Tropical Forests and Climate Change Mitigation: The Global Potential and Cases from the Philippines

Rodel D. Lasco
World Agroforestry Center (ICRAF), Philippines
Email: r.lasco@cgiar.org

ABSTRACT

The Intergovernmental Panel on Climate Change IPCC Fourth Assessment report has highlighted the role of tropical forests in mitigating climate change. Deforestation, especially in tropical countries, contributes about 20 percent to total global greenhouse gas emissions. Development projects geared to reduce the rate of deforestation and forest degradation, and to establish forest plantations will help reduce greenhouse gases in the atmosphere, and significantly contribute to mitigating climate change. Three cases of forestry carbon projects underway in the Philippines are presented to illustrate the constraints facing project developers in undertaking these climate change mitigation efforts. Among the key lessons identified are: the difficulty in establishing land eligibility, the need for partners or buyers from industrialized countries to shoulder the transaction costs, and the crucial role of the local communities, including indigenous peoples, in the development effort.

INTRODUCTION

Tropical forests are among the most valuable ecosystems in the world. Although covering less than 10 percent of the earth's land area, they harbor the largest terrestrial reservoir of biological diversity, from the gene to the habitat level. More than 50 percent of known plant species grow in tropical forests (Mayaux et al. 2005). They are also vital in regulating climate change, being storehouses of vast amounts of carbon in the biomass, necromass, and soil. In addition, more than 800 million people depend on tropical forests for fuel, food, and income (Chomitz 2007).

In spite of their recognized importance, tropical forests are undergoing rapid land use changes, including deforestation, as a result of agricultural expansion, commercial logging, plantation development, mining, industry, urbanization, and road building (Chomitz 2007; Achard et al. 2002; Geist and Lambin 2002). Population pressure, expansion of small-scale agriculture, and shifting cultivation are commonly cited as the causes of tropical deforestation. This trend has adverse impacts on biodiversity resources, water resources, rural livelihoods, and climate regulation.

This paper aims to provide policymakers and scientist from other fields with sufficient background on the key role of tropical forests in the climate change mitigation, as well as examine the progress of three ongoing climate change mitigation forestry projects in the country. The paper specifically highlights the global distribution and trends concerning tropical forests and an overview of their role in addressing climate change. Also, based on case studies of forestry mitigation projects in the Philippines, it identifies key lessons and the factors hindering the success of such efforts.

THE TROPICAL FORESTS IN THE WORLD: EXTENT AND RATE OF CHANGE

An accurate measurement of the global area of tropical forests is limited by current methods used in making global estimates, which include national inventories, statistical sampling, and remote sensing. Nevertheless, it is estimated that about half of the world's forests is located in the tropics (Grainger 2008). Recent estimates show that there are about 2,000 million hectares (M ha) of tropical forests globally (Table 1 and Table 2). The tropical rainforest is the most extensive forest type, constituting 26 percent of the global forest area, and about 60 percent of the tropical forest area (Shvidenko et al. 2005). Most rainforests are in South America (582 M ha), Africa (270 M ha), and Asia (197 M ha). Tropical rainforests are closed-canopy evergreen broadleaf forests that generally require continuous temperatures of at least 25^o C and annual rainfall of at least 1,500 mm. Tree diversity in tropical rainforests is very high, often with more than 100 tree species per hectare. Tropical moist deciduous forests cover about 510 M ha. They develop in areas with a dry season of three to five months, and vary from closed forests to open savanna forests, depending on dry-season length, human pressures, and fire regimes.

Tropical forests are undergoing massive land cover and land use changes. In the 1990s, the global deforestation rate of humid tropical rainforests was estimated at 5.8 ± 1.4 M ha (Table 3), with the largest deforestation occurring in Latin America and Southeast Asia (Table 4). The estimates, between 1990–2000, about 8.6 M ha^{-1} (Table 5). According to the Millennium Ecosystems Report, the main drivers of change in tropical forest ecosystems are habitat change and over-exploitation, and the trend is getting worse. Specifically, the direct causes of tropical deforestation are: agricultural expansion, wood extraction, and infrastructure expansion (Kanninen et al. 2007), while the underlying causes of deforestation include the following: macroeconomic factors (e.g. trade policies), governance factors (e.g. property rights), cultural factors, and demographic factors.

TROPICAL FORESTS AND THE CARBON CYCLE

Terrestrial ecosystems are vital to the global carbon cycle (Figure 1). It is estimated that about 60 Gigatons of carbon (Gt C) is exchanged between terrestrial ecosystems and the atmosphere every year, with a net terrestrial uptake of about –0.9 ± 0.6 Gt C per year for 2000 to 2005 (Denman et al. 2007). The world's tropical forests are estimated to contain 428 Gt C in vegetation and soils.

Table 1. Tropical forest areas derived from the GLC 2000 map*, from the FRA-2000 national statistics and from the FRA-2000 remote sensing survey*** (All figures are in 10^6 ha).**

	GLC 2000 (TREES) M ha			**FRA CS M ha**		**FRA RS M ha**
	Humid tropical forests	Dry tropical forests	Flooded tropical forests	Closed forest	Open forest	Forest
South America	630.5	146.7	25.3	858.3	68.9	780.2
Africa	232.7	415.1	13.1	352.7	288.9	518.5
Asia	230.6	144.8	13.5	416.2	58.3	272.2
Global	1093.8	706.6	51.9	1627.2	416.1	1571.9

Notes: The GLC (Global Land Cover) 2000 and FRA (Forest Resource Assessment) CS statistics presented here cover only the tropical countries; the FRA RS estimates refer to the areas covered by the forest definition, which include the closed forest, open forest, long fallow, and one third of the fragmented forest.
* Bartholome and Belward 2004
FAO 2001; table 5* from Mayaux *et al.*, 2005

Table 2. Natural forest area in 90 tropical countries* (1980–2005) (All figures are in 10^6 ha.).

