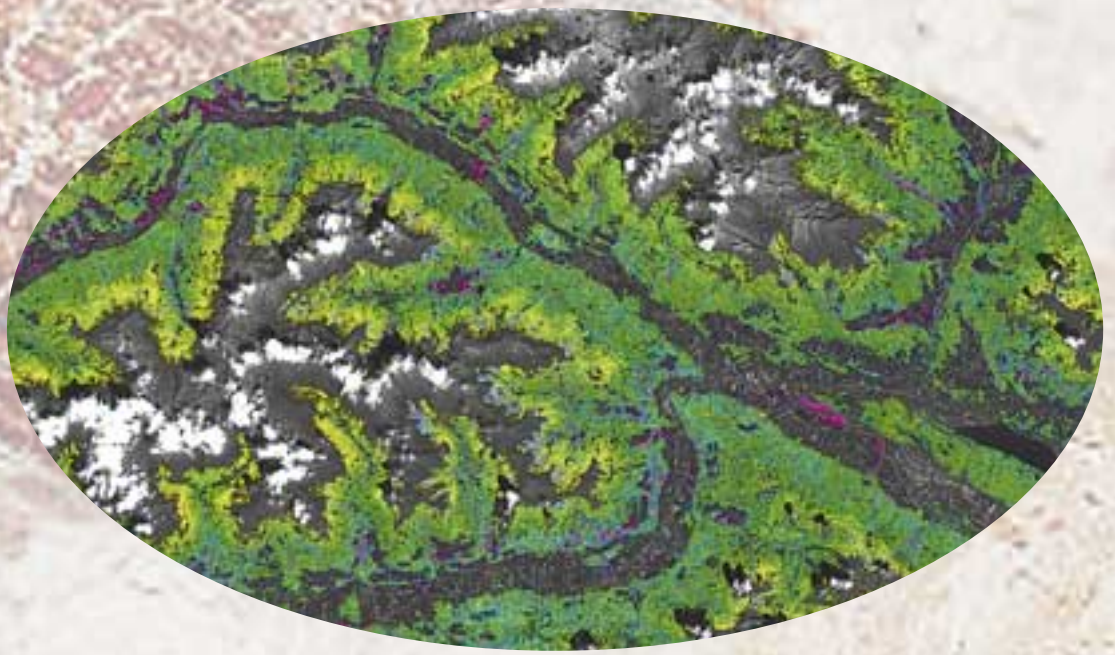
IEA Bioenergy

Task 25

Greenhouse Gas Balances of Bioenergy Systems



Summary of the workshop

Land-Use, Land-Use Change and Forestry: the Road to COP6

28 September 2000

Joensuu, Finland

K.A. Robertson, and B. Schlamadinger (eds.)

September 2000

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Task 25
Greenhouse Gas Balances of Bioenergy Systems

Summary of the joint Task 25 and COST E21 Workshop session

Land-Use, Land-Use Change and Forestry: the Road to COP6

28 September 2000
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October 2000

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Land-use, Land-use Change and Forestry: the Road to COP 6

Summary of workshop session on 28th September 2000

K.A. Robertson and B. Schlamadinger

This workshop session on Thursday 28 September was organised by IEA Bioenergy Task25 (www.joanneum.ac.at/iea-bioenergy-task25) in collaboration with COST E21 (Contribution of Forests and Forestry to Mitigate Greenhouse Effects, http://www.bib.fsagx.ac.be/coste21/), the European Forest Institute (www.efi.fi) and the University of Joensuu (www.joensuu.fi). Other meetings took place during the same week:

- Conference: Woody biomass as an energy source: challenges in Europe (25-27 September)
- COST E21 meeting (continued on 29 and 30 September).

Proceedings of both events are forthcoming and will be available at http://www.efi.fi/publications/

The purpose of the session summarised here was to provide a discussion forum for issues concerning the land use, land-use change and forestry (LULUCF) sector that are currently subject to negotiations under the United Framework Convention on Climate Change (UNFCCC). In December of 1997 the Kyoto Protocol was adopted which allows land use and forestry activities to be used in meeting emission reduction commitments. Particularly, afforestation, reforestation and deforestation, if they occurred since 1990 and are direct human induced, are included. The Kyoto Protocol also sets forth that additional human induced activities in the LULUCF sector may be agreed to in the future. However, many details, such as definitions, accounting rules, and decisions on eligibility of activities, have been left open and subject to further negotiations leading up to the Sixth Conference of the Parties to the UNFCCC (COP6) at The Hague, 13th to 24th November 2000, where important decisions are to be made so that the Kyoto Protocol can be ratified by Parties thereafter.

It was only three months after the conclusion of the Kyoto negotiations that IEA Bioenergy Task 25 organised a workshop on LULUCF issues in Rotorua, New Zealand (March, 1998). The proceedings of that workshop can be downloaded at www.joanneum.ac.at/iea-bioenergy-task25. Many of the issues negotiated now were raised for the first time at this workshop. This workshop session summarized below constitutes a continuation of the work by Task 25 researchers on the issues of LULUCF, bioenergy, and global climate change.

SESSION 1: OVERVIEW OF IPCC SPECIAL REPORT ON LAND USE, LAND-USE CHANGE AND FORESTRY

The Intergovernmental Panel on Climate Change (IPCC) had been requested by SBSTA (Subsidiary Body for Scientific and Technological Advice under the UNFCCC) to prepare a Special Report on Land Use, Land-Use Change and Forestry (LULUCF), to provide a basis for the negotiations now under way. The report was prepared under enormous time pressure and subject to intensive expert and government review. It was accepted by governments at a plenary session of the IPCC in Montreal in May of 2000. The Summary for Policymakers of the report can be downloaded at

www.ipcc.ch, and the full report is available from Cambridge University press (www.cup.org, search for keyword "land use").

Gert-Jan Nabuurs of ALTERRA Green World Research, Netherlands, gave an overview of Chapter 2 of the report: Implications of different definitions and generic issues. There are over 240 different definitions of a 'forest', some of these are very country specific and reflect national circumstances. They can be grouped into 3 categories , administrative, land-use and land cover definitions. Land cover definitions of forest do not always include all wooded land, for example if the cover threshold is low (20%) then countries with high cover forest will be able to deforest to the threshold level without this being accounted for. Conversely if the forest cover threshold is high, forested land in some countries will never reach this threshold, some types of savannah with tree cover for example. Therefore this 'forest' could be deforested without it being accounted for; there are also no incentives for increasing the area of this type of ecosystem.

There are many issues which are affected by definitions, such as consistency of methodologies, comparability, transparency, verifiability, accuracy, and cost effectiveness. Should LULUCF activities be accounted for based on activities or land units? Land based accounting would involve identifying the land, then accounting for all C stock changes on that land in the commitment period. Activity based accounting involves first identifying the activity and counting the carbon stock changes directly associated with that activity. Which activities should be accounted for under Kyoto Protocol Article 3.4? Other accounting issues include baselines, system boundaries and leakage.

There is no one ideal method for monitoring and verifying the stock changes on ARD land, but perhaps the best is a combination of forest inventory, soil sampling and remote sensing, while models could be used for verification. 'Kyoto' projects may have side impacts including sustainability, biodiversity, employment, water quality, soil erosion; and impacts on harvested wood products and the forest industry.

The overview of Chapter 3 on Afforestation, reforestation and deforestation (ARD) was given by Bernhard Schlamadinger of Joanneum Research, Austria. Chapter 3 focuses on Article 3.3 of the Kyoto protocol, ARD activities and how to account for them. Accounting methodologies also depend on the definitions of ARD and the implications of several definitional scenarios (combinations of definitions of ARD and "forest") are given in the chapter. ARD could be accounted for using land-based or activity-based accounting. Using the land-based accounting, the FAO definition of reforestation could lead to net debits in the first commitment period. With activity-based accounting, which excludes debits from harvest that precedes reforestation, overall net carbon credits would accrue for regrowing trees after harvest. Globally carbon debits from deforestation are likely to exceed credits from afforestation in the first commitment period (CP1), if a "land-use change" definition of reforestation is used (also referred to as "IPCC definition" because it is used in the IPCC Guidelines for National Greenhouse Gas Inventories). For example afforestation will be credited for the carbon stock change in the commitment period (5 years carbon increase) and only for those stands established since 1990, while deforestation will be debited for the carbon losses on ALL stands deforested. . Chapter 3 also deals with the possible "perverse incentive" to deforest stands after 1990, put them into an alternative land use for a few years and then reforest to gain carbon credits, and proposes some options to address this. Finally, the presentation suggested that carbon credits could be given for landscape average carbon stock rather than following the ups and downs of afforestation, thinning, harvesting, and regeneration.

The overview of Chapter 4: Additional human induced activities – Article 3.4 was presented by Gregg Marland of Oak Ridge National Laboratory, USA. The chapter contains many ideas, with

much focus on soil science and which activities could be included under this article. The 'how' to account for carbon stock changes due to additional human-induced activities is less discussed. There are two ways in which activities could be defined. If defined in a broad way, activities could be land management within a land-use category (forest management, cropland management, pasture land management)or land-use changes between these categories (afforestation, deforestation, etc.). This definition of activities would require minimum monitoring and verification costs, and potentially yield large amounts of carbon credits, perhaps even with no change in management practices. A narrow definition of activities to be included could result in a long list of practices to be considered. This approach would increase accounting requirements and the associated costs but could be used to closely limit the extent to which the LULUCF sector is included in the Kyoto Protocol.

It is important to note that the admittance of activities under Article 3.4 would affect the ability to meet already-set emission reduction targets, in most cases making the targets easier to achieve. The 'modalities, rules, and guidelines' for accounting for activities under Article 3.4 need to consider several issues including; whether only additional activities undertaken since 1990 should be accounted, whether credits should be limited to cases above 'business as usual', whether they should be accounted for as changes in carbon stocks, whether the banking of carbon credits is allowed, whether credits under Article 3.4 should be limited, and whether carbon credits should decrease as a function of uncertainty.

Although biofuels are not included under Article 3.4, it was thought important that something be said about them: Biofuels are included in the Kyoto Protocol as part of the renewable energy portfolio that can help reduce emissions from fossil fuels. Biofuels can, however, yield a double gain if they come from newly established plantations for which carbon stocks are accounted in the LULUCF provisions of the Kyoto Protocol. The chapter looks at the tradeoffs between biofuels production, carbon sequestration, direct and indirect materials substitution, and food production.

