Forestry-based Greenhouse Gas Mitigation: a short story of market evolution[1]

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Summary

Concern about rising atmospheric concentrations of greenhouse gases has prompted the search for methods for reducing greenhouse gas emissions or ways of sequestering carbon in plant biomass. For reasons of cost effectiveness, high potential rates of carbon uptake, and associated environmental and social benefits, much attention has focused on promoting forestry as a means of offsetting carbon emissions. During the last ten years, forestry-based carbon offsets have evolved from a theoretical idea towards being a market-based instrument for accomplishing global environmental objectives. This paper provides an overview of the evolution of the market and transaction mechanism for carbon offsets and greenhouse gas emission reduction projects. Although many of the concepts and ideas presented here are generic and applicable to any type of greenhouse gas mitigation option, the paper emphasises issues related to forestry-based carbon offsets.

Keywords: carbon sequestration, carbon offset projects, carbon offset costs, Joint Implementation, emission reduction markets, flexibility instruments, clean development mechanism.

1) Introduction:

The notion of compensating for rising atmospheric carbon dioxide (CO_2) concentrations through global scale afforestation was first put forward in the late 1970's (Dyson 1977). During the last ten years, forestry-based carbon offsets have evolved from a theoretical idea towards being a market-based instrument for accomplishing the global environmental objectives of the United Nations Framework Convention on Climate Change (FCCC), signed in Rio in 1992 during the United Nations Conference on Environment and Development (UNCED). While we are still a long way from an organised market with prices defined according to supply and demand forces, the initial voluntary schemes and bartering transactions common in the early 90's have already given way to more sophisticated market mechanisms. If this trend continues, it seems very likely that forestry offsets will play a part in accomplishing the legally-binding emission reduction commitments agreed in 1997 in the Kyoto Protocol of the FCCC. It is estimated that, once fully operational, the international market for carbon projects, credits and allowances will reach tens of billions of dollars each year (World Bank 1997), a sizeable proportion of which could flow to developing countries if the trading regime is properly structured.

For countries rich in forest resources, altering non-sustainable land-use patterns is likely to be a prized greenhouse gas mitigation opportunity. Forestry carbon offsets encompass a range of project-level interventions, including direct preservation of existing forests, reforestation, and reduction of the negative impacts of forest management and harvesting (Moura-Costa 1996a, Brown et al. 1996). There is also the possibility of increasing the production efficiency of swidden agricultural systems or the end-use efficiency of fuelwood resources, both of which help take pressure off of standing forests, with accompanying GHG benefits.

Considering the wider perspective, forestry carbon offset projects can provide support for the other convention signed at UNCED -- the Convention on Biodiversity. While a variety of financial mechanisms are being explored to support biodiversity conservation, initiatives like trust funds and pharmaceutical prospecting rights have yet to demonstrate that they are fully accepted by either policy-makers or the marketplace. Forestry-based carbon offsets -- whether they promote direct preservation, sustainable forestry practices or reforestation -- all have the potential to positively support the goals of the Biodiversity Convention.

2) Forestry and calculation of the costs of greenhouse gas sequestration

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 from the atmosphere will be equally effective whether they are based next to the source or on the other side of the globe. Second, green plants remove carbon dioxide from the atmosphere in the process of photosynthesis, using 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, from 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 content of 45-50% carbon is generally accepted (Chan 1982, IPCC 1996). 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.

Forestry-based carbon offset projects[2] can be based on two different approaches: 1) active absorption[3] in new vegetation, and, 2) avoided emissions[4] from existing vegetation (i.e., from decomposition). The first approach includes any activity that involves planting of new trees (afforestation, reforestation, agroforestry, etc.) or increasing growth rates of existing forest stands (e.g., silvicultural practices). The second approach can be accomplished through prevention or reduction of deforestation and land use change (e.g. through conservation projects), reduction in damage to existing forests (e.g., through uncontrolled logging, fire), etc. All methods have similar results in that they reduce the accumulation of GHG's in the atmosphere, but will require different analytical tools for the evaluation of their merits as carbon offsets (i.e. whether they differ from an ongoing baseline) and for the calculation of their offset potential.

