# *Mechanism design to preserve the conservation value of forest related LULUCF activities under the Kyoto Protocol.*

by

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Keywords: Sustainable forest management, Kyoto Protocol, Mechanism design.

JEL: C78, D44, Q23, Q28

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## Contents

## Abstract

In this paper we identify four main problems that arise from a quantitative cap on land use, land-use change and forestry activities discussed at COP 6. These problems relate to environmental integrity and economic efficiency. First, in stark contrast to the wording of the United Nations Framework Convention for Climate Change and the Kyoto Protocol the proposed provisions for land use, land use change and forestry activities are only about carbon accounting and are devoid of sustainability criteria. This deficiency would make climate actions inconsistent with other international agreements and policy processes. Second, due to lower costs of sequestration activities a quantitative cap produces possibilities for arbitrage in the greenhouse gas market. Third, in a situation of oversupply a fair allocation of highly profitable sequestration projects is unlikely. Fourth, negotiators are overwhelmed by the complexity of the land use, land-use change and forestry issue.

The currently proposed mechanisms, such as adaptation levies or discounted crediting of flexibilities, do not provide adequate solutions. In order to solve these problems we propose a tender auction mechanism that could already be applied today for forest sinks. We distinguish between two information components in this economic mechanism. First, a qualifier component in the form of certification for sustainable forest management practices, which is already in use by market actors worldwide. Second, a competitive trait in the form of carbon sequestration intensities per greenhouse gas emission credit. Under such a regime, negotiators simply need to determine a quantitative cap (as they already started to negotiate at COP 6), while an efficient market mechanism guarantees integrity with respect to sustainability and economic efficiency criteria. The complexity of the issues surrounding land use, land use change and forestry activities is transferred to a decentralized decision making process. The proposed mechanism can also serve as a template for clean development mechanism projects and other international flexible mechanisms or subsidy programs.

## Acknowledgments

Our appreciation goes to Ian McCallum, our colleague in the Forestry Project, for his expert advice and useful comments.

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## Kyoto in Context

Kyoto is not just about the reduction of greenhouse gases (GHG) of 5.2% over the period from 1990 to 2010. After publication of the latest Intergovernmental Panel on Climate Change (IPCC, 2001) report and obeying the binding commitments under the United Nations Framework Convention for Climate Change (UNFCCC) policy makers have to realize that it is about starting a process that should, ultimately, reduce GHGs to at least 40% of 1990 levels over the next 50 years. This process also needs to be embedded in a wider concept that ensures compatibility with other commonly agreed global goals, most importantly those related to the sustainable development paradigm.

Climate change and sustainable development are intimately connected. A formal sign for this connection is that the UNFCCC was opened for signature at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. The UNFCCC itself is very explicit about this in stressing that the Convention's objective is embedded in a wider concept of sustainable development by stating*, inter alia*, in Article 3.4 as a principle: "The Parties have a right to, and should, promote sustainable development". In Article 3.5, the Convention recognizes the importance of merging economic efficiency with environmental and social integrity in one international system.

The Kyoto Protocol, set up in pursuit of the ultimate objective of the Convention, states explicitly to "Being guided by Article 3 of the Convention" and re-emphasizes the central objective of promoting sustainable development in Article 2.1. Article 12 of the Kyoto Protocol also demands sustainable development as the ultimate goal for mechanisms with non-Annex I Parties. However, the currently designed mechanisms of the Protocol are devoid of elements that would aim at an alignment of GHG reductions with the broader concept of sustainable development (see, e.g., Killmann, 2000). This is a serious problem. Even more serious is, however, that sink activities as currently discussed stand too often in stark contrast to other international agreements, such as those related to biodiversity (Convention on Biological Diversity — CBD) and desertification (Convention to Combat Desertification — CCD) (Oberthuer and Ott, 2000), and are not interconnected with work and achievements of other emerging or existing international regimes related to sustainable development in the United Nations (UN) family, such as the Intergovernmental Panel on Forests (IPF), the

Intergovernmental Forum on Forests (IFF) or the newly established UN Forum on Forests (UNFF) in the forest related policy arena.

Substantive discussions on the issue of "sinks" and the land use, land-use change and forestry (LULUCF) sector started late in the preparatory process for the Kyoto Protocol and consultations and negotiations on sinks were widely unrelated to governmental negotiations in other UN fora. Consultations were furthermore seemingly characterized by a lack of available knowledge and the necessity of a decision on sinks, given the impossibility to define the level of emission commitments without deciding on the inclusion or exclusion of sinks. The inclusion of sinks finally allowed some parties to accept the text of the Kyoto Protocol, as it offered prospects of actually being able to fulfill the commitments also in "realpolitik" circumstances. Substantive discussions on sinks and the LULUCF sector did not commence until late in the Ad hoc Group on the Berlin Mandate (AGBM) process (Depledge, 2000). Only after the Kyoto Protocol was fully negotiated was the IPCC asked to bring some light into the unclear and unresolved complex questions related to the so-called LULUCF.

