OPPORTUNITIES AND CHALLENGES IN ENVIRONMENTAL SERVICE PAYMENTS: CARBON SEQUESTRATION

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Abstract

Tropical forests have an important role to play in climate regulation as sources and sinks of carbon. They can help mitigate climate change by conserving existing carbon stocks, expanding carbon in terrestrial systems, and by substituting fossil fuels. The Kyoto Protocol sets greenhouse gas emission limits for Annex 1 (developed) nations. The Clean Development Mechanism (Article 12) is one of the three flexibility mechanisms established to meet the goals of the Kyoto Protocol. In COP-6, the parties agreed to include land use, land-use change and forestry projects under the Clean Development Mechanism but limited projects to afforestation and reforestation. The potential of Philippines forest lands to sequester carbon is presented. Millions of hectares of denuded lands are potentially suitable for reforestation and agroforestry type of activities. Finally, the paper discusses the potential global market size of the Clean Development Mechanism.

1. Introduction: A Changing Climate

Climate change or more popularly known as global warming is one of the primary concerns of humanity today. The Earth's climate has been stable for about 10,000 years (mean temperature fluctuation not > 1^{o}C per century). However, since the advent of the industrial revolution, Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR) concludes that there is strong evidence that human activities have affected the world's climate (IPCC 2001). The rise in global temperatures has been attributed to emission of greenhouse gasses (GHG), notably CO_2 (Schimell et al. 1995).

The concentration of CO_2 in the atmosphere has increased by more than 30 percent since pre-industrial times and is still increasing at an unprecedented rate of an average 0.4 per cent per year, mainly due to the combustion of fossil fuels and deforestation. This is true for other GHG as well. The increased concentration of GHG in the atmosphere enhances the absorption and emission of infrared radiation. This is called the "enhanced greenhouse effect" that leads to warming of air temperature. In the next 100 years, it is projected that the concentration of GHG will further increase as a result mainly of fossil fuel emissions (**Figure 1**).

The IPCC-TAR (2001) provides compelling evidence that Earth's climate is indeed changing as a result of human influence. Its major conclusions are:

- The global average surface temperature has increased over the 20^{th} century by about 0.6°C. Globally, it is very likely that the 1990s was the warmest decade and 1998 the warmest year in the instrumental record, since 1861.
- Temperatures have risen during the past four decades in the lowest 8km of the atmosphere.
- Snow cover and ice extent have decreased. Satellite data show that there are very likely to have been decreases of about 10 per cent in the extent of snow cover since the late 1960s. There has been a widespread retreat of

mountain glaciers in non-polar regions during the 20th century.

- Global average sea level has risen and ocean heat content has increased. Tide gauge data show that global average sea level rose between 0.1 and 0.2m during the 20th century.

In the future, the IPCC TAR (2001) projects the following changes in the world's climate:

- The globally averaged surface temperature is projected to increase by 1.4 to 5.8°C over 1990-2100 (**Figure 2**).

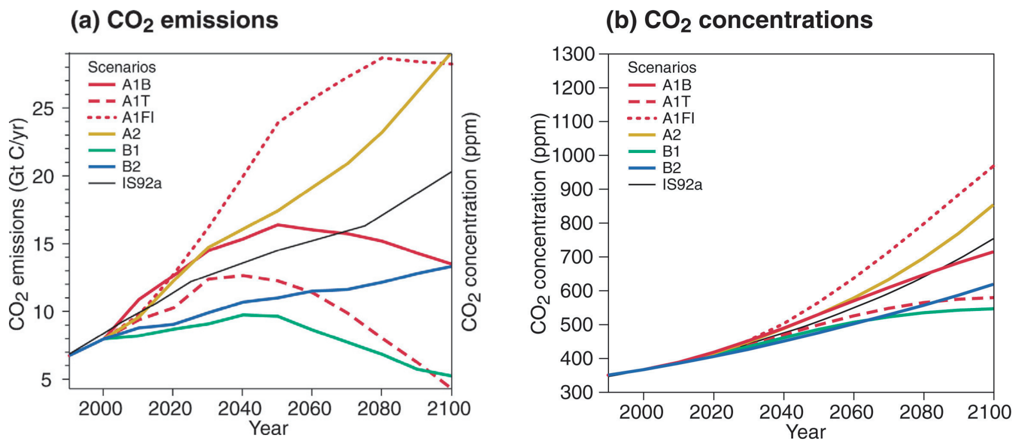

Figure 1. Projected increase in CO_2 emissions and atmospheric concentration in the next 100 years (Source: IPCC WG1 2001)

