Global Carbon Market & Forest Values

- A new economic incentive to forest protection?

by

Roberta Mokrejs Paro

LUMES – Lund University Master's Programme in Environmental Science
Lund University, Sweden
2000

Honours Thesis

Roberta Mokrejs Paro
R. Boquim, 380
05454-001 – São Paolo – Brazil
tel/fax: 55 11 30211095
rmparo@hotmail.com; Roberta.paro.667@student.lu.se

Supervisor:
Lars Nilsson
Lars_J.Nilsson@miljo.lth.se
Dep. of Environmental and Energy Systems Studies
Lund University

Co-supervisor:
Astrid Kander
astrid.kander@ekh.lu.se
Dep. of Economic History
Lund University

Table of contents

List of Figures and Tables

Abbreviations and Acronyms

ET	Emissions Trade
EU	European Union
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CTO	Certified Emission Offset
CIFOR	Center for International Forestry Research
GHG	Greenhouse Gases
IAE	International Academy for the Environment
IPCC	International Panel on Climate Change
LULUCF	Land Use Land Use Change and Forestry
NGO	Non Governmental Organisation
MIT	Massachusetts Institute of Technology
OECD	Organisation for Economic Co-operation and Development
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
WBGU	German Advisory Council on Global Change

Acknowledgments

I would like to thank my supervisor Lars Nilsson for the support, and for encouraging me to carry out this study which, although very much in my interest, had little related to my background. Thanks also to Astrid Kander for the time devoted and the valuable comments, and to Lennart Olsson for the support in the initial phases of this work.

A big thank also to my dear friends Aled Jones, Björn Beeler and Philippe Charest for the continuous support with information in this that may have seemed such a broad and mysterious topic.

For the remarkable moral support, a very special thank to my housemates Anne Carlsvi and Maria Frodig, who are almost as happy in seeing this work being concluded as I am. Without both of you, this final phase would have been surely much harder. Thank you Anne also for your time and suggestions concerning the English language.

Finally, I would like to thank LUMES and the STINT Foundation for awarding me the funds that have made my participation in this Master's Programme a reality.

Introduction

The interconnections among the social, economic and environmental spheres have been internationally recognised as a crucial aspect to be addressed for the future well being of humanity through the concept of sustainable development[1]. However, in the attempt to conciliate the needs of the socio-economic and environmental systems, many difficulties can arise.

Initially, the very hierarchy of these systems is found distorted, and the conventional economic worldview has humans and nature as separate systems (see Turner *et al.*, 1994). On the other hand, under the paradigm of sustainable development, ecological economics has a different perspective. It places the human socio-economic system as a *subsystem* under the broader life-supporting environment of which it is dependent. This, by placing the "economic subsystem" in its proper perspective and understanding its interconnections with the entire system, represents a fundamental step for achieving long term sustainability (Costanza, 1991; Jansson *et al.*, 1994).

However, while fundamental changes in worldview are a slow-moving process, the current pace of environmental degradation and loss of ecosystems by human activities, in some cases irreversible, is still a reason for international concern. This raises the urgency in addressing the core causes of environmental degradation, which lie in the socio-economic system, under the conventional paradigm first. This implies assuming an anthropocentric perspective in relation to this broader system, still, but only in the attempt to introduce the bigger role of the environment in it in a more effective way.

Environmental economists have argued that environmental degradation occurs because the environmental and socio-economic value of natural ecosystems and the goods and services they provide is inadequately reflected in the current methods of evaluation in decision-making (Pearce, 1998; Jansson *et al.*, 1994; Costanza, 1991). In order to address that, monetary values are assigned to ecosystem goods and services in the attempt to incorporate them into economic accounting. By bringing the role of the environment to the monetary dimension operating in the economic system, valuation can represent an important tool for decision-making in the policy level.

In developing countries, however, not always the demonstration of value is sufficient to interfere in the final decisions concerning land use. In this case, problems arise when governments, although acknowledging the various environmental and socio-economic values of natural ecosystems, lack the financial resources to prevent short-term and 'concrete' gains from non-sustainable land uses. Another hindrance is when the decision-maker is the private landowner, which is common in important ecosystems in developing countries. As Pearce & Moran (1994) point out, in this case, if the values associated with the environment come in a non-market form, the landowner does not have any incentive to take them into account.

Thus, once environmental values are demonstrated and acknowledged, it remains necessary to provide the means to capture these values and convert them into local benefits to both finance and compensate sustainable land use. This acquires particular importance for developing countries because it contributes to the economic viability of sustainable practices, which consists, in turn, in a crucial element to ensure the long-term aspect of sustainable development. In addition, the

[1] Officially adopted by the global community in the Earth Summit in Rio de Janeiro in 1992. The concept, however, was first disseminated the Brundtland Report (see WECD, 1987).

reversion of these values to local benefits would also avoid relying on financial resources from other development areas, usually priority in relation to environmental issues.

Thus, the combination of elements such as lack of financial resources, weak enforcement, different priorities and need of economic viability in the long term, in the face of the fast pace of environmental degradation and ecosystems loss, can result in critical situations that require urgent measures to not only halt the current trends, but also change the development path to a more sustainable one. Is under these conditions that the utilisation of market mechanisms, for not relying totally on institutional and financial resources from the government, has the potential of adding dynamism and consequently being more effective in attending the need of economic incentives for sustainable land use.

Tropical forests are a typical example of the context above. Despite the various products and ecological services they provide (e.g. biodiversity, watershed protection, recreation), deforestation is still a major threat to these forests, which are concentrated mostly in developing countries (see Pearce & Moran, 1994). Because there are no markets for many of these values, the focus is mainly on timber, which implies clearing the forest and taking with it most of the associated values.

Meanwhile, a global environmental market for *one* of the ecological services of forest is emerging. The regulations for climate change, concretised by the Kyoto Protocol, have created a demand for carbon offsets. Given the role of tropical forests as both source and sink of carbon, its participation in this market occurs by compensating carbon emissions through reforestation and afforestation, or by avoiding more carbon emissions through *forest protection*. The later would place a market value for carbon storage in *existing* trees. If this is enough to stimulate forest protection, it will consequently contribute to the preservation of the other ecological services of forests.

The participation of developing countries in this carbon market would be through the Clean Development Mechanism of the Kyoto Protocol, which is part of the flexible mechanisms created to provide cost-effective ways of achieving the emission reduction targets. The mechanism allows developed countries to invest in developing countries with the aim of getting cheap carbon credits.

This would bring an opportunity to compensate forest protection in important ecosystems where restricting economic activities (e.g. through legislation) entails very limited return rates, reducing economic viability and therefore acting as a disincentive for conservation.

However, the hypothesis above involves many uncertainties. Some are related to the operationallity of the Protocol and the Clean Development Mechanism itself, and others related to the very inclusion of forest protection and other forestry activities in the accounting. Such uncertainties are still to be defined by negotiations. Still, for this opportunity to become a fact it remains important to consider the limitations imposed by economic and market aspects, which, found in the conventional paradigm, follow its own rules irrespective of the ‘commodity’ being environmental or not.

Thus, what are the concrete possibilities for forest protection to take part of the carbon market through the Clean Development Mechanism? And if that is a fact, to what extent this participation can be considered as an economic mechanism to compensate forest protection?

To answer that, two different perspectives are going to be taken in this study. Initially, the demands of the carbon market will be identified, as well as the possibilities of forest protection to attend such demands. This because such market is created aiming specifically at carbon offsets, and forest protection might not be the most cost-effective way of obtaining it. Therefore, only if forest protection can become a competitive supplier to the carbon market we can say that such market *is a reality* for forest protection. Once this condition is verified, the perspective will then shift to the needs of forest protection. Again, because the market aims only carbon offsets, the remuneration of this 'commodity' alone does not imply in addressing the total costs necessary to promote forest preservation, and thus the ecological services provided by them.

Finally, in order to illustrate how the scenario in discussion would occur in reality, a small case study will be applied as a representative of the missing markets for ecological services of forests. Then, the possibility of applying this case in the framework of the Clean Development Mechanism and its potential contribution to the preservation of ecological services associated to forests will be tested based on the two perspectives described above.

Methodology:

The present study is divided in three Parts:

- Part I: The context of the problem is exposed based on environmental economic principles explaining the interactions of environmental and economic systems. Then, the potential carbon market is identified, as well as the peculiar conditions in which this market is emerging. This is important to understand the uncertainties related to the carbon market, and to visualise the possibilities and constraints on the use of such market for forest protection.

- Part II: The main question (above) is divided in the two following questions, which will be analysed and discussed based on the application of the principles of Part I in the context of the Clean Development Mechanism:

1) What are the concrete possibilities for forest protection to take part of the carbon market through the Clean Development Mechanism?

2) If the answer to the first question is affirmative, to what extent this participation can be considered as an economic mechanism to compensate forest protection?

Analysis and discussion will be based on literature and projections available, as well as real projects.

- Part III: Small Illustrative Case: illustrative application of the overall discussion in a watershed protection case in the Guarapiranga Basin, São Paulo, Brazil - the possibility of applying this case in the framework of the Clean Development Mechanism and its potential contribution to the preservation of ecological services associated to forests will be tested.

Objectives and Limitations

The purpose of this paper is to investigate the potential of using the global carbon market created through the Kyoto Protocol as an economic mechanism to achieve the preservation of ecological services of forests in developing countries.

The objective is to verify the possibilities of forest protection taking part of the carbon market through the Clean Development Mechanism, and to what extent this participation can be considered as an economic mechanism to compensate forest protection.

Although the scientific and operational uncertainties regarding the inclusion of forest protection (avoided emissions through deforestation) in the Kyoto Protocol and the Clean Development in particular are of crucial importance to the market herein discussed, they are not in the scope of analysis in this study. It is assumed that, if the Clean Development Mechanism allows the crediting for forest protection, all these variables will stop being dynamic and will operate according to the rules agreed in the negotiations, still to be elaborated. Therefore, they are going to be addressed in the discussion only through their reflect in the market behaviour.

Similarly, the adequacy of inclusion of sinks in the climate change regime is not in the scope of this study. What is herein examined is a possible opportunity for forest protection. It is not thereby concluded that this justifies the inclusion of sinks in the climate change regime.

It is assumed herein that the preservation of forests implies in the preservation of the ecosystems provided by them, although this might not always be true. However, since the intention here is to compensate conservation as a *preventive* measure, as opposed to recuperation of degraded ecosystems, such relationship is reasonable.

In this study, the term *protection* is used instead of *conservation* only to facilitate the discussion regarding costs. Since conservation projects under the CDM might provide revenue others than only carbon offsets (e.g. timber and other goods in sustainable forest management), this might increase its competitiveness, therefore becoming difficult to analyse the impact of *only* carbon revenues in the compensation for sustainable land use – which is the focus of this study. More over, the contribution to emission reduction in conservation projects allowing sustainable timber harvests can be questioned (see Fearnside, 1995).

PART I: ECONOMIC AND ENVIRONMENTAL SYSTEMS

1. Environment & Land Use

Land use conversion has been an important cause of degradation of terrestrial ecosystems. Conversion of natural habitats for pasture and agriculture is the main cause of biodiversity loss (Pearce and Moran 1994) and, by significantly reducing the forest cover, will have implications in other environmental functions provided by the latter. This brings about problems such as erosion, loss of nutrients, flood control and water supply. As a component of the development process, land conversion gains bigger dimensions in developing countries, where the combination of population pressure, need of economic growth, and an evolving socio-economic condition leaves environmental issues in a disadvantageous position in the rank of priorities.

Besides environmental degradation at the local level, deforestation and loss of ecosystem functions brings effects of global environmental concern, such as biodiversity loss and carbon emissions. The loss of biological diversity has raised major concern world-wide, and most of biodiversity is in the developing world, threatened by the fast pace of tropical deforestation (see Pearce and Moran, 1994; Miller, 1998).

Even though concern about the current trends is widespread, the pace of change in the relation between the socio-economic system and the environmental system does not seem to follow the speed of environmental degradation. Accordingly, it is not hard to agree with Pearce (1998), who explains this as a failure of modern environmentalism "to address the underlying causes of environmental degradation, which lie in the economic sphere". In raw economic terms, he argues that "conservation appears not to pay when compared with the economic returns that society gets from converting natural assets into (explicitly) commercial ones".

Ethically speaking, the problem of valuation goes beyond the acknowledgement of the *economic* value of environmental resources and services. It involves intrinsic values that can not easily be measured by individual preferences and, by its very nature, are not *supposed to be* tied to human values. However, human interference on the environment is affected by the way societies are organised – in which the economic system, in turn, plays a dominant role. Therefore, in the attempt to solve the problem, it seems to be more efficient to look for solutions within this same economic paradigm. For this reason, as well as for its importance in achieving sustainable development, this research will concentrate in addressing and understanding the mechanisms that drive the economic system.

In order to properly address the connections between the economic and the environmental system, environmental economists have attempted to correct the fundamental distortions in the former that have led to the overexploitation of the latter. The demonstration of the economic value of ecosystems is seen as a first step in such effort (see Costanza, 1991 and Jansson *et al.*, 1994).

Still, demonstrating the value is not enough if the economic value suggested can not be captured in the individual level of decision making. Although the conservation of forests brings many benefits to society as a whole, Pearce and Moran (1994) argue that the main reason underlying changes in land use is the fact that, from the perspective of the individual, it is more profitable to 'develop' land than to conserve it. While the benefits from development are tangible and real, the benefits from sustainable land use "accrue in unmarketed form", which results in no incentives for the landowner to take account of them[2].

1. 1. THE MISSING LINK: THE PROBLEM OF VALUATION

Two main sources of distortion of the value of environmental resources in the economic system can be identified. One is the distortion due to the "missing markets" for the external benefits provided by ecosystems, identified as a *market failure.* By not being initially taken into account by markets, such externalities will become later social costs. The other distortion is *government failure*, which results from governmental intervention in the market place in the form of financial incentives for deforestation and underpricing of water resources for example (Pearce & Moran, 1994).

Environmental economists have explained environmental degradation as a result of the fact that environmental and socio-economic values of natural ecosystems and the goods and services they provide are not adequately reflected in the current methods of evaluation in decision-making (Pearce, 1998; Costanza, 1991). Thus, the fact that the true value of natural ecosystems is not properly translated into useful information becomes a major obstacle to the inclusion of environmental concerns in environmental planning and decision making (Groot, 1994). In order to address that, monetary values are assigned to ecosystem goods and services so they can be incorporated into economic accounting (see Pearce 1998; Jansson *et al.*, 1994; Costanza, 1991). By bringing the role of the environment to the monetary dimension operating in the economic system, valuation can represent an important tool for decision-making in the policy level.