Chapter 5: "Project based activities" was presented by Omar Masera, University of Mexico, Mexico. There has been significant experience at the project level but few projects that deal specifically with greenhouse gas mitigation. To date experience has been gathered in 30 projects, covering 3.5 Mha. These projects include carbon sequestration, avoidance of degradation or deforestation, and multi component projects.

Some of the key concerns about GHG accounting at the project level include:

- the setting of baselines to ensure additionality. There is currently no agreed upon standard method for calculating baselines;
- leakage - this can be addressed by using buffer zones, claiming only some components of the carbon sequestration, for example, only claiming for above ground carbon not soil and litter carbon;
- measuring and monitoring;
- permanence (risks), these could be addressed by: debiting when carbon is released, replacement with a new project, claiming only partial credit at beginning of project, or the creation of buffer zones at the project outset;
- sustainability - extent and effectiveness of local people participation, technology transfer and adoption, capacity to develop and implement guidelines

Justin Ford-Robertson of Forest Research, New Zealand presented chapter 6: Implications of the Kyoto Protocol for the reporting guidelines. The aim of the guidelines is to provide a basis for estimating and reporting greenhouse gas emissions and removals, and to ensure comparability

between country data. They were not designed with the Kyoto Protocol in mind, however they could be adapted to provide a framework for reporting required by the Protocol. The guidelines are specified in the Kyoto Protocol for reporting national inventories. Some of the issues to be addressed include:

- the application of the 'since 1990' clause,
- lack of consistency between country data because of the flexibility of definitions
- a methodology for accounting for harvested wood products, currently it is assumed that the stock of wood products does not change. It was noted that the issue of how harvested wood products can be accounted for will be considered by the UNFCCC in 2001 (submissions on this issue are due by March 15).

The session was concluded with questions from the audience, which were mainly intended for clarification of the details in the IPCC Special Report.

SESSION 2: CARBON ACCOUNTING METHODOLOGIES

Kim Pingoud of VTT Energy, Finland presented an evaluation of the ton-year index as a basis for carbon accounting of forestation projects under the Climate Convention. Several carbon sequestration scenarios are explored including afforestation, afforestation followed by later deforestation, and afforestation with bioenergy use. The results show that: tonne-year crediting can give permanent carbon credits even if deforestation occurs and the C stock decreases; temporary sequestration can increase the atmospheric CO_2 concentration in the long term and be in contradiction with the ultimate objectives of the UNFCCC. The conclusion reached is that tonne-year indices may result in inappropriate allocation of resources to meet its objectives.

Annette Cowie of State Forests New South Wales, Australia presented a paper by Miko Kirschbaum et al. on an alternative accounting procedure for land-use change and forestry activities under the Kyoto Protocol. The proposed accounting system takes into account that management of terrestrial carbon stocks can only have a lasting impact by replacing low carbon-storage potential land-use types with types with higher carbon-storage potential, and that only anthropogenic factors should earn credits or debits. The accounting system divides the biosphere into land use types that each have a characteristic average carbon storage potential. Credits or debits are then allocated based on a change in land use type and human induced change in carbon storage potential within a land-use type. The potential for carbon storage is calculated based on an equilibrium carbon density (carbon storage potential of native forest) multiplied by a land-use factor. Most debits and credits are likely to accrue due to land-use change for which only the area undergoing land-use change would need to be monitored. The area undergoing a change then simply needs to be multiplied by the difference in carbon stocks (according to the difference in land-use factor). The proposed accounting method is simpler and has less data requirements than current methods. The full paper is available from www.ffp.csiro.au/publicat/pdfs/alternative_kyoto.pdf

Several issues were raised by the audience regarding the proposed system including:

- Land productivity varies across a region, and land use tends to be determined by productivity, so equilibrium carbon density should be different for each land use type, as a certain land use may not have the potential to reach the equilibrium carbon density based on native forest. Response: the region could be further subdivided to accommodate levels of land productivity.
- This method of accounting seems to require high advance data needs, for instance the equilibrium c stocks and the land use factor. This can be seen as an advantage because once the

equilibrium carbon stocks and the land use factor are known the system does not require continual monitoring of the carbon stock changes but only the area changes.

- How would the carbon stock changes be verified and the uncertainties assessed? Verification could be carried out using standard statistical or inventory methods. There are huge uncertainties in the current system, and this system should reduce them but uncertainty has not been assessed to date. It must also be acknowledged that whatever system is used, management of the biosphere will be difficult, and uncertainties will remain. The proposed scheme has the potential to carry fewer difficulties and uncertainties than other schemes, but even with this scheme, management of the biosphere will still be difficult.
- How does this method fit with the wording of the Kyoto Protocol? If a broad interpretation of the wording in the Kyoto Protocol is taken then this method can be used.
- How is permanence dealt with, for example if fire or insects reduce the carbon stock? If the disturbance is part of the normal forest cycle then this effect is included in the average carbon density. If the disturbance is not part of the normal system then the disturbance would result in a change in land use or equilibrium carbon stock.
- The monitoring system will also require periodic ground based verification and the use of remote sensing.
- It was suggested that the equilibrium carbon density may not be needed as there is no standard forest C stock.
- Is the carbon accounting methodology as described in Kirschbaum et al wishful thinking? It depends on how entrenched negotiators are in particular positions, some countries oppose sinks. This method can be used without over stating the role of sinks

Justin Ford-Robertson of Forest Research, New Zealand presented a comparison of real-time, tonne years and carbon density accounting approaches. “Real time carbon accounting” reflects reality and usually produces a saw tooth pattern associated with the growing and harvesting of a forest stand. This method would allow a credit/debit for every change in carbon stocks. Measurements are required annually, or every five years, therefore the measurement/transaction costs are high and could extend indefinitely into the distant future, eroding the benefits of carbon credits,

“Tonne-year accounting” has been developed to make it easier to trade carbon at the project level. Tonne-years combines the quantity of carbon sequestered in a project with the longevity of the project. This method is based on the removal of carbon from the atmosphere for a time equivalent to that which would allow those sinks to restore atmospheric concentrations to their former level. Calculations based on this premise suggest that between 42 and 150 tonne-years are equivalent to one tonne of emission reductions. There are several difficulties with the tonne year approach including the use of a reservoir to counteract a source, that it provides a disincentive for afforestation and that it is incompatible with the Kyoto Protocol.

The benefit to the atmosphere of afforestation/reforestation lies in the initial decision to convert from a low carbon density land use to a land use with higher long term average carbon density. With “carbon-density accounting” approaches, carbon credits could be a one-off payment made to a land owner who has increased the long-term average carbon density of a piece of land. No further transactions would be required unless the land owner makes land use/cover decisions which will change the long-term carbon density again. Debits will occur if the long term average carbon density decreases. The long-term benefit of trading in carbon sinks may be to stimulate planting and thereby permit the formation of a sustainable biomass resource.

One question concerned the treatment of LULUCF carbon stock increases that are only temporary: If deforestation occurs a debit is received. The issue of permanence is more relevant to the CDM.

An alternative system for accounting for LUCF projects in the CDM has been proposed by Columbia, which regards all LUCF projects as potentially non-permanent and a temporary credit is issued. After the end of the LULUCF project the credit has to be replaced with a credit from another project (either in the energy or LULUCF sector).

The carbon density accounting method is simple and evens out changes. Is there a danger of a country being more interested in increasing C density in forest rather than increasing harvest for increasing bioenergy? In New Zealand the forest industry is generally not in favour of C distorting. C credits may not change industry decisions, may extend rotation but not reduce harvest levels, therefore will not decrease harvesting and processing residues availability.

Robert Matthews (UK Forest Research) and Rebecca Heaton (Cardiff University, UK) investigated the effectiveness of different LULUCF carbon accounting methodologies in achieving the objectives of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol; and the impact of different accounting methodologies on a range of hypothetical countries with different characteristics of fossil fuel emissions and LULUCF sinks/sources. Final results will be available by COP6. First conclusions are that

- If LULUCF is to be included in the Kyoto Protocol, the accounting procedures can, indeed must, be kept as simple as possible, otherwise anomalous results and perverse incentives are very likely to arise.
- Many examples of accounting procedures give undue weight to carbon sequestration through LULUCF projects compared to projects aimed at direct emissions reduction involving use of bioenergy. Care must therefore be taken in formulating accounting rules and indices to safeguard the potential contribution to emissions reduction that can be made by bioenergy.
- Carbon sequestration in wood products appears not to be important at a global level, but can be of marginal importance for some countries.

The model used in this evaluation was CARBINE (originally developed by UK Forest Research in 1989) and it includes wood products, bioenergy and substitution effects and is similar to other carbon sequestration models.

It was asked by a participant that given an increasing world population and increasing housing stock, why is the carbon stock in wood products not increasing? The presenters responded that available information, although limited, indicates that wood products are not important globally but could be important for individual countries. Evidence from country-level analyses and global-level simulations suggests that the global carbon stock in wood products is increasing, but at an insignificant level compared to stock changes in forests and fossil fuel reserves.

During discussion it was commented that the presentations on analyses of accounting indices and rules did not seem to address potential impacts on societies and local communities, both within and outside the Kyoto process – how could such issues be addressed? The response from presenters was that, ultimately, the Kyoto process is a political one. Scientists could only provide evidence, estimates and analyses on which the political negotiations could be based, and evaluate whether accounting systems would support the ultimate objective of the UNFCCC.

One presenter also commented that the method of Kirschbaum *et al.* seemed to meet such aspirations in a number of important ways. Firstly, it provided a simple, transparent and scientifically derived framework that could be applied consistently by different nations. Secondly the method had the potential to avoid excessive monitoring costs, enabling wide involvement of

communities and countries with varying resources to commit to the Kyoto process. Thirdly arguments over the details of land classification and carbon densities at the national level were, rightly, left ultimately to the Parties to negotiate and agree, and this process could be viewed and understood by stakeholders both inside and outside the process. Finally the method met the requirement for monitoring to be verifiable, and this was a potential continuing role for scientists, acting as commentators and referees during the deliberations of the negotiators, as well as during implementation of the methodology. The scientists could 'verify' approaches to land classification, attribution of carbon density values and discounting assumptions. When scientists evaluated proposals and schemes, it was important not to be unduly concerned about whether the methodology was correct as a detailed geographical, physical and biological representation, but rather to evaluate whether it would support the ultimate objective of the UNFCCC if implemented.