Location	FRA 1980	"FRA 1982"	FRA 1990		FRA 2000		FRA 2005		
	1980	1980	1980	1990	1990	2000	1990	2000	2005
Africa	703	703	569	528	684	629	672	628	607
Asia-Pacific	337	337	350	311	307	265	342	312	296
Latin America**	931	896	992	918	936	905	934	889	865
Totals***	1,970	1,935	1,910	1,756	1,926	1,799	1,949	1,829	1,768
No. of countries	76	76	90	90	90	90	90	90	90

*Except for FRA 1980 and "FRA 1982" (a summary of FRA 1980 containing revised estimates). For continuity, East Timor is aggregated with Indonesia, and Eritrea is aggregated with Ethiopia throughout 1980-2005.
**Includes the Carribean, Central America, and South America.
***Totals may not match subtotals due to rounding.
Source: Forest Resources Assessments (FRAs) 1980, 1980 (1982 revision), 1990, 2000, and 2005 (from Grainger, 2008).

Table 3. Humid tropical forest cover estimates for the years 1990 and 1997 and mean annual change estimates for the 1990–1997 period (All figures are in 10^6 ha.).

	Latin America	Africa	Southeast Asia	Global
Total study area	1155	337	446	1937
Forest cover in 1990	669 ± 57	198 ± 13	283 ± 31	1150 ± 54
Forest cover in 1997	653 ± 56	193 ± 13	270 ± 30	1116 ± 53
Annual deforested area	2.5 ± 1.4	0.85 ± 0.30	2.5 ± 0.8	5.8 ± 1.4
Rate	0.38%	0.43%	0.91%	0.52%
Annual regrowth area	0.28 ± 0.22	0.14 ± 0.11	0.53 ± 0.25	1.0 ± 0.32
Rate	0.04%	0.07%	0.19%	0.08%
Annual net cover change	-2.2 ± 1.2	-0.71 ± 0.31	-2.0 ± 0.8	- 4.9 ± 1.3
Rate	0.33%	0.36%	0.71%	0.43%
Annual degraded area	0.83 ± 0.67	0.39 ± 0.19	1.1 ± 0.44	2.3 ± 0.71
Rate	0.13%	0.21%	0.42%	0.20%

Notes: Sample figures were extrapolated linearly to the dates 1 June 1990 and 1 June 1997. Average observation dates were February 1991 and May 1997 for Latin America, February 1989 and March 1996 for Africa, and May 1990 and June 1997 for Southeast Asia. Estimated ranges are at the 95% confidence level (from Archard *et al.* 2002).

The loss of tropical forests, as described above, is the major driver of the CO_2 flux caused by land use changes during the past two decades. The 2007 IPCC Fourth Assessment Report reviewed various estimates of the magnitude of greenhouse gas emissions from this process (Table 6). The best estimate of the IPCC is that land use, land-use change and forestry (LULUCF) activities, mainly tropical deforestation, contributed 1.6 Gt C/yr of anthropogenic emissions in the 1990s (Denman et al. 2007). There is still much uncertainty on the size of the contribution of land use processes to greenhouse gas emissions in general. Indeed, the land use carbon source has the largest uncertainties in the global carbon budget.

The FAO forest resources assessment shows that globally, carbon stocks in forest biomass decreased by 1.1 Gt of carbon annually between 1999 and 2005, owing to continued deforestation and forest degradation. This has been partly offset by forest expansion (including

Table 4. Annual deforestation rates, as a percentage of the 1990 forest cover, for selected areas of rapid forest cover change (hot spots) within each continent.

Hot-spot areas by Continent	Annual deforestation rate (%) of sample sites within hot-spot area (range)
Latin America	0.38
Central America	0.8–1.5
Brazilian Amazonian belt	
Acre	4.4
Rondoˆnia	3.2
Mato Grosso	1.4–2.7
Para´	0.9–2.4
Colombia-Ecuador border	~1.5
Peruvian Andes	0.5–1.0
Africa	0.43
Madagascar	1.4–4.7
Coˆte d'Ivoire	1.1–2.9
Southeast Asia	0.91
Southeastern Bangladesh	2.0
Central Myanmar	~3.0
Central Sumatra	3.2–5.9
Southern Vietnam	1.2–3.2
Southeastern Kalimantan	1.0–2.7

Source: Archard et al. 2002.

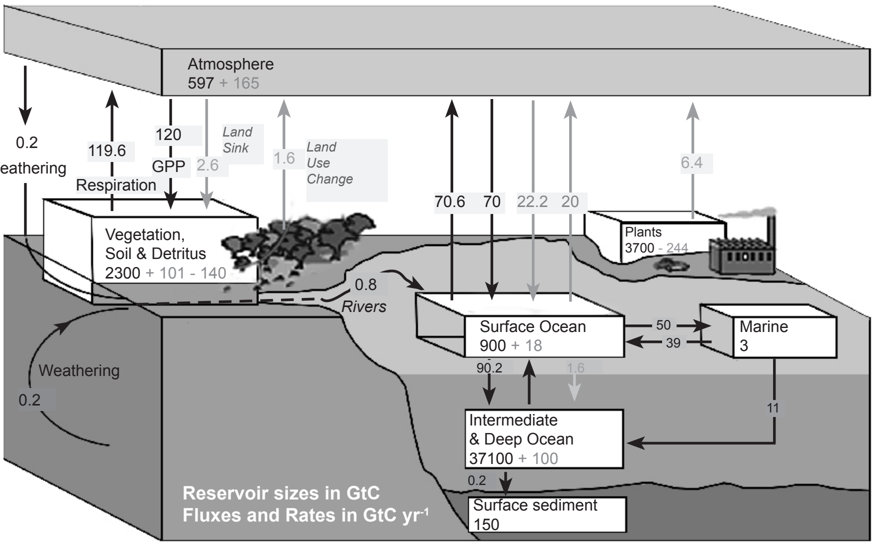


Figure 1: The global carbon cycle for the 1990s, showing the main annual fluxes in GtC yr–1

Note: Pre-industrial 'natural' fluxes are in black and 'anthropogenic' fluxes in gray.
Sources: The figure is modified from Sarmiento and Gruber (2006), with changes in pool sizes from Sabine et al. (2004) (from the IPCC Fourth Assessment Report, Denman et al. 2007).