Different methods have been used for evaluating the carbon sequestration achievements of a project during its life time (Matthews 1996). Most projects and authors (e.g., Verweij 1997, Tipper et al. 1997, Pinard and Putz 1997, Nabuurs and Mohren 1993, Faeth et al. 1994, Swisher 1991) report the amount of carbon stored in a site at a given point in time after the beginning of the project. This approach has the drawback that it ignores the carbon flow dynamics that occur over the lifetime of a project. Furthermore, the time chosen for this "evaluation" varies from project to project, hindering comparison between projects. Other authors (Richards and Stokes 1994, Trexler and Schmidt 1997) suggested discounting techniques to calculate a "net present value" of the carbon flows of the project, but the subjective choice of a discount rate would affect the comparison of projects with carbon benefits at different times (Price and Willis 1993). Another method proposed is to calculate a project's "average storage capacity", by summing the storage on a yearly basis and dividing it by the number of years in a project's life time (Dixon et al. 1991, 1994). This approach takes into account the fluctuations in carbon storage during a project's life, and avoids the time preference issues of discounting. It does not, however, take into consideration the amount of time carbon is stored, giving, for instance, similar values for a plantation that is kept for one rotation or many. A method that takes into account both the dynamics and the time dimension of carbon storage is that of carbon leasing, which uses tonnes of carbon/year as a mensuration unit, as opposed to tonnes of carbon (Moura-Costa 1996b).

Calculation of the costs of carbon sequestration, consequently, has reflected the inconsistencies of using a range of carbon offset quantification methods. Usually, the amount of capital spent in a project is divided by the amount of carbon offset, which is done in a variety of manners. In this paper, we divided the amount spent in a project by the amount of carbon offset provided in the existing literature about this project, but these sources often do not mention the method used for calculation of offsets. These figures, consequently, are bound to contain inaccuracies due to the variety of methods which may have been used. Our analysis attempted to include all existing forestry-based carbon offsets, but, since this is a fast changing field, some projects may have been inadvertently excluded.

3) Early days: voluntary projects

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[2] also referred to as carbon emissions mitigation projects, carbon sequestration projects, etc.

[3] also referred to as carbon fixation, sink creation, sink enhancement, etc.

The earliest forestry-based carbon offset project bear little resemblance to the market transaction systems that are evolving in several quarters today. The first company to express interest in compensating for its GHG emissions through the planting of trees was the American electricity company AES (Applied Energy Services). In the late 1980's AES contracted the World Resources Institute (WRI), an environmental policy think tank and lobbying group, to look for alternative project possibilities to offset CO_2 emissions. While energy options were not excluded from the proposal call, there was substantially greater emphasis placed on forestry options, due to the perception that forestry could be a substantially more cost-effective mechanism. After receiving nearly 100 proposals, WRI developed a framework for evaluation of forestry projects, based on a Land Use and Carbon Sequestration (LUCS) model (Faeth et al. 1994).

At the outset, AES intended to "link" particular offset investments with particular plants, beginning with a coal-fired power plant in Connecticut. For its first investment, AES put US$ 2 million into an existing social agroforestry scheme in Guatemala, managed by CARE (Cooperative for Assistance and Relief Everywhere), an international poverty-relief NGO. The estimated total cost of the project ranges from 6.6 million to $14 million, depending on the value placed on CARE volunteer labour. The original objective of the project was to plant 51 million trees over a 10-year period on a 186,000 ha area (Trexler et al. 1989), with a projected additional carbon storage of 16 million tonnes of carbon. Re-evaluation of the project, in 1994, showed that many initial assumptions were rather optimistic and that under a similar static analysis, at best 10 million tonnes of carbon could be sequestered (Faeth et al. 1994).

Applied Energy Services invested another US$ 5 million on two other projects in South America. To offset a 180 MW coal-fired facility on Oahu, Hawaii, AES partially funded the establishment a Nature Conservancy reserve in Paraguay. The primary source of carbon offset is conservation of standing carbon in a 58,000-ha dense tropical forest tract. The total calculated cost of carbon based on the US$5 million cost (of which AES put in US$2 million) yields a calculated cost of avoided carbon release of US$0.33/ton C. The carbon offset price, reflecting AES's agreement to fund $2 million of the project in return for all the carbon credits, is $0.13/ton C.

Lastly, the Oxfam America-AES Amazon Program (which was tied to a power plant in Oklahoma) represented a 10-year, US$3 million project to protect threatened rainforests by helping indigenous Amazonians gain legal title to and manage the resources of 1.5 million ha of their traditional territories. By funding indigenous land-title and resource-management projects in Ecuador, Peru, and Bolivia, the program claims that it will help save 500,000 hectares of pristine rainforest from imminent destruction. The estimated costs for carbon emissions reduction were around US$0.20/ton C.

