

Afforestation and Greenhouse Gas Mitigation

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1. Introduction

Since the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, policy developments associated with the role of forests in mitigating GHG's have been both rapid and complex. The Kyoto Protocol, with its binding commitments to reduce GHG emissions, outlines the ways in which afforestation, reforestation and deforestation, and other land use activities have the potential to play an important role in the achievement of the FCCC's aims. Included in the Protocol are three flexibility mechanisms, which are designed to facilitate the realisation of the emission reduction targets. Until recently the exact definition of how forestry can be included under the Protocol was not entirely clear and open to different interpretations. However, recent policy developments in Bonn have gone most of the way towards clarifying the role forestry and land use will take with respect to these flexibility mechanisms.

Despite the initial uncertainties, an increasing number of forestry-based emission reduction projects have been established in parallel to the ongoing policy developments. To date, more than 40 forestry projects have been set up with the main objective of fixing carbon or preventing its release to the atmosphere, with a substantial number based on reforestation or other tree-planting activities. Although the market for forestry based carbon offsets is still in its infancy, there is the potential for considerable infusion of capital into the forestry sector. For such investment to be realised, foresters must have a greater understanding of the carbon markets and the mechanisms for transaction of credits, and how this new commodity will affect traditional management practices.

This paper provides an overview of the evolution of the markets and transaction mechanisms for carbon offsets and greenhouse gas (GHG) emission reductions. A host of technical and non-technical terms have been used to describe carbon offsets including carbon credits, Emission Reduction Units (ERUs), and Certified Emission Reductions (CERs). Box 1 explains the technical differences between these terms. For the purposes of this report, carbon offsets, carbon credits and carbon offset projects are used as generic terms covering all the different technical formulations (including the outputs of those projects not explicitly related to international climate change policy).

2. Policy background

2.1. The UNFCCC and the concept of JI

In July 1992, representatives from 155 nations gathered in Rio de Janeiro for the United Nations Conference on Environment and Development (UNCED). Recognition that climate change was a reality led to the signature of the United Nations Framework Convention on Climate Change

(UNFCCC), which resulted in a voluntary commitment by Annex 1 countries (industrialised countries) to reduce their emissions to the levels of 1990 until the year 2000. Imbedded in the agreement was the concept of Joint Implementation (JI) of activities to reduce GHG emissions or promote the absorption of atmospheric CO₂. Investors engaged in these projects would be allowed to claim credits for the carbon emission-reduction (or carbon sequestration) activities financed. These credits should be equivalent to the carbon reduction or sequestration derived from the specific investment, and investors should be allowed to use them to lower GHG-related liabilities (e.g. carbon taxes, emission caps, etc.) in their respective home countries. The rationale of JI is that the marginal costs of emission reduction or CO₂ sequestration are generally lower in developing than developed countries.

2.2. The Activities Implemented Jointly Pilot Phase

Dissatisfaction between G77 countries over the concept of JI led to a growth in opposition to the JI model. Perceived problems included a feeling that this was a mechanism for industrialised countries to avoid addressing the real issues of reducing emissions at source. It was also felt that developing countries might be handing over all their cheap offset opportunities to industrialised countries during this initial phase, in which developing countries had no commitments to GHG emission reductions.

In the first Conference of the Parties (CoP 1) to the FCCC held in 1994, this dissatisfaction was voiced as a formal refusal of JI. Instead, a compromise was accepted in the form of a pilot phase during which projects were called Activities Implemented Jointly (AIJ). During the AIJ Pilot Phase, JI projects were conducted with the objective of establishing protocols and experiences, but without allowing the actual transfer of carbon credits between developed and developing countries.

2.3. The Kyoto Protocol

In December 1997, the Kyoto Protocol was conceived during CoP 3 of the FCCC. The most important aspect of the Kyoto Protocol is the binding commitment by 39 developed countries and economies in transition (the Annex B countries, see Box 1) to reduce their GHG emissions by an average of 5.2% of 1990 levels by the commitment period, 2008-2012. The Protocol also approved the use of three 'flexibility mechanisms' for facilitating the achievement of GHG emission reduction targets. These are QUELRO trading, Joint Implementation, and the Clean Development Mechanism (see Box 1 for definitions).

Another important output of the agreement was the recognition of forestry activities ('sinks', in the jargon of the Protocol) as valid options for reducing the net concentration of atmospheric GHGs. This is mentioned in Articles

3.3 and 3.4 of the Protocol, which deal with "afforestation, reforestation and deforestation" and "additional human-induced activities related to ... land use change and forestry", respectively. It is clear in the Protocol that Annex 1 countries are required to report on land use changes that have occurred since 1990, and are responsible for any changes in carbon stocks associated with these. It is less clear in the Protocol which forestry activities can be conducted as part of Article 12, the Clean Development Mechanism (see below).

The Kyoto Protocol was opened for ratification on March 16, 1998 and becomes legally-binding 90 days after the 55th government ratifies it, assuming that those 55 countries account for at least 55 per cent of developed countries emissions in 1990. As of 13th January 2000, 84 Parties had signed the Kyoto Protocol and 22 had ratified it.