Table 5. Humid tropical forest cover estimates for the TREES II project, the FRA 2000 programme, and the AVHRR time-series analysis.

	Latin America	Africa	Southeast Asia	Pan-tropical
TREES (1990-1997) – *humid tropical forests*				
Forest cover in 1997 (10^6 ha)	653	193	270	1116
Net annual deforested area (10^6 ha)	2.2 ± 1.2	0.7 ± 0.3	2.0 ± 0.8	4.9 ± 1.3
Annual regrowth area (10^6 ha)	0.28 ± 0.22	0.14 ± 0.11	0.53 ± 0.25	1.0 ± 0.32
Annual degraded area (10^6 ha)	0.83 ± 0.67	0.39 ± 0.19	1.1 ± 0.44	2.3 ± 0.71
Mean deforestation rate (%)	0.33	0.36	0.71	0.43
FRA 2000 Remote Sensing Survey (1990-2000)				
Forest cover in 2000 (10^6 ha)	780	519	272	1571
Net annual deforested area (10^6 ha; all tropical forests)	4.2 ± 1.1	2.1 ± 0.4	2.3 ± 0.6	8.6 ± 1.3
Mean deforestation rate (%)	0.51	0.34	0.79	0.52
Net annual deforested area (10^6 ha; all humid tropical forests)	-	-	-	-
FRA 2000 Country Survey (1990-2000)				
Net annual deforested area (10^6 ha)	2.7	1.2	2.5	6.4
AVHRR Pathfinder (1990s)				
Net loss of tree cover, calibrated to Landsat-based studies (10^6 ha)	3.18 (1.69-4.04)	0.38 (0-0.66)	2.01 (0.82-3.17)	5.56 (2.51-7.87)

[a] Area estimates can differ from Table 2 because the TREES and GLC 2000 domains are different in Africa (Angola, Ethiopia and East Africa are not included in the TREES domain) and because semi-deciduous forests (dry dipterocarp forests) are included in the TREES study in Asia, Latin America also included Central America in this table.
[b] The FRA RS estimates refer to forest definitions, which includes closed forest, open forest, long fallow and one third of fragmented forest.
[c] Only the national statistics of the countries covering the TREES domain are included in the current table.

Source: Mayaux et al. 2005.

planting) and an increase in growing stock per hectare in some regions (FAO 2006). Carbon stocks in the forest biomass in Africa, Asia and South America decreased, but increased in all other regions.

The long-term capacity of the world's forest to store carbon is much less than the annual net primary productivity. This is because the carbon initially sequestered will also be released through various processes such as the death of trees and the decomposition of litter (Figure 2). Therefore, there is a need to distinguish between the following measures of productivity (Bolin and Sukuman 2000):

- Gross Primary Production (GPP) – the total amount of carbon fixed in the process of photosynthesis by plants in an ecosystem, such as a stand of trees. GPP is measured on photosynthetic tissues, principally leaves.
- Net Primary Production (NPP) – the net production of organic matter by plants in an ecosystem, or GPP reduced by losses resulting from the respiration of the plants (autotrophic respiration).
- Net Ecosystem Production (NEP) – the net accumulation of organic matter or carbon by an ecosystem; NEP is the difference between the rate of production of living organic matter (NPP) and the decomposition rate of dead organic matter (heterotrophic respiration, RH). Heterotrophic respiration includes losses

Table 6. Land to atmosphere emissions resulting from land use changes during the 1990s and the 1980s (GtC yr–1).*

	Tropical Americas	Tropical Africa	Tropical Asia	Pan-Tropical	Non-tropics	Total Globe
1990s						
Houghton (2003)[a]	0.8 ± 0.3	0.4 ± 0.2	1.1 ± 0.5	2.2 ± 0.6	-0.02 ± 0.5	2.2 ± 0.8
Defries et.al. (2002)[b]	0.5 (0.2 to 0.7)	0.1 (0.1 to 0.2)	0.4 (0.2 to 0.6)	1.0 (0.5 to 1.6)	n.a.	n.a.
Achard et.al. (2004)[c]	0.3 (0.3 to 0.4)	0.2 (0.1 to 0.2)	0.4 (0.3 to 0.5)	0.9 (0.5 to 1.4)	n.a.	n.a.
AR4[d]	0.7 (0.4 to 0.9)	0.3 (0.2 to 0.4)	0.8 (0.4 to 1.1)	1.6 (1.0 to 2.2)	-0.02 (-0.5 to +0.5)	1.6 (0.5 to 2.7)
1980s						
Houghton (2003a)[a]	0.8 ± 0.3	0.8 ± 0.2	0.9 ± 0.5	1.9 ± 0.6	0.06 ± 0.5	2.0 ± 0.8
DeFries et.al. (2002)[b]	0.4 (0.2 to 0.5)	0.1 (0.08 to 0.14)	0.2 (0.1 to 0.8)	0.7 (0.4 to 1.0)	n.a.	n.a.
Macguire et.al. (2001)[e]				0.6 to 1.2	-0.1 to +0.4	(0.6 to 1.0)
Jain and Yang (2005)[f]	0.22 to 0.24	0.08 to 0.48	0.58 to 0.34	-	-	1.33 to 2.06
TAR[g]						1.7 (0.6 to 2.5)
AR4[d]	0.6 (0.3 to 0.6)	0.2 (0.1 to 0.3)	0.6 (0.3 to 0.9)	1.3 (0.9 to 1.8)	0.06 (-0.4 to +0.6)	1.4 (0.4 to 2.3)

Notes:

* Positive values indicate carbon losses from land ecosystems. Uncertainties are reported as ±1 standard deviation. Numbers in parentheses are ranges of uncertainty (from the IPCC Fourth Assessment Report, Denman *et al.* 2007).

a Based on Table 2 of this source.

b Based on Table 3 of this source..

c The mean estimates are based on these authors' Table 2, with the range indicated in parentheses corresponding to their reported minimum and maximum estimates.

d Best estimate calculated from the mean of Houghton (2003a) and DeFries *et al.* (2002), the only two studies covering both the 1980s and the 1990s. For non-tropical regions where DeFries *et al.* has no estimate, Houghton has been used.

e Based on these authors' Table 5; range is obtained from four terrestrial carbon models.

f The range indicated in parentheses corresponds to two simulations using the same model, but forced with different land cover change data sets from Houghton
(2003a) and DeFries *et al.* (2002).

g In the TAR estimate, no values were available for the 1990s.