None of the AES projects underwent any type of government or third party scrutiny after the initial evaluations by the AES/WRI teams. Furthermore, none have been put forth into the emissions reduction registry mechanisms that have emerged since these projects were undertaken. AES claims that it never intended to "use" these offsets officially and that it was simply being a good global corporate citizen. In many ways, this reticence to be peer examined was unfortunate, because it set an example that there was greater value in public relations than scientific certitude. It is notable how many environmental groups continue to be suspicious of forestry-based offsets, as a non-credible window dressing exercise that allows companies to continue GHG pollution without penalty. Much of this scepticism was generated by those early projects. Given the far greater diligence in creating "reasonable" baseline and emission reduction evaluations that future projects have taken, all cost estimates of AES's early efforts should be re-evaluated against current knowledge and practices.

Following on AES, 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 (Dijk et al. 1994). The mandate of the Face Foundation was to promote the planting of enough forests to absorb an amount of CO_2 equivalent to the emissions of a medium-sized coal-fired power plant (400 MW) during its 40-year life time (Face 1994, Verweij 1997). 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 multi-year budget of US$ 180 million was allocated to Face, for the establishment of a portfolio of forestry projects in different parts of the world. The initial investment proved to be a tropical rainforest rehabilitation programme in Sabah, Malaysia (see Box 1:

These initiatives illustrate the first transactions for CO_2 emission mitigation. They were voluntary in nature, since there were no legislation requirements for polluters to reduce GHG emissions. Projects were established in anticipation of changes in environmental legislation, while capitalising on the public relations value of projects. That said, the industry as a whole continued to oppose any type of emission reduction legislation. 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 assumed price paid for carbon sequestration, which averaged US$ 0.19/ton C (Table 2), based upon the costs to the investor.

4) From Rio to Berlin (1992 –1995): first generation JI projects

In July 1992, representatives from 155 nations gathered in Rio de Janeiro for the United Nations Conference on Environment and Development (UNCED). At Rio, the United Nations Framework Convention on Climate Change (FCCC) was signed. This included a voluntary commitment by Annex 1 countries (industrialised countries) to reduce their emissions to the levels of 1990 by the year 2000 (Grubb et al. 1993). Embedded in FCCC was the concept of Joint Implementation (JI). At the initiative of Norway, the Convention approved – in principle -- activities between countries to collectively reduce GHG emissions or promote the absorption of atmospheric CO_2. The investing participants in these projects could presumably claim emission reduction “credits” for the activities financed. These credits could then be used to lower GHG-related liabilities (e.g. carbon taxes, emission caps, etc.) in their home countries. The overall rationale of JI is that the marginal costs of emission reduction or CO_2 sequestration can vary dramatically, and that such costs are generally lower in developing nations than industrialised countries.

Although such crediting arrangements were not officially endorsed by the FCCC, this promise of potential transfers through JI led to a small flurry of activities in the forestry sector. One of the first companies to move forward was the American utility company New England Power (NEP). Like AES/WRI, NEP put out a wide-ranging call for proposals. The eventual winner was a Reduced Impact Logging (RIL) project in Sabah, Malaysia (Putz and Pinard 1994; Moura-Costa and Tay 1996; see Box 2). The Face Foundation, who had already initiated their activities before UNCED, continued expanding its operations by committing funds to four more projects around the world (Verweij 1997). These involved: 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 rainforest rehabilitation in Uganda (1994). Other emerging forestry projects includedthe CARFIX project in Costa Rica (a precursor of the PFP project, see Box 3), established by Fundecor (a Costa Rican NGO, developed partially with USAID funding and supported by a group of Norwegian financiers), and the Rio Bravo Conservation and Management Area Carbon Sequestration Pilot Project, which combines land acquisition with a sustainable forestry programme to achieve carbon mitigation, financed by various US electric utilities, namely the Wisconsin Power Company), Cinergy, Detroit Edison, PacifiCorp and the Edison Electric Institute’s Utilitree Carbon Company (a single purpose investment vehicle 100% owned by a consortium of US and Canadian Electric companies, that invested several million dollars into a portfolio of five forestry projects, three of which were domestic to the US).

The model of these transactions consisted of investor companies paying for the full costs of the carbon saving activities, in return for the promise of carbon credits generated as a result of these activities. This differed in part from the AES model, in which AES had a minority participation in the financing of broad environment/development projects, in return for a “claim” on total emission reductions. As such, it is exceedingly difficult to accurately ascertain the actual cost structure of reduced emissions under the AES sponsored projects.

In the post-Rio model, investing companies determined the direct costs of the carbon beneficial components of the project implementation, and directly claimed the resultant emission savings. The amount paid for carbon, therefore, almost invariably corresponded to marginal costs, accounted for through an open book approach that was requested for the competitive bidding process of project selection. While this led to some interesting comparisons of predicted costs, the actual price discovery model remained oblique, resembling a “barter” system. Often, parties would choose to implement projects based on a variety of negotiation points public relations appeal in either the host or buying country. For suppliers, there were few incentives for participation, as the maximum profit was capped by what the buyer would term "allowable" costs (as under the New England Electric contract in Malaysia).