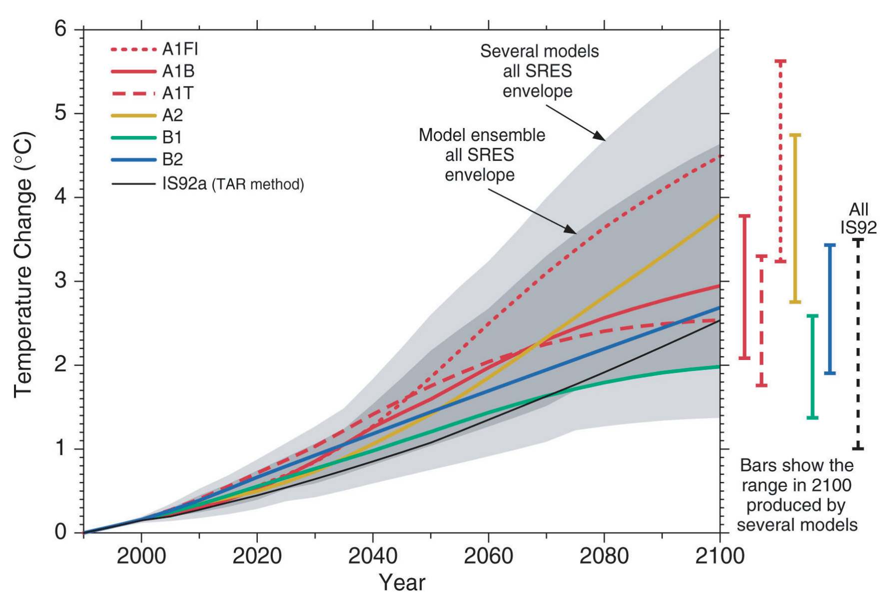

Figure 2. Projected rise in temperature from the present to 2100 (Source: IPCC WG1 2001)

- Global average water vapour concentration and precipitation are projected to increase during the 21st century.

- It is likely that warming associated with increasing GHG concentrations will cause an increase of Asian summer monsoon precipitation variability.

- Global mean sea level is projected to rise by 0.09 to 0.88m between 1990 and 2100. This is due primarily to thermal expansion and loss of mass from glaciers and ice caps.

2. Tropical Forests and Climate Change

There is considerable interest on the role of terrestrial ecosystems in the global carbon cycle. The world's tropical forests covering 17.6M km^2 contain 428Gt C* in vegetation and soils. It is estimated that about 60Gt C is exchanged between terrestrial ecosystems and the atmosphere every year, with a net terrestrial uptake of 0.7 ±1.0Gt C (**Figure 3**). However, land use, land-use change and forestry (LULUCF) activities, mainly tropical deforestation, are also significant net sources of CO_2, accounting for 1.6Gt C/yr of anthropogenic emissions (Houghton et al. 1996; Watson et al. 2000).

In the last few decades there have been massive deforestation and land-use/cover change in the tropics. Annual deforestation rates in tropical Asia were estimated to be 2.0M ha in 1980 and 3.9M ha in 1981-1990 (Brown 1993). In Southeast Asia, the 1990 annual deforestation rate was about 2.6M ha/yr (Trexler and Haugen 1994). A recent review showed that natural forests in Southeast Asia typically contain a high carbon density, more than 200MgC/ha (Lasco 2002). However, logging activities could reduce carbon stocks by at least 50 per cent while deforestation could result in C density of less than 40MgC/ha.