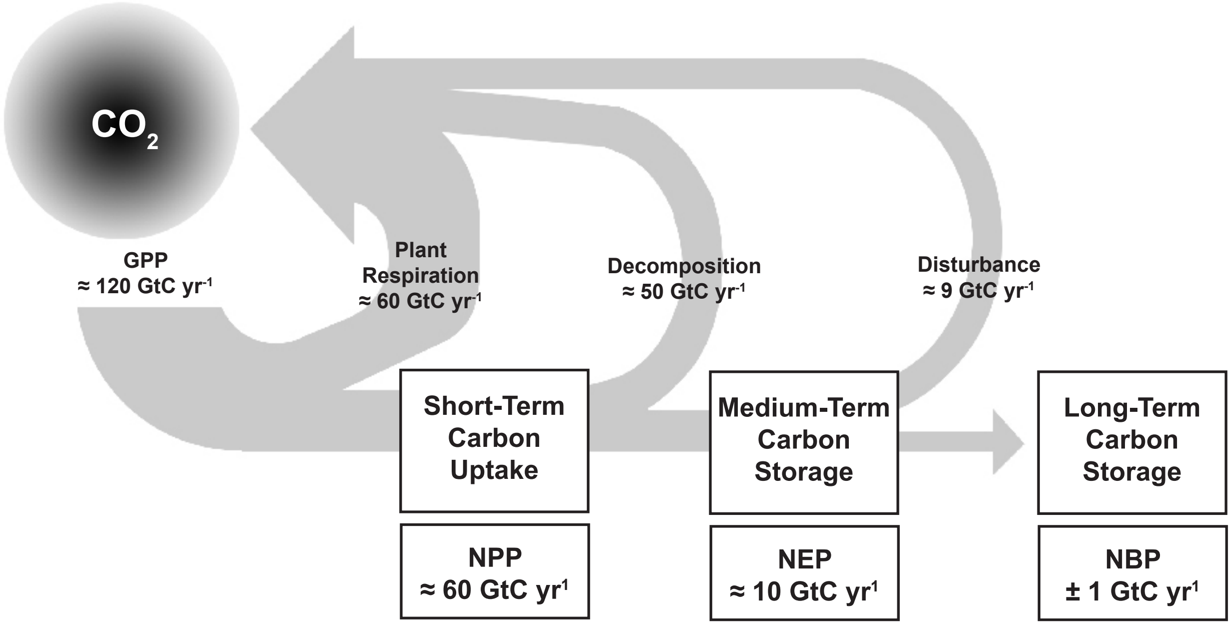


Figure 2: The global terrestrial carbon uptake (from Bolin and Sukumar 2000).

by herbivory and the decomposition of organic debris by soil biota.

- Net Biome Production (NBP) – the net production of organic matter in a region containing a range of ecosystems (a biome) and includes, in addition to heterotrophic respiration, other processes leading to loss of living and dead organic matter (harvest, forest clearance, and fire, etc.). NBP is appropriate for the net carbon balance of large areas (100–1000 km^2) and longer periods of time (several years and longer).

CHANGE MITIGATION

Deforestation, degradation, and poor forest management reduce carbon storage in forests, but sustainable forest management, planting and rehabilitation, can increase carbon sequestration (FAO 2005). It is estimated that the world's forests store 283 Gt of carbon in their biomass alone. The carbon stored in forest biomass, deadwood, litter and soil together, is about 50 percent more than the amount of carbon in the atmosphere.

The tropical region has the largest potential for climate change mitigation through its beneficial forestry activities. It is difficult to quantify the total potential of the world's tropical forests to mitigate climate change. As IPCC Fourth Assessment Report AR4 pointed out, available studies about mitigation options differ widely in terms of their basic assumptions on carbon accounting, costs, land areas, baselines, and other major parameters (Nabuurs et al. 2007). There is still a need to have more detailed estimates of the economic or market potential for mitigation options by region or country in order for policymakers to make realistic estimates of the mitigation potential under various scenarios concerning policy, carbon price, and mitigation program eligibility rule. Initial studies indicate that the largest potential is in avoiding deforestation and enhancing afforestation and reforestation, including bio-energy.

In spite of the different approaches and methods, recent studies estimate that future deforestation still remains high in the tropics. For example, Sathaye et al.

(2007) estimate that deforestation rates will continue in all regions. Africa and South America have high rates of loss, cumulatively about 600 M ha by 2050.

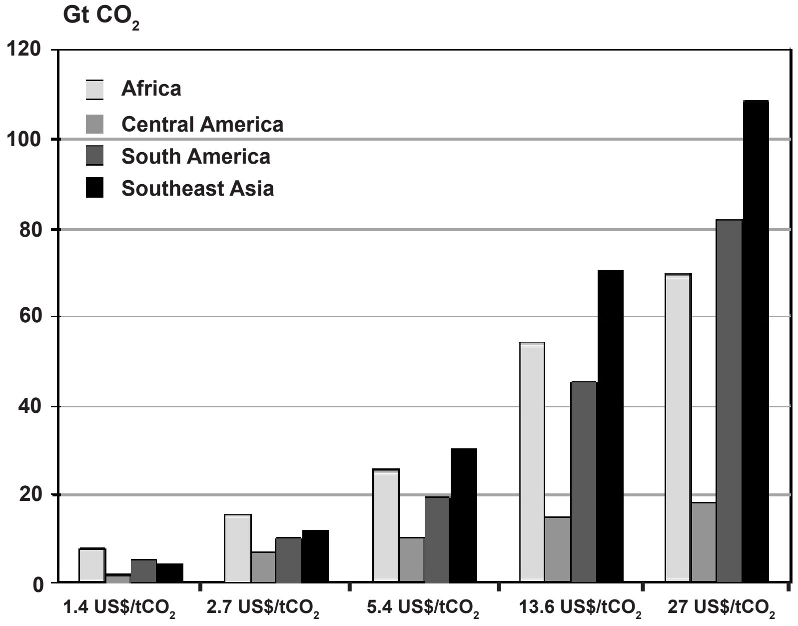
Thus, reducing deforestation is a high-priority mitigation option within the tropical regions. In addition to the significant carbon gains, substantive environmental and other benefits could be obtained from this option. To counteract the loss of tropical forests, the successful implementation of mitigation activities requires an understanding of the underlying and direct causes of deforestation, which are multiple and locally based (Chomitz et al. 2006).

