scenarios. Under such approach, governments would have to establish a "carbon infrastructure" which might include, for instance, the elements showed in Box 1. Referring to a compensation scheme operating nation-wide, Chomitz (2006) notes that the measurement, monitoring and transaction costs could be prohibitively high at the property level, especially for small properties, raising doubts about the practicality of relying solely on payments to conserve forest at the individual forest owner level. Instead, he proposes a portfolio of interventions that governments can use to tackle deforestation such as incentive payments to communities or localities for reduced deforestation or for natural regeneration, improving tenure security, enforcement of regulations against illegal deforestation or logging; setting up taxation of large scale land clearance, promotion of off-farm employment and strategic planning of road improvements. Some of these policies will require fairly sophisticated institutional capabilities, and consequently may not be immediately applicable to all forested countries (Chomitz, 2006).

Box 1. Examples of elements of the "carbon infrastructure" required for national approaches to reduce emissions from deforestation

- Institutions and hardware for monitoring forest cover, forest and land fires, and carbon.
- Institutions to identify potential buyers and/or international funds, negotiate transactions, concentrate and distribute resources.
- Programs to reduce accidental fires, in places where this is a problem.
- Programs to improve tenure security in forested areas.
- Programs for intensification of agriculture in non-forested areas, and to encourage off-farm employment in forested areas.
- Pilot programs of incentives for deforestation reduction.
- Globally-financed monitoring and evaluation to encourage rapid learning at the domestic and international level.

Source: Adapted from Chomitz (2006)

Under a carbon market scheme, additional capacities will be required for governments to be able to identify potential buyers, negotiate individual transactions and concentrate resources. Financial schemes will have to be designed or adapted in order to convert *ex post* carbon resources into up-front funds required to finance measures to reduce emissions (e.g., futures, options, etc.). Governments will have to consider how to deal with potential debts in case they receive up-front funding and emission reductions are not achieved. Additionally, a major challenge will be the distribution of the carbon benefits among the land and/or resource users: a national approach may lead to income at government level when the credits for emission reductions are put into the system, but the efforts to reduce emissions are always made at the local level and land or resource users will thus always be affected (Trines *et al*, 2006). These issues will be of particular concern in the case of countries suffering from weak governance. Examining some relevant governance indicators (government effectiveness, regulatory quality, rule of law and control of corruption, as defined by the World Bank) of the eight countries identified by Grieg-Gran (2006) and cited by Stern (2006) as being responsible for 70% of the total emissions from land use change, it becomes obvious that most of them (with the exception of Malaysia and, to some extent, Brazil and Congo) are facing important governance challenges (Table 7) which hinder their capacity to implement effectively a national approach, at least in the short term. Moreover, as shown in Figure 4, some of the countries with the highest potential carbon income per GDP from REDD appear to have severe governance issues (Ebeling, 2007).

Figure 4. Governance indicators and potential carbon income per GDP from REDD

Source: Ebeling (2007)

Furthermore, it is difficult to envisage that private investors – critical to achieve the level of funding needed - would be willing to share the risk of potential policy failure by directly supporting government programs. It is therefore unlikely that the private sector would participate in a REDD mechanism that links investment risk to government and institutional performance. In a system in which the allocation of funds and potential carbon credits takes place through host country governments, the political and legal risk of the mechanism will be considered too high as to attract private finance (Pedroni *et al*, 2007).

Table 7. Recent trends (from 2002 to 2005) in selected governance indicators for the eight countries representing 70% of total emissions from land use identified by Stern (2006)*

Country/ Governance Indicator	Year	Bolivia	Brazil	Cameroon	Congo D. R.	Ghana	Indonesia	Malaysia	PNG	AVG
Government Effectiveness[1]	2005	23.9 ↓	55.0↑	21.5↓	1.0↓	53.6	37.3↑	80.4↓	16.7↓	36.18↓
	2002	35.4	53.6	25.8	1.4	54.5	34.0	80.9	21.5	38.39
Regulatory Quality[2]	2005	32.7↓	55.0↓	23.3↑	4.5↑	49.5	36.6↑	66.8↓	19.8↓	36.03↓
	2002	47.8	61.1	21.7	4.4	44.3	23.6	67.5	35.5	38.24
Rule of Law[3]	2005	27.1↓	43.0↓	15.5↑	1.0 ↔	48.3	20.3↑	66.2↑	18.8↑	30.03↑
	2002	29.8	43.3	10.1	1.0	49.0	18.3	64.4	14.9	28.85
Control of Corruption[4]	2005	23.6↑	48.3↓	8.4↓	3.0↑	45.3	21.2↑	64.5↓	12.8↓	28.39↓
	2002	22.5	54.4	10.8	2.0	44.6	6.9	66.7	25.0	29.11

