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Zusammenfassung

Kohlenstoffbindungsprojekte im Rahmen des Kompensationsmechanismus für Saubere Entwicklung (Clean Development Mechanism - CDM) des Kyoto-Protokolls leiden unter dem Stigma des Permanenzrisikos. Das Risiko, dass die in Waldprojekten erreichte Bindungs- oder Reduzierungseffekte durch spätere Entwaldung wieder zunichte gemacht werden, ist nicht von der Hand zu weisen, einerlei, wer es zu tragen hat. Das Verdienst des sog. "ton/year approach" ist, die Fiktion der Unendlichkeit in Bezug auf Bindungspermanenz zerstört zu haben. Demgegenüber steht der sog. „kolumbianische Vorschlag", der die Fiktion der Vergleichbarkeit zwischen technischer Emissionsreduzierung und natürlicher Kohlenstoffbindung zerstört. Beide Ansätze stehen derzeit unverbunden im Raum. Der vorliegende Artikel macht sich der Methodik beider Vorschläge zunutze und schlägt die Verbindung zwischen ihnen. Er resultiert im Vorschlag, des *Leasings von Reduktionszertifikaten*.

Abstract

Carbon sequestration projects in the context of the Clean Development Mechanism (CDM) suffer from the stigma of permanence risk. The risk that carbon reduced or sequestered in forestry projects is release further down the road is in fact undeniable, whoever bears the onus. The merit of the so-called "ton/year approach" is to destroy the fiction of infinity when talking about permanent sequestration. The merit of the "Columbian proposal" is to destroy the fiction of comparability between technological emission reduction and sequestration in natural systems. Yet, both approaches are discussed as more or less unrelated alternatives. By making use of both methodologies and providing a link between both proposals on permanence in CDM forestry, the present article puts forward the proposal of leasing reduction certificates.

1. INTRODUCTION

The inclusion of forests as sinks of greenhouse gases in the Clean Development Mechanism (CDM) is one of the most contentious issues in the current negotiations around the Kyoto Protocol. Many parties feel that forests only serve as a loophole for industrialized countries to avoid the emissions reductions that they committed to at Kyoto. Yet, 20 to 30 percent of the anthropogenic greenhouse effect can be directly attributed to the release of carbon previously stored in biosystems. Reducing this kind of emissions requires improved land management practices and forest conservation. Although some of the conclusions of the present article may hold true for Annex I countries as well, it will focus on the most specific problem for CDM forestry – the issue of permanence. For many environmentalists, conserving or increasing carbon stocks in biomass are very uncertain measures to combat climate change. They claim that forest conservation and afforestation or reforestation can only offset GHG emissions from fossil fuel burning if the near infinite existence of forests can be assured. Many developing countries, on the other hand, fear that these lands could become a potential liability unduly putting future use restrictions on large portions of their territory – the so-called "Kyoto lands" that were once used to offset industrialized countries' GHG emissions. Moreover, they regard it as an additional burden on their own future GHG reduction efforts, since these low-cost options would then have been used up by the industrialized countries. Thus, the permanence of forests is a concept that is hard to achieve and may result in inequity. On the other hand, neither environmentalists nor development specialists deny the potential contribution of forests to sustainable development, as these can constitute a source of income, preserve watersheds, prevent erosion, palliate locale temperatures, and, last not least, contribute to mitigation and adaptation to global warming.

Several proposals have been made to solve this dilemma. This article shall resume two proposals, one that tries to operationalize the timeframe of permanence, and another one that limits the timeframe of GHG credit validity. Their comparative advantages will be discussed with regard of the CDM's dual aim defined in Article 12 of the Kyoto Protocol; environmental integrity and sustainable development of the host country. Moreover, the article proposes a mixed scheme that could balance both the desire for assured long-term protection of forests and the developing countries' freedom to adjust their development plans according to changing environments.

2. FORESTS AND THE CDM

Article 12 of the Kyoto Protocol defines a Clean Development Mechanism (CDM) whereby industrialized countries (referred to as Annex-I-countries) may fund emission reduction projects in developing countries (Non-Annex-I-countries) and get credit for Certified Emission Reductions (CERs). These CERs can be used to meet the emission limitation and reduction commitments of the Annex I-countries under the Kyoto Protocol.

The role of tropical forests in the CDM is a contentious issue. Some Annex I-countries, particularly the United States, see stopping or slowing tropical deforestation as a relatively inexpensive way to meet their commitments to reduce emissions. Meanwhile, some key developing countries, e.g. Brazil, see this discussion as an attempt by Annex I-countries to return Non Annex I-countries to "carbon colonies" (Maya & Gupta 1996). In addition to these political and ethical issues, there is debate about legal and technical issues of CDM forestry.[1] From a purely climatic point of view, deforestation of existing forests is an *irreversible* release of carbon dioxide and other GHGs into the atmosphere similar to burning fossil fuels. Consequently, avoiding deforestation could be seen as equivalent to fossil fuel conservation and used to offset GHG emissions in Annex-I countries.

The sequestration of carbon in newly grown forests, on the other hand, is rather different. The fixing of carbon in trees and other biomass is an essentially reversible process that can be undone by destroying the vegetation and changing the land use. In order to offset GHG emissions from burning fossil fuels, it needs to be maintained for a long period of time, ideally as long as it takes for CO_2 and other GHGs to decay in the atmosphere.

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1 See e.g. 1) Vine, E. nd J. Sathaye. 1997. The monitoring, evaluation, reporting and verification of climate change mitigation projects: discussion of issues and methodologies and review of existing protocols and guidelines. (LBNL-40316) Prepared for the US Environmental Protection Agency. Berkeley, CA. 2) Brown, P. and N. Kete. 1998. Forests and Land Use Projects. In: Issues and Options: The Clean Development Mechanism. pp. 163-173. United Nations, New York, NY. 3) Mulongoy, K.J., J. Smith, P. Alirol, and A. Witthoft-Muehlmann. 1998. Are joint implementation and the clean development mechanism opportunities for susatainable forest management through carbon sequestration projects? The International Academy of the Environment and the Center for international Forestry Research. Geneva, Sw. Viewable at www.iae.org/pd/forest-background.pdf.

Article 12 is not at all clear about the acceptance of CDM forestry projects. A placeholder footnote in the original negotiators' version explicitly included "mitigation of climate change … through removals by sinks" (Depledge 2000, p. 76) but was completely deleted afterwards. In the way Article 12 stands, it suggests that if any, only projects aimed to stop deforestation are included. ("activities resulting in emission reductions"). The omission of "removals by sinks" as in Article 6 can be interpreted as a shared understanding of Kyoto negotiators to exclude carbon sequestration from the CDM (Farhana 1998). However, the COP6 chairman's unofficial proposal from 23rd of November 2000 in The Hague explicitly included carbon sequestration (reforestation and afforestation) in the CDM and expelled forest conservation from the CDM, at least during the first commitment period (Pronk 2000). Forest conservation would according to this proposal be funded as part of the adaptation activities of developing countries. i.e. paid by the adaptation tax of 2 percent on CERs. In his proposals from April 2001, Pronk separates three funding modalities, the Adaptation Fund, the Special Climate Change Fund, and a work program for least developed countries. All three should be managed by the GEF and funded jointly by the adaptation tax and Annex I contributions, according to each country's relative share of CO_2 emissions in 1990. An annual one billion of dollars should be reached until 2005, half of the funding going to the Adaptation Fund (Pronk 2001, pp. 3-4). The original proposal to extend the tax on the other flexible mechanisms in case this amount was not reached was retired in the second paper. This funding seems very little, considering the diverse needs emerging from ongoing climate change and the necessities of least developed countries.