The result is known. Under the Kyoto Protocol, certain human-induced activities in the LULUCF sector may now be used by Annex I Parties to offset their emission targets. In fact, at the COP 6 meeting in The Hague policy makers tried to strike a deal on a quantitative cap since 'science could not bring them any further' in the negotiations (Pronk, 2001). The activities allowed should remove greenhouse gases from the atmosphere. However, devils hide in many technical details. The biggest problem is that the 'product' is not yet defined and difficult to measure by nature. Uncertainty and verification of net fluxes, including variability, leakage, non-permanence, attributability and accountability issues still remain largely unresolved (see, e.g., Nilsson *et al*., 2000; Obersteiner *et al*., 2000a; Valentini *et al.*, 2000; Jackson *et al*., 2001). For a good part of these, there is no simple feasible solution on the horizon that is scientifically sound and practical enough for business operations on larger scales.

The future fate of the Kyoto Protocol will, to a good part, depend on feasible solutions to the political and technical dilemmas related to the sink issues that first allowed the Kyoto agreement and later brought the negotiation process close to a halt at COP 6 in 2000.

It is vital to respond to the widely perceived threat of an incompatible and in some contexts damaging international regime. In addition, it is important to adjust the currently proposed Kyoto Protocol instruments to be in line with the overarching objective of other environment related global international regimes, especially those working towards sustainable development.

## Objective

The objective of the paper is to propose a mechanism for the forest related parts of LULUCF within the Kyoto Protocol that:

- contributes to achieving the carbon reduction goal of the Kyoto Protocol,

- is in line with the overall objective of sustainable management of resources and thus compatible with other international regimes such as the CBD, CCD and the United Nations Council for Sustainable Development (UNCSD), and
- is consistent with the market mechanisms of the Kyoto Protocol.

## Methodical Approach

We follow a stepwise approach. In the first step, we review the currently implemented international provisions for sustainable forest management (SFM). We then describe the options that are, in principle, available to manage a LULUCF cap and put these into perspective according to a number of parameters measuring economic, environmental and social performance under these options. In the third step, we briefly sketch the accounting problems that are associated with forest related LULUCF activities. Finally, we describe the Dutch Tender Auction mechanism. We also show that this approach is (1) practical, (2) in line with the overarching objective of other international regimes related to forests, namely to sustainable development, and (3) leads to improved economic efficiency.

## Ensuring Compatibility of Forest Related LULUCF Contributions with Sustainability Objectives

Key areas of Agenda 21 related to forests (Chapter 11), and of the follow-up work of the UNCSD, are to sustain the multiple roles and functions of all types of forests, forest lands and woodlands, and to enhance the protection, sustainable management and conservation of all forests.

In support of the work by UNCSD, over the past decade considerable progress was made worldwide by governmental institutions, including the Food and Agriculture Organisation (FAO), United Nations Environmental Programme (UNEP), United Nations Development Programme (UNDP), International Tropical Timber Organisation (ITTO), and regional processes, such as the Ministerial Conference on the Protection of Forests in Europe (MCPFE), to develop and use criteria and indicators to define, monitor and report progress towards SFM. Over 140 countries are currently involved in one or more of the nine major international processes aimed at the development and implementation of such criteria and indicator (C&I) sets for SFM. As of today, a global set of seven or eight national level criteria has emerged from these decentralized but loosely coordinated processes to define sustainability in forestry in operational terms.

Such criteria and indicators for SFM but also, to the extent available, for sustainable agriculture, wetland or grassland management would allow to distinguish whether initiatives or projects are geared towards or against the ultimate aim of both the Convention, the Kyoto Protocol, and the promotion of sustainable resource management.

Apart from and parallel to the operationalization of the abstract definition of sustainable development in the forest sector, private sector activities have emerged on global,

regional and national levels to define and elaborate operational standards, including criteria and indicators for the assessment os SFM on the operational level with the aim to certify 'well managed' or 'sustainably managed' forests. Certification as such is a market based instrument to communicate high quality/sustainable forest management. Forest certification is based on assessment by an independent external party on whether forest management meets certain quality requirements. Today, certification is, like the work on the governmental level on the development of C&I sets, a global phenomenon with an increasingly stable and working international institutional structure for the verification of claims related to forest management. As is the case for the work on C&I sets, forest certification initiatives are characterized by their adaptation to different regional circumstances. Not only have these initiatives achieved in coming up with regionally differentiated and adapted solutions to global problems, they have also had almost one decade to devise and adapt mechanisms and solutions. This constitutes a tremendous asset over any new attempts to design and establish new mechanisms, given the existing limits of time and resources. It is therefore proposed to use the existing mechanisms of criteria and indicators for SFM and the institutional arrangements for verification in the context of forest "sinks" in the Kyoto Protocol.