This still remained a long way from characterising CO_2 credits as a commodity, since buying parties were required to invest in the production process. Investment was far from passive – indeed, it required a buyers fairly full engagement to a project, from beginning to end. Consequently, there was virtually no liquidity associated with these investments or their resulting "carbon credits"; each was uniquely valuable to its own investor, and such values were virtually non-transferrable to other parties. Projects that were designed and formulated by consultants, academics and NGOs, who did all the ground work of identifying partners, infrastructure and training needs, and negotiation with host country authorities, as well as quantification and monitoring of carbon savings. Little indigenous capacity for undertaking these types of proposals emerged. Development costs, consequently, were comparatively high, though often supported by a variety of agencies like international aid groups, multilateral organisations, foundations and the like.

The difficulty from the buying side was that there continued to be a great deal of uncertainty regarding carbon sequestration credit transfer arrangements. Given that CO_2 emissions were not penalised (indeed, still are not penalised) companies wanted to be sure that their investments would be recognised under future regulatory regimes. While interim regulatory institutions were being established, they were not given the ability to accept or reject emissions credit aspects of projects, rather they could accept or reject them for inclusion in a national registry system. The first institution given a mandate to input such projects was the US Energy Information Administration, under Section 1605-b of the 1993 Energy Policy Act, and in late 1994 was followed by the United States Initiative on Joint Implementation (USIJI), a highly structured system of US government project evaluation for international projects.

During the post-Rio phase, an average of 3.3 new projects and US$ 50 million were committed yearly during the two years between UNCED and the First Conference of Parties (CoP 1) in 1995 (see Table 2). The average price (usually equating costs) paid for carbon sequestration is estimated to be around US$ 1.97/ton C, a 10-fold increase from the prices paid in the previous phase.

BOX 1 - INFAPRO
BOX 2 - New England Power RIL Project

5) AIJ Pilot Phase: more uncertainty (1995-1996)

Growing dissatisfaction among G77 countries led to more concrete opposition to the JI model (Stuart and Sekhran 1996, Stuart and Moura-Costa, in press). Perceived problems included a feeling that JI was little more than a mechanism for industrialised countries to avoid addressing the real issues of reducing emissions at source, maintaining the economic advantage over developing countries. It was also felt that developing countries were in danger of transferring all their inexpensive GHG reduction opportunities to industrialised countries during this initial policy phase in which developing countries had no commitments to GHG emission reductions (and therefore during which such reductions were worthless at home). This brought forth older arguments regarding "terms of trade" which effectively critiques the unfairness of transactions where a commodity is only valuable to purchasing parties. Some developing country observers consistently referred to JI as "eco-colonialism". Moreover, developing countries would find themselves at a strategic disadvantage -- if and when they were brought into the Climate Convention emissions limits process -- as their most advantageous emission reduction opportunities would have already been exported.

These fears were consistently exacerbated by the announced price of offset projects, in which the calculated volume of credits (to be nominally transferred) was based upon the marginal costs of the intervention, without any rents accruing to the supplier. Often, the total volume of credits was sought, even though the claiming party had supplied, at most, only marginal costs. This overt lack of profit potential provided no commercial incentive for developing countries to supply offsets and reinforced the notion that carbon offsets are "win-win" for industrial countries only. Considering the proposed and discussed carbon taxes suggested at the time, which ranged US$25/ton C and upward (Barrett 1991), the nominal prices being paid for emission reductions (less than

In the First Conference of Parties (CoP 1) in Berlin, March of 1995, developing country dissatisfaction was voiced as a formal refusal of JI with crediting against objectives set by the Convention. Instead, a compromise was found in the form of a pilot phase, during which projects were called Activities Implemented Jointly (AIJ). During the AIJ Pilot Phase, projects were conducted with the objective to establish protocols and experiences, but without allowing carbon crediting between developed and developing countries. This was meant to simulate the process of JI, giving substantive information to decision-makers in formulating the final system for emission transaction between countries and private entities.

However, the absence of credit transfer substantially dulled the appetite for participation among private sector parties in particular. The direct statement from Berlin -- that current JI projects were not eligible for future crediting -- meant that these were unrecoverable costs. Because of this lack of real incentives for the private sector (which most observers believe must eventually drive the trading system), the results of the AIJ pilot phase were generally considered poorly representative of the full potential of JI.