SESSION 3: LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER ARTICLES 3.3 AND 3.4.

Timo Karjalainen of EFI presented a study on carbon sinks and sources in the European Union (Liski et al, 2000). The analysis is to demonstrate the relative impact of different definitions on carbon stock estimates for EU countries, and a uniform data set was gathered and the same methods applied to the entire region so there is some consistency in results. Results were presented for all forests and ARD (afforestation, reforestation and deforestation) lands under Article 3.3 using FAO and IPCC definitions of ARD. In the EU as a whole ARD lands account for 2-9% of total forest area. Applying either definitions of ARD, the carbon stock changes under Article 3.3 were negligible (-5.4 Tg/yr for FAO, and 0.1 Tg/yr for IPCC definitions) when compared with the carbon sink in all forests (63 Tg/yr). However for individual countries ARD lands can represent a considerable carbon sink or source. The majority of forest lands in the EU are not covered by Article 3.3 but may be accounted for under Article 3.4 at a later date.

A presentation on the 'Domestic Options for Carbon Management' was given by Doug Bradley of Domtar Inc, Canada. There are a range of forest management projects that could increase the long term carbon stocks including pest and disease control, fire control, juvenile spacing and tree improvement. Carbon stock increases for a juvenile spacing trial were presented as an example. The results showed that juvenile spacing or pre commercial thinning decreases carbon stocks in the short term but in the long term can enhance tree growth and increase the average carbon stocks on high productivity sites. The issue of possible 'early crediting' by governments was also discussed. Early crediting could provide: the incentive needed to implement more 'enhanced carbon sequestration' projects than would otherwise occur; provide a wider range of options for meeting Kyoto net emission reduction targets and allow least cost solutions. There are also risks with early crediting such as issuing credits when the carbon sequestration is overestimated or never occurs.

The presenter was asked whether people/companies will react if given some early credit? Bradley replied that 'yes', currently electricity utilities and energy companies are interested in obtaining carbon credits from such projects because they cost less than other greenhouse gas reduction measures. What is the motivation for establishing such a systems when the government owns the forest estate? Bradley explained that much of the forest land in Canada is owned by the government (93%) but forest product companies manage the forest and own the trees therefore it is contested that they own the carbon in the trees.

Susan Subak, a fellow of the American Association for the Advancement of Science, based at the US Environmental Protection Agency gave a presentation on agricultural soil carbon accumulation

and decisions to be made at COP6. In the US, carbon sequestration in agricultural soils is not as controversial as in forests because credits for soils would be of relatively small scale. In addition, many members of the U.S. Congress are supportive of the prospect of providing farmers with financial benefits related to carbon sequestration activities. The potential for agricultural soil C sequestration is estimated to be about 50 Mt/yr for the US, 43 Mt/yr for Europe and 340 Mt/yr for the Former Soviet Union. In the US, activities considered to have positive environmental and carbon impacts are no-till and cover crop systems. There are several issues on soil C to be addressed to enable accounting under the Kyoto Protocol, these include: additionality, verifiability, reversibility and indirect effects. The Kyoto Protocol requires a decision whether or not agricultural soils are included, taking into account uncertainties, transparency and verification. This may not be possible because sufficient evidence may not be available to meet these requirements.

It was pointed out in the discussion that some countries are close to achieving saturation levels of carbon in their soils. Should credits then be given to countries that have a significant potential for sequestration because they have mismanaged their soils in the past? Subak stated that some countries have so little sequestration potential that investing in a expensive monitoring program may not be justified. The developing world has large areas of degraded soils, so in the long-run it would be constructive to develop soil carbon sequestration incentive programs.

Annette Cowie of State Forests New South Wales, Australia, gave a presentation on measuring and marketing of carbon sequestered in planted forests. The issue of who owns the carbon has been addressed by the State government and separated from the ownership of trees. Several carbon trades have already been made by State Forest New South Wales, and a standard carbon credit product is being developed. Carbon measuring and modelling is linked to existing stem production management systems, expansion factors are then used to estimate other carbon pools. The carbon accounting system must be robust, cost-effective, transparent and stand up to international scrutiny. Once carbon is measured, independently verified and certified it will be available for trading at three levels (40, 60 and 80 % of estimated carbon stock changes), the number depending on the measurement uncertainty. Management of a carbon pool that includes a number of forests or stands was also discussed. The advent of carbon trading provides a challenge to integrate forest management for wood and carbon values.

Replying to questions from the audience, Cowie said that the potential for C sequestration projects to cause social conflict in the Australian situation is not seen as significant, it is thought that they will have social and environmental benefits. In Australia forests can provide multiple benefits, such as addressing soil salinity and biodiversity issues while C sequestration is seen as an additional benefit.

The driving force for a carbon trading market in Australia is the requirement for national utilities to reduce emissions, and internationally because some people/companies are anticipating ratification of the Kyoto Protocol and emission reduction requirements.

In the discussion one participant pointed out that under Article 3.7 of the Kyoto Protocol there is the possibility of double crediting of the same unit of land. E.g. land deforested in or before 1990 would first increase the 1990 base year emissions and thus the assigned amount, and then could receive credits if reforested since 1990. The issue of reforestation credits following deforestation is discussed in the Special Report on LULUCF. One possibility to address it is to only give credits under Article 3.3 for land that was not forest in 1990. However, the “double crediting” would still partly remain for stands deforested just before 1990, due to their continued release of carbon in 1990.

SESSION 4: CURRENT STATE OF NEGOTIATIONS

Heikki Granholm from the Finnish Ministry of Agriculture and Forestry presented an overview of the current status of negotiations on LULUCF. Several key decisions are to be taken at COP6 in the Hague (Nov 2000) such as the inclusion of sinks, the flexibility mechanisms (JI, CDM and ET), compliance and the role of developing countries in the Protocol There are high expectations that the Kyoto Protocol will be ratified by 2002 (Rio +10). Decisions made at COP6 will be confirmed by the first Meeting of the Parties (MOP1). While decisions at COP6 will be made at a political level, this would be facilitated by the agreement of technical solutions in the early stages of the negotiations.

The IPCC Special Report on LULUCF thoroughly explores Art 3.3, 3.4, and 3.7., helps policy makers for upcoming negotiations and has facilitated the policy process. Country specific data on Article 3.3 and 3.4 will also facilitate negotiations, because policy makers will be aware of the implication of these articles on country emission reduction targets.

Key decisions to be made at COP6 can not be postponed any longer if countries hope to meet their emission reduction targets. To ensure emission reduction targets for the first commitment period (overall, -5% of 1990 emissions) is met the Kyoto Protocol should be ratifiable, with some flexibility in how to meet emission reduction targets, retain its environmental effectiveness and provide a balanced treatment of all greenhouse gas sources and sinks. However there is still a need for intensive further research and methodological work in the next few years. Sinks were seen by some as the fourth flexibility mechanism agreed to in Kyoto, and therefore sinks should not have the opposite effect for countries that meet certain land-management related criteria. Finally, there should be a balanced treatment of all items

Andreas Fischlin (ETH Zurich) of the Swiss delegation provided his perspective on where the Kyoto Protocol is heading. Currently greenhouse gas (GHG) emissions are still increasing and are likely to grow further. The ultimate objective of the UNFCCC is the stabilisation of atmospheric GHG concentrations at safe levels. The Kyoto Protocol has to serve this objective. He gave an overview of three possible outcomes of the Kyoto Protocol including 1) the Protocol is abandoned at COP6 or COP7 because of the difficulties associated with sinks or other issues such as compliance, flexible mechanisms, or equity (Article 4.8, 4.9); 2) the protocol is ratified and becomes effective but because of the manner by which sinks are included net emission reduction targets are not met; and 3) the protocol is ratified, becomes effective and sinks conform to the ultimate objective of the UNFCCC. Major outstanding issues that still need to be addressed are the definitions of forest, the definition of ARD under Article 3.3, the eligibility of additional activities under Article 3.4, and the accounting framework, in particular with respect to factoring out certain effects like CO2-fertilization, N-deposition, and beneficial climatic change effects. The inclusion of sinks is expected to affect many countries emission reduction requirements significantly. Fischlin pointed out that already in the first commitment period sinks, under Article 3.3 and 3.4 with land-based full carbon accounting, could exceed Annex I countries' emission reduction targets of minus 5% with respect to 1990 levels and in fact could allow even more than a 5% increase in fossil fuel emissions relative to 1990. He expects that the Kyoto Protocol negotiations will not be abandoned, but not all countries might be happy with the end result, not the least due to the inclusion of sinks.

In the following discussion one participant asked about the inclusion of soil carbon under Article 3.3: Some Parties are pushing for the inclusion of soil carbon, while others oppose this. Fischlin suggested they should be included, but doubts that they should be accounted as frequently as every five years (length of a commitment period), since measuring C uptake in soils after such short time

might be difficult. He emphasised that the Kyoto Protocol would have only a minor impact on the climate system, but was nevertheless of utmost importance as the foundation of a process towards climate protection and it would be important not to delay the process.

Lorenzo Ciccarese from the Italian Environmental Protection Agency presented an overview of issues surrounding the inclusion of sinks in the Clean Development Mechanism (CDM). He noted the most important issues to be addressed are: the type of projects to be included, how the baselines will be set, leakage, additionality, and whether CDM projects also meet countries sustainable development objectives. In an overview of the benefits of inclusion of sinks in the CDM the following were highlighted: promotion of 'early action'; promotion of (re)afforestation programmes; and sinks projects could also have other benefits, such as increased biodiversity and rural development. However there are issues and risks involved in including sinks in the CDM, that need to be addressed, such as the methodological and technical problems; how 'leakage' is to be accounted for; ensuring additionality; and permanence. The CDM could also represent a risk to the environmental integrity of the Kyoto Protocol because of the high potential for sinks resulting in a lot of LULUCF projects instead of projects that enhance clean energy development. One way of addressing some concerns is to put a cap on the percentage of LULUCF in the total CDM volume that a country can use to offset emissions. Concerns about livelihood impacts should not prevent carbon forestry projects' inclusion in the CDM. In this regard, the use of Social Impact Assessment standards, already used in other contexts, could ensure that no activities are carried out that reduce local population rights to land access and discourage sustainable development. Finally, in order to avoid conditions of discrimination for small-scale projects, it is important to define guidelines for project design and standardised contracts and to introduce other elements that reduce transaction costs.