2.4. Project-based mechanisms: the Clean Development Mechanism (CDM) and Joint Implementation (JI)

The Kyoto Protocol created two flexibility mechanisms related to project-based activities: the Clean Development Mechanism (CDM) and Joint Implementation (JI). In short, the CDM involves investment by developed countries in carbon offset projects in developing countries. As defined by the Protocol, its purpose is twofold: firstly, to assist developing countries (non-Annex I Parties) in making progress towards sustainable development and contributing to the FCCC's objectives; and secondly, to assist developed countries and economies in transition (Annex I Parties) in achieving their emission reduction targets. Non-Annex I Parties are supposed to gain the economic, developmental and environmental benefits from implemented projects that generate Certified Emission Reductions (CERs) for export. An important facet of the CDM is that these CERs are supposed to be bankable from the inception of the CDM (originally planned to start in 2000).

Other features of the CDM include:

- project activities must be additional to activities that would happen in a business-as-usual scenario;
- the CDM is open to participation by either private or public entities, or combinations of the two;
- projects must have the express approval of the host government;
- CDM projects must be independently certified;
- the CDM also has a mandate to use a portion of its proceeds to assist those countries, which are Particularly vulnerable to climate change, to adapt to those changes.

Joint Implementation, on the other hand, is a parallel mechanism based on projects involving Annex I parties only. Article 6 of the Protocol defines JI as the creation, acquisition and transfer of emission reduction units (ERUs) between Annex I parties (developed countries and economies in transition), that result from projects aimed at reducing emissions at sources or enhancing GHGs removals by sinks. Credits from JI will only start accruing from the beginning of the first commitment period (2008-2012).

2.5. The CDM & Forestry – an evolving process.

Although Article 3.3 of the Kyoto Protocol specifically mentions the role of afforestation, reforestation and deforestation (although not forest conservation) for reaching the targets agreed by Annex B countries, Article 12 on the CDM refers only to "emission reductions" with no mention of any specifically eligible activities. Contention over the inclusion of forestry in the CDM led delegates at

the recent CoP 4 to the FCCC in Buenos Aires, November 1998, to defer any decision until CoP 6, held in The Hague in November 2000. In the meantime, an international collaborative research network of forest scientists under the auspices of the IPCC (Intergovernmental Panel on Climate Change) was commissioned to prepare a Special Report on Land Use, Land Use Change and Forestry (IPCC, 2000). The report's objective was to provide policy makers with the necessary information to allow the implementation of the forestry aspects of the Kyoto Protocol, by reviewing the requirements and outcomes of different policy options. Chapter 5 of the special report deals with forestry projects, and is generally positive about the potential and feasibility of using this GHG mitigation option. In spite of the Special Report on LULUCF, polemic over sinks remained one of the central points of the negotiations, and eventually drove the process to a halt during CoP 6 (see below).

Since the CDM was initially proposed, many developing countries supported the inclusion of some types of land use activity. Latin American countries, and in particular Costa Rica, Argentina, and Bolivia, have been the most vociferous proponents of CDM forestry, with the equally vocal exception of Peru. Brazil has recently moved to supporting the inclusion of reforestation and afforestation, but remains opposed to activities involving forest conservation. Indeed this position was explicitly stated at CoP 5, and enshrined in the so-called Cochabamba Declaration, from June 1999, at which the Ministers of Bolivia, Brazil, Ecuador, and Colombia agreed on a common strategy regarding the CDM and the Amazon Basin. This declaration included the following paragraphs:

"(We) recommend the inclusion of forestry projects within the CDM, including activities for forestation, re-forestation, restoration, and sustainable management of the natural forests.

(We) recommend the analysis of the inclusion of conservation of natural forests, with the requirement that this type of project not be eligible for implementation among Annex 1 countries."

Asian countries have been less active on CDM issues, but Malaysia and Indonesia appeared to support the inclusion of forestry, while India and China were strongly against. Reasons for this opposition was essentially that India favours energy and technology transfer projects, with China opposing the use of any market-based instruments *per se*. African countries moved from their generally sceptical position on carbon offset forestry (driven in part by their negotiating position's heavy focus on capacity building and developmental assistance), to one of partial endorsement. At CoP 5, the Africa Group stated its support for the inclusion of afforestation and reforestation in the CDM, as well as the preservation of wetlands. Uganda led this position, having already hosted two carbon offset projects.

Industrialised countries were also divided on their views of forestry in the CDM. The EU bloc, whilst not in complete opposition, was keen to maintain the current 'slow track' approach, even in the light of the conclusions of the IPCC Special Report. Within the EU however, Holland was a relatively strong proponent (and indeed has led the way with carbon offset projects through the FACE Foundation), with Germany and the UK more cautious. The umbrella group of Japan, US, Canada, Australia, New Zealand and Iceland, were all strongly in favour of a wide role for sinks in meeting the Kyoto commitments, the CDM included.

Polemic also prevailed amongst the international NGO community. While some NGOs strongly favoured forestry's

inclusion in the CDM (e.g., The Nature Conservancy, Conservation International, Winrock Foundation, Sierra Club, etc.), other international NGOs were still quite uncertain and suspicious (e.g., WWF International, Greenpeace, Friends of the Earth). There was, and still is, support for the CDM from grass-roots organisations and local NGOs, who see the CDM as a potential source of funding for their programmes (e.g., see Letter of Brasilia, 1998; see also the variety of NGOs involved in ongoing carbon offset projects, e.g., Tipper, 1997), but others saw it as another threat to the rural poor from the processes of globalisation (e.g., Centre for Science and Environment, India).