* This table shows the percentile rank on each governance indicator. Percentile rank indicates the percentage of countries worldwide that rate below the selected country (subject to margin of error). Higher values indicate better governance ratings. Percentile ranks have been adjusted to account for changes over time in the set of countries covered by the governance indicators.

1 *Government effectiveness* measures the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies

2 *Regulatory quality* measures the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development

3 *Rule of law* measures the extent to which agents have confidence in and abide by the rules of society, in particular the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence

4 *Control of corruption* measures the extent to which public power is exercised for private gain, including petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

Source: WGI: Worldwide Governance Indicators Country Snapshot, World Bank (2006)

In contrast to the national approach, many Parties, amongst them Costa Rica and other Latin American countries, have underlined the importance of adopting flexible approaches for the immediate participation of all interested developing countries in an international mechanism to reduce emissions from deforestation, yet recognizing that these efforts should eventually lead to the implementation of national approaches by all countries. Consequently, they have proposed that countries should be able to choose the scale of their REDD efforts, going from the project to the national level and including any intermediate option (municipality or state levels, for instance).

In addition to the requirements presented above regarding national approaches, implementing this proposal would entail addressing issues associated to the development of activities to reduce emissions at a sub-national level, particularly leakage. In this case, the institutional capacities required to participate in the mechanism would obviously depend on the scale selected to carry out emissions reduction activities, but would unlikely be inferior to those presently needed for the CDM, namely, the establishment of a DNA. Municipality and state level activities would probably require of simpler versions of the carbon infrastructure described for national ones or, alternatively, the capacities associated to the development of programs of activities under the CDM.

6.2.2. Baselines

Bolivia[16] and Brazil, both of which have proposed a national approach with a baseline-and-credit system, have specified that reference emissions levels should be estimated based on historic emissions rates. Brazil calculates the reference emissions rate on the basis of the emissions from deforestation in the last ten years, underlining that a minimum of 4 representative years needs to be assessed, whereas Bolivia has not specified a minimum period. The use of historic rates to establish baselines is similar to the Annex I base year determination, but it bears the same risk, namely the creation of excess emission allowances ("hot air") - particularly if there is evidence that deforestation is likely to decline in any of the large remaining tropical forest areas.

For instance, the rate of deforestation may be related to the amount of forest remaining and its location: a slowing down of deforestation rates may reflect nothing more than the increasing cost of reaching what is left (Skutsch *et al*., 2006). Moreover, deforestation dynamics and the timing of deforestation differ greatly amongst countries and even within countries. It will therefore make a great difference which base period is chosen in order to estimate a baseline. If one particular base year or base year period was set for all countries that wish to participate, one group of countries will always be put at a disadvantage: those that had low deforestation rates in the base year or base period. These problems are further aggravated by the fact that land-use change and carbon stock data for most developing countries is very incomplete, which could undermine the expected environmental benefits of national approaches. Further, national baselines are also rejected by many developing countries on the basis that they could be a "back-door" way to coerce developing countries into a regime of quantified emission reduction targets (Schwarze *et al*, 2002). As an alternative or complement to the establishment of baselines, Vanuatu has proposed a carbon stock approach, through which a finite number of carbon credits is allocated to participating countries that represent the tons of carbon stored in a country's forestry resources in a base year (UNFCCC 2007).