In the discussion it was pointed out that some countries have so far played an active role about sinks and the CDM (especially South-American countries); others have expressed their opposition to the inclusion on sinks in the CDM (Eastern European countries and China). Some African countries tend to think of forestry as part of adaptation measures and not of direct use of carbon forestry projects in the CDM

Assuming sinks are included to some extent in CDM, should all projects be admitted or the same as for Annex 1 projects? Ciccarese responded that it is counter productive to assume very open inclusion of sinks in the CDM, their inclusion will probably be conditional, eg a 'positive list', and it may be important to view CDM credits as part of group of benefits, including sustainability, rural development.

FINAL DISCUSSION

To frame the final discussion, the question was posed to the presenters and to the audience: "If you had a choice, what would be your wish-list, and in your opinion a positive outcome from COP6 in The Hague?

Responses by participants were:

The Protocol should still lead to a 5% reduction in GHG emissions between 1990 and the first commitment period, so that the atmosphere is not experiencing more emissions than originally intended by the Kyoto Protocol. A fear of "do-nothing-sinks" credits was expressed. Genetically modified species may pose another threat.

Inclusion of sinks but with strict boundaries and simple carbon accounting methodology, so that the role of sinks is not overstated. LULUCF rules should be applied consistently across countries, i.e., a generic system but nations decide how much and what to spend on monitoring sinks, if they think they are important. Sinks included in CDM, but hard to implement in a way that does not distort KP.

Could include sinks in 3.4 and CDM. However, only a fraction (e.g. 5%) of the carbon on the site should be tradable, to cope with uncertainty, and long term maintenance costs of terrestrial carbon stocks.

Delegations go into the process based on good science and concern for the well-being of ecosystems, the Kyoto Protocol is a door to pass through and not the final objective.

One participant would not like to see an outcome in Hague that takes another 3 years to explain what has been agreed to. A simplified and robust approach to accounting for sinks is preferred, because a detailed approach may rather cause damage to the process. The outcome should reflect what the atmosphere sees (i.e., consider more than only stock changes on 2% of the land), and be consistent with sustainable forest management objectives. The credibility of the Protocol will be improved if sustainable forest management, and stock increases lead to credits rather than debits. It is important to have decisions at the Hague on sinks, and to know what sinks mean for different countries.

Another participant argued for the inclusion of sinks, but that clear and strict guidelines for projects are needed. He saw carbon as the by-product to strengthen other social and environmental objectives. He sought a limit on the percent reduction that can be met by CDM, and limit on the percentage of sinks share in the CDM. Start simple and slowly. Should not just include new plantations or other specific land-uses, because this would give the wrong signal, and could provide incentive to deforest old growth and other forests.

One participant feared that people involved in the negotiating process may not all be aware of the subtleties between different definitions and processes in terrestrial ecosystems (e.g., GPP vs. NBP etc.). There is the danger of looking at too much detail, simple systems should prevail. For instance, using the pig example, he suggested that one should rather weigh the pig (measuring stocks) than to look at the flows in and out (fluxes). The pig eats a lot relative to the weight gain!. One should strive for an accounting system which reflects "what the atmosphere sees", and not get lost in nitty-gritty details and overlook the major effects of relevance to the climate. On the other hand, the factoring out of some aspects such as so-called natural effects,(CO2-fertilization, nitrogen deposition, beneficial climate change effects) is of outmost importance. If they are not separated from other effects, net emissions will actually not decrease relative to a business-as-usual scenario without the Kyoto Protocol. Of course, many questions remain, whether certain disturbances such as fires, insect outbreak, negative impacts of climate change etc. will all have to be factored out as well?

Again the need for a decision on the inclusion of sinks was stressed. The world community needed to move forward.

Finally, it was said that some certainty for future investments is needed. For example, countries setting up accounting systems need more information now in order to proceed.

Much attention has been given to carbon sequestration, and less to substitution options (bioenergy, materials substitution). The desire was articulated to recognise the complexity of the problem, and to yield a better balance between carbon sequestration and substitution options. In any case, measuring and monitoring must be possible.

Implications of different definitions and generic issues

Presented by Gert-Jan Nabuurs, ALTERRA Green World Research, the Netherlands

IPCC Special Report Land Use, Land Use Change and Forestry

Chapter 2:
Implications of different definitions and generic issues

1

Issues dealt with in Chapter 2

- Core definitional issues
- Accounting issues
- Methods for monitoring and verifying
- Sustainability issues

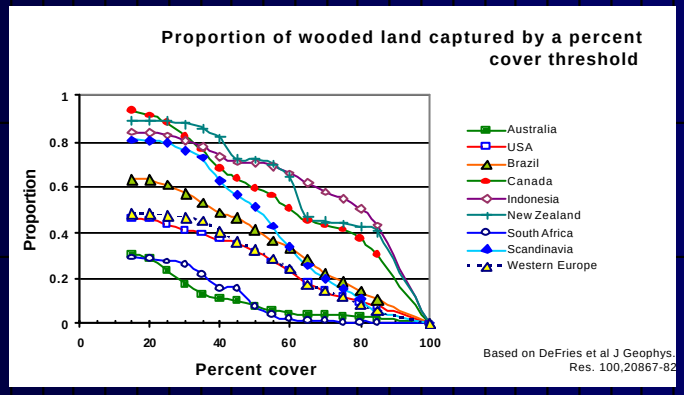
2

Definitional issues: Forests

- Definitions for forest: 240 definitions in use, often country specific reflecting specific national circumstances.
- Three broad categories: administrative, land use, land cover

3 .

Definitional issues, defining a forest by canopy cover



4 .

Definitional issues: delineation of current forest area

5

Definitional issues: Afforestation, Reforestation, Deforestation (ARD)

- Main issue in reforestation, if that is seen in the sense of regular forest management of harvesting and replanting, then afforestation can be regarded as establishment of forest usually agricultural land
- Deforestation always in the sense of long term or permanent removal of forest cover; issue is the canopy cover limit

6

Accounting Issues

Principles of UNFCCC reporting:

- accounting system should adhere to : transparency, consistency, comparability, completeness, accuracy, verifiability, and efficiency.

7 .

Accounting issues

- To what activities does the accounting apply ?
- Will it be based on activities or on land units?
- What carbon related to the activity will be counted?

8 .

Accounting: land versus activity

- Land based: First identify the land, then count all carbon stock changes on that land in the commitment period
- Activity based: First identify the activity, then only count the carbon stock changes directly associated with that activity

9

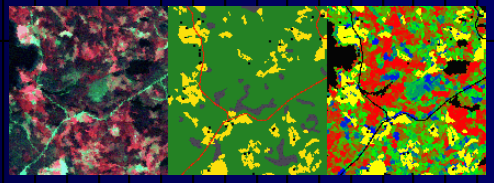
Accounting: other issues

- Direct human induced versus natural
- baselines & business as usual
- system boundaries (pools included)
- leakage
- timing and discounting

10

Monitoring methods

- Forest inventory
- Soil sampling and mapping
- Eddy flux
- Flask measurements
- Remote sensing
- Ecosystem modelling



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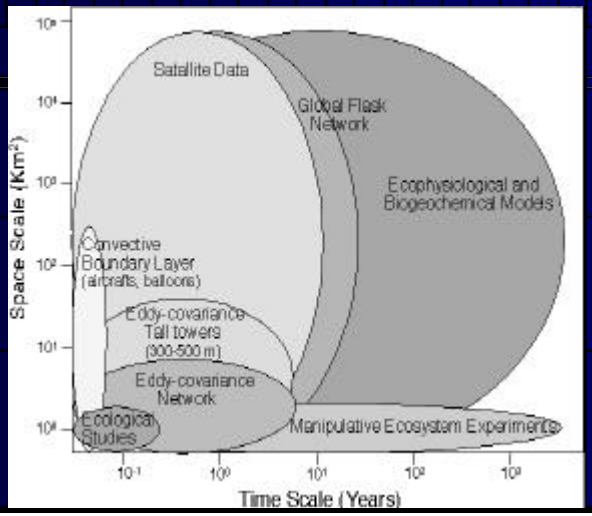
Methods: applicability



12 .

Methods

- No one ideal method
- Depending on project size and definition to be chosen: a combination of remote sensing (area change), forest inventory/soil sampling (C stock change) will be needed
- for verification: eddy flux, modelling

13

Sustainability issues

- Kyoto projects may have side impacts
- biodiversity
- employment
- water quality
- soil erosion
- wood products/forest industry

14

Afforestation, reforestation and deforestation

Presented by Bernhard Schlamadinger, Joanneum Research, Austria

IPCC Special report on LULUCF: Afforestation, reforestation and deforestation

Bernhard Schlamadinger

Joensuu, 28 September 2000

Stand: 09.10.00

Seite 1

1

Contents

- Article 3.3
- Definitions
- Accounting rules
- Stand, landscape and global level analysis
- What are the key problems?

Stand: 09.10.00

Seite 2

2

Article 3.3

Net changes in GHG emissions by sources and removals by sinks

- resulting from direct human-induced land-use change and forestry activities,
- limited to afforestation, reforestation and deforestation since 1990,
- measured as verifiable changes in carbon stocks in each commitment period,

shall be used to meet the commitments of each Annex I Party.

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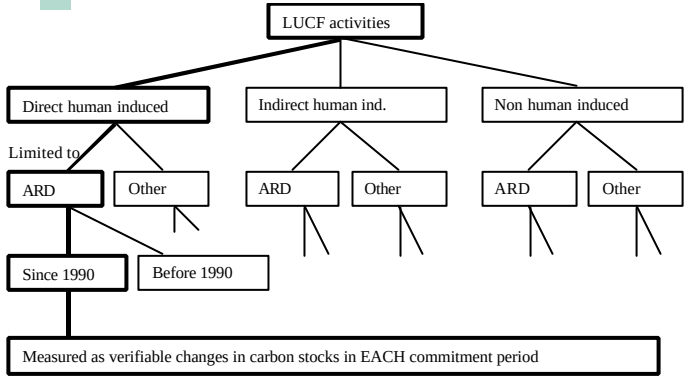
Seite 3

3 .

Afforestation, reforestation and defor



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Seite 4

4 .