3. THE LONG-TERM REQUIREMENT FOR CDM FORESTRY

Article 12 states that CERs will only be awarded for projects that create long-term benefits. It states that emission reductions from CDM-projects "shall be certified on the basis of real, measurable and long-term benefits to the mitigation of climate change".

From a scientific point of view, the long-term requirement of the CDM should ideally cover the period of time that it takes for an (offsetting) emission to decay in the atmosphere. However, due to the bundling of six different types of greenhouse gases in the Kyoto Protocol, there is an extremely high variation of decay times, between twelve years for methane, up to several thousands of years in the case of fluorocarbons. Thus, the long-term requirement of the CDM could imply near eternity of CDM forests. Less than eternity could be sufficient, if we approach the long-term issue from a political point of view. Forest management activities will have an effect on climate change if GHG emissions are reduced or carbon is sequestered for a period of time, while alternative abatement strategies are developed and become widespread. Structural change in the host countries could lead to saving the last virgin forests over the time span necessary for adopting sustainable forestry practices. In this sense, the long-term requirement is defined by the expectation that structural changes in the world economy and technology will arise at some point in the future. It may be possible to solve the problem of GHG emissions by either widespread adoption of non-fossil technologies in a shorter period of time than several hundred years, e.g. 50 years.

Moreover, even delaying emissions has positive effects. These are threefold, as Chomitz (1998, p.3) points out: Economically, given a positive discount rate, damage levels are lowered in the future. Physically, the marginal impact of each ton of CO_2 released in the future, when GHG concentration in the atmosphere will be higher, will be lower than it is today. Technologically, temporary sequestration buys time for progress in industry and transport related emission reduction. Moreover, to add a biological aspect, forest growth leads to the sequestration of permanent inorganic carbon in soils. This factor differs in magnitude, according to the type of forest and its management.

4. THE CONCERNS OF DEVELOPING COUNTRIES

At Kyoto, developing countries did not commit to specific emissions reductions. However, they offered to participate in joint mitigation activities if these served their development needs, and if the funding of these activities was new and additional, over and above the normal development aid package.

Some developing countries have expressed fears that the CDM was a form of carbon colonialism (e.g. Cullet & Kameri-Mbote 1998) that was destined to hinder their economic development. This point of view is partly based on the perception that deforestation equals economic development, which, in fact, was a successful development pattern in the case of many of today’s industrialized European countries. However, it would be worth studying the impoverishment subsequent to periods of deforestation in cases like Spain, where deforestation led to serious draughts and rural famine. Norway, on the other hand, offers an example how to make self-sustaining forestry the basis of successful industrialization. The other part of the idea of carbon colonialism is a systemic problem: The existence of areas permanently protected against any future land use change will conflict with territorial sovereignty, a fact that is hard to deny, even if there is no near-term intention to actually dispose over these lands.

Other arguments indicate that the actual refusal of developing countries to accept binding commitments might vanish on the long run. Once an actual host country does so, the low-cost opportunities will have been used to offset industrialized countries' emissions in the past and, what is worse, in the case of land use projects, still visibly remain as a permanent liability within the country.

As a safeguard against these fears, the Kyoto protocol is an agreement strictly based on voluntary assent.[2] No country is obliged to host any CDM projects if not for its national benefit.

There is, however, the problem of differing timeframes and changing development needs. While the planning period of governments usually does not exceed ten years, CDM forestry projects operate on a significantly longer time scale. If the long-term requirement is taken seriously, it should be valid for the last CO_2 equivalent ton certified during the project has reached the minimum age, which virtually extends the project liability over another 50 to 100 years after the project itself has ended. Compared to the liability arising from nuclear energy (e.g. nuclear waste disposal), this is a short span of time. Still, 50 years or any other reasonable minimum period to achieve structural change is seen by many developing countries as an impediment to their national sovereignty. It overrides by far any political and economic planning horizon in most countries, be they industrialized or developing. Moreover, what seems good business today may turn out to be a rip-off in the future, depending on the speed of structural change and the subsequent demand for emission reduction credits in Annex I countries, or the alternatives in future land use. For example, opportunity costs of forests can rise substantially if beef prices – the dominant alternative use on cleared tropical lands – rise, or mineral resources are discovered in the area. Political

2 Wiener, J. 1999. "Global Environmental Regulation: Instrument Choice in Legal Context" *Yale Law Journal* 108(4): 677-800.

preferences in developing countries may rapidly change, and long-term commitments might be felt to be unfair.[3]

Up to the present, there is no limit to any government's freedom to withdraw its agreement to climate projects, thereby putting at risk any CDM investment. In order to solve this dilemma, individual CDM contracts might include a governmental warranty, or a periodical revision of the credit sharing clauses (Dutschke and Michaelowa 1999, pp. 52-54).

At the most recent round of negotiations in The Hague (COP6), there was considerable debate about the CDM. This is due to the priority of the Parties for deciding CDM issues as expressed under the Buenos Aires Plan of Action. According this plan, the operational details of the Article 12 should have been resolved in 2000 in order to provide a "prompt start" of the CDM. Among the most prominent issues debated in The Hague was the role of forestry under the CDM. Some developing countries argued against expanding the role of the CDM to include forest conservation, fearing that Annex I countries, particularly the United States, would use stopping or slowing tropical deforestation as a relatively inexpensive way to meet their commitments to reduce emissions under the Kyoto Protocol while making only trivial domestic reductions. This would perpetuate inequality between industrialized and developing countries, especially if forest projects could replace "technology transfer" projects. Understandably, many developing countries are more interested in assistance with industrial efficiency projects and other technology transfers. Furthermore, long-term protection of forests is perceived by many developing countries as de-facto expropriation or an ultimate selling of lands. Several key developing countries, e.g. Brazil, have expressed exactly this objection towards CDM forestry. In response to these concerns, the delegation of Columbia presented in Den Haag the idea of limiting the lifetime of CERs created under the CDM. Under the Colombian proposal, CERs generated from sequestration or avoided deforestation expire at the end of a project (without putting any constraint on when to end). It provides developing countries with a maximum flexibility to change their development priorities by making buyer fully liable to replace any expired CERs through other (permanent) CERs (Colombia's Submission on LULUCF 2000).

3 It has to be admitted that the sovereignty concern is often uttered as a rhetoric formula in pursue of other goals. Foreign direct investment always entails a limitation to future governmental decision-making.

Permanence of carbon sequestration is difficult to achieve in practice, and it will conflict with the sovereignty of the host country. Hence, there is a balance between the permanence of sequestration projects and the permanence of the resulting emission entitlements. Before we move forward to the different proposals on permanence, the following paragraph will depict, how forestry projects create CERs, in order to understand the role of time in each project modality.

5. CARBON UPTAKE OF DIFFERENT FORESTRY PROJECT TYPES

In the following, the carbon benefits for the different project types will be defined, in order to later on evaluate the consequences of different permanence approaches.

5.1 Afforestation

While reforestation builds up a "static" carbon stock (although biologists will certainly object this theory), the carbon stock of a plantation is dynamic. With every rotation cycle, the aboveground carbon stock is removed and built up again. The stock change needs to be defined as a medium uptake against the baseline of the medium carbon content of the anterior use.

There is one permanent element of the uptake, the soil carbon, which, depending on the climatic region and given adequate carbon management will be permanent. This phenomenon compares more to reforestation or any other sustainable land use, and will for methodological reasons be left out in the following considerations.