No standard methods currently exist to estimate avoided deforestation project baselines. Pilot projects that currently receive carbon credits have used a number of different approaches, amongst them: a) extrapolation into the future of past trends; b) hypothetical future scenarios; c) prevailing technology or practice; and d) simple logical arguments based on adjusting observed trends (De Jong *et al*. 2005). However, it has been argued that none of the methods allow an objective assessment of whether the baseline is appropriate to the area in question or provide a measure of how accurate the prediction is likely to be (ibid.). Spatial statistical models are considered very appropriate to identify and evaluate the relationship between deforestation and spatially-explicit explanatory variables such as accessibility and pressure on land (e.g. Chomitz and Gray 1995; Cropper *et al*. 2001; Deininger and Minten 1996; Mamingi

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[16] In a joint submission with Central African Republic, Costa Rica, Democratic Republic of the Congo, Dominican Republic, Fiji, Ghana, Guatemala, Honduras, Kenya, Madagascar, Nicaragua, Panama, Papua New Guinea, Samoa, Solomon Islands, Vanuatu (see Table 6).

et al. 1996; Mertens and Lambin 2000; Nelson and Hellerstein 1997). These models are well suited for predicting where deforestation will occur and generally involve large samples and reasonably reliable data (Mertens *et al*. 2002). While such models say little about what tools are likely to be effective in preventing deforestation (Cropper *et al*. 2001), they suggest where deforestation will likely take place in the future if the spatially explicit conditions remain similar (De Jong *et al*. 2005).

6.2.3 Additionality

In general, Parties have not addressed the issue of additionality in their submissions. However, it can be deducted from the existing proposals that all the emission reductions achieved under a national baseline-and-credit scheme would automatically qualify as additional. This interpretation of additionality, nevertheless, contrasts with the one used so far in the context of CDM, where the additionality of projects is not demonstrated solely by the reduction of emissions below the baseline, but by the demonstration that the actions carried out to decrease emissions are themselves additional. Following this line of thought, countries would have to show that the emission reductions linked to a particular policy or measure would not have been carried out in absence of the national REDD scheme. This would avoid the generation of non-additional credits due to the process of “forest transitions” mentioned before. For subnational approaches, a modified version of the “tool for the demonstration of additionality” for CDM A/R projects could be applied.

6.2.4. Leakage

The application of approaches at a national scale for the detection of land-use change would mean that losses in one area could be balanced against gains in other areas, thus controlling leakage[17]. Even though this does not entirely solve the leakage problem, since the issue of international leakage remains, it has been argued that international leakage will diminish if more countries participate (Skutsch *et al*., 2006). Nevertheless, as mentioned above, wide spread participation of developing countries in national schemes in the short and medium term is not likely to happen due to the existing lack of capacities. Therefore, limiting the participation of such countries exclusively to national approaches could generate more international leakage than other more flexible approaches allowing for a wider participation even if at smaller scales. Likewise, it could be argued that the global environmental benefit of a flexible approach could be larger than that of a national scheme limited to a handful of countries with the required capacities in place.

It is often argued that LULUCF projects are more difficult to measure and monitor and have greater leakage of GHG benefits than energy sector projects. Nevertheless, a review of projects in the energy and LULUCF sectors assessed critical technical issues associated to projects, including baselines and leakage, and found that LULUCF and energy projects face parallel, comparable issues in measurement and in ensuring social and environmental benefits (IPCC, 2000). In general, it is thus not possible to assert that energy projects are superior as a class to LULUCF projects on these grounds. Additionally, there is no concrete evidence that any one type of forestry project is more or less susceptible to leakage than others. In fact, leakage can be considered a consequence of project-specific activities, and not of broad categorical groupings, and consequently there is no apparent and compelling reason to discard any one type of climate change mitigation option based solely on leakage (Schwarze *et al*. 2002).

In REDD projects leakage risk will depend on project design and local conditions. Options for responding to leakage at the project level include: site selection, project design, leakage contracts and monitoring. Additionally, several approaches are available for managing leakage that does occur in an affordable and sufficiently accurate manner. First, monitoring beyond the project boundaries for selected indicators of leakage is one practical solution. Second, discount factors may be applied in the short term. Moreover, projects that have an appealing leakage profile – that minimize negative unintended consequences while promoting positive ones – could also be granted a preferential treatment in the process of approval and monitoring to reward efforts in project-design (Schwarze *et al*, 2002). Nevertheless, it is mostly certain

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[17] Leakage is defined by the IPCC´s Special Report on LULUCF as the unanticipated decrease or increase in GHG benefits outside of the project's accounting boundary (the boundary defined for the purposes of estimating the project's net GHG impact) as a result of project activities.

that if a conservation project does not address the underlying drivers of deforestation, activities may shift outside project boundaries and thus leakage will need to be accounted.