In the short term (2008–2012), it is estimated that 93 percent of the total mitigation potential in the tropics will come from avoided deforestation (Jung 2005). In the long term, it is estimated that US\$27.2 /tCO$_2$ is needed to virtually eliminate potential deforestation (Sohngen and Sedjo 2006). Over 50 years, this could mean a net cumulative gain of 278,000 MtCO2 relative to the baseline and 422 M ha additional forests. The largest gains in carbon would occur in Southeast Asia, which gains nearly 109,000 MtCO2 for 27.2 US\$/tCO2, followed by South America, Africa, and Central America, which would gain 80,000, 70,000, and 22,000 MtCO2 for 27.2 US\$/tCO2, respectively (Figure 3).

Next to avoided deforestation, the establishment of new forests through reforestation and afforestation offer the second largest potential to mitigate climate change through enhanced carbon sequestration. The assumed land availability for afforestation options depends on the price of carbon and how that competes with existing or other land-use financial returns, barriers to changing land uses, land tenure patterns and legal status, commodity price support, and other social and policy factors.

Cost estimates for carbon sequestration projects for different regions show a wide range. For forestry projects in developing countries, the cost ranges from US\$0.5 – US\$7 per tCO$_2$, compared to US\$1.4 – US\$22 per tCO$_2$ for forestry projects in industrialized countries (Cacho et al. 2003; Richards and Stokes 2004).

In the short term (2008-2012), an estimate of economic potential area available for afforestation/



Source: Sohngen and Sedjo 2006 (from Nabuurs *et al.* 2007).

Figure 3: Cumulative carbon gained through avoided deforestation by 2055 over the reference case, by tropical regions under various carbon price scenarios.

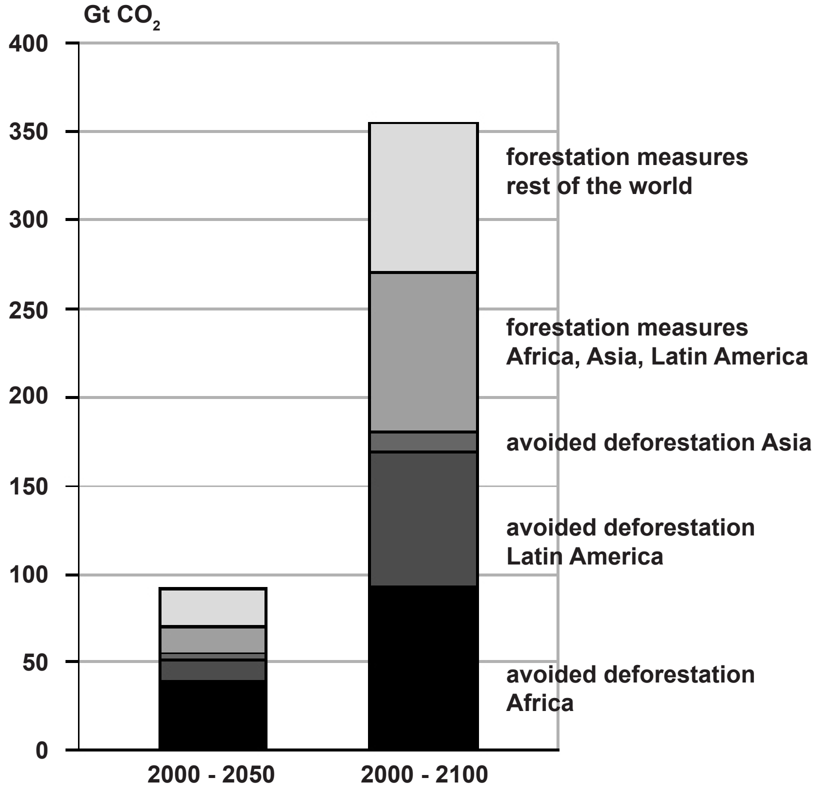
reforestation under the Clean Development Mechanism (CDM) would be 5.3 M ha, an aggregate total in Africa, Asia and Latin America, with Asia accounting for 4.4 M ha (Waterloo et al. 2003).

As illustrated in Figure 4, the cumulative carbon mitigation benefits by 2050 for a scenario of 2.7 US$/ tCO_2 + 5% annual carbon price increment for one model are estimated to be 91,400 $MtCO_{2,}$ of which 59 percent comes from avoided deforestation. During the period 2000–2050, avoided deforestation is the dominant source in South America and Asia, accounting for 49% and 21%, respectively, of the total mitigation potential. When afforestation is considered, Asia dominates. By continent, the mitigation potential in Asia, Africa and Latin America dominates the global total mitigation potential for the period up to 2050 and 2100, respectively.