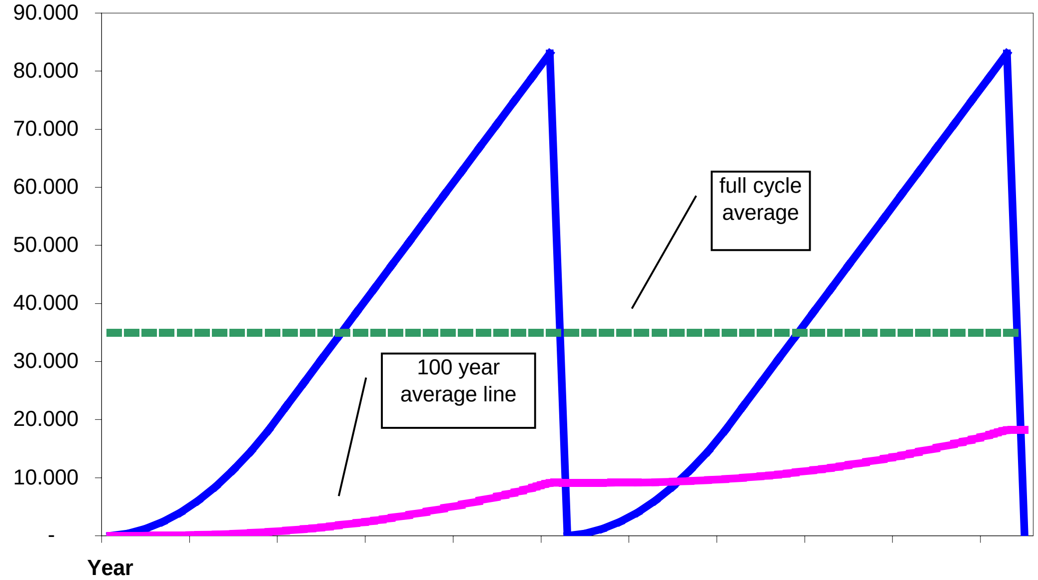
Several other caveats needs to be taken: The carbon buildup line in the following graphs in reality should start below the baseline, because the existing vegetation on the area needs to be removed first, in order to start a plantation.[4] In most AIJ plantation projects this initial removal is not considered. Other directly related input emissions should enter the calculation as well. In the case of unused lands, the use of machinery will lead to CO_2 emissions, as does the timber transport. If fertilizers are used, the related emissions of N_2O lower the project's overall sequestration potential.

4 This might, by the way, be necessary in some reforestation cases as well, where exotic species need to be removed in order to facilitate the restoration of the original bioma.

Keeping this shortcoming in mind, the following theoretical arguments shall however use carbon / time lines that start at zero, in order to reduce complexity.

Basically, there are two ways of regarding carbon uptake in plantations. One is the *average carbon* approach (Phillips et al. 2001, pp. 2-4). Credits will be given up to the average carbon storage. This long-time average however depends on the timeframe. A timeframe shorter than the first rotation cycle is fraudulent, because it does not take into consideration the carbon loss at the moment of harvesting. A very long timeframe will lead to the existence of "untouchable" Kyoto forests, bringing with it problems of enforcement and sovereignty. In Figure 1, the dotted average line is the maximum average under the hypothesis of permanence. In any case, the timeframe would need to be standardized by UNFCCC regulations.

Figure 1: Carbon stocks in afforestation



The saw tooth line is the level of carbon over two rotations of 25 years each.[5] The below line is the average stock over 100 years that can be taken for granted at each moment in time. This line only reaches it maximum after 100 years. The dotted line is the medium carbon stock over all of the rotation cycle.

If, for instance, this timeframe was 100 years, meaning that the line is drawn on the basis of the average carbon stocks over one century, after 20 years one fifth of this

5 The example is taken from the CNFL project in Costa Rica (UNFCC 2000), which has a lifetime of 25 years. For illustration purposes, the data is extended over two rotation cycles.

average can be taken as granted, independently from the potential future land use (see lower line in Figure 1). Economical viability depends on the existence of risk sharing clauses between seller and buyer and on the duration of the timeframe. What then is the age of each ton of carbon? The author would propose, age counts from the moment the carbon stock reaches the average level for the first time.

The other option, which is illustrated in Figure 2, is what we shall call *credit rotation*. Credits are given according to the annual growth progress of the trees. When the landowner fells them, he or she needs to pay the relating credits back.[6] In the end, this is a zero-sum game, and the average growth line is flatter the longer it lasts. Thus, credits help finance plantations closer to the high-cost implementation phase and CERs are repaid when the timber is going to the market. On the other hand, as the payback is *in kind,* at the moment of harvest carbon prices might be too high for the landowner to afford felling the trees. The landowners' liability for carbon removed would create a demand for carbon credits within non-Annex countries. Under the described circumstances, this option seems hardly realistic. However, for the sake of analysis, let's stay with it for a moment. Let alone the growth in soil carbon stocks, the carbon credit rotates, as does the plantation. If removals are compensated, new growth on the areas should entitle for new credits, as the land is free of Kyoto liabilities. Intuitively, the lifecycle approach of compensation for removal seems sympathetic. Nevertheless, in the context of the Kyoto Protocol, the option to generate credits more than once on the same area seems hardly compatible. How can additionality be proven, if the reference scenario of the second cycle is a plantation?

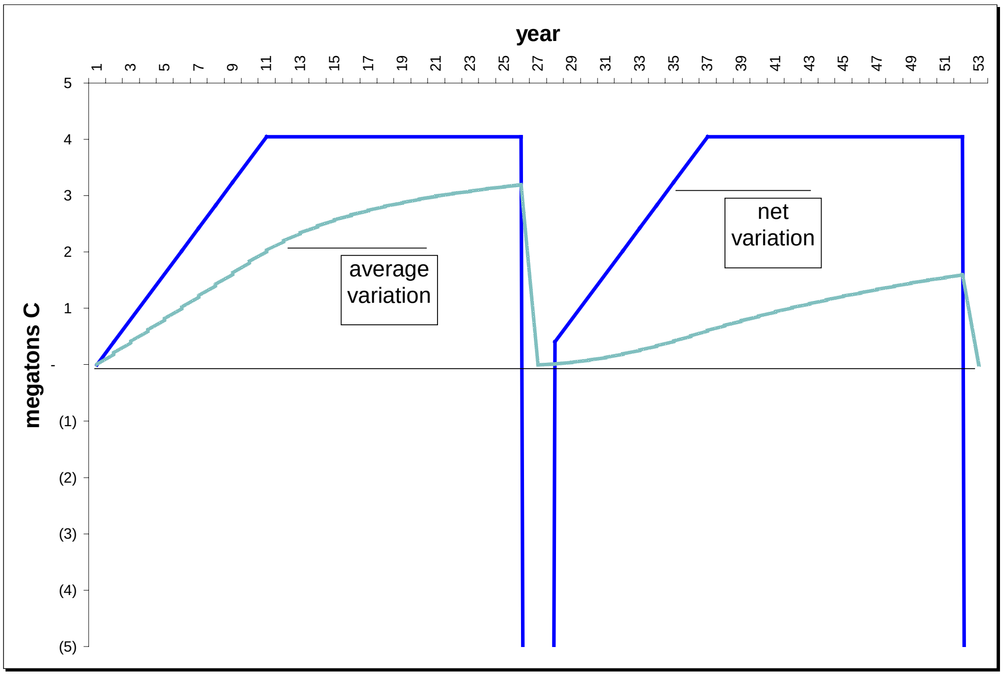
The timeline for afforestation projects rests on the rotation cycle according to the species planted. It can be as short as seven years, in the case of tropical eucalyptus plantations. Prolonging growth cycles over the growth peak will lift the average carbon line, but will cause opportunity costs.

The saw tooth profile of periodical removal and re-growth of a plantation's carbon uptake can be found on top of every managed forest system. Depending on the magnitude of human intervention, it might vanish among the statistical noise of natural variations in carbon stocks. For the purpose of creating CERs, the part of accounting

6 As mentioned above, in real life this will not be 100 percent of the total carbon stocks, because (part of the) roots and inorganic carbon will remain in the soils.

these activities within a reforestation or conservation project compares to the described above.