## A Market Mechanism Design to Manage Caps for Forest Sinks

### Cap Management Options

The design proposed here should allow to ensure that the potential contribution of forest related LULUCF activities in the context of Articles 3.3 and 3.4 of the Protocol to the reduction commitment laid down in the Kyoto Protocol is in line with the overall objective of SFM. Only activities that can prove compatibility with SFM should then be allowed in a GHG market mechanism designed to maximize the efficiency of total reduction commitments.

The allowed share of the contribution of sinks to the total reduction commitment is a political question. Figure 1 provides an overview of the three principle ways to obtain a restricted contribution of LULUCF activities in a market to reduce net GHG emissions to the atmosphere.

Figure 1 (I) illustrates the supply schedule of the benchmark case of a fully unrestricted contribution of sinks. With reference to (II) the first possibility to manage a cap is by a simple quantitative limitation of LULUCF projects. In this context a quantitative cap is reflected by a simple normative rule stating that the share of carbon credits from LULUCF activities is restricted to a certain amount. The allocation rule for the right to deliver LULUCF carbon credits to the GHG market is then based on a first-come first-serve basis. The second option, the qualitative cap (III), is an indirect way to reach a certain quantitative target contribution by tightening criteria and increasing the number of indicators that define eligibility. As outlined previously, criteria and indicator sets for determining the quality of the sink or project in question can be used here. Considerable work has been achieved regarding such sets globally. The IPCC (2000) lists the rates of

potential carbon gains for selected practices for forest lands that are or can be part of such criteria and indicator sets. The third option (IV) is a combination of the former two, where the quantitative target of credits is fixed but a competitive mechanism for project selection is introduced. Projects compete for criteria and indicator points for either SFM or carbon sequestration, or a combination of the two.

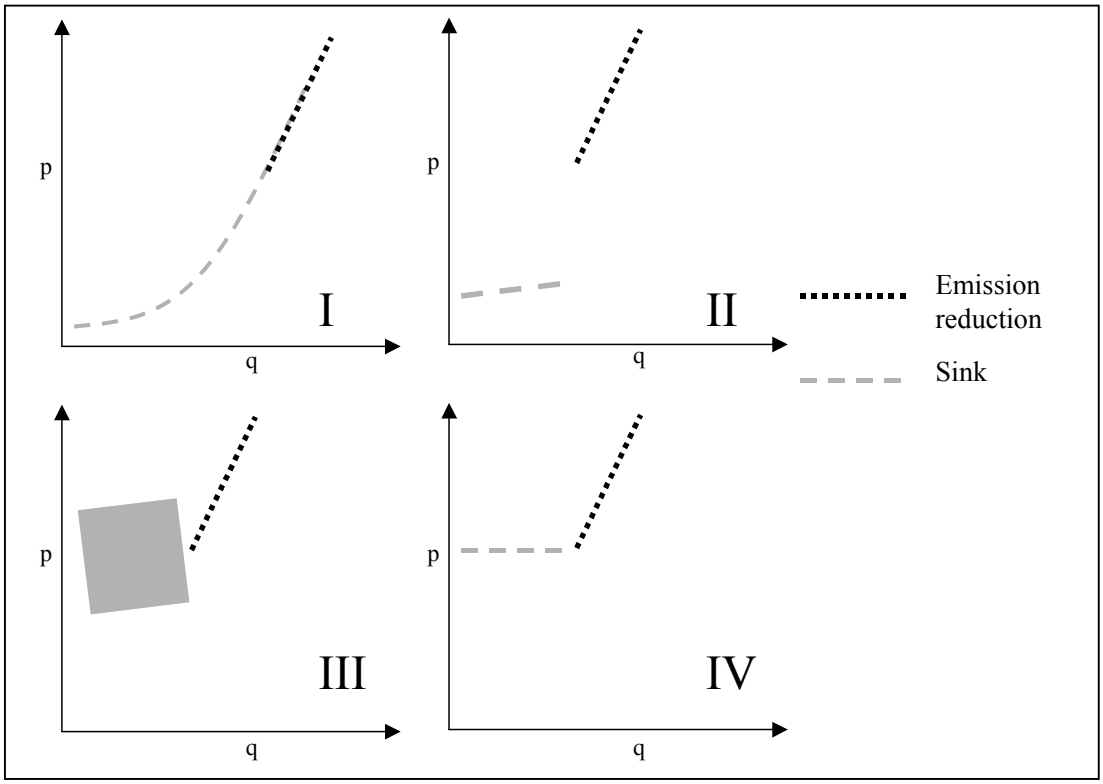


*Figure 1*: Supply schedules of emission reductions and sinks under unconstrained market conditions for LULUCF activities (I), under the introduction of a quantitative cap (II), a qualitative cap (III), and under a quantitative cap for credits with additional demands on SFM and/or carbon sequestration (IV). (Abscissa: quantities in tC (q); Ordinate: Prices in $ per tC (p).)

