CLIMATE CHANGE, CARBON AND FORESTS: SOME GENERAL GUIDELINES FOR CREDIBLE CARBON OFFSET PROJECTS

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The EDINBURGH CENTRE *for* CARBON MANAGEMENT Ltd

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Introduction

Climate change is recognised as one of the greatest environmental threats facing the world today. It threatens to have a major, adverse impact on the natural world and human society. The Intergovernmental Panel on Climate Change, representing the vast majority of scientists internationally, predicts that if no action were taken to limit greenhouse gas emissions, temperatures would rise in the range of 2.0 – 5.0 °C by 2100. This would be a faster rate of warming than at any time since the end of the last ice age, 10,000 years ago[1].

Carbon dioxide (CO_2) is the most important greenhouse gas (GHG) in terms of climate change; the principal sources of anthropogenic CO_2 emissions are fossil fuel combustion and cement production. These currently total around 6.5 billion tonnes of carbon per year (GtC/yr), and are rising at about 0.1 GtC per yr.

Forests play an important and dynamic role in the global carbon cycle. About 60 GtC is exchanged between terrestrial ecosystems and the atmosphere each year, of which forests account for around 80%. During the 1980's emissions due to deforestation were estimated at 1.6 GtC per yr (±1.0)[2], the uptake due to the re-growth of forests in the Northern Hemisphere was estimated at 0.5 GtC per yr (±0.5) and several processes including forest re-growth in the tropics, CO_2 fertilisation of plant growth and N-deposition were thought to account for a further sink of 1.3 GtC per yr (±1.5) (IPCC, 1996).

Recent predictions from the UK's Hadley Centre and the Centre for Ecology and Hydrology indicate that the terrestrial carbon sink is currently increasing. However, complex feedbacks between climate and the terrestrial carbon cycle create a high degree of uncertainty for future predictions due to the effects of increased temperatures on photosynthesis and soil respiration. Many natural forests themselves are vulnerable to the effects of climate change, and according to the Hadley models, there is a danger that large areas of tropical forest in northern Amazonia will die back from around 2040, producing a large source of carbon emissions during the second half of the century.

Any significant reduction in the terrestrial sink would not only cause an immediate increase in the rate of carbon accumulation in the atmosphere but would also increase the atmospheric residency time of CO_2 and therefore the global warming potential of each unit of CO_2.

Carbon Management and Carbon Sequestration

Even if terrestrial carbon sinks are less vulnerable to climatic change than is suggested by the Hadley model, the management of terrestrial carbon stocks must

[1] More information about the causes and impacts of climate change can be obtained from the UK Government's Department for Environment, Food and Rural Affairs www.defra.gov.uk/environment/climatechange/index.htm and the Met. Office www.met-office.gov.uk/research/index.html

[2] 90% confidence intervals as stated in IPCC, 1995.

be a significant component of the international climate change strategy. Carbon management could include a wide variety of techniques to promote increased carbon storage on land - including forest conservation and restoration, afforestation, agroforestry and new agricultural practices.

Several studies have indicated that, by slowing deforestation and by increasing the rate of afforestation, the global potential for enhancing carbon storage in forests may be as much as 60-90 GtC over the next 50 years[3], compared with current emissions from fossil fuels of 6.5 GtC/yr.

It is possible to quantify the amount of carbon being absorbed and stored in a growing forest by measuring the mass of vegetation[4] and organic matter in the soil, using reliable inventory techniques. For example, mature broadleaved forests in the UK may contain 100-250 tC per ha. The long-term average amount of carbon in trees and products for productive conifer plantations, with rotation lengths of approximately 50 years is likely to be 70 to 90 tC per ha. Recent developments in sensor technology mean that it is now possible to measure the uptake of CO_2 by forests in real-time using an integrated gas analyser and sonic anemometer mounted above the forest canopy. Carbon uptake in excess of 4 tC per ha per year can be expected in fast growing stands of conifers[5].

It is also possible to predict future carbon sequestration using computer based models of forest growth. However, care must always be taken when interpreting the outputs of models since there is likely to be considerable variation between sites and forest types.