In this new environment, where companies were faced with even more uncertainty about the potential value of projects for their respective balance sheets, a great reduction in the level of investment in JI/AIJ-type projects was observed (Table 2). Only three new AIJ forestry projects were initiated during this phase, with an average yearly committed investment of US$ 6 million (down from US$ 50 million). The willingness to pay for carbon also reduced, down to an average of US$ 0.59 per ton C.

While few investments took place during this phase, the supply of “potential projects” continued to increase, as more parties perceived this to be a new source of capital for sustainable environment/development projects. In this context, calls for proposals were organised by various organisations including the World Business Council for Sustainable Development and the USIJI, which gathered dozens of project proposals to be considered for investment in the future. Potential investors included the Edison Electric Institute, and the E-7, a global association of mega-sized electric utilities. More JI/AIJ bodies were formed in many countries, including Canada, Netherlands, France, Germany, Switzerland, Norway, Australia and Japan. Several developing countries, including Costa Rica, Guatemala and Sri Lanka, developed domestic AIJ offices to regulate projects from the perspective of the host country.

Although few transactions occurred, there was a growing feeling that some form of JI with crediting would inevitably arise, if developed countries were to commit themselves firmly to real targets. This led to a great increase in the level of interest in the subject, which was manifested world-wide in many forms, capturing the imagination of many economists, policy analysts and scientists. Multiple journals and Internet sites devoted to nothing but joint implementation topics. Innumerable papers, monographs and books began being written on the subject during this period. A variety of consulting “experts” now worked with different clients, developing projects, products, positions, strategies and services. Various business enterprises got organised to look for investment opportunities and formulate lobby strategies.

Nonetheless, only three carbon offset forestry projects were established during this phase (extending from 1994 until the end of 1996). These were: the second phase of the Reduced Impact Logging Project of New England Power, now with other co-investors (see Box 2); the EcoLand forest protection project in Costa Rica (a similar concept to the PAP project, see Box 3), developed by a Costa Rican NGO and a US Consultancy, Trexler and Associates, with US$1 million co-finance from Tenaska Inc.; and the Noel Kempff Climate Change Action Project in Bolivia, a forest conservation and management project developed by The Nature Conservancy and Fundacion Amigos de la Naturaleza, a Bolivian NGO, with funding from American Electric Power (in a later stage, this project also attracted funding from PacifiCorp and British Petroleum).

6) The run up to Kyoto (1997)

In the year preceding the Third Conference of Parties of the Climate Convention (CoP 3), to take place in Kyoto, December of 1997, there was great anticipation that some changes were imminent. Discussions during CoP 2, in Geneva in 1996, determined that binding commitments were going to be a central point in CoP 3. The consequences of these commitments were unknown but could be manifested in the form of carbon taxes, quotas, In this phase of uncertainty, interesting moves have been observed in many sectors previously not involved in this field. Among electricity companies, there has been seen a preference for less carbon intensive energy sources, such as gas. Manne and Richels (1994) estimated that this business was already imputing a value of US$17 per ton of carbon. Several oil companies started to invest in a diversification of their energy matrix, pushing the flow of capital to the renewable energy industry. This can be illustrated by the rising of the solar energy sector and by specific investments such as British Petroleum's (BP) commitment to 1 billion dollars to the solar industry. Shell created its Shell Renewable International division, in the fifth core component of the organisation, with an initial investment budget of US$500 million for forestry, solar and biomass projects. Large car manufacturers, such as Toyota and Mercedes Benz, demonstrated numerous car models with lower GHG emissions, including fuel cell prototypes (Greenhouse Issues 1998). The International Automobile Association, the organisation responsible for Formula 1 competitions, decided to offset the GHG emissions of their events (Tipper 1997b, Greenhouse Issues 1997). The insurance and re-insurance sectors took climate change into consideration, and formed a group under the auspices of the UNEP.

It became obvious that third-party certification was instrumental in the validation and credibility of these new transactions. The first international certification agency to offer a service of independent verification of carbon offset projects was offered by the Swiss company Société Générale de Surveillance (Moura Costa et al. 1997), and other auditing firms are already considering offering similar services.

Four new forestry projects were initiated in 1997. These included two large national carbon offset programs in Costa Rica (see Box 3), the Protected Areas Project (PAP) and the Private Forestry Project (PFP), a 13,000 ha community forestry project in Mexico, financed by the International Automobile Association (Tipper 1997a); and a community forestry project for fuel-wood production in Burkina Faso, financed by the Government of Norway through the World Bank. While the level of investment remained low (US$ 4.5 million per year), the price paid for carbon raised to an average of US$ 12 per ton C.