FORESTRY CLIMATE PROJECTS IN THE PHILIPPINES

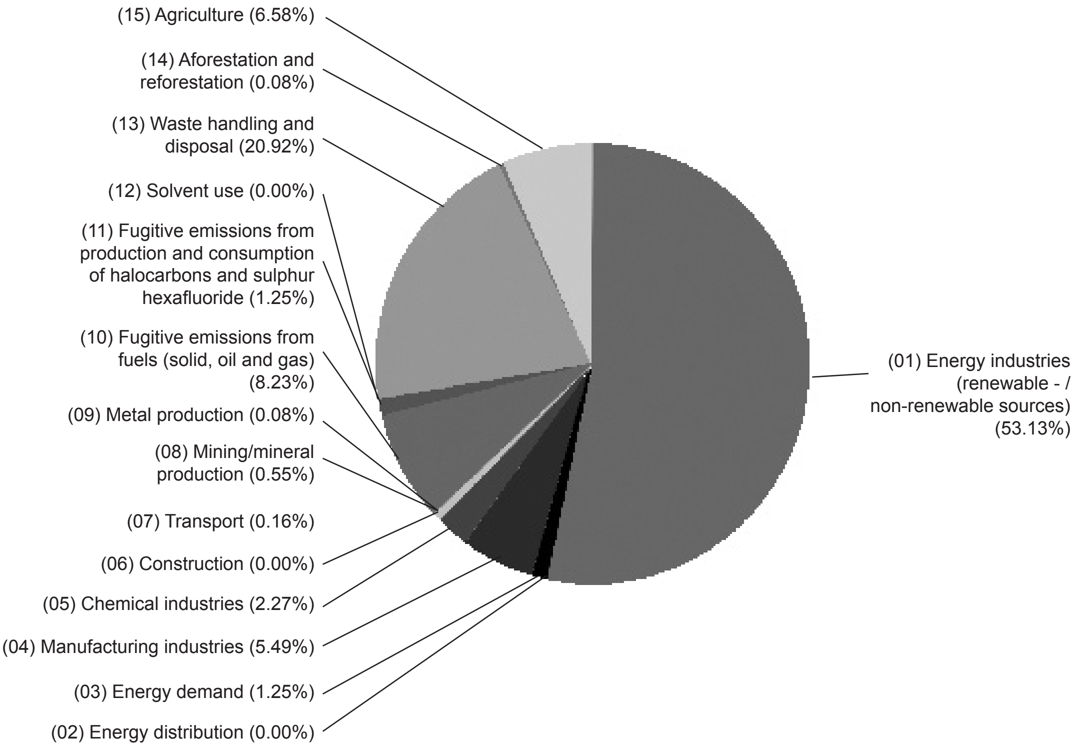
In recognition of the significant role of forests in storing carbon and mitigating climate change, forestry carbon projects have been included in the Clean Development Mechanism (CDM) of the Kyoto Protocol. This allows forestry projects to generate carbon credits which are to be sold in the CDM carbon market.

However, there are still very few takers of forestry carbon projects under the so-called Kyoto market. As of 7 April 2008, there were only 14 registered A/R projects under the CDM of the Kyoto Protocol, which constitutes only about 1 percent of all CDM projects (Figure 5). It has been estimated that up to 13.6 million carbon credits will be available by 2012, based on projects in



Source: Sathaye et al. 2007, as cited in Nabuurs et al. 2007.

Figure 4: Cumulative mitigation potential (2000-2050 and 2000-2100) according to mitigation options under the 2.7 US$/tCO2 +5%/yr annual carbon price increment.



Source: http://cdm.unfccc.int/Statistics/Registration/RegisteredProjByScopePieChart.html

Note: Forestry projects comprised about 1% of all registered CDM projects as of 7 April 2008.

Figure 5. Distribution of registered project activities by scope.

the pipeline (Neeff et al. 2007). Among the reasons for the slow uptake of forestry projects are: high transaction costs, lack of base financing, and complicated rules and methodologies. In spite of these impediments, a number of forestry projects are nevertheless still being developed in many tropical countries.

Forestry carbon projects in the Kyoto Protocol only cover carbon sequestration through planting new trees, and do not address carbon emissions from deforestation. The reasons for such exclusion are more political than the lack of evidence, although this is still subject to negotiation. The lack of a global ‘protocol’ to trade carbon credits from avoided deforestation, however, does not prevent voluntary buyers from generating a market for carbon. The situation in the voluntary carbon market (non-Kyoto) is slightly more encouraging. The voluntary over-the-counter markets are currently the only source of carbon finance for avoided deforestation. They have higher proportion of forestry-based credits out of total market transactions than the CDM (36% versus 1% for CDM). In 2006, forest projects were the largest component of the voluntary carbon market; their share amounted to 23.7 million t CO_2^{-e} valued at US$ 91 million (Hamilton et al. 2007). The voluntary carbon markets have historically served as sources of experimentation and innovation.

In the last five years, there has been a rising interest in climate change mitigation projects in the Philippines. Much of this interest is probably due to the hype associated with climate change, in general, and CDM, in particular. Whether this interest would give rise to more projects would be influenced by three factors, namely: the strict requirements for a CDM project, the level of transaction costs (up to US$ 200,000 per project), and the current price of carbon from forestry projects (about

US$15 per ton C) vis-à-vis the development cost. Three CDM forestry projects under development are presented below and lessons are generated from each of them.

LLDA-Tanay Streambank Rehabilitation Project

The main proponents/sellers of this project are the Municipality of Tanay and the Laguna Lake Development Authority (LLDA) (Lasco and Pulhin 2006). The implementers are the farmers in the Tanay watershed. The main objective of the project is to reduce greenhouse gases (i.e., CO_2) in the atmosphere while helping rehabilitate the Tanay watershed and providing socioeconomic benefits to the local people. Specifically, the project aims to initially:

- Reforest 70 hectares of private lands;
- Establish 25 hectares of agroforestry farms in public lands; and
- Sequester 10,000 to 20,000 tons of CO_2 from the atmosphere in 20 years.

The project area is expected to eventually cover 1,000 hectares.

Streambank rehabilitation: A total of 20 hectares will be planted with 33,333 trees.

The purpose of this activity is to increase the riparian forest cover of the Tanay River in order to reduce erosion. Under this component, owners of private lands will be encouraged to plant trees along the river banks within their property. Seedlings will be given for free after conducting the information and education campaign and signing of a pledge of commitment to the project. Provision of seedlings and support services will be contracted through the Katutubo village, an upland village comprising of indigenous people, namely, the Dumagat and Remontado groups.

Ecological enhancement in upland areas: A total of 50 hectares of denuded and grassland areas will be planted with 83,333 trees at 2 x 3 m spacing. The species will be chosen by the community. The purpose of this second subcomponent will be to reforest upland areas near the headwaters of the Tanay River in order to reduce erosion, and to provide the local people with timber, fruit, and medicinal sources. Seedlings will be provided, while planting activity and maintenance will be implemented by the Katutubo village.