2.6. The collapse of CoP 6, the US withdrawal and the Bonn and Marrakech agreements.

Disagreement over the inclusion of sinks, the extent of the use of flexibility instruments (as opposed to the use of domestic measures to reduce emissions), and mechanisms for compliance, have increasingly created a climate of discord, predominantly between the EU bloc and the Umbrella Group (US, Japan, Canada, Australia, New Zealand, and Iceland). While the former was strongly in favour of supplementary (the requirement that approximately 50% of a country's targets are met through domestic action), and the exclusion of sinks in the CDM, the Umbrella Group supported the unrestricted use of flexibility instruments and the inclusion of sinks, as originally proposed in the Kyoto Protocol. After a series of negotiation rounds, this eventually led to an impasse during CoP 6 (in November 2000), which was suspended until July 2001.

In March 2001, the newly elected President Bush announced that his administration had reviewed the text of the Protocol and decided that in its current form it did not meet the interests of the USA. This decision was heavily criticised throughout the world, particularly because of its unilateral form. Given that the US is responsible for about 36% of the emissions of Annex 1 countries, their non-participation in the Kyoto process may considerably jeopardise the objectives of the Climate Convention.

It is uncertain what impact the US decision will have on the climate change process as a whole. One possibility is that there may be some renegotiation of the protocol, trying to accommodate some of the US requests with a view of having them re-joining the process. Given that the current terms of the protocol (see below) accommodates most of the points demanded by the US at CoP 6, it is not unlikely to see the US coming back. Another possibility is that a parallel climate change initiative is promoted by the US, with a high emphasis on the use of sinks, both domestically (exploring the potential for carbon storage in agricultural soils in the US), and internationally (with a focus on forest management and conservation projects in Latin America). Indeed, even in spite of Bush's announcement, a series of initiatives have been developed in the US for carbon trading, including the carbon purchase tenders backed by the states of Seattle and Massachusetts, and the newly formed Chicago Climate Exchange voluntary market.

In June 2001, CoP 6 Part II took place in Bonn, and a new negotiation text was drafted. With relation to the use of flexibility mechanisms it states that these were to be considered supplemental to domestic action, but there is no required supplementarity targets (i.e. no specific percentage). This is somewhat closer to the US objectives. With relation to sinks, the key points in this document were:

a) That the treatment of these activities be based on sound science and consistent methodologies be used over time for the estimation and reporting of these activities;

b) That the mere presence of carbon stocks be excluded from accounting;

c) That the implementation of land use, land use change and forestry (LULUCF) activities contributes to the conservation of biodiversity and sustainable use of natural resources;

d) That accounting for LULUCF does not imply a transfer of commitments to a future commitment period;

e) That reversal of any removal due to LULUCF activities be accounted for at the appropriate point in time;

f) That accounting excludes removals from a) elevated carbon dioxide concentrations above their pre-industrial level; b) indirect nitrogen deposition and c) the dynamic effects of age structure resulting from activities and practices in land use.

g) Afforestation and reforestation activities were accepted as the only valid project activities in the CDM;

h) The future role of LULUCF projects in the CDM will be decided as part of the negotiations on the second commitment period. This includes a discussion on the inclusion of other activities, such as conservation;

i) The use of sinks in the CDM is limited to about 20% of an investor country's target (1% out of the ca. 5% for each year of the first 5-year commitment period): "...for the first commitment period, the total of additions to and subtractions from the assigned amount of a Party resulting from eligible LULUCF activities under Articles 12, shall not exceed 1% of base year emissions of that Party, times five". This represents about 680 million tonnes CO₂ until the end of first commitment period (2012). Considering the average sequestration of about 300 t CO₂ per ha, this will require the establishment of at least 2 million ha of forests between now and the commitment period.

Some additional references were made to the accounting and types of activities included under Articles 3.3 and 3.4. This covers contributions made by afforestation, reforestation and deforestation (3.3), and additional human-induced activities (3.4) to the assigned amounts for Parties included in Annex 1 (additional activities to include forest, cropland and grazing land management, and revegetation).

The most recent negotiations held in November in Marrakech had relatively little additional impact on the forestry sector, as opposed to the Bonn Agreement. A new accounting unit, the Removal Unit (RMU), was established to represent sink credits generated in Annex 1 countries, which can be traded through the emissions trading and JI mechanisms. RMU's can only be used in the commitment period in which they are generated and cannot be banked for a future commitment period. Another notable change was the increase in the Russian Federation allowances for sink activities, the maximum contribution towards their GHG commitments increased from 17.63 MtC/yr to 33 MtC/yr.