1. 1. 1. Economic values of environmental resources

The Total Economic Value (TEV) of an environmental resource consists of its use value (UV), and non-use value (NUV). The use value is further divided into: direct use values (DUV), which are uses directly consumable (e.g. fishery and timber); indirect use values (IUV), which are values derived from the ecosystem functions (such as watershed protection); and option value (OV), which arises from the combination of irreversibility and uncertainty in the future use values of a resource, representing the willingness to pay now for the option of future use. Non use values are based on non-utilitarian motives and more difficult to estimate, being usually divided into bequest value (BV), which is the benefit accruing to any individual from the knowledge that others might benefit from the resource in the future, and existence value (XV), which derives simply from the existence of any particular resource (Pearce & Moran, 1994). Thus, in total we have:

$$TEV = UV + NUV = (DUV + IUV + OV) + (XV + BV) \quad (1)$$

When applied to reality, some of these values overlap, as when we take the direct use value of timber and an indirect watershed protection function. As Pearce and Moran (1994) points out, when two values are mutually exclusive, double counting should be avoided.

[2] One aggravation is the effect of *discounting*, which is "to discriminate against sustainable uses of the land if those uses have lower *initial* returns, even though the returns last much longer." (Pearce and Moran 1994).

A variety of valuation techniques are available in the literature. The concept usually applied is based on individual preferences and willingness to pay (WTP) for an environmental service or resource (Pearce & Moran, 1994; Costanza, 1991).

1. 1. 2. The value of forests

Forests have multiple competing uses. However, in the decision making process, policy makers often do not take into consideration the values of forests other than timber (Godoy *et al.*, 1993). Besides timber, forests also offer other direct use products such as food, fuelwood, biomass, pharmaceuticals, recreation and other non-wood products. As these uses are related to the existence of biological diversity, forests have an important option value by providing habitat for the preservation of genetic resources, mainly in tropical areas.

Forests also have indirect use by providing ecological services, such as recycling nutrients and watershed protection. Forested watersheds provide quality water and water retention in subsurface reservoirs, resulting in a larger average stock of water supply and a more constant water flow downstream, reducing floods. Increased runoff of rainwater arising from deforestation leads to soil erosion, leaching nutrients and increasing sedimentation in water reservoirs and rivers. In addition, forests influence local, regional and global climate. Local rainfall can be reduced when deforestation occurs, since water storage and evapotranspiration are diminished. Deficiencies in carbon sequestration capacity can contribute to global warming, being carbon storage function the very reason for this study. Aesthetic and spiritual values are also to be considered (Bonnie *et al.*, 2000; Costanza, 1997; Frumhoff *et al.*, 1998; Goldin & Winters, 1995; Godoy *et al. 1993*). As Costanza (1997) points out, the social value of forests exceeds the value of its direct products, and on occasions exceeds it greatly.

According to Costanza (1997), “services of ecosystems are flows stemming from the natural capital stock”, and therefore have an inherent "sustainability" connotation. Thus, services of ecosystems can be valued on a "sustainable basis”, where the value lies in their sustainable flow of timber raw material, food products, carbon sequestration, erosion control, etc. Monetary values assigned to these flows can be based on benefits received or costs avoided by provided equivalent services in another manner.

To illustrate the undervaluation of forest benefits, Miller (1998) values a typical tree as worth US$196,250 of ecological benefits during its life-time (oxygenation, soil fertility and erosion control, water recycling and humidity control, and wildlife habitats), whereas sold as timber the same tree is worth US$590. Only for climate regulation, Costanza (1997) presents estimates of the economic value of total forest control services averaging of U$223 per hectare per year, and suggests that this value might be “dramatically” underestimated. This indicates the dimension of the social losses when forests are largely consumed for short-term economic gains that sacrifice their ecological services.

At the national/local level, neglecting these values is a principal obstacle to slow current trends of deforestation and environmental degradation. Since the depreciation of natural capital is considered zero, profits attributed to projects that degrade the environment are higher than the social profits they generate, leading to the selection of the wrong set of projects (Goldin & Winters, 1995).

The result is that the deforestation process sacrifices all the other values of forests, bringing costs to society in the form of water treatment upgrades, lower water supply, higher risks of flood, health problems related to poor air quality, or even longer travels to fulfil the lost environmental amenities. Citing Panayotou, Godoy *et al.* (1993) argue that, under certain conditions, leaving the forest unlogged and benefiting from its non-timber forest goods and environmental services "may be socially and economically optimal" (see also Godoy *et al.*, 2000).

The reasoning above can be more clearly understood by the following equation (Pearce and Moran, 1994):

$$PV\,[TEV\,(SUB) - C\,(SUB)] - PV\,[B\,(DEV) - C\,(DEV)] > 0 \qquad (2)$$

$$\text{Where } TEV\,(SUB) = UV + NUV = (DUV + IUV + OV) + (XV + BV) \qquad (1)$$

and

B(DEV) = the benefits of traditional development of land;
C(SUB) = the costs of the sustainable use option;
C(DEV) = the costs of the development option;
PV = present value of the future flow of income
r = discount rate[3]
$PV\,(B) = B_t/(1+r)^{t,}$*, and similarly for costs.*

The equation indicates what would be needed for sustainable use of forest (SUB) be preferred over traditional development (DEV) of land from a national point of view, if the goal is to secure the biggest gains in national efficiency. It points that the sustainable use will be preferred if national gains are greater than the costs (Pearce and Moran, 1994). The same is valid if the goal is also to preserve values residing in the global sphere (e.g. carbon storage), which are included in equation (1).

1. 1. 3. The individual level: Can markets capture these values?

However, only demonstrating value can be insufficient if the value is not "captured". While equation (2) refers to costs and benefits for society, relevant importance can be also given to the role of the individual in the decision-making process, given that private costs and benefits will determine the decision of the landowner as far as land use (and its consequences) is concerned. Thus, supposing the inclusion of some of the global use and non-use values, Pearce and Moran (1994) point out that if there are no means for the individual land user to get part of the national gains from conservation, he will have no incentive to act according to equation (2). He will act just according to his own private gains and losses, expressed by equation (3) below. The local appropriation of global gains will be further discussed below.

[3] Discounting allows comparisons between gains and losses that occur over different time futures. Discounting the future emphasises the preference for immediate gains (as opposed to long term gains), and thus turns non-sustainable uses preferable to sustainable ones (see Pearce and Moran, 1994; Turner *et al.*, 1994; Costanza, 1991).

$PV [B (SUB) – C (SUB)] – PV [B (DEV) – C (DEV)] > 0$ (3)

Where B (SUB) - the benefits of the sustainable use option - indicates how the TEV is reflected in the individual's decision.

This local appropriation based on private property might not even be socially fair in some cases, particularly if we consider the land tenure system in countries such as Brazil, for example. However, the landowner, irrespective of owning or not the total economic value accrued by the natural resources in his land, has the right to decide upon alternative land uses that will interfere directly on these values – if we assume no environmentally positive governmental intervention. This gains importance given the considerable portion of important ecosystems held by private property in the developing world. However, while these countries concentrate a significant part of global values tied to tropical forests such as biodiversity and carbon storage, it is also where the resources, to first prevent and later mitigate the societal costs of their loss, are most scarce.

Yet, in many cases governments do intervene in the attempt to avoid degradation. By zoning land use and restricting activities for purposes such as watershed protection or biodiversity conservation, and combining financial and fiscal instruments to control externalities posed by the individuals' decisions. Such policies, however, are not always successful in the long run due to problems as opposition in pressure groups, information, bureaucracy and, very important, enforcement costs.

These problems are aggravated in developing countries. It is especially in the enforcement area that relying on mechanisms that count not only on government intervention, but also on market incentives for sustainable practices, gains a more important role. To the extent that decision-making at the individual level would be more naturally diverted to the direction of conservation (i.e. be based in equation 2), relying less on governmental resources or external loans for policing and operation. In addition, the reversion of these values to local benefits would also avoid relying on scarce financial resources from other development areas, usually priority in relation to environmental issues.

This would contribute to the economic viability of sustainable practices. Moreover, ensuring that local communities benefit constitutes an incentive for the process continuity, thus contributing to its overall sustainability in the long term.

The combination of these elements – fast pace of environmental degradation and ecosystems loss, scarce financial resources, weak enforcement, different priorities, need of economic viability in the long term – is typical of developing countries, and can result in critical situations that require urgent measures in order to be halted. Is under these conditions that the utilisation of market mechanisms, for not relying totally on institutional and financial resources from the government, has the potential of adding efficiency in attending the urgent need of economic incentives for sustainable land use. The Causal Loop Diagram below illustrates this scenario (Figure 1).

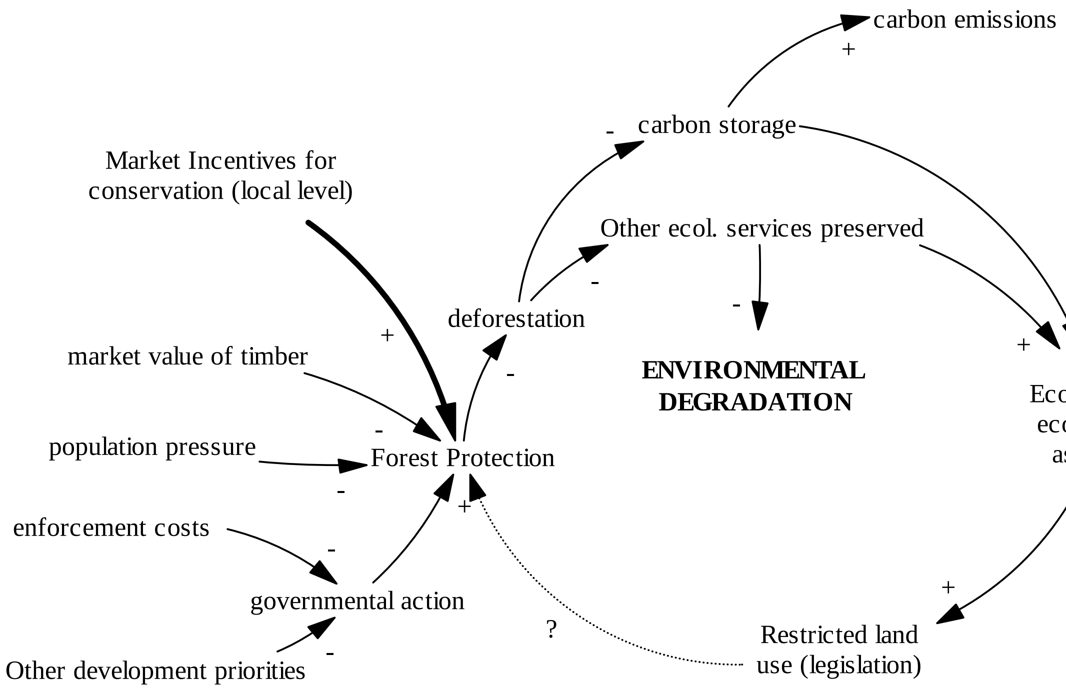


Figure 1. Developing country scenario: Ineffective governmental interference to preserve total values of forests*. The Causal Loop Diagram above illustrates the unbalance between the main factors interfering in forest protection. The economic value associated with a certain forest, although might contribute to guide governmental decisions regarding land use, is not enough to prevent deforestation if it does not address its main causes, be them in the governmental or socio-economic sphere. This leads to ineffective legislation, which does not ensure forest protection. Under these conditions, market incentives could offer a more efficient means of achieving the original goals of forest protection, however faster and without relying heavily on the government.*

1. 1. 4. Consideration about market mechanisms

At this point is important to clarify that the main purpose of this study is not to provide ways of simply compensating non-production. Given the particular context of developing countries, this would not be desirable from the social and economic point of view.

However, the fast pace of environmental degradation of important ecosystems situated in these countries, resulting in worse living conditions harsher to the poorer classes, brings about the need for alternatives that are less dependent on the institutional and financial structures available in developing countries. This can add dynamism to the path towards sustainable development, also for being relatively independent on short term thinking governments. Market mechanisms, as opposed to governmental intervention, would have a relative advantage in that.

Even though the whole idea of sustainable development involves long term processes as opposed to short term or ‘urgent’ answers, in order to achieve sustainability ecosystems must keep a minimum resilience[4] level, which is currently at risk in some of countries (see Barbier, 1994). This, therefore, would risk the capacity of the future generations to meet their needs. Moreover, by raising revenues from its very source – the ecological services – the use of market instruments (herein through the CDM) could contribute to the economic viability, and consequently, the overall sustainability of the development process.

Nonetheless, the use of market mechanisms may not be in itself a safe solution for these problems. By operating around its own principles, markets might bring the risk of diverting environmental policies and regimes from its original goals. Evidences of that are going to be exposed in the following sections (see section 2).

1. 2. GLOBAL ENVIRONMENTAL MARKETS

Pearce & Moran (1994) distinguishes market failure in *local market failure*, which refers to local and national benefits or external costs, and *global market failure*, which relates to "external benefits to people outside the boundaries of the nation faced with the development/conservation choice", such as those provided by biodiversity and carbon storage. The author discusses the disparities of costs and benefits involved in conservation putting the benefits as factors increasing from local to national and then global scale - where they become more substantial. On the other hand, the costs, "in terms of forgone development benefits, tend to be locally significant and nationally and globally moderate". Such disparities, they argue, could be reduced by the creation of an international system for conservation goods through "global environmental markets", which could thus provide the local populations the compensation for the global public goods they "subsidise".

Although not created specifically to address global market failures or the appropriation of indirect use values, these markets are beginning to emerge. The political scenario of climate change brings the creation of a potential global market for one of the forests indirect-use values: carbon storage. Given the role of tropical forests as both source and sink of carbon, its participation in this market occurs by compensating carbon emissions through reforestation and afforestation, or by avoiding more carbon emissions through *forest protection*. The later would place a market value for carbon storage in *existing* trees. This, in theory, can contribute to the preservation of the other ecological services of forests as well (Figure 2).

This would bring an opportunity to compensate forest protection in important ecosystems where restricting economic activities (e.g. through legislation) entails very limited return rates, reducing economic viability and therefore acting as a disincentive for conservation.