Figure 2: Carbon variations in afforestation



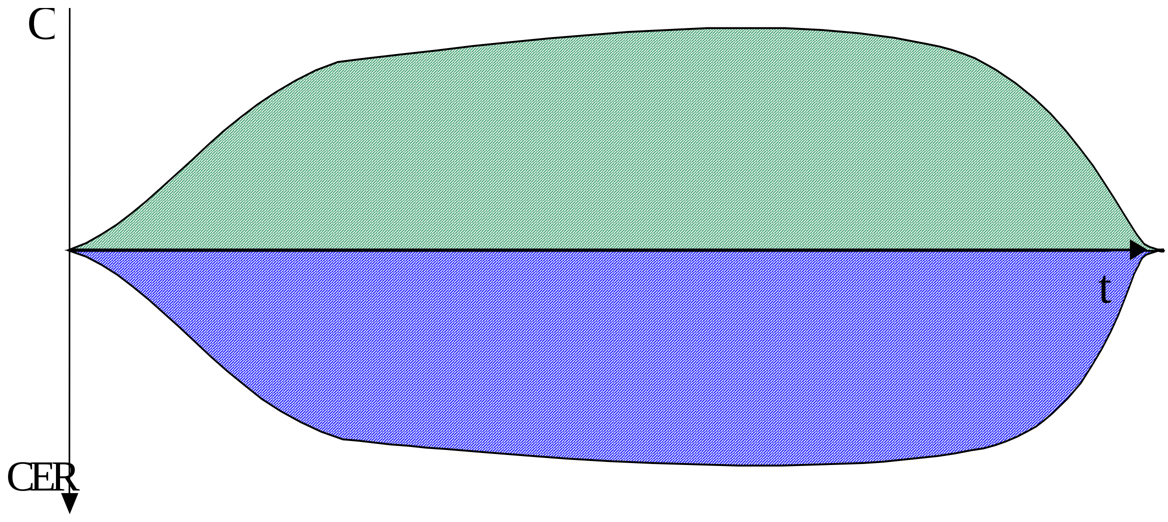
The upper line visualizes the annual carbon variation (C) (not the stocks!) under the reference scenario that the area would not re-grow naturally (baseline = cero). The lower line is the average uptake until the respective point in time. The longer the project runs, the flatter is this average variation line.

Overall, and reminding the caveats taken beforehand, afforestation is not exactly the simplest forestry modality for the CDM. Its advantage lies in measurement, under controlled environmental conditions and using conventional measurement techniques. Uniform species plantation output on standard forestry lots is much easier to calculate than a forested landscape with high biodiversity and a high variety of local geological conditions.

5.2. Reforestation

We need to differentiate between two subtypes of reforestation, natural re-growth in a protected environment, and re-plantation of native species that allow the original vegetation to recover more rapidly. In both cases, the proximity of natural forests is of help to restitute parts of the original biodiversity. The re-growth option is relatively cheap, depending on the measures to be taken in order to prevent further deforestation. On top of these, re-plantation adds costs, which can reach the magnitude of high-yield industrial plantation, given the need to cultivate seedlings of native species, which in many cases are not available on the market. An intermediate option is the one of densifying degraded forests in order to stop degradation. Depending on which option is chosen, carbon stocks will take more or less time to recover. In any case, only a limited quantity of carbon is available for crediting, as forests reach a level of maturity in which only little overall growth takes place.[7] Re-plantation will reach this peak earlier, thus gaining credits faster than re-growth.

Figure 3: Carbon uptake in reforestation



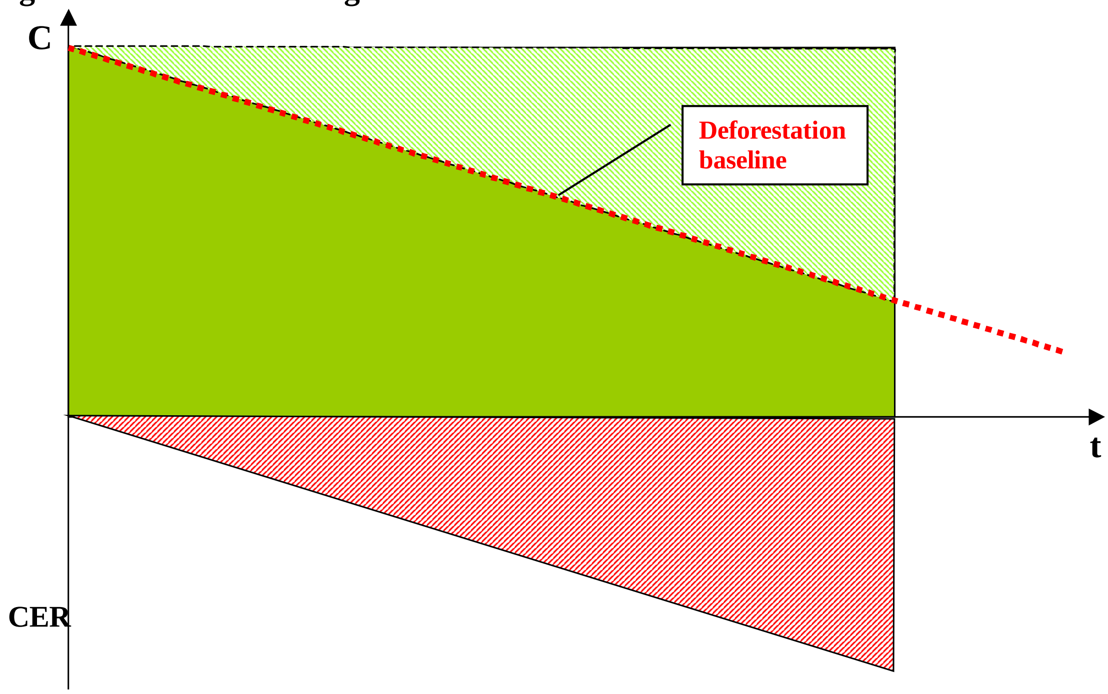
This is a growth curve of a reforestation project; the surface above the time axis represents total carbon uptake, while the surface below the t-axis represents total credits, cumulating over the project lifetime. After the stabilization of carbon stocks, the project turns to deforestation avoidance, however, without generating credits. The reference scenario is that the carbon stocks in the area remained unchanged, which means that the baseline equals the x-axis.

7 According to latest findings (Schulze et al. 2000), even mature forests continue to sequester permanent carbon in soils. The magnitude of this phenomenon however depends on a variety of factors.

5.3 Deforestation

In avoiding deforestation, the baseline is critical. Only if deforestation really progresses the way it is anticipated in the reference scenario, the project gains can be defended. In the AIJ project reality, for any particular area, very little historical information is available, that would allow for predicting behavior in the far future. Therefore, a deforestation baseline needs to be thoroughly checked in the certification process and to be updated regularly. Baseline correction however, has not been a standard procedure in the ongoing AIJ projects.

Figure 4: Carbon crediting in avoided deforestation



CER from deforestation avoidance result exclusively from the actual carbon stock's difference to the hypothetical deforestation baseline.