Definition of „forest“

- Low threshold
- High threshold
- Biome-based threshold
- Flexible threshold

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5

Afforestation, reforestation and deforestation

IPCC
- Based on transitions between forest and nonforest land-uses

FAO
- Includes harvest/ regeneration cycle because regeneration is defined as reforestation

Aggradation / degradation
- Requires multiple or biome-specific thresholds

Accounting approaches
- Land-based:
  - Accounting is over full commitment period (land-based I) or starts no earlier than with the activity (land-based II)
- Activity-based:
  - As Land-based II, but only stock changes resulting from the activity are counted.

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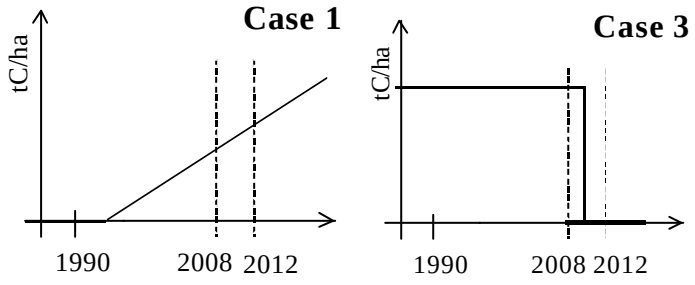
6

Stand level: simple afforestation and deforestation cases



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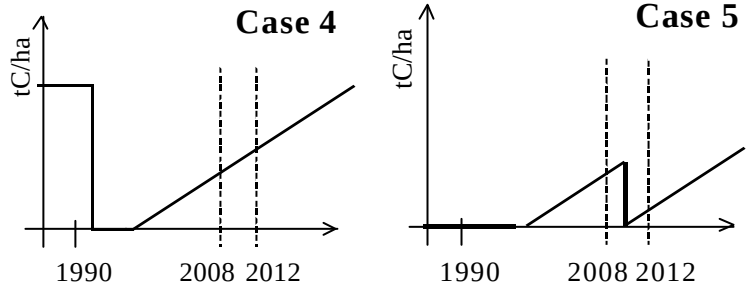
7 .

The report also discusses definitional and accounting options for the following cases:



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8 .

Forest estate managed on sustainable yield basis, FAO scenario

- Land-based approach I:
  - Could lead to net debit during first and subsequent CPs
- Land-based approach II:
  - Net credit for regrowing trees, partly offset by delayed emissions from soils and harvest residues
- Activity-based approach:
  - Net credit during first and subsequent CPs

➔ *In each case would the accounted stock change generally be different from the actual stock change in the forest estate during a commitment period.*

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9

IPCC Scenario

- Countries with net forest sink and a forest area increase often report carbon debits
- This is because all stands deforested are accounted, but only those stands reforested since 1990
- But deforestation is still a significant source of emissions in many countries.

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10

Global

Continuation of ARD at 1990 level

	Annex 1	
Mt C yr^{-1}	AR	D
IPCC definitions	26 (7 to 46)	-90
FAO - Land-based I	-516 (-759 to -243)	-90
FAO - Land-based II	37 (-190 to 295)	-90
FAO - Activity-based	315 (87 to 573)	-90

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11.

What are the problems

- Article 3.3 was not completely understood by all during Kyoto negotiations
- The Article 3.3 anomaly could have been fixed via Article 3.7 by applying a net-net approach for all deforestation activities.
- This may have resulted in less pressure for additional activities under Article 3.4.

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12 .

Some other issues: Assessment unit size

- A maximum assessment unit is needed:
- for example 10 ha, 8.5 ha deforested:

- Solution: smaller max assessment unit or losses greater than e.g. 1 ha must be reported as deforestation

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13

Simplified methodologies

- Simplified methods can reduce costs. E.g.,
  - default values
  - benchmarking
  - statistical sampling
  - modelling
  - temporal and spatial averaging

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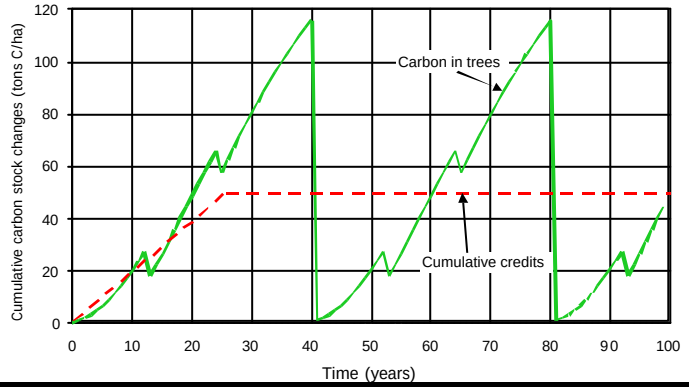
14

Simplified methodologies

Hypothetical Managed Forest Stand



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Some conclusions

- Consistency between reported and actual stock changes on lands undergoing ARD activities:
  ➔IPCC definitions
- In many regions, countries, and for total of Annex I, the IPCC scenario is likely to result in net debits.
- Pre-1990 ARD was purposefully excluded
- LULUCF rules are interrelated with commitments

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Chapter 4, Additional human-induced activities - Article 3.4

Presented by Gregg Marland, Oak Ridge National Laboratory, USA

4

Additional Human-Induced Activities—Article 3.4

R. NEIL SAMPSON (USA) AND ROBERT J. SCHOLES (SOUTH AFRICA)

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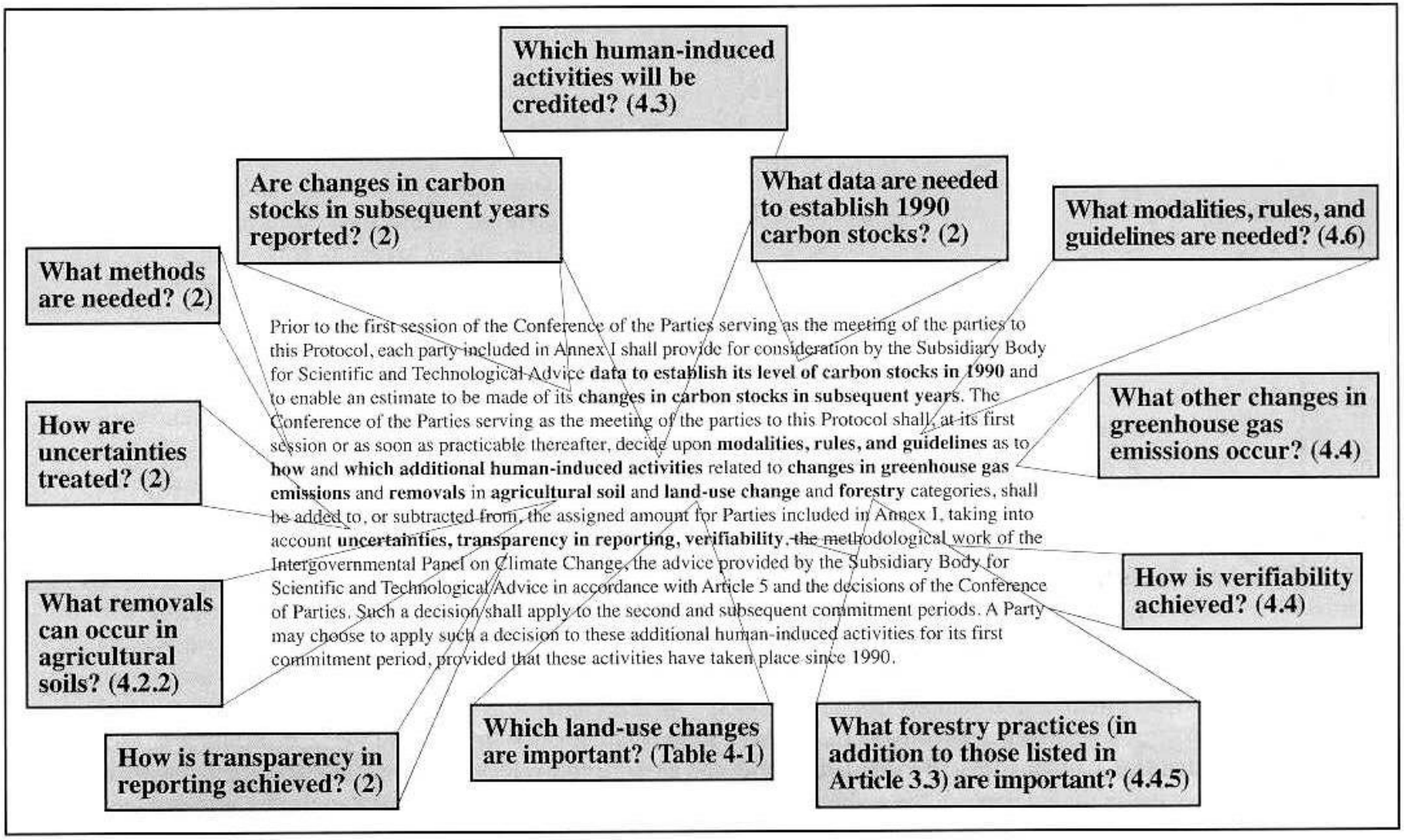


Figure 4-1: Illustration of questions that arise from text of Article 3.4 of Kyoto Protocol. Numbers in parentheses indicate sections of this Special Report where the questions are discussed.