7) The Kyoto protocol and after

In December 1997, 170 countries signed the Kyoto Protocol during the CoP 3 of the FCCC. The most important aspect of the Kyoto Protocol is the adoption of binding commitments by 37 developed countries and economies in transition (collectively called the Annex 1 countries) to reduce their GHG emissions in an average of 5.2% below the year 1990 until the years 2008-2012 (Kyoto Protocol, 1997; web site http://www.unced.de). At the same time, the Protocol approves the use of 3 "flexibility mechanisms" for facilitating the achievement of these GHG emission reduction targets. These are:

1) QUELRO (Quantified Emission Limitation and Reduction Obligations) trading, allowing the international transfer of national allotments of emission rights;
2) joint implementation, the creation of emissions reduction credits undertaken through transnational investment between industrial countries and/or companies of the Annex 1 (note that according to the new terminology, JI includes participation only of Annex 1 countries, which are OECD and the former Soviet block); and,
3) The Clean Development Mechanism (CDM), a new mechanism resembling JI, which allows for the creation of Certified Emission Reduction (CER) credits in developing countries, regulated by a newly formed central authority.

Another important output of the agreement is the recognition of forestry activities as valid options for reducing net concentration of atmospheric GHGs. While the language of the Protocol is somewhat contradictory regarding what types of activities are allowed and by what parties, it is finally clear that forestry sinks will be part of the equation. For a review of these issues, see Schlamandinger and Marland (1998).

The Kyoto Protocol appears to be a real truly international step in the GHG emissions mitigation arena. Overall, what emerged was what business oriented climate activists have always hoped for; a compromise between substantial emissions reduction targets and a fluid market mechanism under which to achieve those emissions reduction requirements. The protocol opened for signature on March 16, 1998 and will close one year later on those 55 countries account for at least 55 per cent of the emissions of the developed countries in 1990. As of July 1998, 48 countries have signed it.

The establishment of binding commitments has led to a more substantial demand for offsets. Sandor (1997) estimated that, for the US alone, the costs of reduction of GHG emissions to the levels 10% below 1990 is in the range of US$ 32 billion a year. If these targets were partially accomplished through GHG emissions trading, this would generate an American demand for GHG Emission Reduction Units in the order of US$ 6 billion a year, a huge increase from the voluntary demand of the pre-Kyoto phase. Another change in demand specification regards the quality of offsets. According to the Kyoto Protocol, all ERU generated outside capped Annex 1 countries will have to be independently certified, creating a potentially high demand for this type of service.

Associated with the endorsement of emissions trading concept, there has been an immediate response in the, still incipient, carbon market. In less than 8 months after the Kyoto Protocol, a variety of initiatives were announced. These include: the creation by BP of a voluntary cap on its internal emissions associated with an internal trading system; the investment by BP in forestry-offset projects in Bolivia; the development of a forestry conservation project in Brazil, by AES; the creation of a consumer-based scheme to offset the emissions of petrol usage through forestry activities, promoted by Tesco petrol stations in UK (Greenhouse Issues 1997); and Green Fleet, a similar consumer-based initiative to offset car emissions through forestry activities in Australia.

The supply of offsets has begun to get more organised, and offer more sophisticated financial instruments. This is the case of the Costa Rican national programme, the first to produce carbon denominated securities (CTOs – Certified Tradable Offsets; Box 3). This system has been used by New South Wales State Forests, a state organisation which sold the carbon sequestration services of some of its plantations in the form of CTOs to Australian power companies in late June 1998. At the same time, the World Bank announced its intention to launch the first carbon offset investment fund (JIQ 1997), which will have initial capitalisation of US$ 150 million.

At the same time that supply and demand is becoming more organised, it becomes apparent that market mechanisms and supporting infrastructure also have to develop to support the expected level of transactions. A number of initiatives aim at supporting this market, such as the GHG tradable permit trading mechanism co-ordinated by the UNCTAD (UNCTAD 1992, 1994, 1995); and the GHG emissions trading programme proposed by the International Petroleum Exchange (IPE 1998).

These new conditions greatly increased the attractiveness (and reduced the risks) of investment in forestry-based carbon offset projects, resulting in an immediate rise in the level of investment, and in the price paid for carbon credits, which reached up to US$ 20-25/ton, in the case of the World Bank carbon fund.

8) Ways forward for the forestry sector

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.

For this to occur, however, more mature markets have to develop. We are still a long way from a price denominated CO_2 credit market determined by equilibrium of supply and demand. Significant transactions will never occur if the model remains that of emitters putting forth calls for proposals, which are answered haphazardly by a combination of environmental, social development and business interests. The direct linkage between supply and demand must be broken and the commodity must become more homogenous. It can no longer be the case that production of this novel commodity only occurs when a downstream client makes a direct investment in the "factory" creating the good.