6. APPROACHES FOR PERMANENCE OF CDM FORESTS

In theory, fixing one ton of GHG emissions in trees will not lead to lasting emission reductions. On the contrary, fire, harvesting, pests, or even the effects of climate change[8] itself can remove carbon fixed in vegetation at any given time in the future. Carbon reduction or sequestration projects used for mitigation of climate change will thus only temporarily outweigh GHG emissions from fossil fuels. On the other hand, the radiative pulse caused by the emission of a ton of CO_2 decays over a certain period of time. IPCC calculations depart from a decay time of 100 to 200 years. This in turn implies that one ton of CO_2 emissions could be offset by CO_2 fixation projects over this period, even if it was to be removed afterwards. If fossil emissions really were to be offset by an equal amount of tons sequestered, certification could only occur after one or two centuries. Put into practice, this requirement would kill any land use practices within the CDM. Political reasoning suggest that a shorter period of e.g. 50 years would be sufficient, if structural changes towards a lesser dependence on fossil fuels can be expected within such a time frame.

Essentially, the problem of permanence is to secure the existence of forests over such a long lifetime. In the AIJ pilot phase, Costa Rica was the driving force in developing new instruments in climate cooperation. Anticipating international carbon trading, the small Central American country has been offering "Certified Tradable Offsets (CTOs)" to foreign investors. Each CTO represented the warming potential of one ton of atmospheric carbon. The majority of CTOs deriving from Costa Rican projects relate to land use. The Costa Rican government guarantees these for the duration of 20 years by holding back part of the CTO certified every year as a kind of insurance. This is, each single CTO is guaranteed for 20 years after its certification. As the risk diminishes over time, parts of this stock are consecutively liberated for sale. As the last ton of carbon is only certified in the last project year, this means that the guarantee survives the project for 20 years (Dutschke 2000, pp. 166, 167). Each ton of mitigation can be sold only once, there will be no recycling of CTOs after the end of their guarantee. These 20 years might be considered a period too short for the permanence criterion. However, as the projects run over a minimum period of 25 years, the warranty easily covers half a century and longer, as the sale of withheld certificates from the guarantee reserve are going to the market and will be covered by the governmental guarantee as well.[9] This

8 According to a new scientific study of the renown UK Hadley Centre, the current sinks in forests could turn to sources of GHGs at the end of this century in response to an increased global surface temperature. This would lead to an accelerated climate change with an overall temperature increase of between 6 to 8°C. (s. Unterlagen von COP6)

9 This statement depends on the size of the lots that give origin to the certificates. If the land unit referred on the certificate was too small, neighboring lots might theoretically be cleared after fulfilling their purpose, at the time the last withhold CTO is sold. This worst-case scenario would

kind of governmental guarantee might in the future be considered a subsidy that distorts the international market for GHG reduction credits. It is therefore preferable to find market-orientated solutions to the permanence requirement.

Disregarding permanence leads to unfair competition against permanent technical GHG reduction and conflicts with the environmental integrity of Annex I targets. Taking permanence as "near eternity" leads to high control and enforcement costs and might even turn out to be completely impossible in many cases. Solutions to the permanence dilemma were brought forward in two directions: one is an exact definition of the time-span, the other extreme is a limitation of responsibility. The following will elaborate on these different approaches for permanence in series of discussions below.

6.1 The ton/year approach

The so-called ton/years approach (Moura Costa 1996, Moura Costa & Wilson 2000) offers a simple accounting solution to the problem of permanence. It is essentially a scheme for the sale of fractions of a long-term project. The authors calculate an "equivalence time", after which the emission of one ton of CO_2 is leveled out by sequestration, independently from the future release of the carbon sequestered. This equivalence time is calculated to be 55 years, while other authors propose 100 years (Wilson et al. 2000, pp. 320-322).[10] This equivalence time can be used for several purposes. It could either help determine the project end for *ex-post* crediting, or the average storage timeframe, for calculating annual fractions of carbon permanently removed, or, consequently calculating the remaining sequestration liabilities after an eventual project failure before the end of the equivalence time. Acknowledging that the decay time of the contribution to global warming of a CO_2 pulse in the atmosphere is a non-linear process, which is rapid in the beginning in slows down asymptotically towards the end; Moura and Wilson propose dividing these 55 years in linear fractions, which does not conflict with environmental integrity, because it understates the effect in the beginning. After half of the equivalence time, half of the first year's credits are accounted as permanent. This scheme provides greatest flexibility for forestry project

however cause severe criticism and put at risk the certification process itself. This aspect will be treated again as the problem of the "last unit".

10 It is not an economist's job to argue in favor of any specific length of the equivalence time. For illustration purpose, I take the 55-year period as a basis; however, the essence for any calculations is that the equivalence time is defined as a finite number of years.

developers and host countries. It allows contracts of practically any duration with equivalence being achieved through increasing the average amount of carbon fixed or, alternatively, the area of protected/afforested land.

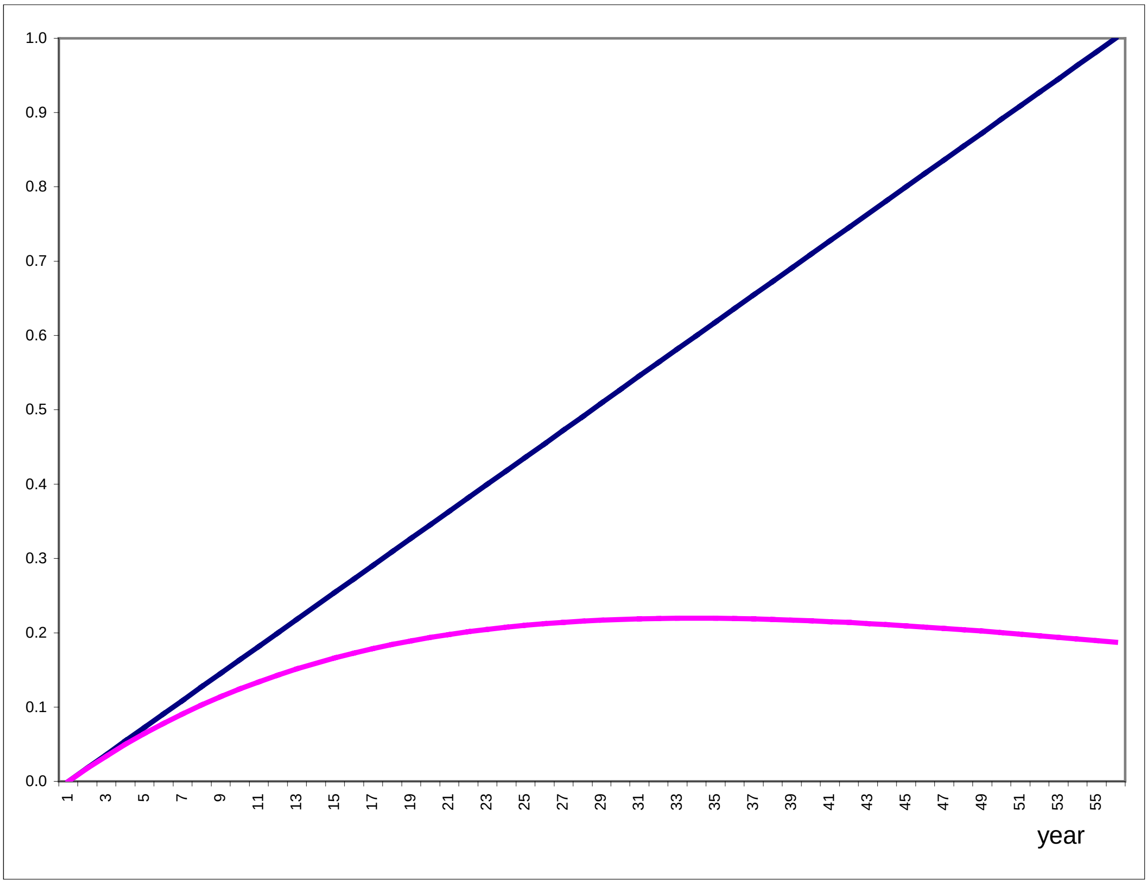
6.1.1 Problems with the ton/year approach

The ton/year approach's advantage is to operationalize a period of time too long to be framed in public and private contracts. From the climatic point of view, there is no difference between sequestering 100 tons of carbon over 55 years and 1,000 tons of carbon over 5.5 years. And conserving 5,500 tons of organic carbon over one year? The short-term attitude towards protection obviously conflicts with the additionality criterion, because it is hard to prove that deforestation is really being delayed for this short span of time. Allowing for such a simplistic project design would pave the way for free riders. A minimum project duration of e.g. 15 years in forest protection could assure the project developers are serious about permanently protecting the area. This is not as much the problem for afforestation and re-plantation projects, as these need a lot of seed capital and have longer economic payoff periods. The problem in tree plantations might be unsustainable land use over the first turnover periods, thus fixing high quantities of carbon, but deplete the soils and overuse water resources. The subsequent loss in land cover might occur only after the end of the CDM contract and thus not be monitored any more. The certification process will therefore need to take special care for sustainable land use practices.