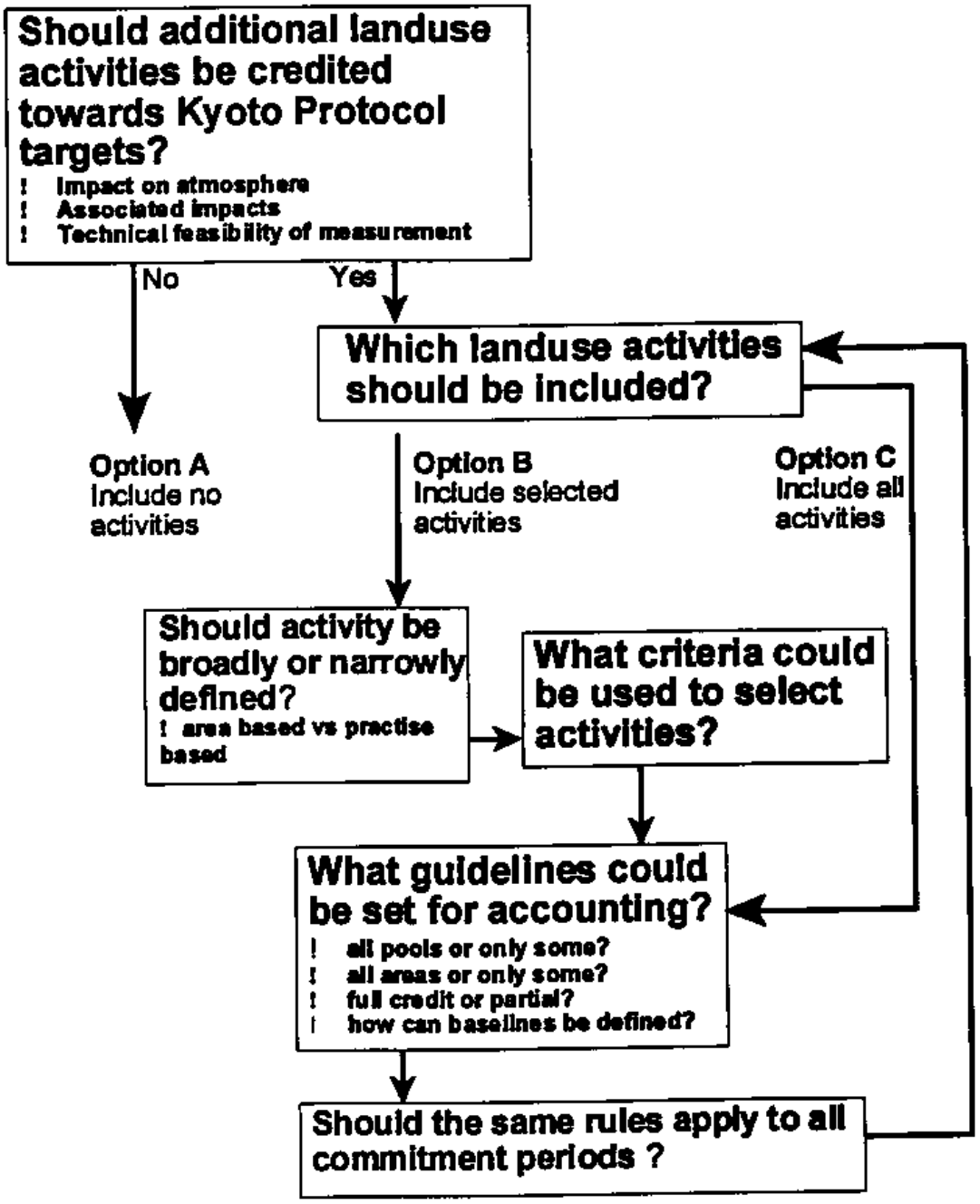


Figure 5-5. Decision Tree to assist in determining Whether and Which Additional Activities to Include under Article 3.4 of the Kyoto Protocol.

Land Cover ⇩ *from* *to* ⇨	**Cropland**	**Grassland, Desert, Savanna**	**Forest, Woodland**	**Urban, Industrial**	**Wetland, Tundra**
Cropland	Cropland management (3.4)	Cropland conversion (3.4)	Afforestation (3.3)	Development (3.4)	Wetland restoration (3.4)
Grassland	Grassland conversion (3.4)	Grassland management (3.4)	Afforestation (3.3)	Development (3.4)	Wetland restoration (3.4)
Forest	Deforestation (3.3)	Deforestation (3.3)	Forest management (3.4)	Deforestation (3.3) Land-use change w/o deforestation (3.4)	Wetland restoration (3.4)
Urban - Industrial				Urban ecosystem management (3.4) Products (3.4)	
Wetland Tundra	Drainage (3.4)	Drainage (3.4)	Drainage (3.4)	Drainage (3.4)	Peat and rice management

Figure 4-6: Suggested land-cover, land-cover/use change, and forestry matrix that illustrates how activities might be identified with different land cover areas. Numbers in parentheses indicate relevant Article in Kyoto Protocol, where apparent.

***Table 4-3**: Possible repositories for additional carbon storage in terrestrial ecosystems or their products, and approximate residence times for each pool. Mean residence time is average time spent by a carbon atom in a given reservoir.*

Repository	**Fraction**	**Examples**	**Mean Residence Time**
Biomass	woody	tree boles	decades to centuries
	non-woody	crop biomass, tree leaves	months to years
Soil organic matter	litter	surface litter, crop residues	months to years
	active	partially decomposed litter; carbon in macro-aggregates	years to decades
	stable	stabilized by clay; chemically recalcitrant carbon; charcoal carbon	centuries to millennia
Products	wood	structural, furniture	decades to centuries
	paper, cloth	paper products, clothing	months to decades
	grains	food and feed grain	weeks to years
	waste	landfill contents	months to decades

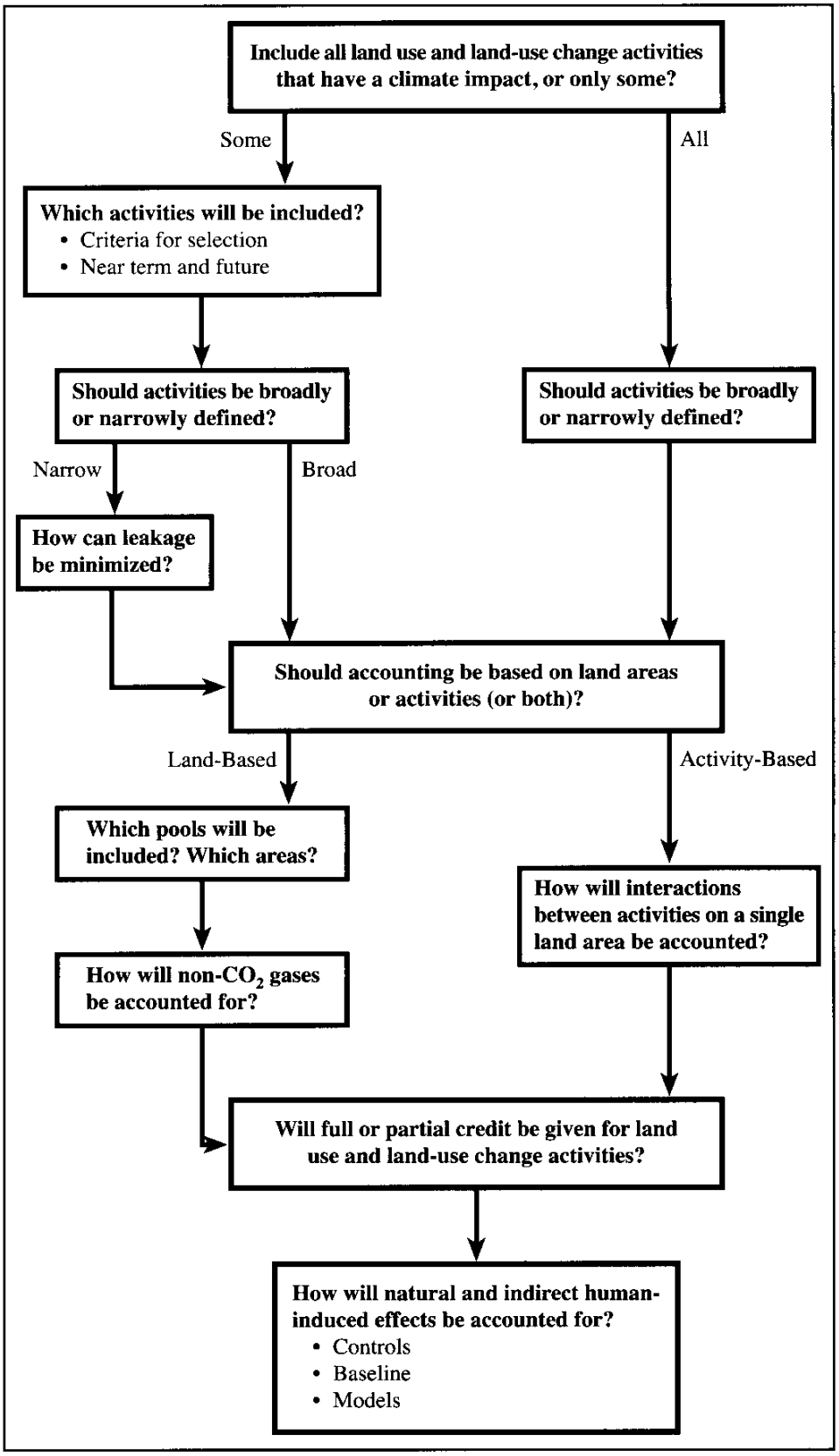


Figure 4-5: Decision tree to assist in determining which additional activities to include under Article 3.4 of Kyoto Protocol.

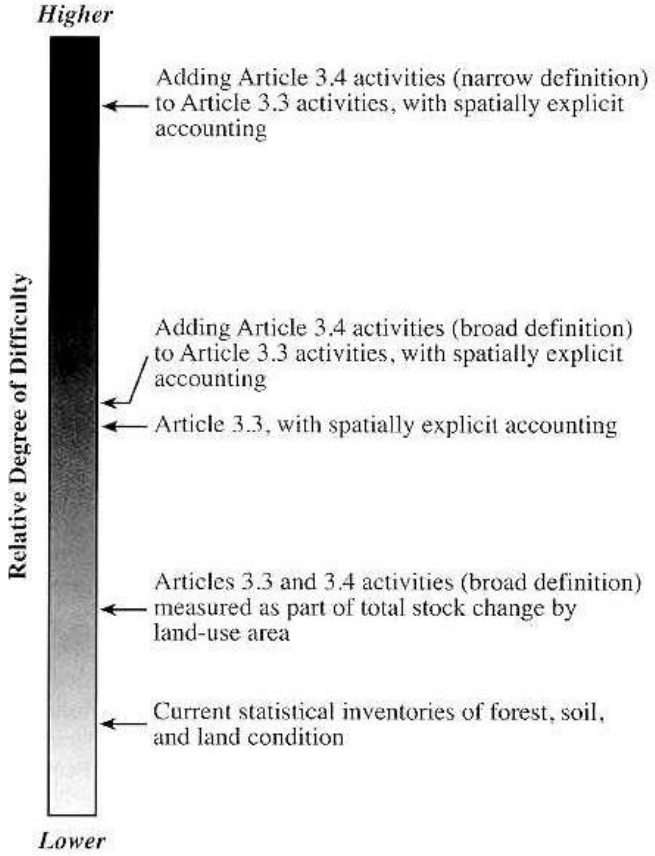


Figure 4-7: Relative costs of measuring and reporting carbon stock changes under different decisions regarding definition of "activities" and requirements for spatially explicit accounting.