On the other hand, tropical forests have the largest potential to mitigate climate change amongst the world's forests through conservation of existing carbon pools (e.g. reduced impact logging),

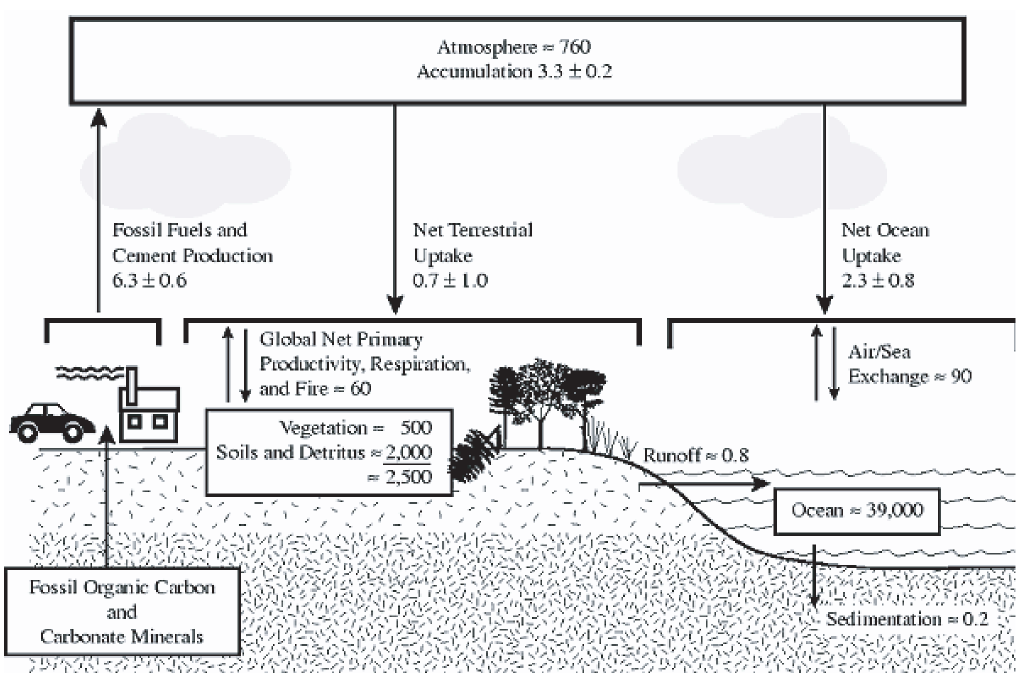

Figure 3. The global carbon cycle (from Bolin and Sukumar 2000)

* Some units of measure commonly used in climate change literature: 1Gt (gigaton)= 1 billion metric tonnes or 10^9 tons; 1 Mg= 1 metric tonne or 10^6g.

expansion of carbon sinks (e.g. reforestation, agroforestry), and substitution of wood products for fossil fuels. In tropical Asia, it is estimated that forestation, agroforestry, regeneration and avoided deforestation activities have the potential to sequester 7.50, 2.03, 3.8-7.7, and 3.3-5.8 billion tons C between 1995 and 2050 (Brown et al. 1996).

3. Mitigating Climate Change Through LULUCF Projects

Mitigating carbon emission through forestry in tropical countries like the Philippines provides a promising way of reducing CO_2 in the atmosphere. Tropical forestry for mitigation is receiving much attention because of its cost effectiveness, high potential rates of carbon uptake, and associated environmental and social benefits (Brown et al. 2000; Brown et al. 1996; Moura-Costa 1996).

(a) Conservation of existing carbon stocks

The goal of this strategy is to maintain or improve existing carbon pools in forests by protecting forest reserves, by the use of appropriate silvicultural practices and by controlling deforestation. Tropical forest ecosystems contain substantial amount of carbon. Activities that destroy forests, such as slash-and-burn farming, logging and conversion to other land uses (deforestation), could significantly reduce the stored carbon in the forest. For example, logging of tropical forests in Mindanao could reduce carbon stocks by about 50 per cent. Similarly, land-use change, such as converting forests to agricultural plantations, could likewise decrease total carbon stocks.

Activities that promote the conservation of the remaining forest cover, or that reduce deforestation, could help mitigate carbon emissions by preventing the release of stored carbon to the atmosphere. Certain silvicultural practices, such as enrichment planting of sparse forests, could also lead to increased carbon sequestration in existing forests. As a general rule, the more biomass produced the greater the amount of carbon sequestered.