From the investor's point of view, the ton/year approach is quite unattractive, as only a short fraction of the sequestration effect can be certified annually.

The NPV over the whole project lifetime will hardly contribute to the project's internal profitability (see Figure 5).

Figure 5: Carbon value and carbon NPV



The figure shows the valuation and the NPV of a single ton of carbon according to the ton/year approach, under the assumption of a moderate interest rate of 3 per cent.

6.2 The Colombian approach for expiring CERs

Many developing countries have urged to limit the duration and share the liability for CDM contracts between Annex I- and Non Annex I-countries. They insist, alongside many project developers, that long-term projects do not necessarily require long-term contracts. Lasting efforts can also be achieved through a series of renewed short-term contracts. The most radical proposal was recently brought forward by the Columbian delegation to the Sixth Conference of the Parties to the Climate Convention. It departs from the worst-case scenario of any forest project, meaning the reversal of all the mitigation achieved after a certain period. Taking this case as a rule, the *expiring CERs* model consists in limiting the lifetime of the credits to the contract period, after which the liability falls back to the buyer. Thus, the offsets are only temporal. They could, for instance, help the investing company to reduce its emissions over one particular budget period. After the end of the contract however, all the reductions accounted for after this period have to be achieved by other means. The investor has the choice either to renew the contract at the end of the leasing period or to offset his emissions by reductions achieved elsewhere. As in the case of ton/year accounting this proposal results in an increased flexibility for project developer and the host state. The project developer in turn has the choice to offer the sequestration contract to another investor after the end of the first contract. As in the case of ton/year accounting, this proposal results in an increased flexibility for project developer and the host country.

Expiring CERs will be a yet another type of emission permits. Differently to permanent CERs resulting from energy related projects, expiring have only a limited validity. Virtually each ton of carbon stored in organic matter has a different lifetime, depending on its certification date. The credits certified for the last year of the project cycle are only valid for one year and will consequently suffer high devaluation. Only once these credits are used to offset a particular GHG emission, their countdown starts. Up to this point in time, they are fully bankable. In the following, the *Columbian approach* will be demonstrated for different forestry modalities.

6.2.1 Expiring credits in the case of reforestation and afforestation

In the case of reforestation, credits can be earned up to the stabilization level, which may vary according to natural and environmental conditions. After that point in time, every reforestation project becomes a deforestation control project, even though it might not receive any more credits. Therefore, after the initial phase of carbon stock uptake, a complete new calculation is required. Temporal CERs help overcome systematic problems resulting from this modality change. If conservation should not be accepted as a CDM modality either by the host country or by the COP, temporary carbon credits could help maintain permanent secondary forests that are often valuable as buffer zones around primary forests and watersheds.

The advantage for the host country is that after the end of the contract period it can freely decide on the future use of the land involved, renegotiate the lending rate, and eventually include it into its own national communication, in case it has adopted own emission targets meanwhile.

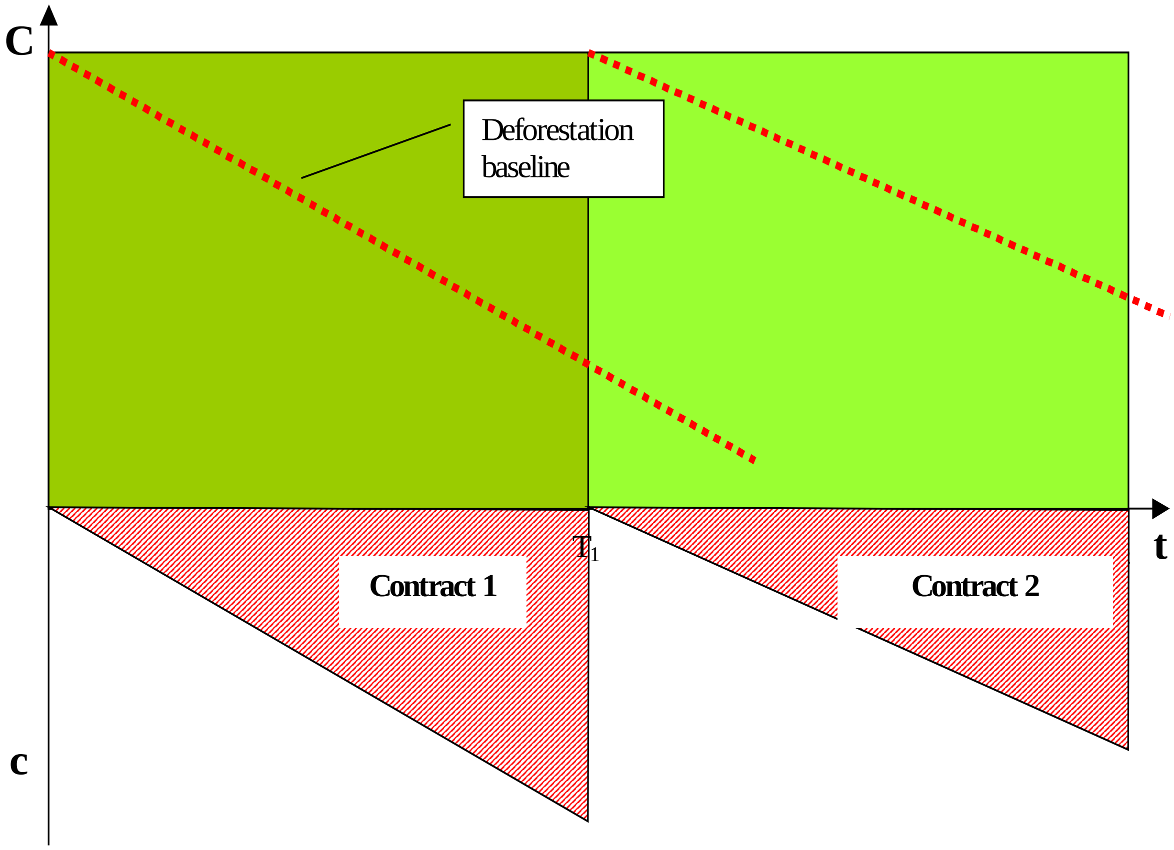
The above-mentioned lifecycle approach to tree harvesting in plantations *(credit rotation)* finds a solution in expiring credits. In this case, the credit validity should not surpass the rotation cycle. The subsequent re-emission of credits in case the project subsists is still based on the reference scenario before the first cycle.