3. Scientific concepts

Carbon sequestration through forestry is based on two premises. First, carbon dioxide is an atmospheric gas that circulates globally and, consequently, efforts to remove greenhouse gases (GHGs) from the atmosphere will be equally effective whether they are based next door to the source or on the other side of the globe. Second, green plants take carbon dioxide gas out of the atmosphere in the process of photosynthesis and use it to make sugars

and other organic compounds used for growth and metabolism. Long-lived woody plants store carbon in wood and other tissues until they die and decompose at which time the carbon in their wood may be released to the atmosphere as carbon dioxide, carbon monoxide, or methane, or it may be incorporated into the soil as organic matter.

Plant tissues vary in their carbon content. Stems and fruits have more carbon per gram dry weight than do leaves, but because plants generally have some carbon-rich tissues and some carbon-poor tissues, an average concentration of 45-50 % carbon is generally accepted (Chan, 1982). Therefore, the amount of carbon stored in trees in a forest can be calculated if the amount of biomass or living plant tissue in the forest is known and a conversion factor is applied.

Carbon fixation through forestry is a function of biomass accumulation and storage. Therefore, any activity or management practice that changes the biomass in an area has an effect on its capacity to store or sequester carbon. A variety of forest management practices can be used to reduce the accumulation of greenhouse gases in the atmosphere, through different approaches. One is by actively increasing the amount or rate of accumulation of carbon (i.e., "sink" creation or enhancement). The second is by preventing or reducing the rate of release of carbon already fixed in an existing carbon "pool". As this paper focuses on forest plantations, these are based on the first mechanism.

Any activity that involves tree-planting results in the creation of new carbon sinks, i.e., carbon fixation during tree growth in afforestation, reforestation, forest rehabilitation, or agroforestry schemes. In the context of the Kyoto Protocol, these activities conform to the concept of Article 3.3. Although carbon sequestration is often discussed in the context of the establishment of new forests, carbon fixation can also be achieved by improving the growth rates of existing forests. This can be achieved through silvicultural treatments such as thinning, liberation treatments, weeding or fertilisation. Since substantial amounts of carbon are stored in soils, management practices that promote an increase in soil organic matter can also have a positive carbon sequestration effect. These activities fit into the spirit of Article 3.4 of the Protocol.

When considering carbon storage, not all forests are equal. Generally, longer-lived trees with high density wood store more carbon per volume than short-lived, low density, fast-growing trees. However, this does not mean that carbon offsets which involve big, slow-growing trees are necessarily better than those involving plantations of fast-growing trees and *vice versa* (Moura-Costa, 1996a and b).

4. Market evolution

During the last ten years, forestry-based carbon offsets have evolved from a theoretical idea to a market mechanism for accomplishing global environmental objectives. While we are still a long way from an organised market with prices defined according to supply and demand forces, there has already been some evolution from the initial voluntary schemes and bartering transactions common in the early 90's, to a market mechanism for accomplishing binding commitments agreed in the Kyoto Protocol. More than 40 forestry projects have been established with the main objective of fixing carbon or preventing its release to the atmosphere (Moura-Costa and Stuart, 1998), with at least 14 based on reforestation or other tree-planting

activities (Table 1). The last few years has seen a considerable increase in parties interested in developing carbon sequestration projects through afforestation.

Traditional financial cost/benefit calculations weigh heavily against all types of reforestation. Carbon offset payments, however, could help change forest plantation economics. There is growing recognition that the economic challenges of plantations - which generally yield little in the way of cash flow for many years - have inhibited investment in this activity. Additionally, high capital costs and delayed returns tend to favour the establishment of high-yield species monocultures, short rotations, and minimal cost management policies, all of which can be environmentally problematic. Risky locales, without track records, are also negatively weighed in such financial calculations. While the wood products industry is already increasing its reliance on planted forests, most studies indicate that plantation development still comprises only a fraction of annual primary forest cut, leading to fears that there is insufficient present investment to ease market pressure on dwindling primary forests (FAO 1991). Joint Implementation investments can, theoretically, make lower growth areas financially viable, make it possible to choose longer rotations, or to use a wider range of species than the eucalyptus, pine and teak varieties which account for 85% of all plantation investments in the tropics (FAO 1991).

4.1. Early days: voluntary projects

The first company interested in the possibility of compensating for its GHG emissions through the planting of trees was the American electricity company AES (American Electric Systems), who invested US\$ 2 million in an existing social agroforestry scheme in Guatemala, managed by CARE, an international poverty-relief NGO. The objective of the project was to plant 4.5 million trees over a 10-year period on a 186,000 ha area. Re-evaluation of the project, in 1994, showed that these initial objectives were not met (Faeth *et al.*, 1994). At a later stage, AES invested another US\$ 5 million in two other projects in South America.

In the early 1990's, the Dutch Electricity Board (SEP), a consortium of five electricity companies in the Netherlands, created the Face (Forests Absorbing Carbon-dioxide Emissions) Foundation. The mandate of the Face Foundation was to promote the planting of enough forests to absorb an amount of CO₂ equivalent to the emissions of a medium-sized coal-fired power plant (400 MW) during its 40-year life time (Face Foundation 1994; Dijk *et al.*, 1994). In this way, SEP would be able to build a new power plant in the Netherlands, with no net emissions to the global atmosphere. A budget of US\$ 180 million was allocated to Face, for the establishment of a portfolio of forestry projects in different parts of the world.