To estimate the overall effect of a forestry project or enterprise in terms of climate change mitigation, one must also take account of the fate of accumulated wood products and changes in soil carbon. The dry weight of wood consists of approximately 50% carbon, therefore the production of durable fibre / timber products will enhance the long-term carbon storage of the forestry activity. When wood products are used to replace fossil fuels as an energy source or energy intensive materials, such as concrete or steel, this leads to even greater emissions savings. However, forestry activities can also generate CO_2 emissions – for example, the ploughing and drainage of peaty soils leads to the oxidation of substantial quantities of organic matter.

Kyoto and Emissions Trading

The main international policy instrument dealing with the threat of global warming is the UN Framework Convention on Climate Change, signed by over 170 countries in Rio in 1992.

[3] 1 GtC = 1 billion ($1x10^9$) tonnes of carbon
[4] About 50% of the dry weight of timber is carbon.
[5] A useful review of carbon sequestration in UK forests is provided by Cannell and Milne (1995) Carbon pools and sequestration in forest ecosystems in Britain *Forestry* **68** (4) 361-378.

At the Kyoto conference in December 1997, industrialised countries as a whole, agreed to reduce their emissions of greenhouse gases to 95% of their 1990 levels by 2008-2010. European countries agreed to cut to 92% of the 1990 level by the same period and the UK committed itself to reduce to 87.5%. These reductions will be legally binding commitments[6] once the Kyoto Protocol is ratified, requiring most governments to implement significant policy measures to constrain the current growth in energy use and fossil fuel consumption. The UK government has set its own target of 1990 levels minus 20%[7].

As a way of reducing the cost of achieving the targets set in the Kyoto protocol, a series of flexible mechanisms were included in the agreement, enabling trade in 'verifiable greenhouse gas emissions reductions' between parties to the convention (UNFCCC, 1997). Those countries that adopted binding emissions limits, listed in Annex 1 of the treaty[8], are permitted to exchange emission reduction credits. Thus, a country exceeding its limit will be able to purchase credits from countries that have reduced their emissions below the required level. Forests planted since 1990 in Annex 1 countries are explicitly included within this part of the treaty. However, mechanisms for allocating emission reduction credits to forest owners have yet to be developed.

Another instrument, the Clean Development Mechanism (CDM), enables emissions from Annex 1 countries to be offset in Non-Annex 1 - developing countries (UNFCCC, 1997). In developing countries the emissions reductions accruing to specific projects are quantified relative to 'baseline scenarios', which are supposed to represent the probable emissions in the absence of intervention. In November 2002, the 7th session of the Conference of the Parties (CoP7) agreed the inclusion of afforestation and reforestation in the CDM. Deforestation, i.e. forest conversation projects, are excluded in the first commitment period.

The development of international trading systems for emissions mitigation has been of considerable interest to industries, wishing to limit their potential liabilities incurred as a result of 'command and control' or tax based policies for emission reductions. Several major corporations, including British Petroleum, Enron, and various US utilities argue that an open market in emissions reduction credit could reduce the cost of meeting specific environmental targets by up to 80%. The experiences of trading in SO_2 permits and agricultural / fishery quota systems are frequently cited as evidence. British Petroleum is currently setting up an internal CO_2 emission reduction market that will operate between its various divisions.

The role of forests within such trading systems could be important as a means of providing a virtual cap to the cost of emission reductions, at least in the medium term. Assessments of various pilot projects around the world indicate that large amounts of carbon may be sequestered by forestry at costs in the range of 10 to 30 USD/tC.

[6] The commitments become legally binding once the treaty has been ratified by at least 55 Parties to the Convention, including developed countries representing at least 55% of total 1990 emissions from this group
[7] UK Climate Change Programme, DEFRA
[8] These include the OECD members and Eastern European countries

Crediting emissions reductions associated with forestry presents certain difficulties because, unlike release of CO_2 from fossil fuel use, which is essentially a one-off process, carbon fluxes from vegetation are two-way and continual processes. At a follow-on meeting from the Kyoto conference the IPCC was commissioned to provide a **special report** on the role of forests and other biotic carbon sinks and the mechanisms that should be used to manage terrestrial carbon stocks.