Another way of minimizing carbon emission from forest lands is by preventing fire which is common in grassland areas of the country. The exact area affected by burning is not known but is likely to have been substantial especially in drier zones. Aside from CO_2, other GHGs such as methane are also released to the atmosphere during fires. Programmes aimed at fire prevention would result in conservation of carbon in plant biomass.

(b) Expansion of carbon stocks

The goal of this strategy is to expand the amount of carbon stored in forest ecosystems by increasing the area and/or carbon density of natural and plantation forests and increasing storage in durable wood products.

Since carbon sequestration is a function of biomass accumulation, the simplest way to expand carbon stocks is to plant trees. For example, in Mindanao the rate of carbon sequestration of two plantation species was estimated to be 1.4 to 7.8 tons C/ha/yr.

The choice of species to be planted will affect the potential to sequester C (Muora-Costa 1996). Fast-growing species such as *Paraserianthes falcataria* and *Casuarina equisitifolia* are commonly used. They accumulate more biomass and carbon than slow-growing species for the same period of time. However, fast-growing species typically have lower wood density and thus contain less carbon per unit volume than wood of slow-growing species.

(c) Substitution of wood products for fossil fuels-based products

Substitution aims at increasing the transfer of forest biomass carbon into products (e.g. construction materials and biofuels) that can replace fossil-fuel-based energy and products, cement-based products and other building materials (Brown et al. 1996). This approach is considered to have the greatest mitigation potential in the long term (> 50 years). For instance, the substitution of wood grown in plantations for coal in power generation can avoid carbon emissions by up to four times that of carbon sequestered in the plantation (Brown et al. 1996).

4. Opportunities under the Clean Development Mechanism

The Kyoto Protocol sets emission limits for six GHGs for the developed nations, mostly industrialized countries and economies in transition, known as "Annex 1" or "Annex B" countries. These countries committed to collectively reduce GHG emissions by at least 5 per cent relative to their 1990 emissions. To enter into force, 55 countries must ratify the Protocol and must include 55 per cent of emissions of Annex 1 Parties for 1990.

On the 90th day after the ratification by Russia, the Kyoto Protocol entered into force on 16 February 2005. The Philippines has ratified the protocol in November 2003.

The Clean Development Mechanism (CDM) is one of the three flexibility mechanisms established to meet the goals of the Kyoto Protocol. The dual goal of the CDM shall be to assist Parties not included in Annex I to achieve sustainable development, and to assist Parties included in Annex I to achieve compliance with their quantified emission limitation and reduction commitments through projects in developing countries.

The CDM essentially offers many opportunities for financing sustainable development projects in developing countries that could generate Certificates of Emission Reduction (CERs). It specifically presents opportunities for a developing country to host projects that rehabilitate degraded lands, among others. [See *Ramos, A. Introduction to CDM,* this volume, for further details.]

Figure 4 shows the project cycle under the CDM. The first step is the preparation of a project design document (PDD), which needs approval at the national and international levels. The national approving body is called the Designated National Authority (DNA). The Philippines is currently working on the identification and development of its DNA.

Eligible participants (buyers and sellers) of the CDM are individuals, groups of individuals, private companies, and NGOs that belong to a country that is a Party (signed and ratified) to the Kyoto Protocol.

At the Conference of the Parties-6 (COP-6), the parties agreed to include LULUCF projects under the CDM but limited projects to afforestation and reforestation (A/R). A key output of COP-9 in December 2003 was the modalities and procedures for A/R CDM projects (Decision 19/CP9) that could serve as a workable basis for project development. The key conclusions of COP-9 relevant to LULUCF projects are as follows:

- *Only afforestation and reforestation are eligible; agricultural sink projects are excluded* (e.g. soil organic matter enhancement projects). Thus, certain types of agroforestry systems that do not meet the definition of forests are not included (e.g. hedgerow cropping with less than 10 per cent tree cover).