2. Creating the market: the Kyoto Protocol

The carbon market in question is currently conditioned to the Kyoto Protocol, which creates the demand for carbon credits through its 'flexible mechanisms'. Given this current dependence of the

[4] *Resilience* is the ability of a system to keep structure and function after disturbance (Jansson and Jansson, 1994).

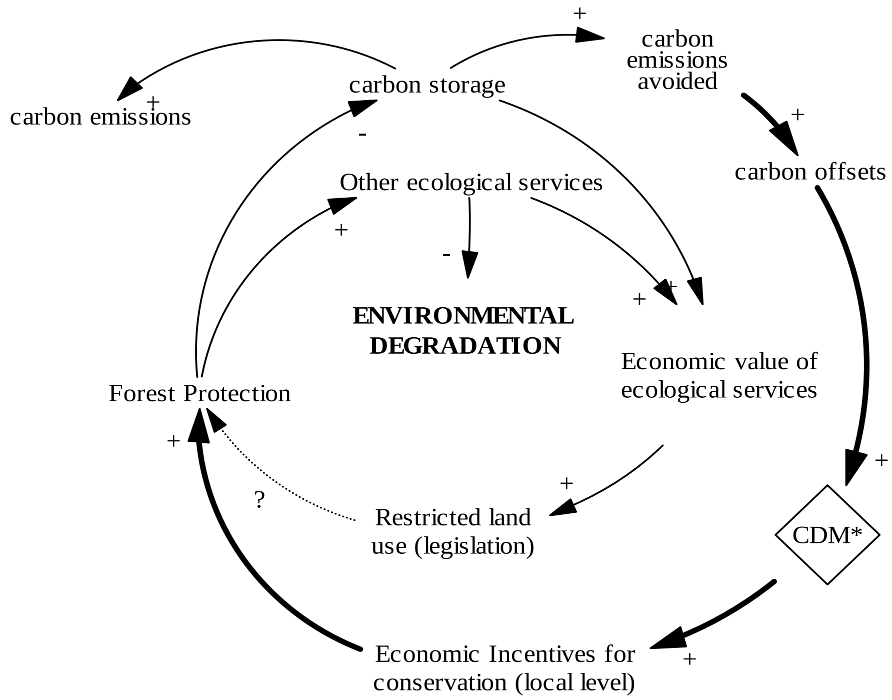


***Figure 2**. The Causal Loop Diagram above shows the potential contribution of the CDM to forest protection. Here, CDM* represents forest protection projects. The CDM would act converting the ecological value of carbon into market value, which in turn would be remunerating forest protection. This scenario, however, would have interference of other factors, such as cost-effectiveness of projects, which are not represented in the Causal Loop Diagram above.*

market on the provisions of the Protocol, this section will expose the conditions in which this market is emerging. This is important to understand the uncertainties related to the carbon market, as well as to visualise the possibilities and constraints on the use of such market for forest protection.

- The Protocol

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol, 1997), adopted in December 1997, attempts to reverse the trends towards rising emissions of greenhouse gases. Considered one of the most ambitious and remarkable treaties ever adopted, markedly given the long-term planning, economic costs and scientific uncertainty involved, the Protocol contains the joint commitment of industrialised countries to reduce their greenhouse gas emissions by at least 5% below 1990 levels in the period 2008-2012. For the first time, binding quantified targets are specified for each country (mostly developed countries), listed in Annex I of the Protocol.

Although a remarkable progress, the Protocol has not entered into force, and the climate change debate has still many questions to solve to produce appropriate action. As Weyant (2000) points out, the stakes are high among the interest groups, and as worrisome as the socio-economic and environmental impacts of climate change are the economic consequences of trying to avoid it. A big concern relates to the implications of greenhouse gas (GHG) emission reductions in the economic growth and production and consumption patterns of modern society.

In order to reduce the costs and facilitate the achievement of reduction targets, the Kyoto Protocol authorises four co-operative implementation mechanisms, also called ‘flexible mechanisms’. These encompass the joint fulfilment of commitments by several parties (bubbles), Emissions Trading (ET), Joint Implementation among industrialised countries (JI), and joint implementation between industrialised and developing countries under the Clean Development Mechanism (CDM). The latter, for being the only access of developing countries to the carbon market, will be the focus of this study.

2. 1. CLEAN DEVELOPMENT MECHANISM

The Clean Development Mechanism (CDM) has its roots in the Brazilian proposal for a Clean Development Fund financed by penalties on non-compliant industrialised countries. This idea was reshaped later by the US, that saw it as an opportunity for ‘industrialised countries interested in “geographical flexibility” for implementation of their commitments’ (Oberthür & Ott, 1999). Thus, the CDM come as an opportunity to assist developing economies in achieving sustainable development and lower carbon emissions growth whilst enabling Annex I (mostly developed countries) countries to realise their emission reduction targets in a cost effective manner.

The basic principle of the CDM is that it allows developed countries to invest in low-cost abatement opportunities in energy and land use, land-use change and forestry (LULUCF) projects in developing countries and receive credit for the resulting certified emissions reductions (CERs). Developed countries can then apply this credit against their 2008–2012 targets, reducing the cutbacks that otherwise would be made within their borders. While developed countries benefit from this cheaper abatement mechanism, developing countries would benefit as well. Not only from the opportunity to participate in emissions reductions, but also from the new source of financing and technology to support their domestic goals of sustainable development, requirement clearly stated in Article 12.2[5] (Austin *et al.*, 2000; Frumhoff *et al.* 1998; Kyoto Protocol, 1997).

2. 2. THE MARKET: GOOD OR EVIL?

The flexible mechanisms bring about the market as a controversial instrument to tackle climate change.

The provisions on JI, Emissions Trading and CDM have not been clearly elaborated. Depending on their design, they can represent a loophole for evading domestic policies and measures in developed countries. If this is avoided, however, these instruments can be considered ‘a major innovation, as they introduce market instruments in international environmental policy to an unprecedented degree’ (Oberthür & Ott, 1999).

---

[5] The Clean Development Mechanism is defined in Article 12 of the Kyoto Protocol. In setting out targets, the Protocol divides countries into Annex I (developed) and non-Annex I (developing) countries. Article 12.2 states: “The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emissions limitation and reduction commitments . . . ”.
Article 12.3 states: “(a) Parties not included in Annex I will benefit from project activities resulting in certified emissions reductions, and (b) Parties included in Annex I may use the certified emissions reductions accruing from such project activities to contribute to compliance with part of their quantified emissions limitation and reduction commitments . . .” Kyoto Protocol, (1997).

2. 2. 1. Long term perspective: Domestic Action

The crediting of emission reductions towards domestic emission targets has been a major issue in the negotiations. It has been criticised markedly by the European Union, due to the danger that industrialised countries might be relieved of the pressure to take the urgent domestic action required to induce technological and deeper lifestyle changes (Schlamadinger & Marland 2000). Oberthür & Ott (1999) have also raised this problem when discussing the role of CDM. A fact to be considered here is that industrialised countries already have a technological edge, and the more they are forced to undertake their reductions at home, the faster and more cost effectively these technological developments will occur.

For this reason, restrictions have been suggested on the quantity of emission reductions achieved through Emissions Trading, JI, CDM or bubbles. Particularly for the CDM, Art. 12.3 does mention that the use of CERs should contribute to compliance "with part" of their emission reduction commitments, even though restrictions are not quantified in Art.12 (see footnote 1; Kyoto protocol, 1997). However, attempts of the European Union to limit the use of the flexible mechanisms and quantify this "part" of the target met the opposition of an informal coalition known as JUSSCANNZ[6] and some developing countries, since it would limit capital flows Oberthür & Ott (1999). As far as the CDM is concerned, such cap would reduce the demand for carbon credits, and consequently reduce potential gains from host countries if the price is also reduced (see Ellerman *et al.*, 1998).

- ***Hot air***

Petsonk *et al.* (1998) discusses other general criticisms of the use of market mechanisms in the Kyoto Protocol. One aspect is the fear that some nations would benefit from emission decreases that occur for reasons other than the implementation of the Kyoto Protocol, while others struggle to achieve domestic GHG emission controls. This could weaken the overall targets of the Protocol as the equivalent credits are used to offset actual emissions elsewhere. The main reason for this concern is related to Emissions Trading and the so-called "hot air", the significant emission reduction of Russia and Ukraine resulting from their economic decline as they were transformed in market economies (Oberthür & Ott, 1999). This poses the risk of substantial transfer of parts of their assigned amount to other Annex I Parties, which could thus be able to achieve compliance without having to make investments in new emission reductions, and the overall reduction would not be as great.

Because this "hot air" requires no costs to be produced, it would accept any price in the market. This, added to the considerable supply it represents, would lower the market price of carbon (Ellerman *et al.*, 1998), which can reduce the competitiveness of more expensive CDM projects and reduce profits for the producers (investors and host country).

[6] JUSSCANNZ is an acronym that denoted Japan, the United States, Switzerland, Canada, Australia, Norway and New Zealand, which have as a common ground a general opposition to stringent commitments for CO^2 emission reductions (see Oberthür & Ott, 1999 chap. 2.2 for more on the role of JUSSCANNZ).

- ***Impacts of CDM in the Kyoto goals***

Concerning the CDM, its future role in the framework of the protocol is difficult to predict, since many factors are unknown or yet to be decided. Thus, no exact assessment of the total emission credits that might be generated can be presented. Some projections give a participation from 33 to 55% of the total emission reductions in 2010 (see Seroa da Motta *et al.*, 2000). Oberthür & Ott (1999) give estimates varying from 27Mt to more than 700Mt of carbon equivalent, which is "equivalent to less than 1% and more than 10% of the overall GHG emissions of industrialised countries in 1990". This could lead to either a "rather negligible" impact or to an inflation of emission allowances, leading environmental NGOs to call for a separate cap on the use of CDM to meet industrialised countries obligations. However, according to Ellerman (1998), this volume is unlikely to be available in its full potential by the first commitment period (2008-2012).

Another concern related to the CDM is that wealthier nations or firms could buy their way out of emissions reduction commitments and leave poorer nations and firms with fewer allowable options for emissions reductions.

2. 2. 2. The decisive factor: Costs

Not surprisingly, the decisive factor for the implementation and enforcement of the regulations to tackle climate change is in the economic sphere: the costs implied. That is where the market has its main potential contribution to the achievement of compliance.

For some Annex I countries, a factor of concern in relying exclusively on domestic action is the fact that improvements in energy efficiency aiming at reducing carbon emissions can be offset by economic growth and increasing dependence on fossil fuels. For the United States, the Protocol calls for a decline in emissions of 7% from 1990 levels, while most of the baseline projections point about a 30% increase in the U.S. carbon emissions from 1990 to 2010 (Weyant, 2000).

Meanwhile, the implementation of activities aimed to mitigate global greenhouse gas emissions is more cost-efficient in developing countries than in most of the industrialised world - being this very reason for the creation of the CDM (Chomitz, 1999, Dutschke & Michaelowa, 1998). From an economic point of view it is efficient to give countries with emission targets a maximum flexibility concerning the location of emission reductions, since it can maximise environmental benefits by enabling investments in those places and activities that provide the greatest environmental benefits per amount of funds invested. Because GHG emissions contribute equally to climate change irrespective of where they occur, the impact on the global environment is the same, allowing the lowest cost measures to be taken first, regardless where they take place (Dutschke & Michaelowa, 1998; Petsonk *et al.,* 1998).

Analysis of the costs of different actions to address climate change vary considerably, strongly influenced by the fact whether flexible mechanisms are included or not in the policy regimes. This, therefore, will reflect on the positions of the main actors in the climate change regime.

The United States is the largest emitter of CO^2 and GHGs, either in absolute as well as in relative terms, responsible alone for more than 35% of the total CO^2 emissions of industrialised countries (Oberthür & Ott, 1999). Therefore, its positioning as for taking action has crucial importance to tackle global warming. This turns it into the most powerful among the countries in opposition to stringent commitments for GHG emission reduction. In fact, the US Under Secretary for Global Affairs Frank Loy has recently reinforced this opinion. He rejects 'the notion that tackling climate change should be unreasonably painful', expressing the hope that the COP-6 can 'mold the Protocol into a […] practical shape, one which the United States can support' (ENS, 2000).

According to Weyant (2000), projections of domestic costs of achieving compliance suggest carbon prices (i.e., the amount of money one would have to pay to reduce emissions by a ton of carbon) varying from $360 to $20 per ton in the US. Among other factors, the author attributes the magnitude in which these projections differ to the policy regime considered. The more flexibility provided for achieving the targets (concerning alternatives as trade and use of sinks), the smaller its economic impacts.

Thus, allowing flexibility would also be convenient from the political point of view, by facilitating that countries adopt the emissions reductions commitment. If in the one hand structural domestic changes are essential, on the other hand any attempt to restrict market mechanisms, as Petsonk *et al.* (1998) point out, 'may risk driving away Parties whose participation is essential to the success of the Protocol'. Before ratifying it, most of major industrialised countries are waiting for the outcomes of the negotiations on the flexible mechanisms in the COP-6, scheduled for November 2000 (Oberthür & Ott, 1999).

2. 2. 3. Creating and capturing value

The issues above will both shape and limit the potential carbon market for forest protection projects. Moreover, the demand for carbon as a 'commodity' is currently subordinated to the enforcement of binding targets to comply with the Protocol. If there are no provisions for non-compliance, there will be no demand for carbon accountability and credits, and a limited market if existent. If enforced, however, the Protocol will be creating a demand for carbon offsets, which can be obtained in large amounts by tropical forests.

The establishment of flexible mechanisms would be one way of providing the concrete means to internalise carbon costs (and carbon storage value) in the economic system, which is what shapes the decision making process and drive the necessary measures towards reduced emissions.

In the next section will be exposed other factors relevant for the realisation of such projects under the CDM which, by creating difficulties of approval, will reflect negatively in the costs of projects (i.e., it will raise costs).

2. 3. CDM & FORESTS: MAJOR ISSUES

2. 3. 1. Forests and Climate Change

Forests play multiple and important roles in the regulation of global climate, making carbon forestry projects a vital ingredient of any climate change regulatory regime.

Estimations about the potential of the terrestrial biosphere to mitigate climate change indicate that until 2050, 12-15% of cumulative fossil fuel emissions could be offset by slowing deforestation, promoting natural forest regeneration in the tropics, and implementing a global forestation program. Tropical forests have the potential to sequester 80% of these emissions (IPCC, 1996).