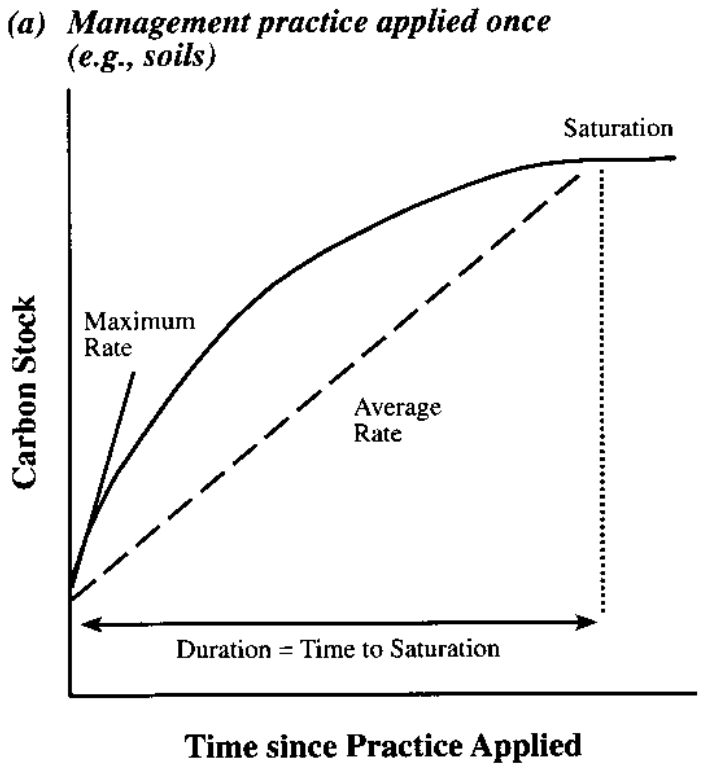


***Table 4-1**: Potential net carbon storage of additional activities under Article 3.4 of the Kyoto Protocol. Increases in carbon storage may occur via (a) improved management within a land use, (b) conversion of land use to one with higher carbon stocks, or (c) increased carbon storage in harvested products. For (a) and (b), rates of carbon gain will diminish with time, typically approaching zero after 20–40 years. Values shown are average rates during this period of accumulation. Estimates of potential carbon storage are approximations, based on interpretation of available data. For some estimates of potential carbon storage, the uncertainty may be as high as ±50%.*

Activity (Practices)	Group[a]	Area[b] (10^6 ha)	Adoption/ Conversion (% of area) 2010	2040	Rate of Carbon Gain[b] (t C ha^{-1} yr^{-1})	Potential (Mt C yr^{-1}) 2010	2040
a) Improved management within a land use							
Cropland (reduced tillage, rotations and cover crops, fertility management, erosion control, and irrigation management)	AI	589	40	70	0.32	75	132
	NAI	700	20	50	0.36	50	126
Rice paddies[c] (irrigation, chemical and organic fertilizer, and plant residue mgmt.)	AI	4	80	100	0.10	<1	<1
	NAI	149	50	80	0.10	7	12
Agroforestry[d] (better management of trees on croplands)	AI	83	30	40	0.50	12	17
	NAI	317	20	40	0.22	14	28
Grazing land (herd, woody plant, and fire management)	AI	1297	10	20	0.53	69	137
	NAI	2104	10	20	0.80	168	337
Forest land (forest regeneration, fertilization, choice of species, reduced forest degradation)	AI	1898	10	50	0.53	101	503
	NAI	2153	10	30	0.31	69	200
Urban land (tree planting, waste management, wood product management)	AI	50	5	15	0.3	1	2
	NAI	50	5	15	0.3	1	2
b) Land-use change							
Agroforestry (conversion from unproductive cropland and grasslands)	AI	~0	~0	~0	~0	0	0
	NAI	630	20	30	3.1	391	586
Restoring severely degraded land[e] (to crop-, grass-, or forest land)	AI	12	5	15	0.25	<1	1
	NAI	265	5	10	0.25	3	7
Grassland (conversion of cropland to grassland)	AI	602	5	10	0.8	24	48
	NAI	855	2	5	0.8	14	34
Wetland restoration (conversion of drained land back to wetland)	AI	210	5	15	0.4	4	13
	NAI	20	1	10	0.4	0	1
c) Off-site carbon storage							
Forest products	AI	n/a[e]	n/a	n/a	n/a	210	210[e]
	NAI	n/a	n/a	n/a	n/a	90	90
Totals	AI					497	1063
	NAI					805	1422
	Global					*1302*	*2485*

[a] AI = Annex I countries; NAI = non-Annex I countries.
[b] Areas for cropland, grazing land, and forestland were taken from IGBP-DIS global land-cover database derived from classification of AVHRR imagery (Loveland and Belward, 1997). Each land-use/land-cover type was subdivided by the climatic regions defined in Table 4-4, using a global mean climate database (Schimel *et al.*, 1996) of temperature and precipitation, with additional calculations of potential evapotranspiration (Thornthwaite, 1948). Each climatic region was further subdivided by Annex I and non-Annex I countries. Modal rate estimates from Table 4-4 were then weighted by the relative area of each land use by climatic region for Annex I and non-Annex I countries to derive a global area-weighted mean rate for each land use.
[c] Riceland area was subtracted from cropland area.
[d] Of the 400 Mha presently in agroforestry, an estimated 300 Mha are included in the land-cover classification for cropland; the remaining 100 Mha are included in forestland cover. These areas were subtracted from the respective totals for cropland and forestland.
[e] Assumes that severely degraded land is not currently classified as cropland, forestland, or grassland.
[f] Estimates for 2040 are highly uncertain because they will be significantly affected by policy decisions; n/a = not applicable.

Table 4-4: Summary of potential rates of carbon gain and associated impacts for various activities.

Activity	Ecozone[a]	Key[b] Practices	Rate[c] ($t C ha^{-1} yr^{-1}$)	Confi-dence[d]	Duration (yr)[e]	Other GHGs[f]	Associated Impacts
Cropland management	Boreal	Ley/perennial forage crops, organic amendments	0.3–0.6 (0.4)	M	40	$+N_2O$	Increased food production, improved soil quality
	Temperate – dry	Reduced tillage, reduced bare fallow, irrigation	0.1–0.3 (0.2)	H	30	$+N_2O$	Increased food production, improved soil quality, reduced erosion, possibly higher pesticide use
	Temperate – wet	Reduced tillage, fertilization, cover crops	0.2–0.6 (0.4)	H	25	$+N_2O$	Increased food production, improved soil quality, reduced erosion, possibly higher pesticide use
	Tropical – dry	Reduced tillage, residue retention	0.1–0.3 (0.2)	L	20	$+N_2O$	Increased food production, improved soil quality, reduced erosion, possibly higher pesticide use
	Tropical – wet	Reduced tillage, improved fallow management, fertilization	0.2–0.8 (0.5)	M	15	$+N_2O$	Increased food production, improved soil quality, reduced erosion, fertilizers often unavailable, possibly higher pesticide use
	Tropical – wet (rice)	Residue management, fertilization, drainage management	0.2–0.8 (0.5)	L	25	$++CH_4$, $+N_2O$	Increased food production
Agroforest management	Tropical	Improved management	0.5–1.8 (1.0)	M	25	$+N_2O$	
Grassland management	Temperate – dry	Grazing management, fertilization, irrigation	0–0.3 (0.1)	M	50	$\pm CH_4$, $+N_2O$	Increased energy use, salinity, higher productivity
	Temperate – wet	Grazing management, species introduction, fertilization	0.4–2.0 (1.0)	M	50	$\pm CH_4$, $++N_2O$	Higher productivity, acidification, erosion, reduced biodiversity
	Tropical – dry	Grazing management, species introduction, fire management	0.1–1.5 (0.9)	L	40	$-CH_4$, $++N_2O$	Reduced soil degradation, higher productivity, woody encroachment (reduced productivity)
	Tropical – wet	Species introduction, fertilization, grazing management	0.2–3.9 (1.2)	L	40	$-CH_4$, $++N_2O$	Increased productivity, reduced biodiversity, acidification
Forestland management	Boreal and Temperate – dry	Forest regeneration, fertilization, plant density, improved species, increased rotation length	0.1–0.8 (0.4)	L	80	$+N_2O$, $+NO_x$	Leakage (rotation length), high cost efficiency

***Table 4-9**: Rates of potential carbon gain under selected practices for forestland in various regions of the world.*

Practice	Country/ Region	Rate of Carbon Gain ($t\ C\ ha^{-1}\ yr^{-1}$)	Time[1] (yr)	Other GHGs and Impacts	Notes[2]
Improved Natural Regeneration	India	0.55	30		a
Increased Rotation Length	Canada	0.022	80	Leakage (increased	b
	USA	0.036	80	harvest elsewhere)	b
	The Netherlands	0.035	80		b
Forest Fertilization	Canada	0.03–0.19	20	$+N_2O$, $+NO_x$	b
	USA	0.08–0.48	20	Ecological changes	b
	The Netherlands	0.1–0.6	20		b
	Norway	0.44	20		c
Forest Conservation	India	0.48	30	Environmental improvements	a
Reduced Forest Degradation	Tropical/ Global	1.7–4.6	40	Environmental improvements	h
Several Practices Combined	USA	3.1	50	Ecological changes	d
	Norway	0.12–0.20	20		e
Several Practices Combined,	USA	1.2	40	Ecological changes	f
Loblolly Pine	USA	3.5	25		g
Species Change (Aspen to Red Pine)	USA	0.88	80	Ecological changes	f

[1]Time interval to which estimated rate applies. This interval may or may not be time required for ecosystem to reach new equilibrium.