- *Definitions of "forest", "afforestation", "reforestation" for domestic activities apply under the CDM*, i.e. those used for reporting under Articles 3.3 and 3.4 of the Kyoto Protocol in the UNFCCC decision 11/CP.7 for the first commitment period. This implies that non-Annex I countries that wish to host A/R projects need to choose ranges of potential project area sizes, tree densities and tree heights, derived from their reporting standards to FAO (see section 1.3.4 above).

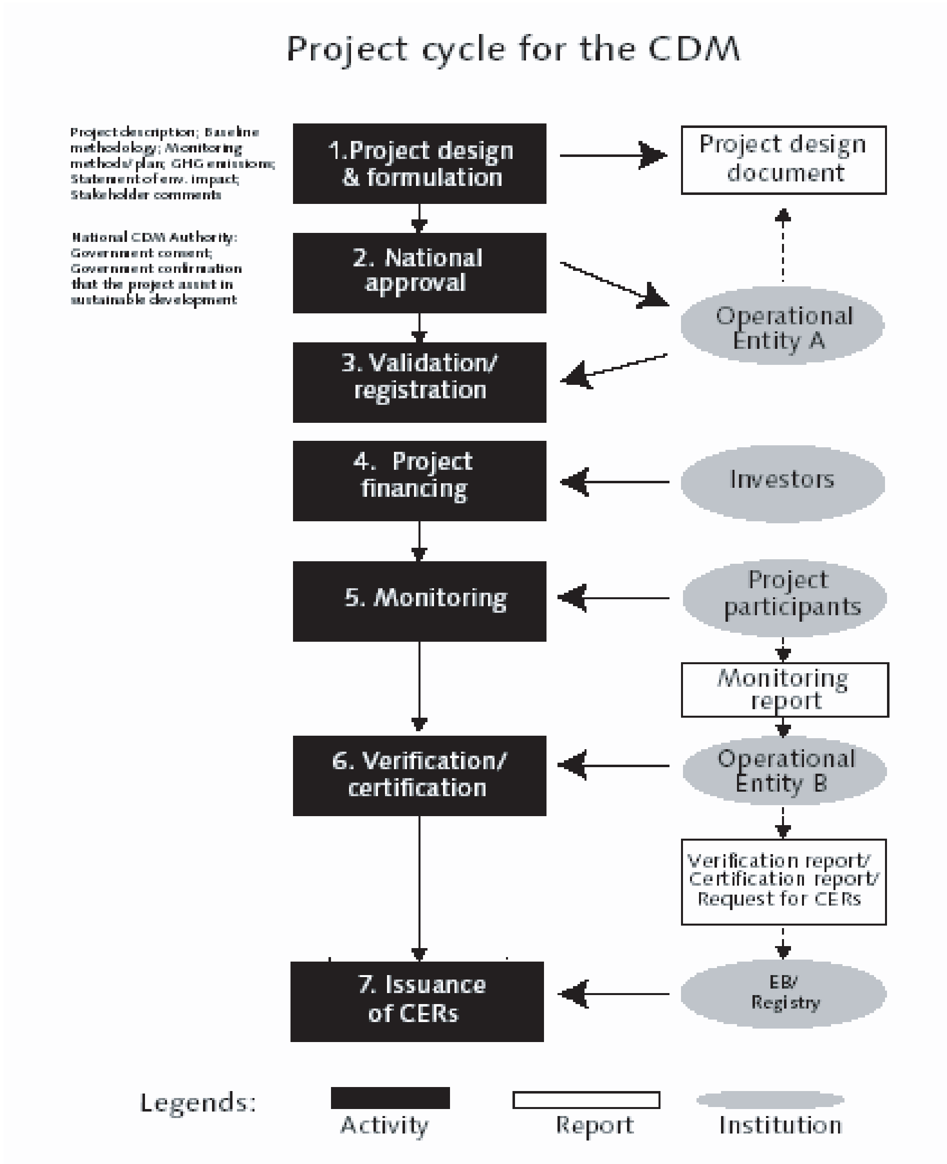

Figure 4. The CDM project cycle

- *"Reforestation" can only be done on lands that were not forests prior to 1990.* The main implication of this decision to many countries, such as Indonesia, is that it reduced the area of land potentially available to CDM because significant deforestation occurred since 1990.
- *Permanence of carbon sequestration ensured via two options*:
    - tCER's: temporary carbon emission reduction units, which expire after at most 10 years
    - lCER's: long-term carbon credits, which are valid for the crediting period of the project or the project lifetime

Both CER's need to be replaced after their expiration date; in addition CER's need to be replaced if reversal of sequestration has occurred during crediting period.