Conversely, when a forest decays or is destroyed, both a reservoir and a potential sink of carbon are eliminated, and the forest becomes a substantial source of emissions. According to figures from the IPCC (1996), 20-22% of the world's annual emissions of carbon dioxide comes from the destruction of tropical forests.

2. 3. 2. Forest and the CDM

Besides measures related to efficiency in the energy sector, the CDM creates opportunities to benefit from the enormous potential of obtaining carbon offsets in what is characterised as land use, land-use change, and forestry (LULUCF) sector. Increasing carbon in the terrestrial biosphere, particularly tropical forests, are among the most cost-effective means of mitigating the raising concentration of atmospheric CO^2 while providing ancillary benefits in terms of protecting forests, biodiversity, water quality, and soil fertility. Besides the low costs, the attractiveness of many LULUCF activities lies in the possibility of being pursued now, without technological innovation (Schlamadinger B. & Marland G. 2000; Rotter, 2000).

From the perspective of climate change, Schlamadinger & Marland (2000) point out that sequestering carbon in the terrestrial biosphere alone can not solve the increasing concentration of CO^2 in the atmosphere. The emissions from fossil fuel burning are the main issue to be addressed. The authors say, however, that CO^2 sinks can help as part of a strategy to mitigate the long-term increase in atmospheric, especially in the short term. They argue that, even though small compared to the total GHG emissions, “activities in the LULUCF sector might be implemented more quickly than many other types of mitigation strategies and could play a significant role […] given the reductions necessary, and the time available, for compliance in the first commitment period”. In general, forests have the highest sink potential, but this depends on the age and conditions of the forest, as well as anthropogenic factors (fires, clearing) and climatic conditions (WBGU, 1998, Oberthür & Ott 1999).

Carbon offsets in the LULUCF sector (Certified Emission Reductions under the CDM) are produced by projects that sequester carbon or prevent its release. An offset is defined as the difference between observed carbon storage and hypothetical storage, had the project not been implemented (Chomitz 1999).

The basic mechanisms for managing terrestrial carbon so that it affect stocks and flows of carbon to the atmosphere are basically three (Schlamadinger B. & Marland G. 2000; Frumhoff *et al.* 1998):

- Avoid emissions through the conservation of existing carbon stocks in forests and other ecosystems, including in soils (i.e., reducing LULUCF emissions from deforestation).

- Sequester additional carbon in forests and other ecosystems (including in soils), in forest products, and in landfills (i.e., enhancing LULUCF removals through afforestation or forest restoration).

- Substitute renewable biomass fuels for fossil fuels (i.e., reduce emissions through fuel substitution).

The first mechanism is the one in focus in this study, since it captures the value of carbon stocked in existing forests, which is important to compensate forest protection.

2. 3. 3. Conditions and parameters for the inclusion of forest protection projects in the CDM

Given the significant role of forests in climate change presented above, the question of whether and which carbon forestry projects can receive credit under the CDM is an important one. That will also define the opportunity and conditions for conservation of existing forests being credited under the CDM, which is the main interest in this study.

However, accepting LULUCF activities for crediting is a controversial issue, given the fact that they do not address the main issue for the reduction of GHG emissions in the long term, which is reducing fossil fuel consumption, besides its inherent implementation difficulties. The major issues involved are going to be exposed below.

2. 3. 3. 1. Sinks

It is presently not clear whether activities involving carbon sequestration in forests or emission reductions resulting from land use change and forestry activities will be accounted as GHG reductions.

As WBGU (1998) points out, the offset of emission reduction commitments against sources and sinks[7] of terrestrial ecosystems “was a contentious issue” in the negotiations for the Protocol, due to the many uncertainties involved in their estimations (Oberthür & Ott,1999). As for other aspects of the Protocol, many issues related to LULUCF activities were left to further elaboration[8] (Austin *et al.*, 1999; Oberthür & Ott, 1999; Frumhoff *et al.* 1998).

The discussion over the inclusion of sinks in CDM projects relates to the interpretation of sinks in Art. 3.3, which states that net changes in GHG emissions by sources and removals by sinks resulting from LUCF activities limited to afforestation, reforestation and deforestation shall be used for calculating emissions in the first commitment period. Other sinks not specified in these three activities, as agricultural soils, land use change and other forestry categories, had their inclusion to be decided in further negotiations. This debate is also valid to their application for crediting under the CDM (Schlamadinger & Marland 2000).

Regarding specifically the CDM, Art.12 refers to reductions in emissions but does not mention removals by sinks, leaving to be decided if CERs reffer only to ”gross emissions, gross emissions plus emissions from LULUCF (such as from deforestation and forest degradation), or whether they can be more broadly interpreted to refer to the net emissions, and hence to include removal by sinks” (Schlamadinger & Marland, 2000).

---

[7] Sink a system that stores more carbon than it emits (Oberthür & Ott, 1999).

[8] See Oberthür & Ott (1999) for the negotiation process, and IPCC (2000) or further discussion on the elaboration of LULUF activities.

This unespecified phrase "emissions reduction" is interpreted by some as a general term, which can describe both activities that reduce emissions from sources and activities that enhance removals by sinks. Rotter (2000) argues that, even if removal by sinks is to be excluded from the interpretation of Art.12, “forest protection projects would still be viable because they […] reduce emissions from a source, i.e. by preventing or reducing imminent destruction of forests, they reduce emissions that would otherwise occur”.

Depending on the definition of sinks, the Protocol could be diverted from its original purposes. According to Oberthür & Ott (1999), the inclusion of sinks in the accounting reduces the obligation of a number of Parties to control emissions (see also WBGU, 1998). Moreover, similarly to the other flexible mechanisms, the possibility of offsetting emissions through sinks would distract the Protocol from tackling carbon emissions from fossil fuel dependence (see WBGU, 1998).

Another issue on the provision on sinks raised by Oberthür & Ott (1999) is its “disconnection from other regimes” related to the protection and sustainable use of forests, such as the Convention on Biodiversity. This would be important to avoid a conflict between different environmental priorities, as the elimination of native forests to implement plantation projects (see WBGU, 1998).

If LULUCF activities are accepted under the CDM, and among them the conservation of existing forests, their inclusion is still submitted to their ability to meet acceptable levels of additionality, baseline definition, and verifiability. These, as well as other factors concerning carbon projects in the LULUCF sector, are going to be exposed below.

2. 3. 3. 2. Important parameters

In order to be accepted and implemented, there are also some concerns that need to be solved to ensure the credibility of carbon projects in the LULUCF sector.

- Additionality:

In order to ensure that the reductions are really offsetting emissions elsewhere, and therefore the integrity of the CDM, the projects must be certified according to the criteria of “additionality” . Art. 12. 5 (c) stipulates that certified emission reductions would be for “reductions in emissions that are additional to any that would occur in the absence of the certified project activity” (Kyoto Protocol, 1997, see also IPCC, 2000).

The CERs acquired by an Annex I country will be added to its assigned amount, thus increasing its emission allowance. Because developing countries are not currently subject to quantified targets under the Kyoto Protocol, the credits accrued are not balanced by a corresponding reduction of the assigned amounts of another Party (as would occur in JI[9]). This results in an increase of the overall amount of GHG allowances to Annex I countries, which is acceptable as long as based on *real* and *measurable* benefits to the atmosphere.

Another point of caution is that, because developing countries are not subject to quantified targets, in this situation both Parties have an incentive to maximise the transfer of emission reductions. This peculiarity of the CDM will demand scrutiny to ensure that the transactions involve actual

[9] see Schlamadinger & Marland (2000).

reductions that are *additional* to what would have otherwise occurred in the absence of the CDM project, being essential a third-party auditing and verification of project activities. There is no difference between LULUCF and energy sector projects in this regard. (Oberthür & Ott, 1999 ; Petsonk *et al*,. 1998; Schlamadinger & Marland, 2000).

Demonstrating additionality for forest protection projects would not be difficult if it can be proofed that, in the absence of the project, deforestation would occur. In this aspect forest protection has an advantage in relation to plantations, because the latter usually presents profitability and thus represents a business opportunity even in the absence of carbon crediting (see Seroa da Motta *et al.*, 2000; Fearnside 1995, Frumhoff *et al*, 1998).

- Baseline Definition

Establishing baselines is a crucial part in defining carbon offsets as a commodity. In order to ensure that the credits resulted from a project are real and measurable improvements for the atmosphere, they have to be measured in relation to some reference – the scenario in the absence of the project - that specifies the carbon emissions in the 'business-as-usual' (Schlamadinger & Marland 2000).

However, in a project-specific approach, developers may choose scenarios that maximize their projected benefits (IPCC, 2000). Choosing scenarios of high baseline emissions (or low sequestration) can lead to an overstatement of actual emission reductions, and the volume of offsets sold can "threat the integrity of the system" Chomitz (1999). The baseline projections in the absence of the projects can sometimes be difficult to predict, as when determining the exact rate and extent of deforestation in forest protection projects. Baseline methodologies must strive to be accurate on average without being too costly and difficult to implement (Chomitz 1999).

For the same reasons explained above for additionality, a third-party auditing and verification should be conducted to evaluate baseline assumptions and ensure "transparency, efficiency and accountability"[10] of project activities (Oberthür & Ott, 1999 ; Petsonk *et al.* 1998). This will mean additional costs for forest protection projects and LULUCF activities in general.

- Leakage

Carbon projects can have substantial indirect impacts on carbon emissions or sequestration beyond the boundaries of the project site, requiring calculations to be adjusted to this *leakage*. The implementation of a carbon project itself does not guarantee that the carbon emissions avoided will not be transferred to another area, specially if the project reduces access to land, food, fiber, fuel and timber resources (IPCC, 2000).

Chomitz (1999) points out that susceptibility to leakage will vary dramatically by project types. According to him, projects that do not affect markets – such as regeneration of degraded land within national parks – will generally not have leakage. However, it represents a challenge for forest protection projects, since it is related to the level of pressure on the land. The IPCC (2000) recommends that leakage should be addressed by increasing the spatial and temporal scale of the accounting system boundaries (IPCC, 2000). The implications of doing this on costs will be discussed in Part II.

---

[10] Required in Article 12.7 (Kyoto Protocol, 1997).

- Permanence

Carbon will appear as a credit when it is accumulated in the biosphere and as a debit if it is subsequently lost back to the atmosphere. Different from energy-based projects, which embodies a reduction in fossil fuel consumption that will result in atmospheric CO^2 reductions for centuries, a peculiarity of forest carbon projects is the risk of *reversibility*. Besides the risk of future releases of carbon due to climatic or human-induced adverse factors, increasing the amount of carbon stored in terrestrial ecosystems bears the lack of guarantees that forests will remain intact for the long time-scales required, supposing carbon storage will have the same long-lasting effect as the avoidance of fossil fuel emissions into the atmosphere (Oberthür & Ott, 1999).

This problem can be aggravated with the fact that, since developing countries have no reduction commitments, there is no long term commitment to report carbon losses back to the atmosphere - which would turn credits into debits - in a national account. Suggestions to address this issue include the requirement that the Annex I country partner retain responsibility for permanence, that a reserve of carbon credits be required to cover future losses, or that an insurance system be created to cover possible losses (Schlamadinger & Marland, 2000).

Even if it were possible to ensure perpetuity of carbon sinks, such commitment would raise concerns about sovereignty, since it implies the elimination of future options of land use change (Chomitz, 1999).

However, many authors question the real need of ensuring perpetual sequestration. Some argue that having a *delay* in the carbon release to the atmosphere represents already a considerable contribution to the mitigation of climate change. Fearnside (2000) argues that emission reductions from fossil fuel and forest protection have the same effect of "delaying for one year the time that C is released from each barrel of oil or hectare of forest that would be burned or deforested in subsequent years". He points out that, in this sense, "even in a case [where the forest is destroyed] within the time horizon, delaying deforestation should receive some credit if a more complete accounting is made of the stocks in the atmosphere using a Mg-year approach" (see also Schlamadinger & Marland 2000).

Chomitz (1999) argues that a temporary guarantee of sequestration for 20 to 30 years can be desirable in the sense that "it delays climate-associated damages, which has an economic benefit" and buys time for "technological advance and capital turnover in energy-consuming devices", which is also considered the advantage of the flexible mechanisms in general. Moreover, he says, many projects can increase the probability of continued sequestration by self-reinforcing incentives, which may be "particularly true for forest preservation projects, where the threat to the forest is of limited duration and will recede as wage levels increase over the long term".

2. 4. Contribution to sustainable development

As mentioned earlier, the CDM is required to contribute to sustainable development in the host countries. Frumhoff *et al.* (1998) points out that "properly designed and implemented, CDM projects incorporating any of [the allowed activities] can both help stem climate change and promote sustainable development”.

However, the broad and vague character of the term ‘sustainable development’ can bring ambiguous results (see Table 1). Recent studies about the potential activities to be implemented under the CDM in the forest and energy sector in different countries suggest that setting parameters for what is a desirable contribution to sustainable development is not straightforward (see Austin *et al.*, 1999). From the perspective of the host country, defining priorities in the project selection can be a hard task when financial resources for most of development goals are scarce, as it is typical in developing countries. Thus, different sectors (energy, forestry) and ‘sub-sectors’ (silviculture, ethanol industry, biodiversity conservation, etc.) would see the potential investment flows as essential for the development of their activities, and their outcomes could be easily classified as a contribution to the broad and vague concept of ‘sustainable development’. Depending on the perspective, the relevance of project benefits will change, and all of them will probably have substantial contributions to development goals, followed or not by sustainable development achievements. Table 1 summarises some aspects affected by the implementation of forest protection projects taking plantation as a reference.

	Forest Protection	Plantations
Environmental Impacts	High (Biodiversity and watershed conservation)	Negative or low (soil erosion, use of agrochemicals, danger of replacing native ecosystems)
Economic Impacts	Medium to high	Low (Increased output, employment)
Social impacts	Moderate	Nil to high, depending on scale and nature of plantations.
Carbon Costs	Low to high	Negative to low

Source: Adapted from Seroa da Motta *et al.*, (2000) and Chomitz (1999).

Table 1: Evaluating two potential CDM projects in the forest sector.

These ambiguities, if not identified, can yield catastrophic results if in the hands of incautious governments or firms. For example, LULUCF projects that are designed to reduce or offset carbon emissions through forests have the potential to make positive contributions to other ecological services associated to them, such as biodiversity, water quality, soil conservation, etc. On the other hand, negative contributions would be the support of measures as clearing native forests to plant quick-growing plantations aiming at accounting under *reforestation* (see WBGU, 1998; Chomitz, 1999).