Apart from international efforts to address climate change, a number of companies have become interested in the provision of **carbon neutral products and services**. The idea of voluntarily offsetting the emissions associated with the consumption or use of a particular product or services has now been applied by several companies in the UK, including Mazda Ltd, J.W. Thompson Ltd, and Wholearth Foods Ltd. It is worth noting that the cost implications for each product or service depend on the energy intensity relative to the value of the product - thus the cost of offsetting CO_2 emissions associated with the manufacture and distribution of a compact disk are around 0.1% of the retail price. The cost of offsetting emissions from petrol at UK prices may be 1.5% of the retail price.

Requirements for Credible Corporate Carbon Offset Initiatives

1) Assessment of Greenhouse Gas Emissions

Offset initiatives should be based on a reasonably accurate assessment of the company's greenhouse gas emissions. Some companies monitor and keep accurate internal records of their greenhouse gas emissions, others may require assistance with the assessment of their emissions. ECCM provides a comprehensive independent service for assessing emissions associated with a wide range of business related activities – from one-off events to construction projects and project life-cycle assessment. The table below shows how we divide emission-producing activities into groups for the purposes of environmental claims. For manufacturing industries, all groups may be relevant. For service industries, only the management groups may be relevant.

Category	Energy Inputs	Waste Outputs
Management	running of the organisation or event, *e.g. electricity and gas used for heating and lighting in offices and other accommodation, fuel used for business travel*; removal of waste, *e.g. fuel used by lorries*	unrecycled waste from office and business activities, *e.g. incineration or decomposition in landfill of paper, packaging, plastics, furniture, etc.*
Manufacture	manufacture of product on site, *e.g. electricity and fuel used by power tools, conveyor belts, ovens, furnaces, etc.*; removal of waste, *e.g. fuel used by lorries*	unrecycled raw material and product waste from the manufacturing process, *e.g. incineration or decomposition in landfill of product waste*
Distribution	transport of product from manufacturing site to market, *e.g. fuel used by lorries, ships, etc.;* electricity used in storage facilities; removal of waste, *e.g. fuel used by lorries*	unrecycled waste from distribution activities, *e.g. incineration or decomposition in landfill of tyres, lubricants, packaging, etc.*
Construction	renovation, construction, dismantling or demolition of buildings used by the organisation, landscaping of grounds, *e.g. fuel used by generators, diggers, cranes, trucks, etc.*;	unrecycled waste from building and renovation activities, waste from demolition of obsolete buildings, *e.g. incineration or decomposition in landfill of plastics, wood, etc.*

removal of waste, *e.g. fuel used by lorries*

2) Integration with Corporate Environmental Policies

Carbon offset activities should be designed to integrate with existing corporate environmental policies. If possible, targets for reducing greenhouse gas impacts should be incorporated within the businesses' environmental plan. Specific measures to control greenhouse gas emissions are likely to be included in the Government's proposed Integrated Pollution Prevention and Control Directive. The numbers of industries included in the directive is likely to increase, and there are also likely be further measures to encourage more widespread adoption of ISO 14000.

3) Responsible environmental claims

The promotion of offset initiatives should accurately reflect the scale and scope of the actions being undertaken. The Department of Environment, Transport and the Regions (DETR) provides useful advice regarding green claims (see box).

From the Department of the Environment, Transport and the Region's Green Claims Code

A green claim should be:

- Clear, accurate and capable of being supported by scientific evidence which can be independently verified.
- Relevant to the product or service and used only in an appropriate context or setting.
- Clear about what aspect of the product or service the claim refers to.
- Significant in terms of the overall impact of the product or service on the environment.
- Open about any significant doubt or division of scientific opinion over the issue on which the claim is based.
- Explicit about the meaning of the symbol used in the claim.
- Written in plain language.
- Legal, decent, honest and truthful.

Thus, in the context of carbon offsets, vague terms such as "Climate Friendly" are not appropriate.