- *Small-scale forestry projects are now eligible, i.e. those with maximum annual sequestration of 8000t CO_2 or 2180t C*; such projects would enjoy simplified and special facilitating conditions to be decided by COP-10, based on: submissions by countries and observers until the end of February 2004. The participation of low-income individuals or communities was set as a precondition. Depending on the agro-ecological conditions and the species selected, the maximum project area is estimated at 500-1,000ha.

Reforestation and afforestation are officially defined by the UNFCCC as follows (Decision 11/CP7, 2001):

- "Afforestation" is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.

- "Reforestation" is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but was converted to non-forested land. For the first commitment period, reforestation activities would be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.

It should be noted that how a country defines a forest is very important in determining which activities qualify. Under the CDM, a "forest" is a minimum area of land of 0.05-1.0ha with tree crown cover (or equivalent stocking level) of more than 10-30 per cent with trees with the potential to reach a minimum height of 2-5m at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all plantations that have yet to reach a crown density of 10-30 per cent or tree height of 2-5m are included under forest, as are areas normally forming part of the forest area that are temporarily unstocked as a result of such human intervention as harvesting or natural causes but which are expected to revert to forest. Depending on how a party chooses its definition, certain type of agroforestry systems may not be eligible for CDM. For example, if a low cover is selected (e.g. 10%), then many agroforestry systems, such as tree farms, will be classified as forest already and are thus not eligible for "reforestation or afforestation".

For the first commitment period, credits from CDM LULUCF projects cannot exceed 1 per cent of total commitments of Annex 1 parties.

Our initial estimates showed that the life-cycle cost of potential forestry projects (not necessarily Kyoto Protocol compliant) in the Philippines ranged from about US$0.12 per tC to US$7.60 per tC (Lasco and Pulhin 2001). On the other hand, the cost of protecting a Philippine National Power Corporation - Exploration Corporation (PNOC-EC) geothermal forest reservation in the island of Leyte was US$2.94 per tC (Lasco et al. 2002). In contrast, a systematic comparison of sequestration supply estimates from national studies in the USA produced a range of US$25 to US$75 per tonne for a programme size of 300 million tons of annual carbon sequestration (Stavins and Kenneth Richards 2005).

Areas suitable for CDM in the Philippines, which include those that need to be permanently forested for legal, ecological or social reasons, are the most likely candidate areas for climate mitigation projects. These include the following areas:

- critical watersheds
- forest reserves (including those under the management of other government agencies and government-controlled corporations, such as the Philippine National Oil Company and National Power Corporation, academic institutions and the military)
- forest lands under the National Integrated Protected Area System (NIPAS), including those with 50 per cent slope and 1,000m asl altitude.

The total area of the above forest lands is about 5 million ha (FMB 2001), a large portion of which needs to be either protected or rehabilitated.

Another way of estimating potential areas for climate projects is to look at the extent of degraded areas needing rehabilitation. Grasslands and brushlands in the uplands cover 3.5 million ha (Lasco and Pulhin 1998). In addition, many of the supposed agroforestry lands (5.7 million ha) are actually shifting cultivation areas or simply degraded farmlands that need stabilization most likely through some form of agroforestry and soil conservation practices.

Once new financing schemes are available, property rights issue may become important (Lasco and Pulhin 2003). Competition on who will control forest lands may intensify. In the Philippines, many upland areas are being claimed by indigenous peoples. Such claims may be ignored in favour of establishing climate-change forests. Thus, the guidelines should have adequate provisions respecting the rights of local users. This is easily said than done in many developing countries. These issues could be adequately addressed, however, through public consultation and participation in project planning and implementation. The Environmental Impact Assessment (EIA) system is the main mechanism for facilitating this in the Philippines. Existing policies and procedures embodied in the Indigenous People's Rights Act (IPRA) should also be able to ensure that the rights of the IPs are fully safeguarded.