However, plantations are able to offer carbon offsets at extremely low costs. In Brazil, where the climatic and land availability conditions are favourable to forestry activities, studies have brought out plantations as the lower cost activity to be implemented under the CDM (in comparisons within both the forest and energy sector). With costs usually negative (i.e., they are already profitable without carbon payments) to very low, plantations can accept any positive carbon revenue (see Fearnside, 1995; Seroa da Motta *et al.*, 2000; Salati, 1998).

This fact, combined with the ambiguity in defining what is a real contribution to sustainable development, might lead cost-effectiveness to become the ultimate parameter for project development under the CDM.

3. Overlapping Needs?

From the perspective of the climate change, solving the problematic points presented above is essential to ensure that LULUCF activities and the CDM contribute towards the meeting of climate change objectives. However, too restrictive rules for LULUCF activities and CDM implementation might discourage participation and the achievement of targets. The same effect would be caused if the consequent transaction costs become too high. Thus, a balance of these two demands is required to facilitate ratification and enforcement while ensuring the necessary domestic action, so that both lead to the stabilisation of CO^2 in the atmosphere.

Meanwhile, the fact that the CDM provides the mechanism to capture the value of carbon stocks in forests in developing countries can bring about, indirectly, contributions to other important environmental aspects of sustainable development in these areas.

However, the main interest in this study as far as the climate change is concerned is the possibility of using the CDM as a global environmental market to address the valuation problem of ecological services in developing countries. In this context, the discussion above concerning the CDM and forests intend to show the precarious state in which a global market for carbon is currently found. The level of uncertainties and difficulties involved represents not only an obstacle to the crediting of the LULUCF themselves under the Kyoto Protocol, and ultimately to the very existence of a global market for carbon storage, but also means higher risks and costs surrounding CDM and LULUCF investments. This obviously concerns forest protection projects.

If LULUCF activities under the CDM are approved for crediting, whatever the rules decided in the negotiations are, these will become relatively fixed parameters for project design. As such, they represent a first ‘eligibility’ trial, after which the selection of activities will occur aiming to obtain cheap carbon credits. Thus, the market will demand specifically carbon offsets, which can be obtained by projects whose contribution to sustainable development can be higher or lower in significance, as discussed above.

This raises questions concerning the initial condition for forest protection projects to be *de facto* included by investors in the CDM as a viable option. Forest protection projects, while providing multiple environmental and societal benefits, might not be as profitable as other CDM alternatives in the forest sectors. This factor, depending on the importance given by the investors, might reduce the interest for protection activities.

Thus, what would be the potential of projects yielding multiple benefits for sustainable development to compete with other projects offering the same ‘commodity’ - carbons credits?

Once this is clarified, we can then shift perspectives and investigate if the CDM, in turn, can be a satisfactory incentive for forest protection.

These two questions can give a better picture of what would be the interplay between the demands of the carbon market associated to the climate change issue - operating here through the CDM – in one hand, and the needs of economic incentives for forest protection and its ecological services in the other. Although born in precarious conditions, perhaps this global carbon market could yield benefits in cases where sustainable development is the ‘additional’ outcome that would not occur in the absence of such market. These two questions are going to be discussed in the next Part (II).

PART II – MARKET AND CONSERVATION NEEDS

The creation of a market capturing the value of an indirect use of forests represents a move towards its incorporation in the economic sphere of decision-making. However, that fact alone does not do all the work in addressing the causes of deforestation. The market will work purely around the 'commodity', which in itself does not necessarily lead to positive effects its preservation as an environmental function. It is up to society to define the functioning rules according to the context and the goals envisaged. In the case of carbon, the effects can be opposite to the goals, since forests can suddenly change from sinks to sources. While this can limit the use of market instruments to determined circumstances, the assignment of market values for carbon storage has potential benefits that are going to be explored in this section.

1. Market Demands

The existence of a market for carbon storage in developing countries supposes the approval of the CDM and LULUCF activities under certain conditions, which can be more or less strict according to the negotiator's interest in facilitating ratification and compliance. For the sake of the following discussion, herein we assume that LULUCF activities are allowed in the CDM, including the crediting of avoided emissions under conservation projects. From this point, once the rules are set, the selection of activities among the 'creditable' ones would then shift to the market.

Keeping in mind that the intention with the CDM is to provide cost-effective alternatives for achieving the Kyoto targets, once a project meets the technical criteria of eligibility, equally important is to be qualified as attractive for investments amongst all the other options for obtaining emissions credits. Thus, in order to take part of a global market for carbon offsets, conservation projects in developing countries should also be able to compete, on economic grounds, with other projects offering the same 'commodity': carbon offsets.

In this section, the major factors at stake when comes to the use of the CDM as a market incentive for conservation will be identified from the perspective of the carbon market needs. Although highly relevant from the climate change and forest perspective, the technical aspects of implementation discussed in the previous section are assumed from here on be designed to meet the ultimate aims of the Kyoto Protocol. Thus, they will be considered in the discussion only through their reflect in the market behaviour.

1. 1. FACTORS INFLUENCING INVESTMENTS

Currently, very little is known about the priorities of potential CDM investors (Smith *et al.* 2000). While usual factors such as financial risk, political stability in the host country, availability of additional funding, rate of return and revenue of associated products (e.g. timber or electricity), are certainly influential, some particularities of the carbon market where the CDM is inserted, as well as its reflects in the market behaviour, are still to be defined.

The uncertainties surrounding the implementation of the Protocol as a whole brings difficulties in defining the major parameters to assess the size of the market, which are the demand and supply of carbon credits (see Smith *et al.* 2000). Many factors can influence the demand for credits, and the supply remains undefined while the rules allowing for crediting are not set. These would be the basic factors affecting the relevance of all the others in the investor's decision, turning the identification of prevailing factors a difficult and speculative task while the market is not yet active.

The ultimate parameter shaping the competitiveness of a forest project under the CDM, however, is *cost-effectiveness*. This is the basic issue permeating the debate over the actual feasibility of climate change policies, as already discussed, being the very reason for the creation of the CDM.

If we consider the whole set of alternatives for obtaining carbon offsets, cost-effectiveness can be regarded as a limiting factor since it is supposedly the greatest advantage of the CDM. Apart from that, the CDM tend to be more disadvantageous when compared to other less complicated ways of acquiring offsets, as carbon trading for example. Once a specific project is less cost-effective than other options, the likelihood of being implemented, under normal market conditions and targeting only carbon credits, would be significantly reduced.

Still, the cost-effectiveness of tropical forestry depends on emission reduction targets. According to Smith *et al.* (2000), estimates indicate that for emission reduction targets above about 20%, tropical forests appear to be substantially more cost-effective than energy projects in either industrialised or developing countries. For less ambitious targets, on the other hand, the energy sector appears to provide a number of low cost opportunities and the cost-effectiveness of tropical forests becomes less evident.

As discussed earlier in section 2.4 (Part I), conservation projects, while providing multiple environmental and societal benefits, might not be as profitable as other CDM alternatives in the forest sectors. Plantations, for example, present high rates of return, offering carbon credits at negative or very low costs (see Fearnside, 1995; Seroa da Motta *et al.*, 2000). This factor, depending on the importance given by the investors, might reduce the interest for conservation activities, keeping away those interested in financial returns besides the CERs.

Narrowing down to the group of investors that would have interest purely in CERs as a valuable asset in the market, the main economic parameter for decision is probably the cost-effectiveness of the project. As initially aimed with the creation of the CDM, they will be seeking the cheapest way of obtaining carbon credits, which exists in abundance in non-Annex I countries.

The cost-effectiveness of CDM projects, in turn, can be directly affected by other factors than simply the costs of reducing one ton of CO^2. Depending on the institutional, operational and administrative design of the CDM, these factors can be decisive or become weakened in the overall cost-effectiveness of CDM projects. But, since they are either not present or smaller in the ET or domestic reduction, they can be considered disadvantages of the CDM, increasing in importance concerning conservation projects in particular given the difficulties of LULUCF activities.

1. 1. 1. Transaction costs

Transaction costs include the costs involved in partners and project identification, negotiation, approval, monitoring, verification, validation and certification, fines, insurance and project supervision (World Bank, 1999).

Although some of these costs are included in any market activity, the CDM and LULUCF activities in particular bring additional costs. As a market induced by international regulation, the commodity is not an end in itself. Since it is acquired as a means of achieving the ultimate aim of reducing CO^2 emissions in the atmosphere, the sort of activity that produced the offset is relevant, due to all the aspects discussed in the previous section. Not meeting the eligibility criteria set might risk the accounting of the respective offsets, which would then loose their market value.

Thus, costs of meeting (and proofing) the eligibility criteria will be additional to the cost of simply producing one ton of carbon. Experiences from the Pilot Phase of JI indicate that high transactional costs can be a major barrier to project expansion, being a disadvantage of CDM and JI, as opposed to ET, especially if we consider the large amount of "hot air" that exist in the system (see section 2.2.1 – Part I). The importance of these costs in relation to the total emission costs, however, might be reduced if compensated by cost-effective opportunities in non-Annex I countries. According to Subak (2000), experiences with JI in Costa Rica have pointed that the aggregate costs of project developing, monitoring and auditing are significant, but not considered excessive to the point of reversing the cost-effectiveness of CDM projects.

- ***Share of Proceeds and Risks***

Article 12.8 of the Protocol states a share of proceeds from certified project activities should cover administrative expenses of the CDM and assist particularly vulnerable developing countries (Kyoto Protocol, 1997). This share of proceeds will further raise transaction costs. However, opinions vary as to how the share of proceeds is to be defined, considering they are likely to limit the amount of CERs available to Annex I Parties, therefore reducing the attractiveness of CDM projects. The higher they are, the greater will be the incentives for investors to look for other options, be it at home or the other Kyoto mechanisms (Oberthür & Ott, 1999).

Bolivia, for example, has negotiated a 49 percent share of the total offset credits from the Noel Kempff Mercado pilot carbon offset project, with the rest going to the investing companies (Frumhoff *et al*, 1998). This, in theory, doubles the cost of one CERs to the Annex I country, although it does not say much in relative terms.

Similarly, a share of the CERs produced can be set aside as insurance for the risk of project failure related to aspects such as leakage and permanence, for example. The project CARFIX, on Costa Rica, expanded the system boundaries in order to account the risk of leakage and accidental losses, setting aside 15% of its protected areas as "insurance" against these risks (Goldberg *et al.*, 1998). While this provides greater certainty to the investor and the overall goal of the Protocol, it reduces the total potential gains of the project, consequently increasing the costs.

1. 2. GETTING IN THE MARKET: POTENTIAL TO ATTRACT INVESTORS

As discussed before, if we consider pure market conditions, forest protection projects will take part of the carbon market though the CDM if they can offer carbon credits in a lower cost than the other alternatives of emission reduction.

Thus, if we visualise a situation where investors are choosing among different options for emission reduction, Annex I Parties will have a mix of domestic action, emissions trade (ET), which include the *hot air* from the former Soviet Union, Joint Implementation (JI) among Annex I countries, and reduction in developing countries through the CDM. From that, they will be investing in developing countries up to the point in which the costs of doing so are equal to the price of the CERs produced. After that, they are likely to prefer obtaining credits from emissions trade among Annex I countries, up to the point in which this price equals the domestic marginal abatement cost. Above this point, i.e., when the price in the market is higher than the costs of domestic action, a country would prefer to undertake domestic abatement, with the potential of becoming a supplier of carbon credits (Ellerman *et al.*, 1998).

Considering this broader context, we can now examine the competitiveness of forest protection projects.

1. 2. 1. Competition level: LULUCF & CDM[11]

Although tropical forests contribute significantly to carbon emissions, projects aiming at deforestation reduction are not easily implemented. The Amazon, for example, with huge net emissions, would represent considerable contribution to global warming through projects avoiding deforestation, since the biomass of one hectare of this forest is much greater than that of a hectare of plantation (see Fearnside, 1995). In addition, whereas plantations will take years to fix carbon, deforestation can produce immediate benefits in avoided emissions, representing a comparative advantage in any form of discounting (Frumhoff *et al.*, 1998). Still, according to Fearnside (1995) the difficulty of assessing the costs of avoiding one hectare of clearing, along with government policies, is one of the principal impediments for deforestation projects in the area.

Experience with early forest conservation projects in non-Annex I countries under the pilot phase of Joint Implementation have actually included afforestation and reforestation in large areas, rather than dedicated uniquely to avoiding carbon emission from current stocks (i.e., forest protection). This makes it difficult to point out, based only on previous experiences, a reference cost of protecting carbon stocks without the additional costs of promoting reforestation, and without the potential revenues from timber in the case of sustainable forest management.

Meanwhile, cost variations are expected irrespective of that, due to particularities such as different implementation costs in each country, variable values of land within countries, and the type of funding (bilateral, multilateral, participation of funds from the host-country) agreements. Thus, from the experiences existent we can observe that the range of the costs to obtain one ton of carbon can vary from as low as US$ 0,9/ ton C in the ECOLAND forest preservation project in Costa Rica, US$ 1.17/ton C in the Bilsa Biological Reserve in Equator (see UNFCCC 2000a; UNFCCC 2000b), or US$ 1,25/ ton C, as in the Noel Kempff Mercado Climate Action Project[12] in Bolivia (see UNFCCC 2000b, WRI 2000), until U$ 5,4/ton C for watershed protection in Thailand, reaching US$ 10,00/ton C for national parks in India (Frumhoff *et al.* 1998).

While such examples point to significantly low costs, for a long term effectiveness it remains important if they reflect the additional CDM-related costs - such as monitoring, enforcement and verification – and thus signal what the real costs for conservation in the CDM would be. Goldberg

[11] Dollar values are not adjusted for the present year, since not all the projects herein selected offered this information.
[12] The Noel Kempff Mercado project includes explicitly the costs of leakage prevention, monitoring and verification, and institutional development. For the other projects, this inclusion is unclear.

et al. (1998) points out that these additional costs quickly increase the costs of the project, and so does those related to environmental and social co-benefits. The latter are also important for the climate change perspective given that they will provide for local communities the long-term incentive necessary to ensure the success of the projects.