For forestry professionals, the next steps in this process require that they begin formally recognising the potential of emission reductions in their planning process. They can then develop verifiable volumes of develop a new production possibility boundary, based on relative values of the main output (forest products) together with the associated carbon sequestration potential (for a discussion, see Boscolo and Buongiorno 1997). Once a more detailed understanding of the production process comes on line, more sophisticated emissions reduction services will emerge and there will likely be a bloom of structured financial instruments based on this value. For this to occur, however, policies must emerge – sooner, rather than later -- that better define the acceptable quality range of the commodity. That said, however, the forestry community would be immediately well served to more actively participate in the current debate, so that the most rational policies from a sustainable forestry perspective do ultimately emerge.

In large part, this futuristic model reflects an expansion of the current mechanisms within the Costa Rican national programme, which provided the first true break between supply and demand, reduced transaction costs and the development of standardised instrumentation regarding carbon flows. However, smaller and private organisations are less likely to be able to dedicate similar internal resources to invent similar products. We expect that a new class of forestry investors may arise, speculating in the environmental performance of new varieties of forestry projects, according to anticipated markets for verifiable GHG commodities. This may well be the next market evolution, where emitter-based or internal financing gives way to venture capital financing, based on perceived future market evolution. Forestry professionals need to prepare to meet this new world, armed with information and with a recognition that they may control a valuable commodity in a greenhouse-gas enhanced world.

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Box 1: 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 CO_2 from the atmosphere to partially offset the emissions of their power stations (Dijk et al. 1994, Verweij 1997). 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 (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 fix at least 4.25 million tonnes of carbon (15.6 million tonnes CO_2) during its life-time (Stibbe et al. 1994) at an average cost of US$ 3.52 per ton of carbon (US$ 0.95 per t CO_2).

Its been estimated that the project will also produce over 4 million m^3 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 spill-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 2 - The ICSB-NEP Reduced Impact Logging (RIL) Project is a cooperative venture between Innoprise Corporation Sdn. Bhd. (ICSB), a semi-government organisation which has the largest forest concession in the state of Sabah, Malaysia, and the New England Power (NEP) Company, an American utility trying to address the challenge of reducing its net CO_2 emissions. The objective of the project is to introduce the use of reduced impact logging (RIL) techniques in order to lower the level of damage caused by selective harvesting operations, reducing the release of CO_2 from decomposing vegetation and soil loss.

In an initial phase, 1,400 ha of forests were logged using reduced impact logging techniques, from 1992 to 1994. The project managed to reduce logging damage by 50%, thus saving approximately 40 tonnes of carbon per ha and a total of 58,000 tonnes of carbon (212,860 t CO_2, Pinard and Putz 1995). Given the project cost of US$ 450,000, the cost of carbon saved was US$ 7.60 per tonne C (US$ 2.00 per ton CO_2) at 2 years after logging (Moura-Costa and Tay 1996). Higher savings are expected in the longer term. All the incremental costs of training and implementation of the project were paid by NEP, who has full rights to the carbon savings. ICSB benefits from improved management of its forests, and a better residual stand after logging.

The first phase of the ICSB-NEP RIL project has created a positive momentum in the direction of achieving sustainable logging practices. The contract has been renewed and a second phase was initiated early 1996, which will consist of 9000 ha of RIL during a 3-year period. In 1996, NEP placed the project into the Edison Electric Institute Utilitree consortium, which will pay for 1000 hectares of RIL.

The Innoprise RIL CO_2 offset offerings are based on an explicitly commercial contract for services between two huge private sector entities. While there has been some modest assistance from third parties in developing the quantification methodologies, this project is comparatively unleveraged, i.e, the cost of the contract truly reflects the cost of the emissions savings. The project was initiated well before the development of the USIJI and other JI programs, and its contractual nature, involving arbitration, defined credit assignment, credit re-sale clauses, insurance and the like all point to a more business-like carbon offset arrangement. The project is also highly scaleable, given that Innoprise harvests between 10,000 and 20,000 hectares of its own concession holdings each year, and could easily transfer the techniques to other concessions which it is managing (though the costs and carbon estimates would clearly change). This is substantially different to project level investments, which tend to have much more defined parameters and are not necessarily able to expand quickly in case of market demand for the CO_2 offset service.