Agroforestry orchard: This will be established in 25 hectares of communal land belonging to this Indigenous People IP community. A total of 2,500 trees will be planted, integrating cash crops within the 10 x 10 m spacing of mango trees, adopting the alley cropping design.

The purpose of this subcomponent is to provide income for the Katutubo village through agroforestry, while reducing erosion in the upland areas.

The expected greenhouse gas GHG benefits in terms of carbon sequestration are calculated using a high and low scenario. For the project period 2004–2014, the project will have total net carbon benefits of 3,204 tC (11,759 tCO_2^{-e}) and 1,424 (5,230 t CO_2^{-e}) under the high and low scenarios, respectively (Santos-Borja and Lasco 2005). The anticipated Total Emission Reduction Purchase Agreement (ERPA) value is US$31,380 for the low scenario and US$70,554 for the high scenario. The buyer of the carbon credits is the World Bank carbon fund which is also providing technical assistance to the LLDA and its partners.

The key lessons drawn from this project which could be useful in the design and implementation of other projects are discussed below.

First, the support of the potential buyer is vital to overcome the high transaction costs. In this project, the World Bank shouldered all the costs associated in the design and documentation of the project. These include the preparation of the Project Design Document (PDD) and the verification costs amounting to US$20,000 per visit of the Designated Operational Entity (DOE) from Germany. The cost is much higher when project implementation is delayed because of the return visits of the DOE.

Second, transaction costs could increase unexpectedly due to the delay in project implementation. This project has been under development for more than three years already. With the limited experience at the national and international levels in developing forestry CDM projects, there are many uncertainties on how methodologies (even if approved by the CDM Executive

Board) will be applied. For example in this project, project designers and the DOE have different interpretations of the methodologies.

Third, the selection of eligible sites, which is based on the adoption of the Philippines' forest definition, has become problematic. The Philippines defines a forest as those with at least 10 percent forest cover. This greatly limits the eligible areas for reforestation since only those areas that are practically devoid of trees such as denuded grassland areas can be included. When there are trees in the site, no matter how few, the DOE validator tends to assume that the area is in transition to a forest, and thus finds no need for human intervention to reforest/rehabilitate the said site. Therefore, the area is deemed to be no longer eligible under the CDM forestry project. It is therefore imperative for the government to reassess its official definition of a forest. For instance, it could follow the example of Indonesia which has set its limit to about 30 percent forest cover. The advantage of a higher forest cover threshold is that more areas will be eligible for rehabilitation. A simple agroforestry system with trees as alley cropping could be included.

Fourth, the LLDA project showcases an innovative funding scheme. The budget for tree establishment comes from the regular World Bank-funded project while a World Bank carbon fund buys the carbon credits that can be derived from the project. In this project, both base financing (tree establishment cost) and carbon credits are assured from the very start of project development. In a typical reforestation program in the Philippines, the cost for tree planting and maintenance could reach US$ 1,000 per hectare in three years. This makes reforestation projects very expensive. Taking the current price of carbon which is around $15 per ton C, this would not be enough to cover the costs of project development.

CI—Philippines Sierra Madre Project

This proposed carbon sequestration project is part of the joint efforts of Conservation International (CI) Philippines to build alliances with local communities, the private sector, government agencies, and NGOs to facilitate the management of the Sierra Madre Biodiversity Corridor and strengthen the enforcement of environmental laws (Lasco and Pulhin 2006). It uses a multifaceted approach to alleviate threats and to restore and protect 12,500 hectares of land within the Corridor.

The CI's ultimate objective for the project is to demonstrate that a properly designed and implemented carbon offset project not only offers an economically attractive, risk-managed portfolio option, but also generates multiple benefits such as biodiversity protection, watershed restoration, soil conservation, and local income-generation. It will also demonstrate that tradeoffs such as soil erosion, water table decrease, and loss of livelihoods can be avoided.

Specifically, the project has the following objectives:

- To conserve biodiversity in the long term, the project will protect 5,000 hectares of natural forests (old growth and second growth) slated for cutting;
- To reduce pressure on the natural forest and provide incentives for local communities, the project will establish an agroforestry project on 2000 hectares of brushland areas that will provide a more stable income to the population and lessen the reliance on forest projects; and
- To help sequester carbon dioxide from the atmosphere and to increase the connectivity of sensitive habitats for the world's most threatened species, the project will restore 5,500 hectares of grassland areas to original hardwood forests using a mix of fast-growing species and native species.

The main strategy of the project will be community-based forest management. The key stakeholders of the project will be as follows: the local community/people's organization (PO), local NGOs, the local government unit (LGU), the Department of Environment and Natural Resources (DENR), the project monitoring team, and the funding organization. It is expected that after 30 years, a total of 512,000 tons of carbon will be sequestered by the project. Most of this will come from the reforestation component (453,000 tC).

The aforementioned lessons from the LLDA project also apply to the CI project. The project had also encountered the same difficulty in the selection of eligible areas for reforestation. Using their available remote sensing image, they had difficulty in delineating the areas with less than 10 percent forest cover. Obtaining high resolution images would mean higher development costs. The advantage of the CI project initiative, is that they have the capacity to shoulder the transaction costs, They can tap support from their international offices in Japan and the USA, for instance.

In addition, the CI project aims to showcase that biodiversity conservation efforts can be compatible with climate change mitigation efforts. It is the first project in the country that explicitly aims to utilize carbon finance to assist in biodiversity conservation. If successful, it could provide a model for other conservation areas not only in the Philippines but also in other countries.

Kalahan Forestry Carbon Projects

The Ikalahan Ancestral Domain, covering 58,000 hectares of mountainous forest and farmlands, is found in the provinces of Pangasinan, Nueva Ecija, and Nueva Vizcaya, in Northern Luzon. The identified key stakeholders of the project are as follows: the Ikalahan-Kalanguya indigenous communities, local NGOs, the DENR, project monitoring team, and the funding organization. The Kalahan Educational Foundation (KEF) will catalyze the community organizing and development process as well as manage and implement the project. The project monitoring team will quantify the carbon sequestered and assess the impacts of the project. The funding organization will provide the financial resources for the project.