In Costa Rica, the ECOLAND project is an example of not inclusion of these additional costs. This allowed the deliverance of carbon credits at very low costs, which resulted in a failure to provide the government the resources to carry out forest protection. According to Goldberg *et al.* (1998) this problem was corrected in following projects, such as the Private Forest Project and the Protected Areas Project. These projects are part of an umbrella programme aiming to sell carbon credits (Certified Tradable Offsets - CTOs) in exchange of funds for conservation and reforestation. Here we have an unusual case where the *host country* establishes the price which, according to Goldberg *et al.* (1998), is “sufficient to provide substantially more protection”, as part of the money goes for a fund for enforcement and monitoring activities. Therefore, the average cost of US$ 10,00 ton/C reported by the Private Forest Project (UNFCCC, 2000a) can then be taken as a reference cost that reflect the transaction costs mentioned above. Data from Subak (2000) suggests that the transaction costs included in this price range from 10-20%.

However, Subak (2000) points out that Norway, the investor country, has been able to purchase the carbon offsets for “only” US$ 10,00/ton C due to the contribution of Costa Rica’s gasoline tax and other national sources to the whole programme. The market price of this CTOs is currently at US$ 20 ton/C (Subak, 2000). This, given the information above, might indicate costs below this level, assuming the country wants to cover them. Thus, if we take the Costa Rican case as an example of protection project providing reasonable economic viability as well as social and environmental benefits for the host country, and that here the host country is *unusually* the one defining the price and not under competition yet, we can consider US$ 20 ton/C a high cost for protection projects. Providing economic sustainability for the host country is essential not only for climate change purposes but also to ensure the long term character of sustainable development.

In this case, though, it is the host country organising the projects and selling the credits, rather than the carbon credit reflecting simply the costs of producing one ton of carbon, as usually estimated. Such flexibility is unlikely to occur if developing countries are not allowed to participate directly in the emissions trade. In addition, there would be a competition among developing countries offering costs generally below US$ 5/ton C. For those reasons, costs are more likely to stay below this multi-beneficial level of $ 20/ton C.

If costs of current pilot projects (and estimations of potential CDM projects) are good indications of the actual costs of future CDM projects for forest conservation, we can take a general range from US$ 1,00 to US$ 10,00 to obtain one ton of carbon, which places conservation projects as the ones presenting higher costs among the LULUCF projects. The costs will also reflect the level of difficulty in exceeding the opportunity costs of the activities causing deforestation in each region, which will be discussed below.

Considering only CDM in the forest sector, such possibly high costs for conservation can already seem unattractive when compared to options as plantations. In Brazil, for example, where the favourable climate conditions offer an enormous potential for carbon sequestration through the expansion of plantations, CDM funds would be simply an additional source of revenue in activities already profitable. According to Seroa da Motta *et al.* (2000), even assuming high future land values - to which project costs are very sensitive - the costs of carbon in pulp and charcoal plantations would be below US$ 1.5/ton C, whereas sawlog plantations would accept any positive price for carbon[13]. Contribution of the expansion of plantations to sustainable development, however, would be reduced by the negative environmental impacts associated such as the use of agrotoxics and the effects in the soil, besides a relative low contribution to biodiversity.

A study about the potential applications of the CDM in Brazil has indicated that the cheapest projects are not necessarily the ones that produce the higher co-benefits, and more expensive options as sustainable management of forests – estimated at US$ 9/ton C in the Amazon - would provide higher environmental and development benefits for the country (Austin *et al.* 1999). Since the carbon market aims basically at the provision of cheap carbon offsets, forests of carbon that fulfil such demand at the lowest prices are likely to be attractive. Carbon provision, however, is not that simple under the Kyoto Protocol, and all the environmental risks entailed by triggering such 'carbon farms' are one of the many delicate issues involved in the inclusion of activities in the LULUCF sector in the accounting (see WBGU, 1998). Moreover, in what concerns the CDM, contribution to sustainable development is a requirement that might balance pure market trends, perhaps allowing the absorption of cost increases due to non-carbon related benefits. The question would be to which extent this could happen, given the vague definitions of sustainable development, as well the different immediate developmental needs of non-Annex I countries.

When compared to some of the options of the energy sector, however, the situation is different. The higher upfront costs can increase carbon costs above US$15/ton C, sometimes to levels much higher than that (see UNFCCC 2000b, Salati, 1998; Austin *et al.* 1999, Jacobson & Schumacher 2000).

In both the energy and forest sectors, credits from JI (i.e., among Annex I countries) can show lower costs if the design of the CDM allows the additional costs of monitoring and verification to be reflected directly in the projects' cost-effectiveness. On the other hand, this can be compensated by the lower costs of activities implemented in the Annex I. The exact balance, however, will depend on how the weight of the extra transaction costs of the CDM will reflect on its cost-effectiveness.

Different perspective will have those investors seeing carbon as an emerging market among other investment opportunities in developing countries. The question then is not the relative cost of obtaining carbon offsets and achieving compliance, but the financial returns provided by this new modality of investment. In this case, instead of seen as an opportunity of reducing the risk of higher costs later to achieve compliance, CER is a commodity as any other, and financial criteria for investments are likely to prevail.

Thus, investors aiming CERs as a commodity may prefer activities in the energy sector, even when implying higher costs, based on potential financial returns other than carbon credits. According to Seroa da Motta *et al.* (2000), from the financial point of view, few projects are likely to be implemented based only on the potential returns from the CER given the uncertainties about the future value of CERs. Instead, as a protection against risks, CERs are more likely to constitute only part of the expected investment returns, while the returns from the core project would be the ones justifying the investment, e.g. the revenues from selling electricity.

---

[13] Costs assume a high land value of US$ 200/ha and 12% discount rate (Seroa da Motta *et al.*, 2000).

Taking this cost range for CDM projects as a general parameter, we can then conclude that projects focusing more strictly in conservation, emphasising social and environmental benefits but not necessarily including good financial returns, can participate in the carbon market through the CDM as long as their costs are kept below the net carbon costs in energy sector. This, because, according to Subak (2000), if not for the cost-effectiveness, investments in the energy sector are likely to be preferred for being less complicated, particularly when comes to quantification and verification. Although we are considering here the perspective of investors interested in carbon credits mainly for compliance purposes, other factors as familiarity with the sector and facility in providing the technology needed are likely to influence the decisions. This is likely to occur particularly in the energy sector.

1. 2. 2 A broader competition level: adding options in emissions trade & domestic action

Under a full global trading, the different costs between regions would be balanced by the market, reaching the equilibrium emission permits price between the available supply and the amount demanded (Weyant, 2000). Therefore, carbon prices under emissions trading is likely to be the reference cost for investors.

Emissions trade represents an alternative for obtaining emission credits that is actually simpler than the other mechanisms. However, considering the price level estimated, the relative advantage of forest protection projects from the CDM starts to become more evident. Taking as a reference a full global trading scenario, where the prices from trade will reflect the participation of developing countries (i.e., these countries participate in conditions equivalent to the Clean Development Mechanism), Weyant (2000) presents estimates of various computer models, where projections vary from US$ 25,00 to US$ 130,00/ton C in 2010. Similar simulation by Ellerman *et al.*(1998) results in a market price of US$ 24,00 in 2010.

These models, however, ignore the transaction costs associated with the CDM and the possible restrictions in the amount of credits obtained from the CDM to force domestic reductions. If we take a cap of 50% on credits imports, for example, as it has been suggested in the negotiations, according to the projections of Ellerman *et al*. (1998) it would lead to a decrease in the price to US$ 13,00/ton C. However, if the additional costs related to the CDM are included, there would be a difference in the price paid by the consumers and that one received by producers in developing countries. By adding for example 25% of the original price as referring to additional costs, the market price of carbon would increase to US$ 27,40/ton C.

Another consequence of the negligence of transaction costs is the fact that the potential supply might not come in its full capacity as soon as trade is allowed, but rather develop slowly, as experience is gained (Ellerman *et al.*, 2000). That aspect can become relevant if we consider other factors that might limit the ready participation of some developing countries, such as the refusal in taking part of the CDM for political reasons or the lack of institutional capacity. The latter in particular could mean an overestimation of the participation of China (Seroa da Motta. *et al.*, 2000), for example. Since China, for being largely dependent on coal, is the country offering the cheapest abatement costs and huge opportunities for investment (with potential to receive 47% of the investment flows assuming a full supply – see Ellerman *et al.*, 2000), the distortions related to this assumption can be significant. Thus, considering an initial supply of only 5% of the full potential, the price would be rather high, US$ 180,00, decreasing as the supply increases (see Figure 2, from Ellerman *et al.*, 2000).

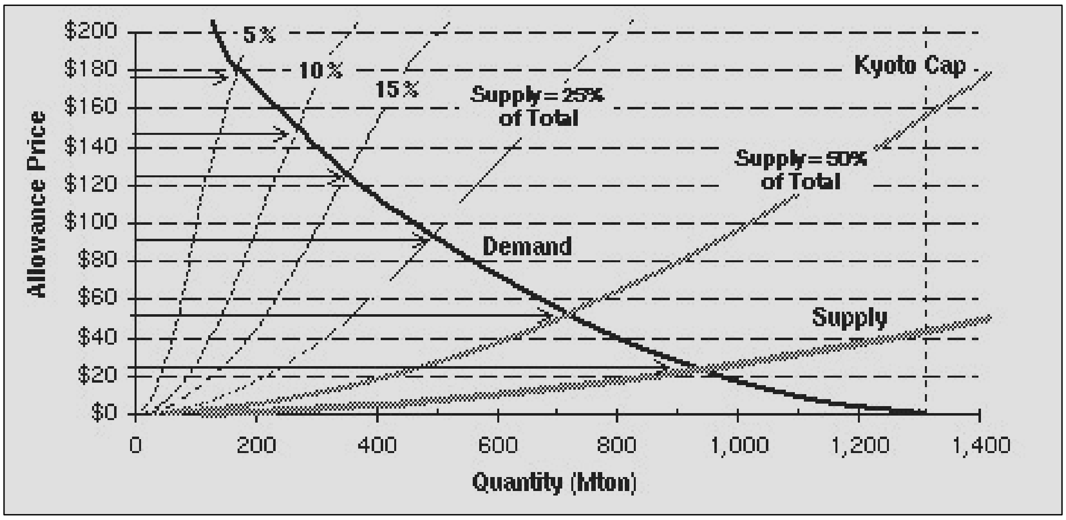


Figure 3: World Permit Supply and Demand in 2010 under Kyoto Constraints. Limitation on Supply: Supply = 50%, 25%, 15%, 10%, and 5% of Total.
Source: (Ellerman *et al.*, 2000)

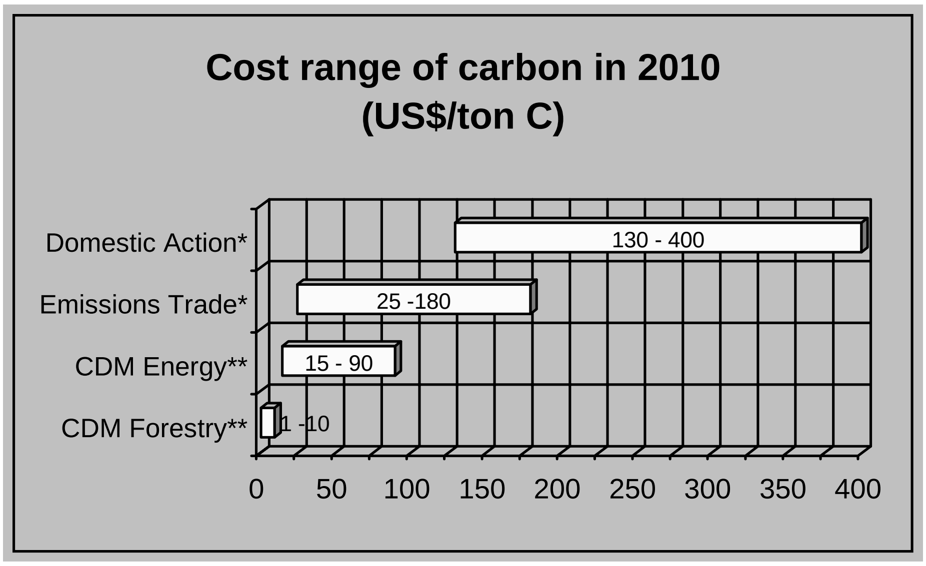
This general price projection, relatively high when compared LULUCF activities under the CDM, is what would lead some Annex I countries to take the risk of developing time-consuming CDM activities in exchange for carbon offsets. In fact, as Subak (2000) points out, this is what led Norway to purchase credits from Costa Rica at US$ 10,00 before even having the clear permission to use it against their emission commitments. Such differences in magnitude of the cost range of different options for meeting compliance can be more explicitly seen in Figure 3.

The costs of domestic action, which is the original reason for the creation of the flexible mechanisms, are obviously much higher than all the previous options. We can have an idea of their level by taking as a reference cost estimations of reducing domestic emissions in the absence of trading using the US as an example. Weyant (1998) presents scenarios from different models indicating costs approx. from US$ 130,00 to US$ 400,00/ton C[14] in 2010. For the European Union, Ellerman *et al*. (1998) projects US$ 273,00/ton C, and for other OECD countries US$ 233, 00/ton C.

1. 3. CONCLUSION

The combination of these scenarios in a broader context suggests that protection projects can, to a certain extent, correspond to the needs of a market interested basically in cost-efficient carbon offset producers - as long as they can provide cheaper CERs in relation to other ‘suppliers’ in the carbon market as a whole (see Figure 3). The fact of not offering additional financial returns, although reduces its competitiveness, it is not an impediment for its participation in this market through the CDM.

[14] The author attributes this difference in magnitude to the different baseline scenarios and the difficulty in adjusting energy demands in each model - see Weyant (2000) for more on the reasons for projection variations in climate change models.



* Projections (Weyant 2000; Ellerman *et al.* 1998)
** Based on ongoing projects in the pilot phase of JI

Figure 4: Cost range of different options for meeting the Kyoto targets.

Thus, if the costs entailed are not an impediment, we can say that the carbon market is also available for forest protection projects. A second step is to investigate the extent to and the conditions in which the CDM can contribute to the compensation of forest protection.

2. Shifting Perspectives: Conservation Needs

2. 1. CAN THE CARBON MARKET ATTEND THE NEEDS OF FOREST PROTECTION?