6.2.5. Monitoring

The ability to quantify and verify tropical deforestation is critically important for assessing carbon credits from reduced deforestation. Key elements of a possible monitoring system include its ability to measure changes throughout all forested area within a country, use consistent methodologies at repeated intervals to obtain accurate results, and verify results with ground-based or very high-resolution observations (Herold *et al*. 2006). Nationwide monitoring of changes in forest or non-forest vegetation cover is required if accurate national accounting is to be attained. In particular, the full forested area of the country needs to be represented so as to account for leakage. For countries with a small forested/vegetated area, change in cover may be tracked on the ground. However, when forest or non-forest vegetation areas occupy hundreds of thousands of hectares, then the costs of ground tracking are elevated and accuracy is lowered. For most nations, the only practicable approach for monitoring changes in forest and vegetation cover at the national scale is through the interpretation of remotely sensed imagery (including both airborne and satellite imagery). Furthermore, transition points from intact to non-intact forest are hard to determine by remote sensing as a canopy may still be closed, whilst the carbon stocks may well be reduced by 75% (UNFCCC 2006a).

A variety of remote sensing methods can be applied depending on national capabilities, available resources, deforestation patterns and forest characteristics, but the key constraints in implementing national systems for monitoring changes in forest cover are cost and access to data at the appropriate resolution. Where cost is reasonable and/or the area to monitor is small, then wall-to-wall coverage with high resolution imagery such as Landsat or even with airborne imagery will provide a high level of certainty to estimate land use change (UNFCCC (2006)).

The alternative to wall-to-wall coverage is sampling**.** With respect to sampling remotely, one approach is to use a 'hierarchical nested approach' using medium to coarse resolution imagery (DeFries *et al*. 2002, 2006, Morton *et al*. 2005), whereby coarse resolution imagery is used to identify areas of rapid land use change that then become the focus of further study with higher resolution imagery. Furthermore, Chomitz (2006) points out that there are economies of scale in sampling as the accuracy of the estimate depends on the size and representativeness of the sample, and not on the size of the population. Consequently, costs of monitoring deforestation at a rather coarse scale to pick up 25 ha patches would not differ so much by country and could be as little as US$2 million per year. However, he recognizes that this would not serve for an accurate assessment of changes in carbon stock but would be an important part of an implementation strategy (Chomitz pers comm. cited by Grieg-Gran, 2006). This lack of accuracy could, in any case, have important implications on the possibility of including national approaches in the carbon market. Moreover, even though monitoring deforestation at the national level is often assumed to be less uncertain than at the project level, as in many developing countries national data on rates of deforestation and corresponding carbon stocks are poorly known. In these cases, it probably makes more sense to develop regional baselines at sub-national administrative levels (DeFries *et al*, 2005)

The project approach, in contrast, can be more promising. The IPCC Special Report on LULUCF (2000) suggests that land-use and forestry projects are easier to quantify and monitor than national inventories because of the clearly defined boundaries for project activities, the relative ease of stratification of the project area, and the choice of carbon pools to measure, although larger projects (at the state level, for example) might encounter difficulties similar to those faced by national inventories. Techniques and methods for sampling design and for accurately and precisely measuring individual carbon pools in LULUCF projects are based on commonly accepted principles of forest inventory, soil sampling, and ecological surveys. However, standard methods have not been universally applied to all projects, and methods of accounting for carbon benefits have not been standardized, thus resulting in some difficulties when comparing results across different LULUCF projects.

The IPCC report (ibid) also points out that although techniques and tools exist to measure carbon stocks in project areas to a high degree of precision, the same level of precision for carbon benefits may not be achieved. As the difference between the with and without project cases decreases, the percentage error of the carbon benefit increases, and in the case of avoided deforestation projects the carbon benefit per unit area is usually high. To reduce this error, monitoring can be designed to measure the change in carbon stocks directly. Additionally, remote sensing can provide a useful means to monitor LULUCF projects.