6.2.2 Expiring credits in the case of avoided deforestation

Forest conservation consists in avoiding emissions resulting from the human-induced destruction of natural forests. Its positive externalities lie in the field of biodiversity conservation, watershed protecting and microclimatic benefits of standing forests. Virgin forests have long been considered expansion area for economically beneficial uses. Standing forests are only slowly admitted a land *use* in public conscience of developing countries.[11] Industrialized countries have almost used up this resource, much to their own economic benefit. CERs could create economic benefits attached to standing forests. In case of forest conservation, all of the project credibility rests on the reference scenario, because the only activity in this type of projects is to prevent the carbon stocks from harmful human intervention. Temporal CERs from forest protection can lead to a temporary delay of emissions, or even help to definitively avoid deforestation by carrying the protected area into a time when the menace to virgin forests will have diminished. If this risk reduction occurs however, any new contract period will suffer from a lower emissions baseline. Depending on future development, after 20 – 30 years forest protection might turn out to loose interest for carbon investors, because the emissions baseline is too low. Temporal credits will certainly have to accept a discount over definitive certificates. Therefore, project developers might turn out to be better off with forwarded definitive protection certificates. This is not as hypothetical as it may seem: Most of the destruction of tropical forests has occurred only during the last 50 years. Where the reasons for deforestation lie in de-capitalization, the opening of world commodity markets, may instigate a trend away from unsustainable slash-and-burn practices towards intensifying agriculture on existing areas.

11 For example, the Brazilian Portuguese does not distinguish between “weeds” and “virgin forest”.

Figure 6: Temporal CERs for avoided deforestation



The CERs in the subsequent contract periods cannot be allowed to cumulate in order not to account twice for the same amount of carbon sequestered. It is crucial to adapt the baseline at least every time the contract is renewed.

6.2.3 Problems of the Colombian proposal

Some problems may arise from expiring credits on the international level. Expiring credits require a more complex bookkeeping at the international registry, because they need to be notified at the moments of transfer, first use, and replacement. The demand, sustained by the European Union and other negotiation partners, to limit the use of flexible mechanism, will be even more difficult to operationalize than it already is (Dutschke and Michaelowa 1998, p. 51-59). If a part of one party's emission reduction obligations is postponed due to the use of expiring CERs, it is impossible to tell if they later on are replaced by domestic action. Therefore, the EU might be opposing the creation of expiring CERs.

In the negotiation language, the fulfillment of foregone obligations in a future budget period for countries was referred to as *borrowing*. Borrowing for countries was explicitly excluded. Applying the Columbian approach could lead to a share of borrowing on the country level. On the other hand, it can be argued, that during the contract lifetime the emissions are temporarily being compensated.

The idea of temporal expiring carbon credits seems to conflict with the longevity of greenhouse gases in the atmosphere. However, temporal expiring carbon credits are just a part of a long-term liability that arises from greenhouse gas emissions in Annex I countries. If this long-term liability was fulfilled through a set of successive actions to withhold carbon from the atmosphere, the rule of equivalence would be still obeyed. If, for instance, a re-grown forest is incidentally destroyed by pest or fire, the lost carbon storage can be replaced by carbon fixation on other sites. In the same manner, CERs resulting from a project that runs out due to other reasons than expired credit validity can be replaced by emission reductions or sequestration activities in other projects or through surplus assigned amount units (AAUs) of the international AAU market. The Colombian proposal for limiting CERs makes use of this equivalence to establish shorter contract periods for CDM forestry projects.

There is a serious drawback to temporal credits in the case of forest plantations: The potentially limited destination of the land to this specific use may tempt for unsustainable forest management practices. Project owners will need to carefully prove that they respect watersheds and practice soil conservation in order not to leave desertified land behind after two or three harvests.

Theoretically, expiring credits for forestry projects can be sold over and over again, without losing their value. Holding in mind however, that a radiative pulse originated from GHG emissions has a limited lifetime, credits from offset measures should not be valid forever.

The fact that the credit validity only starts when the buyer chooses to use the acquired temporal CERs may lead to the paradox situation that the area they were created upon has meanwhile been deforested or is being used to generate new expiring carbon credits. This may lead to ethical problem, although it may be argued, that using credits *post festum* is a kind of banking, which is allowed in Kyoto terms, because it does not conflict with environmental integrity. However, the temporal separation of project and

CERs poses high responsibilities on the shoulders of the certifier. If the certification is contested (in which case the CERs already certified will have to be replaced) or the certifier goes bankrupt, it will be difficult to sustain any subsequent certification on the same area, because basic data may be missing.

7. COMBINING THE DIFFERENT APPROACHES

The merit of the ton/year approach is to destroy the fiction of eternity when talking about permanent sequestration. The merit of the Columbian proposal is to destroy the fiction of comparability between technological emission reduction and sequestration in natural systems. Yet, both approaches appear as more or less unrelated alternatives. This article's contribution is to make use of both methodologies in order to provide a link between both proposals on permanence in CDM forestry.

A common problem of defining and delimiting permanence can only be solved by the UNFCCC's highest authority, the Conference of the Parties. It is the problem of the *last unit*. Most forestry projects will accumulate carbon or reductions until the end of their lifetime. The last unit virtually accrues in the last days before the end. Both proposals on permanence presented above could deal with this problem, either by discounting its value accordingly, or by making it repayable at once. It is questionable, if the certification process would pay off in this case. Anyway, if the permanence requirement was taken literally, that is, for single CERs, carbon gains that come too close to a project's end could not be certified as such. The other interpretation could be to put a minimum duration requirement for projects as such, leaving the decision, whether the *last unit* is certified or not to the project management.

Taking expiring CERs as the basis for CDM forest projects respects its difference to energy related emission reductions. As stated above, a minimum credit lifetime of 15 years is proposed. There is little interest of the host partners to exceed this limit. On the one hand, for the investor 15 years are a reasonably long period, as compared to other investment decisions, and given the political uncertainty over future obligations. On the other hand, the host country will be interested in maintaining formal sovereignty over the area and in renegotiating the deal as soon as possible. Without any other considerations, the host country could lend the carbon content of the area over and over again, and even thereby eventually exceed the decay time of the CO_2 compensated. As a safeguard, the ton/year approach is introduced, in order to discount the carbon value of the leased area on both sides of the balance. This model shall be denominated the *leasing approach.*

Leasing means that the ownership of carbon credits is not transferred to the buyer, but remains with the host country. As any other asset, the leased carbon sequestration suffers from (linear) depreciation over the equivalence period. This is to avoid re-lending long after the initial warming pulse, which is offset, has decayed. Put in other words: Carbon offset has its value in time and cannot even temporarily compensate several warming pulses over the years. Taking the 55 years equivalence period as a reference, the first year's carbon vintage will be linearly devaluated after 55 years. Under the minimum leasing period of 15 years, this amount can be leased for three subsequent periods, only that its value needs to be corrected year after year. After the end of the first 15 years contract, for example, one ton of carbon sequestered in the first year will be worth 727 kilos.