## Cap Management Options in Perspective

Table 1 evaluates the different ways of cap management using four criteria: (1) the occurrence of arbitrage possibilities for LULUCF projects, (2) the possibility that LULUCF projects can be allocated in a fair way among all potential suppliers, (3) the quantitative target can be exactly be met, and (4) the degree of difficulty to operationalize the instrument.

*Table 1*: Overview of the methods proposed for cap management.

| | **No Arbitrage gap** | **Fair Allocation** | **Meeting the cap exactly** | **Difficulty to operationalize** |
|---|---|---|---|---|
| Quantitative cap (II) | no | no | yes | small |
| Qualitative cap (III) | - | yes | no | high |
| Quantitative cap & C&I (IV) | yes | yes | yes | small |

As shown in Figure 1 (II) a quantitative cap would result in discontinuities of the supply curve. Discontinuities lead to market distortion in the sense that there are a limited number of relatively cheap LULUCF activities that could earn large profits without taking additional efforts or risks. We call the difference between the market-clearing price, which mostly reflects costs of emission reductions in the energy market, and the cost of the individual LULUCF project the *arbitrage gap*.

The costs of emission reductions are expected to be much higher than LULUCF costs for carbon sequestration. For example, forestry actions are estimated to cost about 1–10 US$ per MtC (see, e.g., Sohngen and Mendelsohn, 1999), while the lowest cost estimates for emission reductions in the energy market start at 15–20 US$ per MtC (see, e.g., Grubb, 2000; Karani, 2000), but are expected to exceed this level. Similar to quotas in the production of oil set by the Organization of the Petroleum Exporting Countries (OPEC), a restriction of cheaper LULUCF activities will push the market clearing price for carbon credits up with the consequence that LULUCF activities become highly attractive (Figure 1 (II)), as a sink project can earn more carbon dollars on the national or international market that is dominated by emission reduction in the energy sphere. The result of the artificial quantitative cap are high profits for LULUCF activities that participate in the GHG market. These profits are generated without additional efforts or risks to be carried by the agent running the LULUCF activity resulting in an arbitrage gap.

Possibilities for arbitrage will in turn lead to oversupply of such activities. If the arbitrage gap is large the oversupply of highly profitable LULUCF projects will lead to keen competition due to the artificial quantitative cap. However, due to these demand rigidities introduced by the cap, prices will not be able to adjust and will stay at high levels compared to LULUCF costs. This leads to a situation where a fair allocation is impossible to generate on the basis of a price based mechanism. Price, as the only information to clear the market, is not sufficient under such circumstances. With this single criterium no other selection mechanism will be available other than a first-come first-serve rule. In a situation of asymmetric information, which certainly will be the case, a fair allocation of rights to deliver carbon credit from LULUCF activities will be impossible to produce under such a market rule. In other words, those LULUCF players that have a competitive advantage in 'through the backdoor' guessing will most likely be able to earn large profits from arbitrage. The principles of equitable and fair allocation are violated if such informational advantages are rewarded.

The only practical way that is currently suggested to minimize the arbitrage gap is by depreciating LULUCF activities by some lump-sum rate. For other reasons, many argue that restrictive measures should indirectly reflect the higher uncertainty of net sequestration of LULUCF projects (e.g., Gabus, 2001). Also the Pronk (2001) statement suggests 'discounted crediting to factor out non-direct human induced effects and to address uncertainty' under Article 2.4. However, such an approach to penalize for uncertainty is not providing the right incentives to solve the uncertainty problem and will also not eradicate the arbitrage gap. Uncertainty and arbitrage are idiosyncratic to the project and only a penalty for uncertainty of individual projects would provide the necessary incentives to reduce uncertainty of sequestration. Uncertainty has to be treated by a different set of rules and more appropriate verification provisions (see, Obersteiner *et al*., 2000b,c).

Besides efficiency and fairness considerations another drawback of a quantitative cap is that there is no guarantee that LULUCF projects conform to the overall sustainable development goal of the Kyoto Protocol. Social and environmental leakages especially from LULUCF activities based on Article 3.3 can be substantial. There are already numerous illustrative examples, mostly from CDM carbon plantation projects available, that question the social and environmental integrity of 'cheap' LULUCF activities (Koskela *et al*., 2000).

The second way to define a cap is by introducing qualitative criteria that LULUCF activities must meet. In this way the quantitative cap of LULUCF in the carbon market is reached indirectly. Meeting the additional criteria is usually costly and, if sufficiently restrictive, the introduction of such criteria will shift the supply schedule of LULUCF activities into a range where they will directly have to compete with energy projects as illustrated in Figure 1 (III). However, various types of uncertainties make it impossible to predict the final market share of LULUCF activities. First, uncertainties of current cost levels of both LULUCF and energy activities are large (Vrolijk and Grubb, 2000). Second, there is large uncertainty on the elasticity of additional requirements on the costs of LULUCF activities. In addition, the transaction costs are potentially high as new institutions will have to be built and capacity building in the business sector is a slow process.