These initiatives illustrate the first transactions for CO₂ emission mitigation worldwide. They were voluntary in nature, since there were no legislation requirements for polluters to reduce GHG emissions. Projects were established anticipating changes in environmental legislation, while capitalising in the public relations value of projects. In the case of AES, their first projects did not even have any contractual arrangement for carbon credit allocation and transfer, and they were never submitted as Joint Implementation initiatives (see next section). This voluntary aspect was somewhat reflected in the low average price paid for carbon sequestration, which was on average US\$ 0.01/ton C.

4.2. UNCED and early generation JI projects (1992-1994)

In 1992, the Framework Convention on Climate Change was proposed at the UNCED meeting in Rio, and the concept of Joint Implementation (JI) of activities to reduce GHG emissions or promote the absorption of atmospheric CO₂ was put forward.

Although not officially endorsed by the convention, this promise of credit transfer through JI activities has led a series of companies to engage in JI-type activities. One of the first to move was the Face Foundation, with a 25,000 ha enrichment planting initiative in Malaysia (see Box 2; Moura-Costa *et al.*, 1996). This was followed by four other projects involving the reforestation of degraded pasture land by small farmers in Ecuador (1992), rehabilitation of an acid-rain degraded park in the Czech Republic (1992), urban forestry in the Netherlands (1993), and rain-forest rehabilitation in Uganda (1994). Another American utility, SAP, initiated a reforestation project in Russia. Approximately US\$ 120 million dollars were committed to the implementation of these projects during this phase, with an average of US\$ 4.50 paid per ton C, a substantial increase from the previous phase.

4.3. AIJ Pilot Phase: more uncertainty (1994-1996)

With the establishment of the AIJ pilot phase in 1994, there was a reduction in appetite for investment in carbon offset projects. Because of the lack of real incentives for investor participation (no carbon credit transfer to investors was allowed), the results of the AIJ pilot phase were not representative of the full potential of JI in terms of international investment and GHG reduction achievements (Stuart and Moura-Costa 1998). Only four new tree planting projects were initiated between 1996 and 1997, with a much reduced level of investment (US\$ 4 million during this phase). These included: a 6,000 ha reforestation project with klinky trees in Costa Rica; a 13,000 ha community forestry project in Mexico, financed by the International Automobile Association; and a community forestry project for fuel-wood production in Burkina Faso, financed by the Government of Norway through the World Bank. At the same time Costa Rica initiated the development of its large national carbon offset programs (see Box 3), including the Private Forestry Project (PFP), and attracted US\$ 2 million from the Government of Norway.

4.4. The Kyoto Protocol and its aftermath (post 1998)

In December 1997, 170 countries signed the Kyoto Protocol during the CoP 3 of the FCCC. The establishment of binding commitments has led to a more real demand for offsets. According to a study of the MIT/World Bank (Eilermann *et al.*, 1998), if these targets were accomplished through GHG emissions trading, this would generate a demand for GHG Emission Reduction Units (ERUs) in the order of US\$ 20 billion a year, a substantial change from the previously voluntary demand of the pre-Kyoto phase.

The provisions in the Protocol (even if still far from certain) greatly increased the attractiveness (and reduced the risks) of investment in forestry-based offset projects, leading to an immediate response in the, still incipient, carbon market. The supply of offsets began to get more organised, and offer more sophisticated financial instruments. This is the case for the Costa Rican national programme, the first to produce carbon denominated securi-

ties (CTOs – Certified Tradable Offsets) which was the first producer-led carbon offset initiative in the world, and the first one to utilise independent certification and insurance (Box 3). This project was followed by New South Wales State Forests (NSWSF), a state organisation that sold the carbon sequestration services of some of its plantations in the form of CTOs to Australian and Japanese power companies in late June 1998. Other forestry companies also realised that they had the capacity to attract carbon funding, with important implications for the financing of their operations, as illustrated by the prospectus-based forestry investment funds in Australia (see Box 4). At the same time, the World Bank launched its Prototype Carbon Fund, with an initial capitalisation of US\$ 130 million, which intends to include some forestry projects.

5. Ways forward

To date, several million ha of forests world-wide are under forest management regimes related to GHG mitigation funding. According to the IPCC (Brown *et al.* 1996), forestry has the potential of offsetting approximately 15% of the world's GHG emissions, a partial solution to the overall problem. If this investment trend continues, we may see a huge infusion of new capital into the forestry sector, which will have enormous importance in addressing some of the topical issues of sustainability and conservation of biodiversity.

In order for investment to be directed, however, markets have to be developed. Suppliers (forestry and renewable energy concerns, countries or companies) will have to learn about this new commodity (or service) generated by their enterprises (activities), and adapt to a new production possibility boundary based on the relative values of their main output (forest products) and of this new environmental value (carbon sequestration or emission reductions).

Investors (those with an environmental liability) will need to identify the full extent of their environmental liabilities and utilise market mechanisms to lower them through the purchase of credits or options. For the environment, this may mean a huge infusion of new capital into forestry activities world-wide. For the global economy, the full participation of the market may enable meeting the global environmental targets at a fraction of the costs.

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Table 1. Carbon offset projects involving tree planting activities implemented to date. The list is comprehensive until 1997, but a series of initiatives have been conducted since then which have not necessarily been registered with official AIJ registration bodies.