In 2003, the KEF was selected as a pilot site by the World Agroforestry Centre's (ICRAF) Rewarding the Upland Poor for Environmental Services (RUPES) project to develop a carbon sequestration payment mechanism. The KEF is targeting the two types of carbon markets – the regulated market through Kyoto's Clean Development Mechanism (CDM), and the voluntary carbon market (Villamor and Lasco 2006). To date, the KEF has done preliminary activities in preparation for these markets, notably the preparation of project idea notes (PINs) and awareness-building among the members of the indigenous group. They have already signed a purchase agreement with a Japanese buyer.

The KEF aims to convert marginal and abandoned agriculture land into more productive tree-based systems; enhance the livelihood of the communities through agroforestry; and protect the watershed, enhance the biodiversity, and improve the aesthetic value of the area.

Specifically, for the Kyoto market, the project aims to convert 900 hectares of marginal and abandoned agriculture land to more productive tree-based systems through reforestation ─ making it the only "sinks" project allowed under the CDM. The main strategy of the project will be community-based forest management. All the project activities will be developed with the participation of indigenous communities in the project area.

The project will employ two rehabilitation technologies: agroforestry and reforestation. The agroforestry component will involve the introduction of fruit trees to existing upland farms (typically with annual crops such as corn and rice). Fruit trees are intended to provide livelihood for poor upland farmers and at the same time to provide environmental benefits,

The reforestation component will target degraded areas that have been covered with grasses for many decades. Native tree species and species that have been introduced in the Philippines for the last 10 years ─ and which are already growing in and around the project area ─ will be used. The following species, which are observed to be favorable to wildlife, have been identified, namely: mostly indigenous Dipterocarp species, with *Bischofia javanica,and Alnus nepalensis*. Indigenous species will be planted in more favorable areas and underneath fast-growing nurse trees. Fast-growing species (e.g., *A. nepalensis*) will be also planted to rapidly establish vegetative cover, especially in the highly degraded areas.

It is estimated that the 900-hectare area will be able to sequester 89,776 tons CO2-e for 20 years under the medium tree growth scenario. This estimate is based on Philippine tree growth rates (Lasco and Pulhin 2003) and is consistent with IPCC values. More site-specific estimates can be done in the future since local growth rates are being analyzed at present.

For the voluntary carbon-offset markets, the objective is to maintain 10,000 hectares of secondary forests for production forest and carbon sequestration. Since this type of project is not currently allowed under the CDM, they plan to tap the voluntary market. Currently, the KEF is preparing a concept note with focus on enrichment planting and the rigid implementation of a Forest Improvement Technology developed by the Ikalahans to enhance carbon sequestration. Initial estimates show that the forest area can sequester 1.7 million tons of CO_2 for a period of 20 years. Growth-rate studies of the indigenous trees of Kalahan forests are currently being completed which can be used to calculate site-specific carbon sequestration rates.

Among the three cases presented here, this project is unique for several reasons. First, the prime mover of this project is an organization of indigenous peoples. There are fears that indigenous people's rights may be put in jeopardy by forestry climate mitigation options (e.g., in the context of avoiding deforestation as pointed out by Barnsley 2008). The experiences of the KEF to engage in climate mitigation projects such as forestry carbon projects could provide future lessons for other indigenous people.

Second, it is noteworthy that a people's organization now has the potential to access global finance through the CDM notwithstanding the fact that it faces daunting tasks. With limited resources, they have to seek strategic partners to allow them to comply with the various requirements of the CDM. ICRAF, through its RUPES project, is providing limited technical assistance while the prospective buyer is also assisting in CDM documentation.

Third, involving the local communities directly in the activities as the main proponents and implementers could help lessen the cost. As pointed out, one of the major constraints hampering forestry projects is the high cost requirements. Given that as much as 80 percent of the total cost is due to labor, the plan of the KEF is to mobilize its members to contribute their labor in planting and maintenance. In this way, most of the benefits of the projects will go to their members since there are only a few other intermediary organizations with whom they will share the available project funds.

CONCLUSION

Tropical forests are vital in addressing climate change. Tropical deforestation remains a major challenge that needs to be hurdled since it contributes 20 percent to global greenhouse gas emissions. There are initial indications that avoided deforestation or REDD (short for "reducing emissions from deforestation and degradation") is possible at acceptable costs although still fraught with enormous challenges (see Kaninen et al. 2007). The *Stern Review* (2006) has pointed to evidence showing that the prevention of further deforestation would be relatively cheap compared with other types of mitigation, if the right policies and institutional structures were put in place. Aside from climate change mitigation, tropical forest conservation has a number of co-benefits like biodiversity conservation and providing livelihood for the rural poor. Developing countries should explore the implications of the ongoing REDD discussion in line with their national situation. For example, in countries like the Philippines where deforestation has slowed down, avoiding further forest land degradation could be a more viable alternative.

The expansion of tropical forests through reforestation and agroforestry could also help mitigate climate change through the increase of carbon stocks in biomass and soil. The case studies presented here showed that many organizations, including people's organizations, have been attempting to implement projects to obtain carbon credits. Critical issues and concerns emerging from these projects should be addressed by policymakers to ensure the success of forestry CDM projects.

One of the crucial lessons drawn from these project cases is the need for government agencies to link local project developers to potential buyers who may be willing to shoulder partly or fully the transaction costs and even the establishment costs. Without this assistance, local communities or even the private sector may not be willing to undertake the risk of the high transaction costs. Second, policymakers should also look into the possibility of spearheading the identification of eligible lands and likewise examine the implications of the forest definition of the country. All the project cases presented here attributed the delay of their project implementation to issues surrounding the land eligibility of their project area. Third, the direct involvement of the local communities, including indigenous peoples who reside in the project areas, could be a key factor in ensuring the acceptability and financial profitability of the proposed projects.

For the scientists in developing countries like Philippines, there are still enormous research gaps to fill like developing a simplified carbon measurement and monitoring methodology to help bring down the project cost. There is likewise a need to develop more country-specific biomass equations to increase the precision of estimates. Also, a cost-effective method of determining land eligibility will prove valuable to project developers.

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