5. Potential Size of the CDM Market

A recent World Bank-commissioned study showed that the estimated market potential of the CDM is a demand for CERs in 2010 of 250MCO_2e (range 50-500MCO_2e) at a price of US$11.00/t$CO_2$e (range + 50%) (Haites 2004). This potential is based on the assumptions of continued preference for CERs and Emission Reduction Units (ERUs)

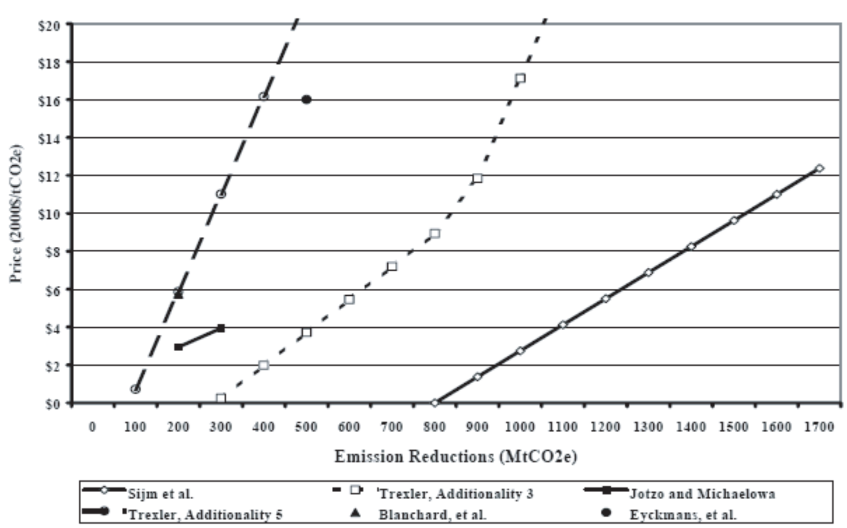

Figure 5. Potential supply of CDM in 2010 (Haites 2004)

by buyers, a sustained flow of new CDM projects, and a realization of a substantial share of the potential emission reductions in Asia.

The total potential supply of CDM has been variously estimated, depending on certain assumptions (**Figure 5**). The CDM could potentially supply up to 32 per cent of the Annex B commitments based on one study (**Table 1**). This will translate to over US$1 billion in revenues during the first commitment period (**Table 2**). Of this amount, about US$300 million could come from the sale of 67Mt CO_2 of CERs from forestry carbon sequestration projects. China and Indonesia are expected to get the lion's share of sinks projects (**Table 3**).

Table 1. Share of mechanisms in meeting Annex B Kyoto Protocol commitments (Jotzo and Michelova 2001)

Mechanism	Mt CO_2/year	Share in market
CDM	297	32%
Domestic abatement in net buying countries (Annex B OECD countries except United States)	149	16%
Joint implementation in EIT countries	78	8%
Sales of AAUs by EIT countries ('hot air') – modelling assumption	400	43%
Total	923	100%

Source: PET modelling, standard scenario.

Note: See text for assumption on hot air volume.

Table 2. CDM volume, prices and revenue (Jotzo and Michelova 2001)

	PET standard scenario
Total CER sales (Mt CO_2/year)	297
Of which:	
CERs from non-sink projects	230
CERs from sink projects [a]	67
International quota price ($US/t CO_2)	0.90
Total CDM revenue over first commitment period ($US million) [b]	1,332
Total adaptation tax over first commitment period ($US million) [b]	27

Source: see table 3.1.

a Sink CERs limited to 1 per cent of assigned amounts of participating OECD Annex B countries. EIT countries (net sellers of quota) are assumed not to use the quota of sink CERs they are allowed to purchase.

b Revenue calculation assuming same price for sink and non-sink CERs. In practice, prices for sink CERs may be lower, leading to lower overall CDM revenue.