Project name	Date proposed/ initiated	Estimated Carbon offset (1000 t C) ^a	Area (ha)	Host Country	Investor country	Project description
AES - Care	1990	10,500	186,000	Guatemala	USA	Agroforestry
Face Malaysia	1992	4,250	25,000	Malaysia	Netherlands	Enrichment planting
Face-Kroknoze	1992	3,080	16,000	Czech Rep.	Netherlands	Park rehabilitation
Face Netherlands	1992	885	5,000	Netherl.	Netherlands	Urban forestry
Face-Profafor	1993	9,660	75,000	Ecuador	Netherlands	Small farmers plantation forestry
RUSAFOR-SAP	1993	79	450	Russia	USA	Plantation forestry
Face Uganda	1994	6,750	27,000	Uganda	Netherlands	Forest rehabilitation
Private Forests Project (PFP)	1996	open ended	open ended	Costa Rica	open	Reforestation, forest protection, and management
Klinki forestry	1997	1,600	6,000	Costa Rica	USA	Reforestation with klinki
Burkina Faso	1997	67	300,000	Burkina Faso	Denmark	Fire wood community forestry
Scolec Te	1997	15	13,000	Mexico	UK/France	Community forestry
New South Wales State Forests and Pacific Power	1998	69	1,041	Australia	Australia	Reforestation
NSW and Tokyo Electric Power Company (TEPCO)	1999	130 to 5,200	1,000 to 40,000	Australia	Japan	Reforestation
Australian Plantations Timber	1999	3,075	25,000	Australia	undefined	Reforestation

a. These figures relate to the average storage capacity of the planted stands, which may not reflect the amount of carbon credits, which different policy regimes will authorise to be traded.

Box 1. A Glossary of Terms related to Climate Change Mitigation Projects

Since the early 1990's, a variety of terms have been used to refer to different project-level climate change mitigation mechanisms and their outputs. The meanings of these terms have changed gradually. Below are some of the definitions that have been used. Most bear some relation to stipulations of the UN Framework Convention on Climate Change (FCCC) signed in 1992, whose provisions are fleshed out by the Kyoto Protocol, signed in December 1997.

MECHANISMS (1) --- EARLY PRE-KYOTO DEFINITIONS

Joint Implementation (JI)

The concept of joint implementation (JI) was introduced by Norway into pre-UNCED negotiations in 1991. This was reflected in Article 4.2(a) of the FCCC which gives Annex I countries (see below) the option of contributing to the Convention's objectives by implementing policies and measures jointly with other countries. The investing participants in these projects could presumably claim emission reduction 'credits' for the activities financed, and these credits could then be used to lower greenhouse gas (GHG) related liabilities (e.g., carbon taxes, emission caps) in their home countries.

Activities Implemented Jointly (AIJ)

In the first Conference of the Parties (CoP 1) to the FCCC held in 1995 in Berlin, a Pilot Phase of Activities Implemented Jointly (AIJ) was created. During the AIJ Pilot Phase, projects were conducted with the objective of establishing protocols and experiences, but without allowing carbon credit transfer between developed and developing countries. The AIJ Pilot Phase is to be continued at least until the year 2000.

MECHANISMS (2) --- POST-KYOTO DEFINITIONS

The Kyoto Protocol of the FCCC created three instruments, collectively known as the 'flexibility mechanisms', to facilitate accomplishment of the objectives of the Convention. A new terminology was adopted to refer to these mechanisms, as detailed below. Note that because of the Kyoto Protocol's distinction between projects carried out in the developed and developing world, some AIJ projects may be reclassified as CDM or JI projects.

Joint Implementation (JI)

Set out in Article 6 of the Protocol, JI refers to climate change mitigation projects implemented between two Annex 1 countries (see below). JI allows for the creation, acquisition and transfer of "emission reduction units" or ERUs.

The Clean Development Mechanism (CDM)

The CDM was established by Article 12 of the Protocol and refers to climate change mitigation projects undertaken between Annex 1 countries and non-Annex 1 countries (see below). This new mechanism, whilst resembling JI, has important points of difference. In particular, project investments must contribute to the sustainable development of the non-Annex 1 host country, and must also be independently certified. This latter requirement gives rise to the term "certified emissions reductions" or CERs, which describe the output of CDM projects, and which under the terms of Article 12 can be banked from the year 2000, eight years before the first commitment period (2008-2012).

QUELRO (Quantified Emission Limitation and Reduction Obligations) trading

Article 17 of the Protocol allows for emissions-capped Annex B countries to transfer among themselves portions of their assigned amounts (AAs) of GHG emissions. Under this mechanism, countries that emit less than they are allowed under the Protocol (their AAs) can sell surplus allowances to those countries that have surpassed their AAs. Such transfers do not necessarily have to be directly linked to emission reductions from specific projects.

WHICH COUNTRIES IN WHICH MECHANISMS?

Annex 1 countries

These are the 36 industrialised countries and economies in transition listed in Annex 1 of the FCCC. Their responsibilities under the Convention are various, and include a non-binding commitment to reducing their GHG emissions to 1990 levels by the year 2000.