Requirements for Credible Forestry Carbon Offsets

1) Selection of planting sites

Selection of new sites should be carefully considered before proceeding to planting. In terms of sequestration performance over a long (100 year) period there are likely to be 3 or 4 fold differences between different sites, due to variations in soil type and fertility. The selection process could involve (i) an initial scoping visit to potential sites to permit a rapid assessment of current vegetation / land use, soil quality, windthrow hazard and landscape characteristics; (ii) a more detailed survey of promising areas; (iii) analysis of other background information that may be available. A thorough but efficient selection mechanism, perhaps involving consideration of the evidence by a board of reviewers, should be considered.

2) Assessment of existing carbon stocks

An accurate estimate of the initial stock of carbon on the planting sites is required to provide a credible reference point. For land use types with little above ground vegetation, medium to low soil organic matter and not subject to regular flooding published figures may be used to provide an initial estimate of carbon stored in vegetation, soil, roots and litter. For sites with existing forest cover a statistically based carbon inventory will be required. ECCM is able to design and apply carbon inventory schemes based on survey and / or permanent sample plots, as may be appropriate for given circumstances.

3) Development of woodland management plans

Silvicultural prescriptions (species composition, density, thinning regimes) described in the management plan will determine the carbon sequestration potential of the proposed woodland. However, woodlands serve a wide range of functions in addition to carbon sequestration and the plan should consider other benefits, such as enhancement of biodiversity, conservation, social, amenity and landscape values. The management plan should therefore be developed in collaboration with a range of project stakeholders.

4) Prediction of sequestration

A variety of modelling techniques may be applied to predict the take-up of carbon by forests. Broadly speaking, models may be based on empirical estimates of tree growth (such as forestry yield tables) or on simulations of the underlying processes of plant growth. Simulation modelling has the potential to provide more detailed outputs and can allow project managers to explore the possible effects of alternative management scenarios. Models may also be used for educational purposes.

5) Monitoring of changes in carbon stocks

Predicted uptake of carbon must be verified by measuring the actual growth of vegetation and carbon stock in soils. Monitoring should include a periodic tree stock inventory (height, diameter, and survival). It may also be necessary to conduct a number of experiments on soil-carbon dynamics, since soils can either gain or lose carbon as a result of afforestation. For some sites it may be necessary to conduct 100% biomass measurements of selected trees (stem, branches, twigs, leaves, roots). This would involve harvesting and weighing of a small number of individual trees to obtain an accurate relationship between height, dbh and total biomass.

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About ECCM

ECCM is the leading source of independent advice in Europe on climate change mitigation through forestry.

The company was established by environmental professionals from the University of Edinburgh and Ecology International Services Ltd to bring together top-level expertise in CO_2 emissions, carbon sequestration, climate change, modelling and forest management. We provide a flexible service, designed to meet the individual needs of clients. Staff are able to advise in most aspects of carbon management, including:

Greenhouse gas emissions assessment:
- Identification and quantification of CO_2 and other greenhouse gas emissions for all organisations, in both public and private (manufacturing and service) sectors
- Development of 'carbon neutral' products and services through carbon offset projects

Policy advice:
- Assistance with the development of corporate strategies for emissions reduction
- Advice on national and international policy on climate change mitigation
- Design of regional and national systems for regulating carbon offsets from forestry and agriculture

Project design:
- Design and implementation of carbon offset projects
- Adaptation of existing forestry initiatives to provide carbon offsets
- Development of carbon offset investment portfolios
- Preparation of project management systems for audit and certification

Monitoring and evaluation:
- Design and application of project monitoring systems
- Evaluation of project baselines and project carbon storage
- Modelling of carbon sequestration potential
- Training in monitoring techniques

Ecological and economic research:
- Research into the exchange of CO_2 between plants, soil and the atmosphere, at all scales (individual plants, forest stands or regions)
- Investigation of the costs and benefits of carbon management

ECCM Directors include: members of the Intergovernmental Panel on Climate Change; advisors to the UK Government on Climate Change and Forests; a trustee of the Millennium Forest for Scotland and the Scottish Woodlands Advisory Panel.

Clients include: BP, Ford, Mazda, Avis, Tilhill Economic Forestry; the UK Department For International Development, Central Scotland Countryside Trust and Edinburgh City Council.