An alternative way to define a cap is to set a quantitative cap with additional qualitative C&I for sustainable resource management and carbon management (see Figure 1 (IV)). Such an approach would allow installing a market for "sink" activities based on a competitive selection mechanism among suppliers of LULUCF projects geared towards maximizing the potential contribution to the reduction goal of the Kyoto Protocol. Competition for quantifiable actions for carbon sequestration or for sustainable resource management closes the arbitrage gap and allows a fair allocation. In addition, certification of SFM is a market driven approach where the international institutional structures are already fully established and working. Carbon issues could readily be integrated in such certification mechanisms on a worldwide scale benefiting from previous experiences and institutional infrastructures.

### *The accounting and additionality problem*

The set of criteria and indicators used requires a design that allows rankings between different alternatives. This can either be based on ordinal scale "star-ranking" for activities with different sequestration or emission potential, actual increase of sequestration or reduction of emissions, and on additional criteria to avoid leakages such as incentives to establish fast growing monocultural plantations while being ignorant to deforestation of natural old growth forests. Any reduction in the rate of deforestation has the benefit of avoiding a significant source of carbon emissions (especially in the tropics) and reducing other environmental and social problems associated with deforestation. Possible additional criteria could be *inter alia* a biodiversity index, additional criteria points on the management of existing forests.

As a first step, criteria additional to carbon sequestration could be derived from the existing sets of criteria and indicators for sustainable forest management. Table 4-9 in Chapter 4 of the IPCC (2000) report lists rates of potential carbon gain under selected practices for forest land in various regions of the world. Most of the practices, such as improved natural regeneration, preventing forest degeneration and others, form part of the criteria and indicator sets already established.

With reference to Article 3.4 "changes in greenhouse gas emissions…and removals", implies that credit will be based on a comparison between two points in time or two paths through time. Forest certification currently usually works on a 5-year period basis, which would allow assessing differences between two points in time between 1990 and the first commitment period. In such a case only changes with respect to SFM would be honored.

Referring to Article 3.4, this requirement would suggest that the carbon stock change during the commitment period should be compared with the carbon stock change during the base period (1990). For LULUCF activities undertaken under Article 3.3, net emissions are defined as the change in stocks during the first commitment period, 2008–2012. In essence, this definition specifies that, for qualifying activities, carbon stocks in 2008 are the reference against which to measure carbon sequestration by Afforestation Reforestation and Deforestation (ARD) during the first commitment period.

Furthermore, details with respect to carbon accounting, the system boundaries, measuring and monitoring of carbon are still under discussion (see, e.g., IPCC, 2000; Kirschbaum *et al*., 2000) and will be treated in greater depth separately in an IIASA follow-up publication. It is stated that carbon accounting must be conducted in such a way that they are real, additional and verifiable (see, discussion on these points in Jonas *et al*., 1999). Issues of verifiability and treatment of uncertainties as discussed earlier can be solved. Contrarily, the additionality concept, i.e., accounting for an error prone difference with the counterfactual, is still poorly defined and full of loopholes. However, in a competitive mechanism the baseline scenario is endogenously determined through competition, i.e., projects that are not additional (perform better than the baseline scenario) will not be competitive to begin with. Thus, this artificial concept of additionality is not needed in the economic mechanism design proposed in this paper.

### *The mechanism design — Dutch tender auction*

The Dutch tender auction mechanism (see, e.g., Obersteiner, 1998) shall ensure that a fixed quantitative cap is achieved in a competitive setting without arbitrage gaps and a fair allocation of approvals to high quality projects. In the auction mechanism considered in this paper a qualifier indicator and an indicator for the competitive trait must be considered. If the qualifier to enter the market is basic certification then the competitive trait is the verifiable amount of carbon sequestered per carbon credit. If, on the other hand, the qualifier is one unit of carbon sequestered then the competitive trait must be the delivery of sustainability points per unit carbon. In both cases the price of one carbon credit, i.e., the right to emit one unit of a GHG equivalent, is treated as given and fixed (see, discussion on how to fix the price below).

So, for example, the Dutch auction with sustainability criteria as the competitive trait works as follows:

Figure 2 describes in greater detail the Dutch tender auction for LULUCF contracts. A central agency (e.g., a commodity exchange) auctions off to LULUCF suppliers the right to deliver carbon sequestration credits at a fixed price. The price remains unchanged throughout the auction. Given the fixed price for one unit of carbon sequestration the auctioneer starts to collect bids for carbon sequestration of individual suppliers at the maximum possible sum of sustainability points a project can collect. Subsequently, the auctioneer lowers the points and collects bids at this lower total sustainability level. The auctioneer continues to lower the points until the cap, which is essentially a supply constraint, is filled by LULUCF projects (the lowering of the total sum of indicator points is symbolized in Figure 2 by the thick line arrow). Competitive bidding is not based on price or quantity but, in this particular mechanism design, is based on bidding for the delivery of 'sustainability points' that a project promises to collect. The collection of sustainability points is based on well-established criteria indicator systems, which are already in use.