Annex B countries

These are the 39 emissions-capped industrialised countries and economies in transition listed in Annex B of the Kyoto Protocol. Legally-binding emission reduction obligations for Annex B countries range from an 8% decrease (e.g., EC) to a 10% increase (Iceland) on 1990 levels by the first commitment period of the Protocol, 2008 – 2012.

Annex 1 or Annex B?

In practice, Annex 1 of the Convention and Annex B of the Protocol are used almost interchangeably. However, strictly speaking, it is the Annex 1 countries which can invest in JI/CDM projects as well as host JI projects, and non-Annex 1 countries which can host CDM projects, even though it is the Annex B countries which have the emission reduction obligations under the Protocol. Note that Belarussia and Turkey are listed in Annex 1 but not Annex B; and that Croatia, Lichenstein, Monaco and Slovenia are listed in Annex B but not Annex 1.

PROJECT OUTPUTS

Carbon offsets – used in a variety of contexts, most commonly either to mean the output of carbon sequestration projects in the forestry sector, or more generally to refer to the output of any climate change mitigation project.

Carbon credits – as for carbon offsets, though with added connotations of (1) being used as 'credits' in companies' or countries' emission accounts to counter 'debts' i.e. emissions, and (2) being tradable, or at least fungible with the emission permit trading system.

ERUs (emission reduction units) – the technical term for the output of JI projects, as defined by the Kyoto Protocol.

CERs (certified emission reductions) – the technical term for the output of CDM projects, as defined by the Kyoto Protocol.

RMUs (removal units) – the new technical term representing sink credits generated in Annex I countries, which can be traded through the emissions trading and JI mechanisms

Box 2: The Innoprise-Face Foundation Rainforest Rehabilitation Project (INFAPRO) is a cooperative venture between Innoprise Corporation, a semi-government forestry organisation which has the largest forest concession in the state of Sabah, Malaysia, and the Face (Forests Absorbing Carbon-dioxide Emissions) Foundation of the Netherlands, an organisation set up by the Dutch Electricity Generating Board to promote the planting of forests to absorb CO₂ from the atmosphere to partially offset the emissions of their power stations. The objective of the project is to rehabilitate 25,000 ha of logged forests by enrichment planting and reclamation of degraded areas using indigenous tree species such as dipterocarps, fast growing pioneers, and forest fruit trees, over a period of 25 years (see Moura-Costa, 1996a and Moura-Costa *et al.*, 1996). The total investment committed by the Face Foundation amounts to US\$ 15 million over 25 years.

In the pilot phase (1992-1994), 2,000 ha of logged-over forests were planted as an initial trial of the effectiveness of this system. The planting phase will be extended for 25 years and the forests maintained for 99 years. The long term nature of the project should enable the maintenance and silvicultural treatments required to sustain growth rates during the project life. It is expected that at the end of the first 60-year growth cycle, these forests will be exploited for timber, which will belong exclusively to Innoprise. However, timber harvesting will have to be done in a careful way, so that a healthy residual stand can again regenerate a well-stocked forest in order to maintain a carbon pool for the Face Foundation, which has the exclusive rights to the carbon sequestered through the 99 years of the project. It is expected that the project will sequester at least 4.25 million tonnes of carbon (15.6 million tonnes CO₂) during its life-time at an average cost of US\$ 3.52 per ton of carbon (US\$ 0.95 per t CO₂).

It has been estimated that the project will also produce over 4 million m³ of hardwood sawn timber, worth close to US\$ 800 million, which belongs to Innoprise Corporation. Given that Innoprise is fully owned by the Sabah Foundation, a semi-government organisation with the mandate of improving people's welfare in the state of Sabah, it is expected that the project will generate considerable social spin-offs. Additionally, during its initial 25-year planting phase, the project will directly generate 230 jobs-year, for various activities such as field planting, silviculture, nursery work, mapping and GIS (geographical information systems), computing, financial control, and research. It is important to note that 90 % of the project's budget is spent on personnel.

Box 3: The Costa Rican system of direct payment for environmental services

In 1997 Costa Rica launched two national level innovative forestry-based carbon offset programmes. Commercialisation of CO₂ reduction credits is done through the sale of Certified Tradable Offsets (CTOs), the first security-like instruments backed by carbon offsets, which are issued by the recently created Costa Rican Office on Joint Implementation (OCIC). These CTOs are credits of carbon fixation based on the amount of CO₂ fixed in forests or emission reductions derived from their renewable energy plants. The first batch of CTOs (200,000 tons of carbon) was sold to a Norwegian consortium at US\$ 10/ton C (US\$ 2.70/t CO₂), for a total of US\$ 2,000,000.

The Private Forestry Programme (PFP), encourages land owners to opt for forestry-related land uses by providing direct payment for environmental services. Environmental services include CO₂ fixation, water quality, biodiversity, and landscape beauty. The monetary incentives aim at increasing the attractiveness of forestry compared to higher impact forms of land use. Incentives are paid to land owners over a period of 5 years following the signing of a contract to keep their land under a specified type of utilisation for a minimum period of 20 years. Farmers who receive these incentives assign the rights to the environmental services of the government, who bundles them for potential sale. The resources for initiating the PFP programme were raised by a domestic 15 % tax on fossil fuels, which is expected to raise US\$ 21 million per year. It is hoped that future payments to farmers will be based upon successful sales of resultant CTOs.