Once verified that the needs of the demand side of carbon markets can be attended by projects aiming forest protection, the opportunity is then available to the capture of carbon storage values. Since this ecological function is tied to the existence of *standing* forests, we can say that there is a chance of a global market as such, indirectly, becoming an incentive for conservation. To answer that it remains to know, however, until each point capturing this partial value of forests alone is enough to promote the preservation of the other ecological services it provides.

The answer to this question can be different if the decision-maker is the government or the individual. The relative weight of carbon gains in the decision making process can be higher than its absolute values if we consider a country seeking to secure the preservation of the environmental values in the national level. Otherwise, i.e., if sustainable development is not a concern permeating decision making, the behaviour of the government is likely to be more similar to the one of individuals.

Taking the first case of the governmental standpoint, according to the economic principles driving decision-making in the developing process discussed earlier (see section 1.1.2 - Part II), we have that sustainable land use will be preferred if (Pearce & Moran, 1994):

$$PV\ [TEV\ (SUB) - C\ (SUB)] - PV[B\ (DEV) - C\ (DEV)] > 0 \qquad (2)$$

$$\text{where } TEV = UV + NUV = (DUV + IUV + OV) + (XV + BV) \qquad (1)$$

The CDM, by capturing the value of carbon storage, provides concrete gains from the indirect use values (IUV) of forests that otherwise would not be tangible in practice. This value of carbon storage thus becomes a concrete input in TEV (SUB). This can be a decisive factor by turning part of the total economic value into immediate gains, as opposed to the typically discounted long-term benefits of sustainable development. Thus, although in absolute numbers the immediate gains from developing land might still be bigger than the benefits from protecting it for carbon storage, they might weight against development land use when in addition to the other total economic values intended to be preserved. In other words, the concrete short-term gains from carbon storage can be enough to shift the balance of the equation in favour of conservation, assuming a context of political will but lack of financial resources to do so.

Costa Rica can be taken as an example of the difficulties of developing countries in coping with the feasibility of taking total environmental values into account, even when lack of political will is not an issue. In a country strongly interested in biodiversity conservation and with a history of leadership in this area, the marketing of carbon offsets provides an opportunity to leverage scarce funding for conservation and consolidate a broad nation-wide programme of conservation and reforestation (Goldberg *et al.*, 1998). In this context, even if carbon compensation alone is not enough to exceed the value of development, the government is interested in covering apparent economic losses of forgone development, based on the other values that constitute the TEV. Very important, though, is that this means assuming *part* of the expenses instead of the whole budget, and that is where the CDM can make a difference.

Other countries taking part of the pilot phase of the Activities Implemented Jointly (AIJ), with less tradition in conservation yet in the first positions in the rank of biodiversity in forest frontiers are Indonesia, Equator and Bolivia (WRI & IUCN, 1998). For these countries, gains from carbon offsets are more project-related (see UNFCCC 2000), representing the core part of financial resources usually lacking for conservation projects, given the other priorities equally in need of public funds. Such resources would otherwise probably come in the form of foreign loans. The fact that the financial resources flowing through the CDM come, essentially, as a payment for carbon offsets instead of as a *loan* is an important aspect, given the current state of indebtedness in these countries. Besides, being a trade (as opposed to aid or loan), the financial flow is more constant over time, which also reduces vulnerability to political and budgetary changes and therefore contributes to the economic sustainability aspect.

However, in many cases the decision is not only in the hands of the government. When considering the individual standpoint, absolute and marketable values, as opposed to non-marketed environmental values, are more influential. Taking again the economic principle that explains the decision-making for land conversion (Pearce & Moran, 1994), we have that conservation (here sustainable land use) will be preferred if:

$$PV\ [B\ (SUB) - C\ (SUB)] - PV\ [\ B\ (DEV) - C\ (DEV)] > \ (3)$$

Thus, when the benefits of carbon storage start to accrue in a marketable form through the CDM, there is incentive to the individual to take account of them. From equation (3) we can deduce that conservation will be preferred if, in the absence of other incentives for conservation, carbon storage as an indirect value of forests (IUV) can be compensated in a way that turns the value of conservation [PV (SUB)] higher than the forgone development value [PV (DEV)]. The latter is usually represented by the opportunity cost of alternative land uses.

In order to prevent the depreciation of social benefits due to individual preferences, the government intervenes by regulating land use. Although legislation can be reasonably progressive regarding the environment and some developing countries, enforcement can be a major problem, as in the Amazon, for example (see Fearnside, 1995). Weak enforcement increases the role of individual's decisions in the development process, turning it into an important factor to be addressed in land use planning. While social organisation and institutional empowerment in these countries can take a long time to occur, the current pace of deforestation and environmental losses, in some cases irreversible, calls for solutions not too demanding on financial and institutional resources. Is in this context that a monitored market mechanism as the one provided by the CDM can represent a significant contribution to sustainable development.

In the earlier projects of joint implementation in non-Annex I countries involving private property, the government usually either buy the land for conservation, as the ECOLAND project in Costa Rica (see Goldberg *et al.*, 1998) and the Bilsa Biological Reserve in Ecuador (see UNFCCC 2000b), or propose the participation of the landowners individually in conservation projects, as in the Private Forestry Project (see Subak 2000), also in Costa Rica. In this case in particular, the offer for the landowner should follow the rule above and take the opportunity costs into account, in order to be attractive.

The Private Forest Project in Costa Rica attempts to do that through an innovative system of payments to compensate landowners for the conservation of environmental services. The payments average $60/ha/year for forest protection. Although intending to provide the landowner with sufficient income to compete with cattle grazing, such value is not competitive with other agricultural activities, such as diary farming. According to Subak (2000), this has reduced the participation of landowners in important areas for water supply and hydropower capacity, due to the fact that it is a diary farming region, and land values are higher.

This can signal that the potential of the CDM in becoming an economic incentive for conservation, as far as individuals are concerned, will depend on its capacity of covering the opportunity costs of land, which in turn vary from one region to another. In areas of high environmental value but also high opportunity costs related to unsustainable practices, compensating the value of carbon alone will probably be insufficient to cover forgone development gains. However, if such areas have various environmental values so as to justify limited or non-use – with all the social and economical implications in countries seeking economic growth – the carbon payment could be combined with payments for other environmental services. Initiatives involving economic compensation for environmental values are already emerging world-wide (see Daily *et al.* 2000), such as those related to biodiversity, as pharmaceutical plants and other tropical forest products (see Pearce and Moran 1994), and water purification and supply.

While the development of multiple markets for environmental services is not a reality yet, there is a considerable space for the application of the CDM in areas equally or even more important environmentally, so as to be under official protection of legislation, as watersheds.

2. 2 CONCLUSION

The analysis above suggests that the potential of the CDM in becoming an economic incentive for conservation, as far as individuals are concerned, will depend on its capacity of covering the opportunity costs of land, which in turn vary from one region to another. In areas with high opportunity costs but various environmental values so as to justify limited or non-use, the carbon payment can be an additional input, combined with payments for other environmental services. When governments are concerned, the CDM can contribute by providing an additional and immediate (in relative terms) input for the expenses with forest protection, relieving governments from covering the whole budget entailed.

While not all environmentally important areas can be set to conservation due to high opportunity costs – which is also probably not desirable given the social and economic implications in a developing country – there are priorities already acknowledged by legislation. Nevertheless, they may present distorted effects in practice due to unfavourable circumstances such as lack of financial resources, weak enforcement, poverty, population pressure, etc, found in developing countries. For these cases - and their aggregate effect can be significant - the CDM could make a difference concerning incentives for conservation, both at the governmental and individual level of decision-making.

PART III. ILLUSTRATIVE WATERSHED CASE

In order to illustrate the discussion on the competitive potential of conservation projects to take part of the CDM, as well as the outcomes and possible contributions to sustainable development, a watershed case is going to be applied as a representation of the valuation problem when comes to the incentives for land conservation. This case characterises a situation of ineffective protection through legislation.

1. Watershed Protection

Watershed protection is a typical example of underestimation of the benefits provided by forests. Although conservation of forest cover protects watersheds and brings benefits as soil protection, water quality and retention, and flood control (see section 1. 1. 2, Part I), the limitation of activities required by it often conflicts with pressures from alternative land uses (agriculture, pasture, urban expansion, etc). The missing markets for environmental services turn any alternative land use 'preferred' than the restricted use implied by conservation in the case of watersheds, leading, directly or indirectly, to deforestation and improper uses, and therefore environmental losses. Eventually, such losses are transferred to society in the form of environmental deprivation including water scarcity and pollution, floods, health risk, and all the economic costs entailed.

1. 2. GUARAPIRANGA BASIN

1. 2. 1. Background

The Guarapiranga Basin is a major source of water supply in Sao Paulo, occupying an area of 626 km^2 and responsible for the supply of 25% of drinking water to the urban population, equivalent to 3.5 million people. The area is part of the last 7.3% remaining from the Atlantic Forest, which is characterised by one of the highest biodiversity levels in the world. At the same time, the area is occupied by 70% of Brazilian population, being one of the world's tropical forests under highest threat (WWF, 2000).

The 'Law of Protection of Basins', created in 1976 and in force until 1998, has imposed severe land use restrictions in the catchment area (see Jacobi *et al.* 1998). The landowners, unable to develop their properties, left them vulnerable to invasion by squatters, bringing the formation of *favelas*[15]. Meanwhile, the law, by classifying the settlements close the reservoir as *irregular*, hinders the State from developing any infrastructure in the area. Consequently, without access to solid waste and sewage system, the local population discharges solid and water waste directly into the reservoir[16] (Jacobi *et al.*, 1998). The population in the Guarapiranga Basin has now reached around 600,000 inhabitants. Around 65% of this population are located around the reservoir itself, and the

[15] Favelas are public areas with bad conditions for construction occupied disorderly, and its constructions usually do not follow any constructive technical criteria and do not have any superficial protection. Many times, these dwellings launch their wastewater over the soil surface, which favours even more the lack of stability of the land in the prone risk areas, as well as aggravates the sanitation aspects.

[16] Given the alarming dimensions of the problem, a large part of the area occupied irregularly has been recently urbanised (see Guarapiranga Programme, 2000). However, the fact that the process of occupation is still ongoing is a matter of great concern.

remaining mainly in the three municipalities in the upper part of the catchment area (World Bank, 1993).

The consequences for the environment and the population (in the basin and the city) are catastrophic. Water quality of the Guarapiranga reservoir has been seriously affected, compromising the water supply of 3.5 million people. This in turn has led to a significant increase in treatment costs, obstruction of treatment filters, and taste and odour problems (World Bank 1993). The monthly treatment cost has jumped from US$150,000 in 1980 to US$700,000 in 1998 (Jacobi *et al.* 1998). The Guarapiranga Programme has spend more than US$ 140 million attempting to improve sanitation conditions in the area, but the situation is still worrisome as occupation still occurs[17].

As a result, the suburban system Guarapiranga has brought strong effects in the larger urban system represented by the São Paulo Metropolitan Region. This whole scenario, combined with exceptionally scarce rains in 2000, has culminated with one of the most severe water crises faced by the city (see ISA, 2000).

1. 2. 2. Contextualisation: Economic valuation & CDM

In this case, there is political will (at least in the legislative level) to preserve the environmental function and the respective economic values of the watershed. Nonetheless, the strict legislation regulating economic activities in the area caused a devaluation of land. This, in turn, left it vulnerable to other pressure factors, such as the strong population pressure historically high in Sao Paulo, the habitation deficit, poverty and weak enforcement in the vast basin area (see Jacobi *et al.,* 1998). This combination of factors left the basin vulnerable to occupation by a low-income population and brought about the exact harmful effects originally intended to be avoided: deforestation, erosion, serious reduction in water quality and supply, and the additional human health problems related to poor basic infrastructure.

Reducing deforestation in the basin would not only reduce further health and water-related problems, but also help preserve the few remains of the Atlantic Forest. Moreover, the pertinence of this case lies in its illustrative character. First, it shows the importance, specially in developing countries, of not only acknowledging environmental values (law does it here), but also providing means to capture the economic values associated, which can then be reverted in local benefits. By that is meant both the government level – to finance enforcement without diverting resources from other development areas - and the individual level - as a short-term strategy that might last as long as the development process itself does. This can contribute to the economic viability essential to ensure sustainable patterns of development in the long term. Second, the case illustrates how the distorted relation between the economic and the environmental system, when not acknowledged and corrected, ends up inevitably being exposed later, in the form of degradation and costs for the society as a whole.

1. 2. 2. 1. Insertion in the CDM context

Given the present scenario, a project aiming watershed protection could be inserted in the CDM under either reforestation or conservation of areas under threat of deforestation. However, the main

[17] For a more information on the Guarapiranga Basin, see ISA (1998).

interest in this essay is to study a market for environmental services *while they still exist* and thus prevent its loss. Therefore, the focus here will be on the application of a conservation project, although reforestation would be equally important as a corrective action[18].

Thus, there is a clear need of activities that can aggregate value to land while contributing to the conservation of the forest cover and its environmental functions. Nonetheless, very few activities combine these two characteristics - ecotourism, elderly and rest houses are some of the options considered (yet the latter would have little contribution given the large dimensions of the basin). In this context, the opportunity of capturing the value of carbon storage through the CDM could have a significant role to play by aggregating value to land.

1. 2. 2. 2. Meeting the requirements of the CDM

- ***Eligibility Criteria***

For the sake of this study, it is assumed the inclusion of crediting of avoided emissions from deforestation in the CDM. Similarly, the watershed project is assumed to meet the eligibility criteria - regarding baselines, additionality, permanence, leakage - according with the future decisions for the implementation of the Kyoto Protocol, so that the discussion can focus on the economic aspects implied[19].

- ***Contribution to sustainable development***

The contribution of this case for sustainable development is discussed above, as this is the very reason of its application here. Considering the conjuncture factors, once more deforestation of the Atlantic Forest is avoided, the benefits would include biodiversity protection, soils conservation, maintenance of water quality and supply, and flood control. Economic benefits for society would include the savings of public resources in continuous corrective actions such as infrastructure installation and water treatment, which do not address the root of the problem. This aspect in particular would represent economic benefits both at social and private levels, therefore increasing the local interest in supporting conservation and consequently, the overall sustainability of the process. Social benefits would result not only from the previous two factors, but also for reduced risks of water scarcity and public health related.

Social exclusion is evidently the main factor not addressed here by the CDM, for obvious reasons. Although not within the scope of such project, social exclusion could however be reduced, as the demand for housing would be diverted to areas where the law is not the obstacle for providing basic infrastructure and housing for the population.