Table 3. Distribution and magnitude of sink CERs - examples (Jotzo and Michelova 2001)

	Allocation based on potential for plantations a				Memo: Non-sinks projects
	Trexler and Haugen 1995 [a]		Niles et al. 2001 [c]		PET modelling
	Share	Mt CO_2/year given global cap	Share	Mt CO_2/year given global cap	Mt CO_2/year
China	(37%) [b]	24.7	7%	4.5	120
India	5.6%	3.8	1.3%	0.9	29
Indonesia	25%	17.0	0.7%	0.4	5.6
Other Asian countries	12%	8.3	22%	14.6	24
Middle East	0%	0.0	0%	0.2	18
Africa	2.4%	1.6	13%	8.8	25
Brazil	15%	9.9	33%	21.8	1.3
Other Latin American countries	2.5%	1.7	24%	15.8	7.3
Total	100%	67	100%	67	230

a Shares in non-Annex B potential carbon storage in new plantations using Trexler and Haugen (1995). Author's calculations based on data for plantation potential in hectares and average carbon density.

b China estimate substituted from shares provided in Polidano et al. 2001 (data based on projections for new plantings).

c Shares in non-Annex B potential carbon storage through reforestation using Niles et al. 2001.

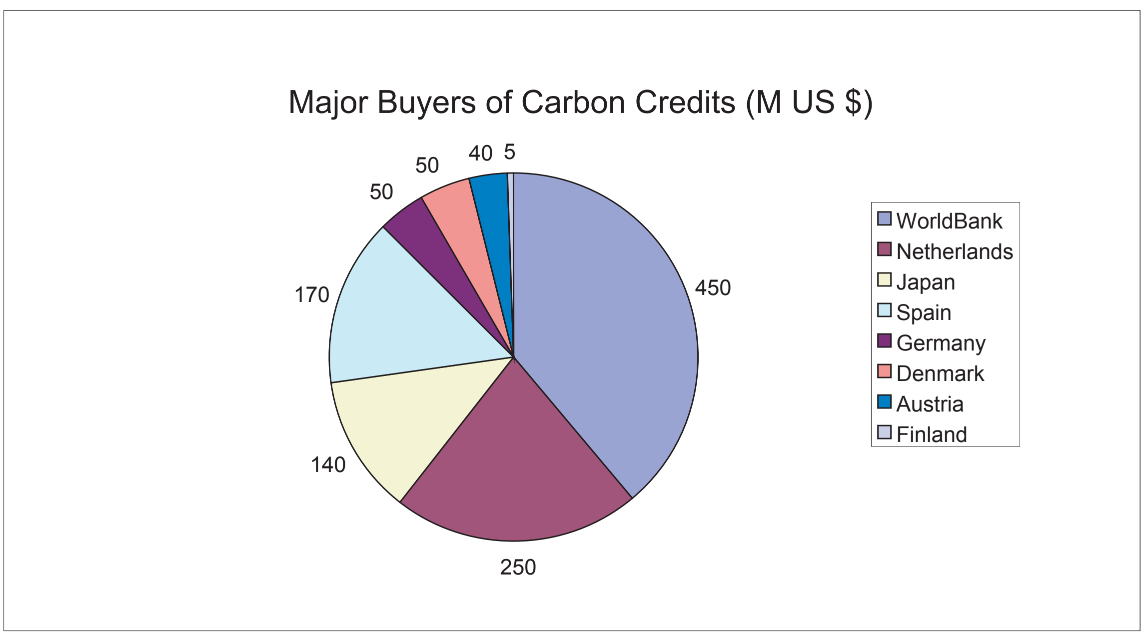

Figure 6. Major buyers of carbon credits (total = US$1.2 billion) (Cosbey et al. 2005)

To date, over US$1 billion of carbon credits have been purchased with World Bank as the leading buyer (**Figure 6**). Other leading buyers include the Netherlands, Japan and Spain.

6. Conclusions

There is a high level of interest for carbon sequestration projects as a strategy to mitigate climate change. The Philippines can take advantage of the emerging market for carbon credits arising from sinks projects. However, there are pitfalls that must be addressed if the country would truly benefit from the carbon market.

At present, there are still a couple of barriers to investments in CDM sinks project in the Philippines. First, there is the uncertainty of allowing sinks projects. Earlier, there were some sectors that had reservations on forestry projects. Recently, however, there has been more openness in allowing forestry projects. Second, there are yet no rules and guidelines for forestry projects.

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