The value of PFP incentives varies. There are three main areas of interest: conservation of existing forests, selective harvesting for sustainable wood production, and reforestation or natural regeneration of degraded pasture or agricultural land. In the case of private forest conservation, farmers receive US\$ 56/ha/year to a total of US\$ 280/ha. They are also waived payment of land tax. Those opting for natural forest management receive US\$ 47/ha/year, to a total of US\$ 235/ha, in addition to the revenue derived from timber harvesting. In order to enforce compliance with low impact logging guidelines, the law requires that any harvesting operation must be supervised by a trained forester. Farmers who choose to reforest part of their agricultural land receive a series of payments related to the costs of plantation establishment, to a total of US\$ 558/ha.

The institution co-ordinating the administration of the private sector incentives is called Fonafifo (Forestry Financing Fund), an office created by the MINAE (Ministry of Energy and Environment). Fonafifo has the role of receiving and analysing applications, conducting field verifications, carrying out the payments, and monitoring field implementation of forestry projects.

Costa Rica is also working on a second national level land use project, called Protected Areas Programme (PAP), with the objective of reducing deforestation rates by consolidation of its national parks network. The programme aims at consolidating 570,000 ha within 28 national parks, and claim the carbon savings derived from avoided deforestation, which historically has averaged 3% per year. Costa Rica expects to avoid the release of about 18 million tonnes of carbon (66 m t CO₂) through the implementation of the PAP. These savings have been independently verified by the international certification company SGS Forestry (Moura-Costa *et al.*, 1997), with the assistance of EcoSecurities, a specialist consultancy firm, and CTOs will be issued accordingly. At a projected price of US\$ 10 per tonne of carbon, Costa Rica expects to raise US\$ 180 million through the Protected Areas Programme. The sale of CTOs from the PAP has been done with the assistance of international environmental brokers. In conjunction with the Earth Council, who is providing some of the catalytic finance for the PAP, Costa Rica will use a portion of those proceeds to finance construction of the Earth Centre, which is envisioned as a research/demonstration project highlighting various aspects of sustainable development and environmental values.

These Costa Rican programmes provide good examples of how carbon trading could be utilised by developing countries to attract international investment into national priorities. The whole programme has been entirely conceived by the Costa Rican government and, consequently, totally conforms to national priorities. While Costa Rica managed to secure catalytic funding for the initial phase of the PAP (provided by the Earth Council and the World Bank), all other costs will be borne by Costa Rica

Box 4: Australia Plantations Timber and prospectus based forest investment funds

Australian Plantations Timber (APT) is a forestry company specialised in commercial plantations of eucalyptus trees in Western Australia, South Australia and Victoria. Every year, since 1992, APT raises capital from investors for the establishment of new forest plantations, based on investment prospectus offering a pre-tax rate of return of about 7-8 %, derived from the sale of the eucalyptus trees harvested at the end of an 11-year rotation.

In 1999, with the assistance of EcoSecurities (an environmental finance company specialised on the GHG mitigation sector), APT included provisions in its prospectus to enable the sale of the carbon sequestration credits which may arise from its forestry operations, becoming the first private company world-wide to do so. In practice, the prospectus alerted investors that the rates of return of this fund could potentially be increased through the sale of this new commodity (carbon credits). EcoSecurities estimated that the internal rates of return could rise by 1-3 % depending on the value accrued through carbon sales.

The prospect of higher returns led to an increased amount of investment into APT: the 1999 prospectus was oversubscribed and the company had to limit its capital uptake to Aus\$ 136 million, because of constraints related to land availability and operational capacity. APT plans to plant 25,000 ha of new forests in 2000, as opposed to the previous rates of 2-3,000 ha.

In April 2000 APT floated in the Australian Stock Exchange, with initial market capitalisation of Aus\$ 340 million and shares valued at Aus\$ 3.20 each on the first day of trading. Stock analysts from Macquarie Equities in Australia have valued the company at A\$4.50 per share and have attributed Aus\$ 0.50 of the share price to the value of carbon credits to be produced by APT's plantations.

APT is currently working towards selling the carbon credits generated, and is likely to benefit from the various financial mechanisms that have been developed to facilitate the trade of carbon credits, creating liquidity for this new type of securities. Amongst them, the Sydney Futures Exchange have plans to launch futures contracts on carbon credits and their derivatives, and a series of brokers are already offering derivatives such as options based on carbon.

This case study provides an example of how carbon credits are beginning to be used for promoting the funding of forestry activities. Increasingly, carbon is being incorporated into project finance structures, in addition to other debt and equity sources of finance, leveraging the amount of capital that is currently available for forest finance.

With regards to the environment, this type of project is fully aligned with Australia's objectives of increasing forest cover, in order to reduce salinisation problems currently affecting large tracks of agricultural lands. In relation to the Kyoto Protocol, this example illustrates the *additionality* effect that extra financial returns can generate. In global terms, this demonstrates how market approaches could facilitate reaching global environmental objectives at optimal financial costs.