The costs of measuring and monitoring REDD projects are thus a function of the desired level of precision - which may vary by the type of project activities -, the size of the project, whether the project area is a contiguous or dispersed bundle of small landowners, and the natural variation within the various carbon pools. The IPCC report (2000) provides some preliminary estimates of costs for measuring and monitoring of carbon in LULUCF projects in tropical countries. For instance, in the case of the Noel Kempff Project in Bolivia, the total cost was about $350,000. The precision of the inventory, based on sampling error only, was ±4 percent with 95-percent confidence. Estimates of the revised carbon benefits from this project for its duration based on additional measurements and data collection and the additional cost to collect this information result in an estimate of about $0.10/tC. Moreover, future monitoring costs are likely to decrease because different sampling intensities will be used, project implementers can build on previous experience, and advances in technology will be available. In the Costa Rica's Private Forestry Project (PFP), the organization responsible for monitoring carbon sequestration and for acquiring remote-sensing information has an annual budget of $200,000 (Subak, 2000). Additional costs relate to the costs of monitoring forests and plantations on-site, including visits by forest engineers as well as more detailed audits of some sites (approximately a 5%). The labor costs for auditing are estimated to be $10 ha^{-1} yr^{-1}, compared to $1 ha^{-1} yr^{-1} for monitoring and $2 ha^{-1} yr^{-1} for certification. The aggregate costs of project development, recruiting, and auditing are significant, but they have not been judged to be excessive or to reverse the cost-effectiveness of the PFP as a LULUCF project.

6.2.6. Permanence

Parties have so far proposed mainly two options to deal with the permanence issue, applicable to approaches at any scale. Brazil, on the one hand, requires countries to convert any increase in their emissions from deforestation above the reference emissions rate into a debit from future financial incentives. Although this alternative may provide a simple solution to deal with permanence, it could also discourage the participation of countries with poor performance, particularly at the initial stages when capacities would still be in the process of being established or strengthened. As a consequence, fewer countries may be able to effectively participate, and a smaller amount of emissions would be reduced globally in the short term.

The second option on the table to deal with permanence is the use of temporary Certified Emissions Reductions (tCERs), which would mean that the onus would be on the buyer of the carbon credits to renew them on a regular basis, as currently is the case of afforestation and reforestation projects in the CDM. Temporary credits however have an uncertain value (the only certainty being that they will be worth less than CERs (Schlamadinger *et al*. 2005), which has so far limited their attractiveness. The use of tCERs would, on the other hand, imply that the REDD framework results in another Kyoto-type mechanism which does not lead to any further commitments by non-Annex I countries (ibid.).

6.2.6. Equity

The implementation of national approaches as an exclusive instrument to provide incentives to reduce emissions from deforestation in developing countries could have negative equity implications. These would arise from the general lack of capacities in most developing countries to successfully implement such an approach in the near future and the impossibility of obtaining incentives for smaller contributions more in line with their current situation. The resources (including international support) and time that have been required to put in place operational Designated National Authorities (DNAs) for the CDM in many developing countries – a relatively simpler institution than those required for controlling national GHG emissions from deforestation – provide an idea of the effort and time that would be necessary to establish the “carbon infrastructure” drawn in Box 1. Likewise, under an exclusive national approach, countries with large forest areas and those currently suffering mostly from degradation would be in a disadvantageous situation, since they would require more expensive monitoring methods. Moreover, even though – as argued by countries supporting national approaches – the use of the IPCC Good Practice Guidance and Guidelines for National Inventories could facilitate the estimation of emissions from deforestation at the national level, those countries with less capacities would have to rely on default values, by definition conservative. Under a carbon market scenario, this might imply that these countries could receive fewer incentives (carbon credits) for the same reduction effort than a country with available data and country-specific carbon content values.