The contract between the central agency and the LULUCF projects must be a future contract. This is due to the fact that LULUCF activities become measurable only after some time lag until management changes become measurable in the biological resource.[2] Contrarily, a technological modernization of an industrial plant becomes immediately measurable (disregarding leakage effects).

As already mentioned, the tender auction mechanism is used to generate an efficient and fair allocation of future contracts where, in the proposed mechanism, the supplier promises to deliver the product in the future and can expect a fixed financial return at some point in time at the end or prior to the end of the contract period. Hence, in order to operationalize the auction there must be a price forming mechanism prior to the end of the contract period that allows determining the fixed financial return for the supplier of the carbon sequestration. There are two possibilities (1) determine a market clearing price prior to the end of the contract period (say 2005) by a bidding procedure; or (2)

[2] Here, the question of the day when the promised criteria are due to be met and the carbon sequestration is verified must still be solved. Ideally, the full contract should be measurable in nature by the end of 2012 so that accounting tricks are avoided.

the auctioneer fixes a price based on market analysis and sells the contracts on a speculative market that carries the risk of selling the contract at the end of the contract period (2010–2012).

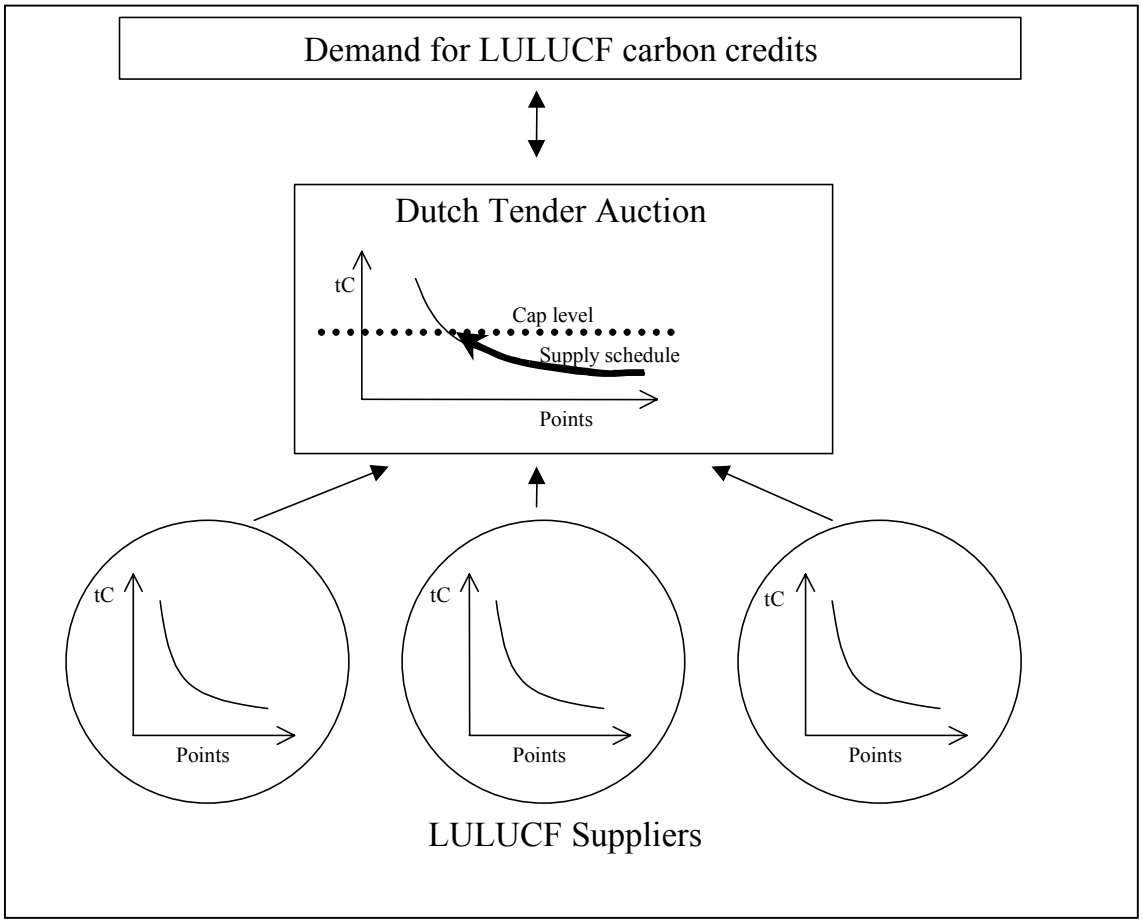


*Figure 2*: Supply scheme of the cap management mechanism by Dutch tender auctions for carbon or sustainability points.