7.1 Costing and pricing of CERs in the combined leasing approach

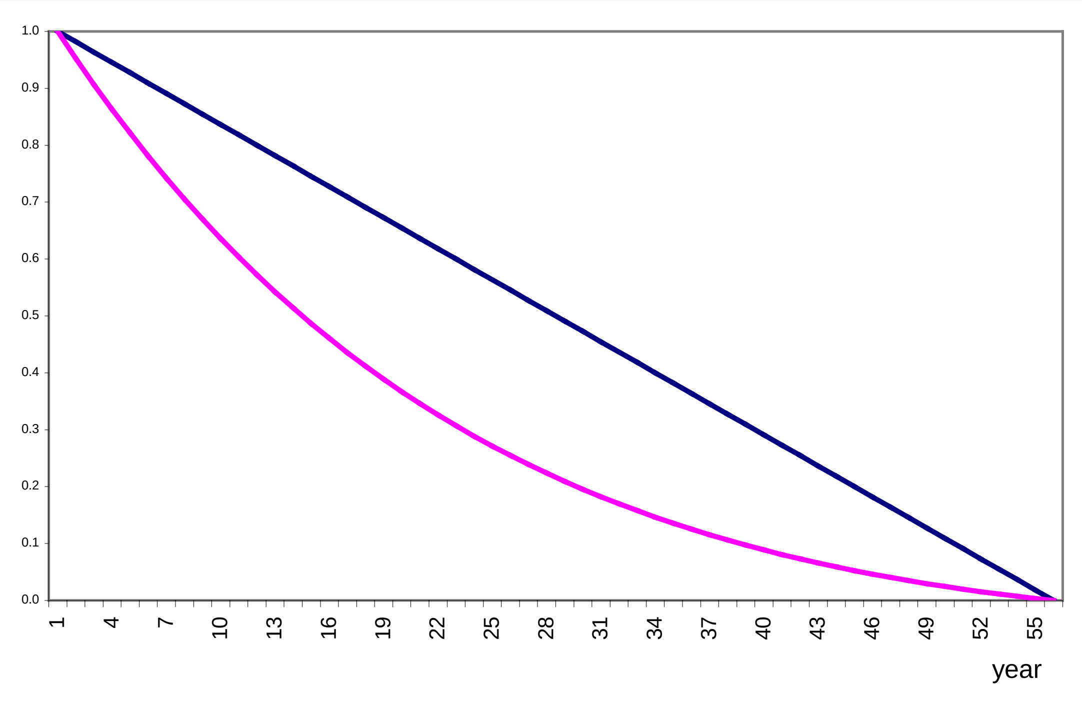
In the case of reforestation and afforestation, the bulk of costs will arise in the beginning of the project, while on the long run maintenance and monitoring costs will stabilize on a lower level. The same is true in the forest plantation case, only that there is a capital turnover when the trees are harvested that allows for replanting, while the starting point causes a negative cash-flow, when costs for seedlings and labor require seed capital. These costs can be split in transaction costs and direct project-related costs. Transaction costs will certainly be higher, comparing to a lifelong transfer of credits, as contract and compliance costs are due every time the contract is renewed. On the other hand, these may as well be standardized, and assuring compliance might turn out easier within 15 years than over 50 years and more. The combined expiring CER and ton/year approach makes direct cost calculations comparable to industrial calculation schemes. Credits stemming from forestry projects as an asset are suffering an annual depreciation in terms of the decay time of the global warming pulse of the emission that is temporarily compensated by them. As state above, using a linear depreciation scale does not reflect the decay curve, but will not harm the environmental integrity. Thus, the buyer will be due to replace this annual loss in value during the contract duration. On the other hand, re-selling the remaining expiring credits will allow sharing the costs among the different leasers.

> *Taking the example of one ton of carbon stored and assuming a moderate interest rate of 3.5 percent annually*[12]*, the total NPV over the 55 years of decay time is 29.8 percent of the one-off value of the same amount. Thus, each temporary ton of carbon leased will cost 3.4 times more than its price for permanent sale. However, in contrast to the ton/year approach, after 11 years already 50 percent of the credit's value has been realized.*

Under the present assumptions, the bulk of profits will arise over the first and the second contract phase, due to the ton/year element. This is a clear advantage over the ton/year approach (see Figure 7). The same calculation needs to be done for every year's vintage. The 55-year decay period leads to the lowest turnover for CERs. Thus, profitability for non-Annex countries would rise if the credit depreciation was slower.

12 In reality, this interest rate is a construction. It is influenced by the investors' time preference, the expected development of CER prices, and the prevailing rates on the finance markets that are accessible for the investor.

Figure 7: Linear devaluation and NPV under the leasing approach



The figure shows the linear devaluation curve of one ton of leased carbon credits. Differently to Figure 5, the leasing value of a carbon credit *de*creases, and so does the NPV of the leasing rates. This helps improving the cash-flow situation of a forestry project.

What is the advantage of credits with limited lifetime of CERs to the investor? In the first place, using expiring CERs is rational if the future compliance costs are expected to drop. This is improbable on the macro level, but might occur on the enterprise level if specific technological options for reduction are expected to be available at a significantly lower cost after the credit will have expired or a change in production patterns allows for using up the company's emission budget. Credits from forestry projects have shown to be considerably cheaper than from energy use projects. Liberating them from the blemish of permanence doubts will certainly cause surplus costs, but will still allow them to compete with energy use related CERs. On the transaction cost side, leasing credits over various periods instead of permanently buying them may lead to a slight increase in contraction costs, but on the other hand insurance, control and compliance costs will decrease. In order to minimize contraction costs, leasing contracts could be standardized by the host country's focal point or even by the UNFCCC Secretariat.

8. CONCLUSION

Carbon sequestered in developing countries' forests could offset carbon emitted in industrialized countries, which in turn may be beneficial for both parties, if the installed land use is protected for long-term. Nevertheless, how long is "long-term", and how can long-term contracts be enforced within a weak legal framework such as the Kyoto Protocol? Many developing countries fear that long-term binding commitments to protect their forests could restrict their right to access own lands and interfere with changing development objectives. As the greenhouse effect is mainly caused by industrial processes, the ultimate solution of this problem requires a worldwide change in production and consumption patterns. Clearly, investing in carbon sequestration instead of energy-related emission reduction, leads to permanence risks, whoever bears the onus. Storing new carbon in biomass is not *the* solution to climate change. However, as structural change cannot be achieved overnight, these practices might mitigate and defer the overall rise in temperature. In the political discussion, forestry options have gained a doubtful image, because they were frequently misused to nourish hopes by industrialized countries to avoid changes in their use of fossil fuels. This article has shown, how the burden can reasonably be carried by the polluters themselves, using developing countries' help and at the same time generating an income stream for forestry in developing countries.

The contribution of this article to the discussion consists in reformulating the so-called Columbian Proposal for the creation of expiring CERs and combining it with the ton/year approach. The advantages of this methodology are the following:

- The leasing approach makes carbon sequestration and reduction by conservation an asset with a defined value and lifetime.
- The definite CERs from emission reduction and the CERs resulting from carbon sequestration in organic matter are made comparable.
- There is no need for transferring the ownership of CERs. If CDM host countries wish so, they can keep ownership of all credits generated on their respective territory.
- As leasing is only a financing mode for CERs, there is no need for creating a new type of certificate.
- Control and compliance costs for long-term projects become calculable.

– Host countries do not see themselves confronted with large portions of their territory whose use is permanently blocked by international contracts (“Kyoto Lands”).
– The contract renewal will lead to an income stream for the host country over the whole project lifetime and will allow for revaluation of the certificate.
– The certificate remains with the host country. After the contract’s end, the country may decide on retaining the certificate, in order to fulfill own GHG control targets it may eventually accept in the future.

Still, some problems will have to be solved. There is an incentive for over-using soils in the first one or two contract periods. Only if land use projects will have to undergo a strict environmental audit as part of the sustainability test, this risk can be mitigated. In order to maintain ownership of CERs within the host countries, their participation in emissions trading (Article 17 of the Kyoto Protocol) needs to be clarified. Although there is actually no limit to temporarily transferring emission permits, advocates of a clear-cut distinction between domestic reductions and acquired emission permits might object the recognition of CER leasing contracts.

Independently from the approach chosen, two definitions need to be made by the COP. One is the timeframe for the average storage capacity of plantations, if this method is applied. The second is the decay time or equivalence factor that allows comparing emission reductions to temporary carbon storage.

Further studies should look into the question if the model of leasing CERs eventually makes sense for energy related CDM projects as well, as a means to integrating Non-Annex I countries into the Kyoto regime. Leasing CERs give any Non-Annex I country the chance to “warm start” as soon as it wants to join Annex I. After the ending of their respective leasing periods, the country’s CERs could be used as “early credits” for the fulfillment of own obligations.

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