In contrast, allowing for a series of different approaches according to existing capacities would allow for a broader participation in international REDD efforts. Equity concerns associated to this alternative could be expected to be similar to those currently experienced by the implementation of CDM projects. A number of authors have suggested means by which the CDM and similar mechanisms can be constructed in order to ensure poverty and pro-poor development benefits, such as geographical quotas, simplified methodologies for small scale activities, and the creation of niche markets for ethically motivated investments where sustainable development are prioritized (Brown *et al*. 2004).

Finally, it is worth noting that, in addition to the mechanisms presented above, Parties have unanimously underlined that international support for capacity building and pilot activities is urgently needed. Indeed, the analysis of approaches presented here makes obvious that none of the proposed options will achieve the expected environmental and sustainable development goals in an equitable manner if they are not supported by substantive capacity building efforts, including support for policy design. Some encouraging initiatives have recently emerged as a consequence of the discussions within the framework of the UNFCCC, such as the World Bank's Forest Carbon Partnership Facility (FCPF) and Australia's Global Initiative on Forests and Climate (GIFC). Some Parties have also suggested the creation of a "stabilization fund" with the aim of supporting countries with low rates of deforestation. The operational details of this fund have not been published, but proposed sources of funding include voluntary contributions and levies identical to those proposed for the Avoided Deforestation Carbon Fund noted above.

7. CONCLUDING REMARKS

Deforestation in developing countries contributes to a significant share of global GHG emissions. However, specific mechanisms and incentives to address emissions from deforestation are currently lacking in the international climate change regime. Quantifying these emissions involves large uncertainties, both at the global, national and project levels, mainly due to a lack of monitoring capacities and accurate data on carbon stocks. Reducing emissions from deforestation seems a cost–effective mitigation option entailing a number of additional environmental and social benefits.

Current negotiations under the UNFCCC for the creation of an arrangement to provide incentives and build capacities to avoid emissions from deforestation have resulted in a series of proposals on innovative sources of funding, incentives mechanisms and capacity building activities. Incentives mechanisms applicable to a broad range of scales (from project to countries) may be able to generate some emissions reductions in the short term.

The expected creation of capacities through the establishment of a REDD-specific fund under the UNFCCC (or the enhancement of an already existing one), together with initiatives from Annex I countries (e.g., Australia's GIFC) and multilateral organizations (such as the FCPF of the WB) may provide the basis for these initial efforts in a number of countries. Likewise, the inclusion of REDD activities in the CDM or another carbon market mechanism under the UNFCCC may constitute an incentive for the private sector to support additional conservation and sustainable forest management projects. Yet equity concerns related to market instruments should be effectively and timely addressed, e.g., by putting special emphasis on capacity building efforts in forested countries with the least capacities and, wherever possible, by promoting synergies with adaptation measures and resources.

However, in order to significantly reduce deforestation and realize the full potential of REDD as a climate change mitigation option, effective actions at the national level to foster structural changes in the LULUCF and development sectors will be needed. We have shown that economic factors and policy frameworks constitute the main drivers of land-use change. In fact, misguided governmental policies and corruption have been among the major drivers of deforestation (in part because of the influence of large logging and timber trading companies), and even those governments willing to design and implement appropriate regulations tend to face severe capacity problems when it comes to their enforcement (Fuchs 2006). Therefore, in addition to strengthening developing countries´ technical and institutional capacities, effectively addressing governance weaknesses will be paramount for the success of national scale REDD initiatives. Nevertheless, improving governance in developing countries implies a lengthy effort surpassing the climate change and even the environmental agendas, making it difficult to foresee massive emissions reductions from avoided deforestation in the short-term.

We should seek further coordination among international and sources of funding for development and segments of the International Environmental Regime, including hard and soft legal instruments (e.g., the UNFCCC, the Convention on Biological Diversity, the UN Forum on Forests), and private certification instruments (e.g., Forest Stewardship Council), and across international governance regimes, such as the World Trade Organization. As Humphreys (2006) argues, unless a harmonization of the values and objectives behind forest and biodiversity conservation across international regimes takes place, it is likely that the interests of private corporations and developers will continue to prevail, thus rendering forest conservation a panacea. Therefore, placing excessive enthusiasm on an international climate policy framework to halt large-scale land-use change in the short term would be misguided, as governance issues remain the central challenge we should collectively address and reflect upon.

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