On the other side of the market the decision rule of an individual investor to enter a LULUCF carbon market is defined in Box A (see, Appendix). Decision support can be given by multiple criteria optimization techniques, which are also well established and operational in the field of forestry (see, e.g., Hyttinen *et al*., 1995).

If the delivery of carbon sequestration units becomes the competitive trait and SFM certification is the qualifier the mechanism works analogously. This type of mechanism design appears to be the most practicable way to combine provisions for SFM with the delivery of maximum carbon sequestration from forests within the framework of the Kyoto Protocol. Also the institutional framework for the qualifier, i.e., a certificate securing SFM, is already fully established and could easily be integrated in such a scheme. The issues surrounding the competitive trait, i.e., the rules defining the eligibility of carbon sequestration, are less established and are still under serious discussion. The competitive trait itself, regardless of its definition, is defined by the

amount of carbon sequestered (under the respective accounting provisions) per carbon credit. Under such a definition the mechanism proposed can also be viewed as a way to idiosyncratically discount LULUCF projects in order to bring their price level up to the energy market price level through the introduction of SFM provisions and competition for carbon intensities per credit earned. It is also interesting to observe that eligibility issues are becoming less important since LULUCF activities are self-restricting due to competition under the auction mechanism. In fact, an artificially restricted LULUCF contribution, i.e., a type of qualitative cap, would lead to efficiency losses and to losses with respect to sustainability. Contrarily, however, accounting and verification will play a more important role in an auction scheme as measurability of the 'product' is the key ingredient in any anonymous market mechanism (e.g., North, 1997).

## Discussion and Conclusion

The Kyoto Protocol envisages the first-ever international market mechanism for environmental goods. It is now crucial to design the institutions of the GHG market such that the integrity of the Convention and the Protocol with respect to sustainable development is preserved. Cutajar (2000) mentions that the greatest challenge of the COPs to come is to balance economic efficiency with the credibility of the use of flexible mechanisms. The aim of the use of flexibilities and sinks is to seek lower costs for achieving part of the target of the Kyoto Protocol.[3] In this paper we ignored issues related to notions of environmental integrity with respect to the question of whether sinks should be used at all. We were interested in the question on how to make sink activities more compatible with the broader goal of sustainable development by using market mechanisms. Clearly, compatibility with other international agreements on the use of natural resources will help to preserve the environmental integrity of carbon sequestration activities.

In the Kyoto Protocol negotiation phase there was, at least on paper, broad consensus that carbon sequestration activities, if used in one way or the other, should be aligned with sustainable development objectives. Although there is widespread agreement on this issue, it is stunning to see that there were no provisions for sustainable resource management proposed so far. The currently discussed rules for sink activities to be eligible for inclusion in the carbon market do not ensure that sustainability criteria are met by sink projects in addition to carbon sequestration. Thus, the environmental integrity of LULUCF activities is not guaranteed under the currently discussed provisions.

The flexibility of the proposed mechanism defines an adaptive efficient carbon market. The appropriate set of carrots and sticks is crucial for the functioning of any market mechanism. The international market mechanism needs to reflect the current knowledge about the goods and actors in the market so that the environmental good, reduction of net fluxes of GHG to the atmosphere, is delivered according to the Articles of the

[3] The auction mechanism proposed in this paper will necessarily lead to efficiency improvements in the sense that total costs for reduced GHG fluxes to the atmosphere will be smaller under the inclusion of LULUCF activities.

Convention and the Protocol (see, e.g., Sugiyama, 2001). The proposed mechanism is simple and flexible in its nature and can be well integrated in the currently discussed provisions of the Kyoto Protocol and international processes concerning SFM. The mechanism also carries the potential to reduce the seemingly unresolvable complexity of the sink problem significantly by decentralizing the decision making process, which in the end leads to a self-restriction of activities by still preserving economic efficiency.

Under the proposed provision the policy makers could still preserve the environmental credibility of the Kyoto package by including LULUCF activities. The decisions for policy makers require little technical knowledge in the field of LULUCF activities and are thus easy to negotiate. Most of the complexity of the issue is transferred to a decentralized and competitive scheme of decision making.[4] Policy makers would have to decide only on the share of LULUCF contributions to the Quantified Emission Limit and Reduction Commitment (QELRC) and whether the share applies to the country level or total market share. Such simple decisions are purely political in their nature and are relatively easy to negotiate in comparison with the current questions of dispute. In fact, these two questions are negotiated as such at the 'current' COP 6. Due to the simplicity of the proposed mechanism a compromise can probably be generated in a relatively short time (see Box 1).