Thus, for environmental, economic and social reasons, the urgency in halting the current trends is evident, and the overall contribution for sustainable development clear.

---

[18] The current Brazilian official position is, however, against the inclusion of credits from avoided deforestation in the CDM.

[19] Despite the difficulties involved, meeting the eligibility criteria it is possible, since it has been done in the pilot phase and there are proposals in how to deal with them, as discussed earlier (see also Fearnside, 2000 and Rotter, 2000).

1. 2. 3. Market perspective: cost-effectiveness

According to La Rovere (1998), purchasing private land of forest and improving the policing of public parks "are not so costly" in Brazil, and future conservation projects would be able to provide carbon offsets at "very low abatement costs", possibly around US$ 3,5 /ton C.

Taking this as a parameter, and based on the discussion about the competitiveness of conservation projects in section 1.2 (Part II), the Guarapiranga Project can be considered attractive for investments as long as it is found within a cost range inferior to the costs provided by other sources of offsets - such as the energy sector, emissions trade and domestic action. If this condition is met, any cost between US$ 1,00 to US$ 10,00/ton C is likely to be reasonable for investors, leaving precise costs irrelevant for the present discussion.

The amount of credits accruing from the preservation of primary tropical forest is another factor that might influence investors seeking large amounts of CERs accruing from a single project. While the IPCC (2000) indicates an average stock of 120ton C/ha in tropical forests, Fearnside (1995) points out 200ton C/ha. This represent a large amount of credits accruing in the short-term, as opposed to the low and gradual uptakes of plantations, around 4 – 8 ton/ha/year (IPCC, 2000). This factor can therefore be considered an advantage of forest protection projects if the investor is interested in short-term gains with CERs.

1. 2. 4. Watershed perspective: Does compensation really occur?

If costs are not an impediment for the participation of the project in the CDM, the opportunity of capturing the monetary value of one of the indirect use values of the Atlantic Forest becomes available. Now, the next step is to analyse if the CDM meets the needs of conservation, i.e., if it is able to address the underlying causes of deforestation adequately and thus become an incentive to conservation.

In the root of the problem is the fact that both PV (SUB) and PV (DEV) of land under strict regulation tends to be zero to the landowner. Without the benefits of the sustainable land influencing his decisions, the landowner did not have incentives to protect the land, thus allowing, intentionally or not, the irregular land use. In this case, since opportunity costs tend to be zero, any increase in the net benefits of protecting land [PV (SUB)] would turn protection more interesting for the landowner (see section 1.3 – Part II). Considering the importance of the Atlantic Forest, now with less than 8% of the original area remaining, the CDM applied in this case would yield relevant environmental benefits.

1. 3. CONCLUSION

From this case we can see how legislation, in the attempt to protect the environmental values of forests and ecosystems, can lead to a reduction in the opportunity costs of land without providing a compensatory increase in the benefits from sustainable land use. This has led to land devaluation and the absence of incentives for property protection. This would not be a problem if factors as population pressure, poverty and mainly weak enforcement were not creating a demand for this cheap land, leading to deforestation and occupation, therefore imposing a threat to the environmental values initially intended to be preserved.

In this context, remunerating the value of the carbon stocks in the forest through the CDM would be a way of aggregating value to the protected area, which, in this context, is better than having *no* value. Besides, even if the competing use represents opportunity costs higher than zero, when combined with other values as recreation and biodiversity (through ecotourism or scientific research), carbon values could make a difference and avoid irregular uses, as well as the consequent depreciation of the values all together. In addition, other water-related values are not far to be captured, as local governments now plan to charge water use (see Guarapiranga Programme, 2000).

Whereas this does not solve the problem of social exclusion, it can avoid health and safety problems for the local population (usually related to floods or landslides in sloped areas) associated with irregular housing.

General Conclusion

In this essay, we could examine one example of the current dominant role of the economic system in relation to life-supporting systems. Although economic valuation of environmental goods and services attempts to give a more realistic picture of the role of the environment, it has limitations in going all the way in avoiding environmental degradation if such values are not traded in the market.

This essay attempted to address this issue by investigating the potential of using the global carbon market created through the Kyoto Protocol as an economic mechanism to achieve the preservation of ecological services of forests in developing countries.

For that, initially it was verified the possibilities of forest protection in developing countries taking part of the carbon market through the Clean Development Mechanism, currently the only access to the carbon market. The inclusion of the costs of forest protection projects in a market context suggests that these projects can be competitive to a certain extent. The fact of not offering additional financial returns it is not an impediment for its participation in this market through the CDM.

A second step was to analyse until which extent this participation can be considered an economic mechanism to compensate forest protection. This will depend generally on the CDM's capacity of covering the opportunity costs of land, especially concerning private property. However, in areas with multiple environmental values, carbon could be combined with payments for other environmental services, such as recreation, biodiversity and water supply. While not all environmentally important areas can be set to conservation due to high opportunity costs, in areas already protected by legislation the CDM could make a difference and compensate conservation, both in the governmental and individual levels.

The use of market mechanisms is not in itself a safe solution for environmental problems. It is an instrument that should be used with caution to avoid diverting environmental policies and regimes from its original goals, as well as the risk that markets stop being a means to become an end in itself. On the other hand, carbon markets can help developing countries in reducing deforestation and ecosystem degradation. Because it does not rely heavily on governmental resources, it can therefore be more efficient in addressing such problems with the urgency needed to preserve the capacity of future generations to meet their needs.

References

Austin, D. *et. al.* (2000). *Financing Sustainable Development with the Clean Development Mechanism.* Washington, D.C.: World Resources Institute. Available at: http://www.wri.org

Barbier, , E.B. (1994). Natural Capital and the Economics of Environment and Development. In: Jansson, A-M.; Costanza, R.; Folke, C. ; Hammer, M. (eds). *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*.Washington, DC: Island Press.

Bonnie, R.; Schwartzman, S.; Oppenheimer, M. ; Bloomfield, J. Counting the cost of deforestation. *Science.* 288:1763-1764. Available at: www.sciencemag.org . Viewed in Sptember, 2000.

Chomitz, K. (1999). *Forest Carbon: A discussion Brief on Issues, Project Types, and Implications for the World Banks's Forest Policy Strategy.* Available at: www.worldbank.org

Costanza, R. (editor) (1991). *Ecological Economics: The Science and management of Sustainability.* New York: Columbia University Press.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R. G., Sutton, P. and van den Belt, M. (1997) The value of the world's ecosystem services and natural capital. *Nature* 387: 253-260. Appendix at www.nature.com Viewed in November 2000.

Dutschke, M; Michaelowa, A. (1998). *Creation and Sharing of Credits through the Clean Development Mechanism under the Kyoto Protocol.* HWWA – Discussionspapier 62.

Daily, G.C. *et al.* (2000). The value of Nature and the Nature of Value. *Science.* 289: 395-396.

Ellerman, D. ; Jacoby, H. D.; Decaux, A. (1998). The effects on Developing Countries of the Kyoto Protocol and CO^2 Emissions Trading. MIT *Report Series,* 41.

ENS (2000). *Environmental News* 2000-09-15. Available at http://ens.lycos.com/ens/sep2000/2000/L-09-15-16.html. Viewed in September, 2000.

Fearnside, P.M. (1995). Global Warming Response Options in Brazil's Forest Sector: Comparison of Project-Level Costs and Benefits. *Biomass and Bioenergy***.** V.8, n. 5:309-322.

Fearnside, P.M.; Lashof, D.A.; Moura-Costa, P. (2000). *Accounting for Time in Mitigating Global Warming Through Land Use Change and Forestry.* Available at www.ecosecurities.com. Viewed in October, 2000.

Frumhoff, P.C., Goetze, D.C, Hardner, J.J., (1998). *Linking Solutions to Climate Change and Biodiversity Loss Through the Kyoto's Protocol Clean Development Mechanism.* Union of Concerned Scientists, Cambridge, M.A:UCS.

Godoy, R.; Lubowski, R.; Markandya, A. (1993) A Method for Economic Valuation of Non-timber Tropical Forest Products. *Economyc Botany* 47 (3):220-233.

Godoy, R. *et al.* (2000). Valuation of Sale and Consumption of Forest Goods from Central American Rain Forests. *Nature.* 406:62-63.

Goldberg, D. *et al.* (1998). *Carbon Conservation: Climate change, Forests and the Clean Development Mechanism.* Washington, D.C. : Center for Environmental Law, CEDARENA.

Goldin, I. & Winters, L.A. (1995); *The Economics of Sustainable Development.* Cambridge: Cambridge University Press.

Groot, R.S. (1994). Environmental Functions and the Economic Values of Ecosystems. In: Jansson, A-M.; Costanza, R.; Folke, C. ; Hammer, M. (eds). *Investing in Natural Capital: The Ecological Economics Approach to Sustainability.*Washington, DC: Island Press.

Guarapiranga Programme (2000). Available at: http://www.prodam.sp.gov.br/invfut/guara2/livros/livro2d.htm . Viewed in August, 2000.

ISA – Instituto Socioambiental (2000). *Urbanismo Ecologico nos Mananciais.* Available at: http://www.socioambiental.org/website/parabolicas2/resenha.htm . Viewed in September, 2000.

ISA – Instituto Socioambiental (1998). *Diagnóstico Socioambiental Participativo Preliminar da Bacia do Guarapiranga..*

IPCC – Intergovernmental Panel on Climate Change (1996). *Climate Change 1995 – Impacts, Adaptations and Mitigation of Climate Change: Scientific-technical Analyses.* Contribution of Working Group II to the Second Assessment Report of the IPCC, New York: Cambridge University Press.

IPCC (2000). *Land Use, Land Use Change, and Forestry.* (Summary for Policy Makers). A Special Report for IPCC.

Jacobi, P.; Calderón, A.; Teixeira, M.A.C.; da Silva, R.A.. (1998) Sao Paulo: Ocupacâo do Solo e Degradacão Socioambiental. *Cadernos Cedec*, n.66, Sao Paulo: Cedec.

Jansson, A-M.; Costanza, R.; Folke, C. ; Hammer, M. (eds) (1994). *Investing in Natural Capital: The Ecological Economics Approach to Sustainability.*Washington, DC: Island Press.

Kyoto Protocol, (1997): *Kyoto Protocol to the United Nations Framework Convention on Climate Change.*

La Rovere, E.L.(1998). *The Challenge of Limiting Greenhouse Gas Emissions Through Activities Implemented Jointly in Developing Countries: A Brazilian Perspective.* Available at: http://www.epa.gov/globalwarming/publications/international/ . Viewed on September 2000.

Miller, G. T. (1998). *Living in the Environment: Principles, Connections, and Solutions*. California: Wadsworth Publishing Company.

Oberthür, S & Ott, H. E. (1999). *The Kyoto Protocol: International Climate Policy for the 21st Century.* Verlag, Berlim, Heidelberg: Spring.

Pearce, D. and Moran, D. (1994). *The Economic Value of Biodiversity*. London: Earthscan.

Pearce, D. (1998). Auditing the Earth. *Environment.* March, 1998.
Available at: http://www.findarticles.com/cf_0/m1076/n2_v40/20463464/p1/article.jhtml . Viewed in September, 2000.

Petzonk, A.; Dudek, D.J.; Goffman, J. 1998. *Market Mechanisms & Global Climate Change: An Analysis of Policy Instruments.* Environmental Defense Fund and Pew Center on Global Climate Change.

Rotter, J. (2000). *Carbon Forestry and the Kyoto Protocol's Clean Development Mechanism: A Legal Analysis.* Journal of Forestry. 28:5.

Salati, E.; Amaral, W.; Santos, A. A. dos (1998). *Investing in carbon Storage: A Review of Brazilian Forest Products.* Draft.

Schlamadinger B. & Marland G. (2000) .*Forests, Land Management and the Kyoto Protocol.* Pew Center for Climate Change.

Seroa da Motta, R.; Ferraz, C.; Young, C.E.F.; Austin, D.; Faeth P. (2000) *O Mecanismo de desenvolvimento Limpo e o Financiamento do Desenvolvimento Sustentável no Brasil.* Textos para Discussão, n. 271.

Smith, J.; Mulongoy, K.; Persson, R.; Sayer J, (2000). *Harnessing Carbon Markets for Tropical Forest Conservation: Towards a More Realistic Assessment.* CIFOR and IAE.

Subak, S. (2000). *Forest Protection and Reforestation in Costa Rica: Evaluation of a Clean Development Mechanism Prototype.* Environmental Management. V.26, n.3, pp.283-297.

Turner, R. K.; Pearce, D.; Bateman, I (1994). *Environmental Economics - An Elementary Introduction.* Hertfordshire: Harvester Wheatsheaf.

UNFCCC (2000b). *Activities Implemented Jointly: List of Projects.* Available at: http://www.unfccc.de/program/aij/aijproj.html. Viewed in November 2000.

UNFCCC (2000a). *Costa Rica – Norway: Uniform Reporting Format: Activities Implemented Jointly under the Pilot Phase.* Available at: http://www.unfccc.de/program/aij/aijact00/crinor-01-00.html. Viewed on November 2000.

WBGU – German Advisory Council on Global Change (1998). *The Accounting of Biological Sinks and Sources Under the Kyoto Protocol: A step Forwards or Backwards for Global Environmental Protection?* Special Report 1998. Berlin, Heidelberg, New York: Springer.

WCED-World Commission on Environment and Development (1987). *Our Common Future*. Oxford: Oxford University Press.

Weyant, J.P. (2000). *An Introduction to the Economics of Climate Change Policy.* Pew Center on Global Climate Change: Washington, D.C.

World Bank (1993). Watershed Protection in the São paulo Metropolitan Region: a Case Study of an Issue-Specific Urban Environmental Management Strategy. *Infrastructure Notes.* April, 1993. Available at: http://www.worldbank.org/html/fpd/urban/publicat/rd-ue9.htm . Viewd on September, 2000.

World Bank, (1999). *Lessons from the World Bank for the Kyoto Mechanisms - A Review Of Worl Bank Reports.* Available at: http://wbln0018.worldbank.org/essd/kb.nsf/environment/climate+change/general+information Viewed on September, 2000.

WRI & IUCN (1998). *Climate, Biodiversity and forests.* Available at: http://www.wri.org/ffi/climate/cbf-ntro.htm . Viewed on September, 2000.

WWF – World Wide Fund for Nature (2000). *Ecossistemas – Mata Atlantica*. Available at: http://www.wwf.org.br/wwfec04.htm