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

Costa Rica is launching three national level innovative carbon sequestration programmes, two in forestry and a third in renewable energy. Commercialisation of CO_2 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 – Executive Decree N. 25066 Minae, 1996). These CTOs are credits of carbon fixation based on the amount of CO_2 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 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 CO_2 fixation, water quality, biodiversity, and landscape beauty [Forestry Law N. 7575, April 1996; La Gaceta (1996)]. 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 of to the environmental services of the government, who bundles them for potential sale. The resources for initiating the PFP programme were raised by a domestics 15 % tax on fossil fuels, which is expected to raise US$ 21 million per year (Franz Tattenbach, pers. comm). It is hoped that future payments to farmers will be based upon successful sales of resultant CTOs. Due to the promising international market for carbon fisaxtion, this is the area that the government has focused its external marketing efforts.

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 U$ 56/ha/yearfor 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 (Fondo Nacional de Financiamento Forestal – Forestry Financing Fund), an office created by the MINAE (Ministerio del Ambiente y Energia - 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 CO_2) through the implementation of the PAP. These savings will be independently verified by the international certification company SGS Forestry, 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 will be done with the assistance of the Centre of Financial Products, possibly through Chicago Board of Trade transactions. 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.

All of these Costa Rican programmes provide good examples of how could JI 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 conform 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 itself, who is also responsible for determining the sale price of CTOs. In this way Costa Rica maintains full control of the production costs and profits associated with the commercialisation of CTOs, which will be redirected into priority areas within the country.

Table 1: Forestry JI projects initiated to date.

Project name	Date proposed/ Initiated	Carbon offset (1000 t C)	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-Kroknose	1992	3,080	16,000	Czeck R.	Netherlands	Park rehabilitation
Face Netherlands	1992	885	5,000	Netherlands	Netherlands	Urban forestry
ICSB-NEP 1	1992	56	1,400	Malaysia	USA	Reduced Impact Logging
AES – Oxfam – Coica	1992	15,000	1,500,000	South America	USA	Forest protection
AES – Nature Conservancy	1992	15,380	58,000	Paraguay	USA	Forest protection
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
Rio Bravo	1994	1,300	87,000	Belize	USA	Forest protection and management
Carfix	1994	2,000	91,000	Costa Rica	USA	Forest protection, and management
Ecoland/Tenaska	1995	350	2,500	Costa Rica	USA	Forest conservation
ICSB-NEP 2	1996	39	980	Malaysia	USA	Reduced Impact Logging
Noel Kempff M.	1996	14,000	1,000,000	Bolivia	UK/USA	Forest conservation and management
Klinki forestry	1997	1,600	87,000	Costa Rica	USA	Reforestation with klinki
Burkina Faso	1997	67	300,000	Burkina Faso	Denmark	Fire wood community forestry
Scolel Te	1997	15	13,000	Mexico	UK/France	Community forestry
PAP OCIC	1997	18,000	570,000	Costa Rica	Norway, USA	Forest conservation
Norway-Costa Rica	1997	230	4,000	Costa Rica	Norway	Forest rehabilitation and conservation
Tesco "green petrol"	1998	n.a.	n.a.	Undefined	UK	Forestry
Green fleet initiative	1997	n.a.	n.a.	Australia	Australia	Reforestation
AES - Ilha Bananal	1998	n.a.	n.a.	Brazil	USA	Forest rehabilitation
NSW + Pacific Power + Delta Electricity	1998	69	1,041	Australia	Australia	Reforestation
World Bank Prototype Carbon Fund	1998	n.a.	n.a.	International	International	Renewable energy and forestry
Totals/average	-	103,310	3,970,171	-	-	-

n.a. = not available

Table 2: Yearly average number of new JI projects, yearly area committed to new JI projects (ha), average investment committed yearly (US$ millions, based on value of contracts signed) and price paid for carbon sequestration (US$/ton C) during 5 phases since 1989. Figures for the Post-Kyoto phase were based on non-official data, and were adjusted to give a proportional idea of a one-year contribution. Some figures were based on press announcements and bound to contain inaccuracies.

	Pre-Unced	Pre-CoP 1	AIJ PP	Pre-Kyoto	Post-Kyoto
Number new projects per year	0.5	3.3	1.5	4	14
Area of new projects (ha/year)	93,000	628,467	501,740	893,000	2,002,082
Investment committed (US$ millions/year)	1.00	49.25	6.05	4.48	347.00
Carbon price (US$/ton C)	0.19	1.97	0,59	11.07	> 12.00

Pre-UNCED = before 1992; Pre-CoP 1 = phase between UNCED and the 1st Conference of Parties to the FCCC, 1992 to 1995; AIJ PP = Activities Implemented Jointly Pilot Phase, from 1995 to 1996; Pre-Kyoto = 1997; Post-Kyoto = January to June 1998.