**Box 1: Decision making schedule to implement LULUCF tender auctions**

1. Tender mechanism:
   - 1.1 Qualifier: Certification for SFM
     Competitive trait: Carbon sequestration intensities per GHG emission credit.
   - 1.2 Qualifier: Unit carbon sequestration per GHG emission credit
     Competitive trait: Sustainability points according to C&Is.

2. Definition of eligibility, accounting rules and verification requirements.

3. Contribution of LULUCF activities to QELRC:
   - 3.1 Applies to the national target.
   - 3.2 Applies to the international target.

4. Mechanism to determine benchmarking price:
   - 4.1 Competitive bidding for LULUCF credits prior to 2010.
   - 4.2 Initially determined by a market maker.

Due to competition the provisions lead to self-organized restriction in the scope of different sink activities without *a priori* physical restrictions of potential sink activities. The very issue of differences among Parties on the scope of what activities are eligible for carbon crediting is resolved by a transparent and efficient market mechanism that is defined through sets of criteria and indicators. This market mechanism would not only

[4] The proposed mechanism can be applied to both a restricted or unrestricted set of LULUCF activities.

produce an efficient allocation of a multi-criteria environmental and social good, but also lead to a fair allocation among LULUCF project suppliers. Moreover, self-organized restriction is more prone to reflect the peculiarities of the site conditions and thus lead to site-specific adaptation of LULUCF activities. In addition, the error prone concept of environmental, social and financial additionality becomes unnecessary in a competitive environment.

The institutional framework of the Protocol aiming at reducing the net emission of GHGs in a sustainable manner looks more like a traditional regulatory command-and-control method that exclusively deals with GHGs. Such methods have so far proven to be very ineffective to push technology frontiers and institutional best practice (Victor *et al*., 1998). Real technological and institutional change that induces a reduction of the total environmental rucksack, including the carbon footprint, in a sustainable manner can thrive only in an economic environment that fosters creativity and innovation in a decentralized decision making mode. The Protocol is lacking these elements of business-friendly approaches that are workable and pragmatic and that are at the same time effective with respect to broader development goals. Thus, an incentive structure must come into action that honors business performance in terms of its totality of social, environmental and economic values. Image score improvement by economic agents must also be trackable by outside stakeholders (Nowak and Sigmund, 1998). In the case of forest management such a process is already materializing by the introduction of forest certification schemes. With respect to economic performance competitive bidding as an instrument to allocate financial resources to alternative energy suppliers have proved to be superior to traditional restrictive command-and-control methods (Klaassen *et al*., 2001) The auction mechanism presented in this paper is a natural extension of both the process of SFM and the Kyoto process and preserves integrity, transparency and is business friendly. In contrast to novel command-and-control provisions for LULUCF activities (e.g. eligibility and additionality) discussed at COP 6 in The Hague, both forest certification schemes and mechanisms of competitive bidding are way ahead of the experimental stage.

C&I and mechanisms of competitive bidding are fully established and are already implemented by market actors all over the world. Not only would one benefit from the institutional learning from these processes, but LULUCF entrepreneurs could also start using already fully established instruments that are widely accepted and successfully used by the market actors. In addition, the LULUCF entrepreneur could expect additional market or non-market benefits from the natural resource holding.

Finally, it should be mentioned that the proposed mechanism can after some modification, be or even should be equally applied to energy projects under CDM, joint implementation of the Kyoto Protocol or any other subsidy scheme on national and international levels.

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## Appendix

**BOX A: Decision rule for a potential LULUCF supplier to participate in the GHG market given competition rules that are based on carbon sequestration or C&I points**

$$\left(P(CI^{i} > CI^{-i})\,p_T + P(CI^{i} > CI^{-i})\,p_T^{*}\right) - c(q) \geq \pi_t\, e^{rT}$$

$P(CI^{i} > CI^{-i})$ Probability that the CI value of the project *i* is larger than those of the losing *–i* projects.

$p_T$ Market price of one GHG emission credit at time *T*.

$p_T^{*}$ Market price of all joint products of sequestration and SFM at time *T*.

*c(q)* Average cost of the LULUCF project. The average cost is a function of the quantity supplied due to diminishing marginal transaction costs.

$\pi_t^{*}$ Return from a risk-free portfolio at time *t* over *T* periods with a guaranteed interest-rate *r*.

The decision rule for a LULUCF supplier to participate in a Kyoto market consists of a comparison of the expected return from an LULUCF investment in a Kyoto market with a risk-free portfolio. Returns depend on the price of GHG emission credits and additional benefits from joint production such as image scoring due to certification for SFM, and finally on the costs of production. Those costs can be roughly divided into transaction costs (e.g., certification, verification, monitoring, consultancy) and costs for operation (e.g., silvicultural costs, harvesting). Decision support tools are relatively easy to build once carbon accounting prescriptions will be available.