[2]a. Ravindranath *et al.* (1999).
b. Nabuurs *et al.* (1999).
c. Lunnan *et al.* (1991).
d. Birdsey *et al.* (2000).
e. Hoen and Solberg (1994); assuming harvest volume is kept constant.
f. Row (1996).
g. Albaugh *et al.* (1998); refers to intensive fertilization and irrigation on an infertile drained sandy soil in North Carolina. Rate is an average estimate of 3 years of measurements starting in 8-year-old stands.
h. Based on mean biomass stock differences between non-degraded and degraded tropical forests as reported in FAO (1996). Stock differences are 182, 126, and 70 tons dry matter per hectare for tropical wet, moist, and dry zones, respectively, with carbon content as 50% of dry matter.

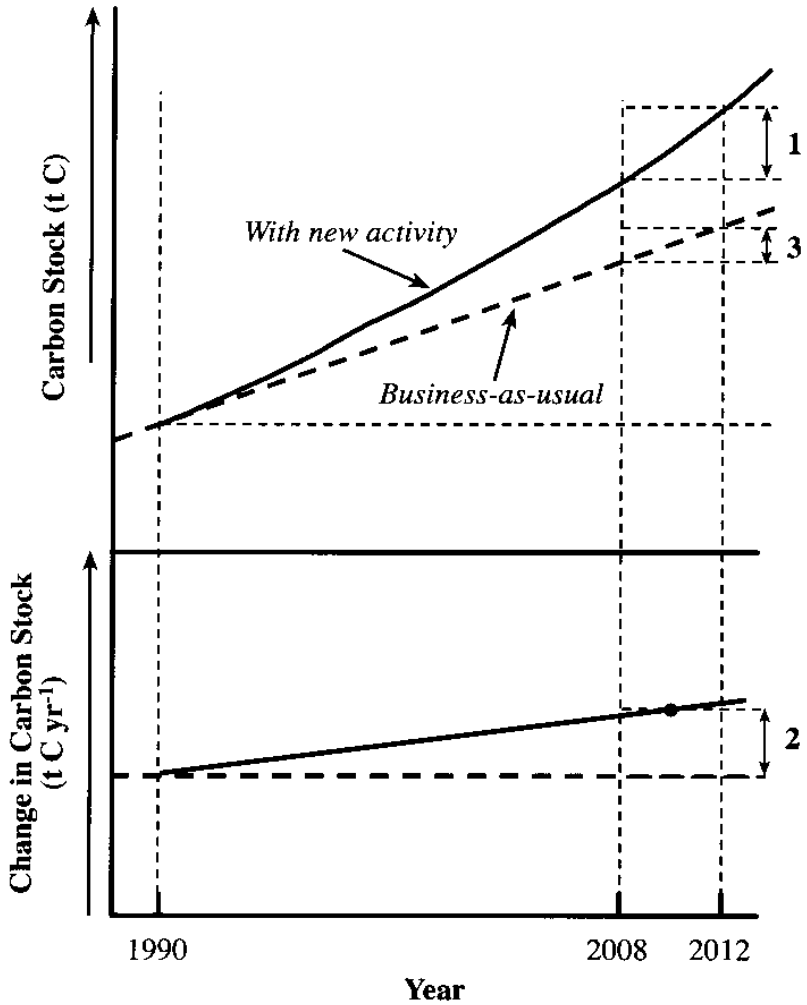


Figure 4-12: Three possibilities for evaluating change in carbon stocks attributable to Article 3.4 activities. Figure shows total carbon stock (above) and annual change (below) for an activity that causes an increase in carbon stocks and the path that would have been followed without the activity. The activity is arbitrarily assumed to have begun in 1990. The example chosen shows an increase in carbon stocks with respect to business-as-usual, but the principles are equally relevant if the activity resulted in a decrease in carbon stocks with respect to business-as-usual. If the stock in 2008 is taken as the reference (Section 4.6.3.2), the credit for the first commitment period will be as shown by arrow 1. If the change in carbon stocks in 1990 is taken as the reference (Section 4.6.3.1), the credit will be as shown by arrow 2. If the business-as-usual scenario is taken as a baseline (Section 4.6.3.3), the credit will be as shown by arrow 1 minus arrow 3.

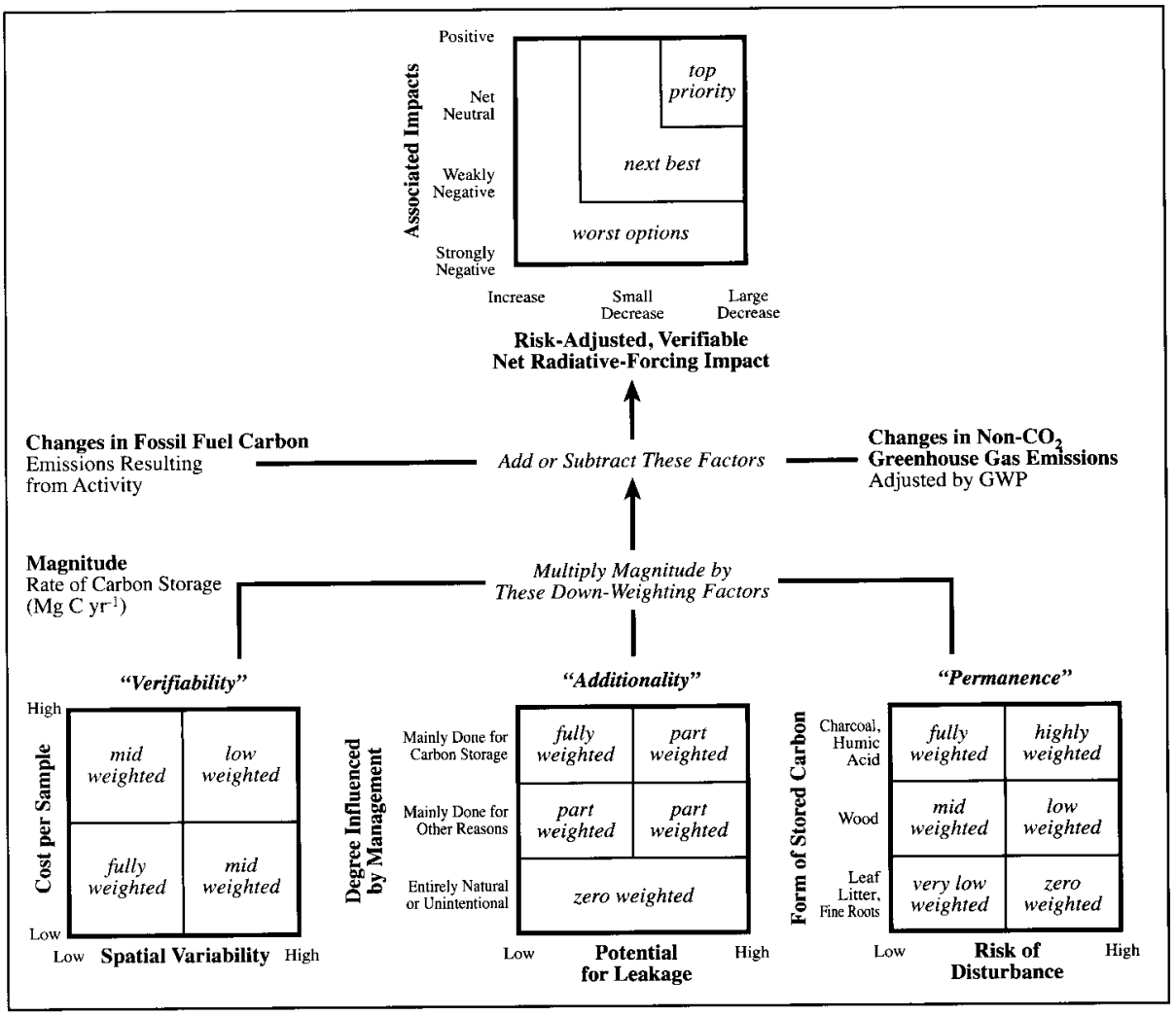


Figure 4-13: One possible framework for systematically considering a variety of factors that have a bearing on the suitability of an activity for inclusion under Article 3.4 of Kyoto Protocol. The entry point is an estimate of the magnitude of the carbon stored by the activity (lefthand side, lower middle). This estimate is then progressively down-weighted by considerations such as how easy it is to verify, the degree to which it is an intended consequence of a management action, and how likely it is to be lost through disturbance (note that this is an example list; the Parties have yet to decide which criteria will be employed). The estimate then must be adjusted for changes in non-CO_2 GHG emissions and changes in fossil fuel consumption resulting from the activity. Finally, this adjusted estimate must be weighted up in relation to the non-climate benefits or disbenefits it may cause.

Chapter 5, Project based activities

Presented by Omar Masera, University of Mexico, Mexico

IPCC Special Report on LULUCF

Project-based Activities

Omar Masera
Institute of Ecology, University of Mexico

Land-Use Land-Use Change and Forestry: The Road to COP6 Joensuu, Finland, 25- 28 June 2000

1

Road Map

- Project Experience
- Key Concerns on LULUCF projects

2

Project Experience

- **Projects -- Planned set of activities that are**
  - **confined to one or more geographic locations in the same country**
  - **belong to specified time periods and institutional frameworks, and**
  - **allow monitoring and verification of greenhouse gas (GHG) emissions or changes in carbon stock**
- **Much experience with LULUCF projects, but few specifically for GHG mitigation**

3

Project Experience

- About 3.5 million ha of area is covered in about 30 projects in 19 countries implemented during the 1990s
- For 21 projects where sufficient data are available
  - Unit mitigation 10-108 tC/ha
  - Costs range from 0.2-28 tC/ha

4 .

Project Type	Land Area (Mha)	Carbon Mitigation (Mt C)	Costs $ t^{-1} C	Carbon Mitigation t C ha^{-1}
Emissions Avoidance via Conservation:				
Forest Protection (7*)	2.9	40-108	0.1– 15	4 - 252
Forest Management (3*)	0.06	5.6	0.3 – 8	40 - 85
Carbon Sequestration				
Reforestation and Afforestation (7*)	0.10	12	1 – 28	26 - 328
Agroforestry (2*)	0.2	10.8	0.2-10	56-165
Multi-Component and Community Forestry (2*)	0.53	20-49	0.2 – 15	0.2 – 165

5

Key Concerns on Climate Change Projects

- Credibility of baselines and the tests for additionality
- Controlling leakage of carbon
- Measuring and monitoring of GHG emissions and carbon stock
- Permanence (risks): Duration of carbon stocks of a LULUCF project
- Sustainability concerns about LULUCF projects

(most of these concerns apply also to energy projects)

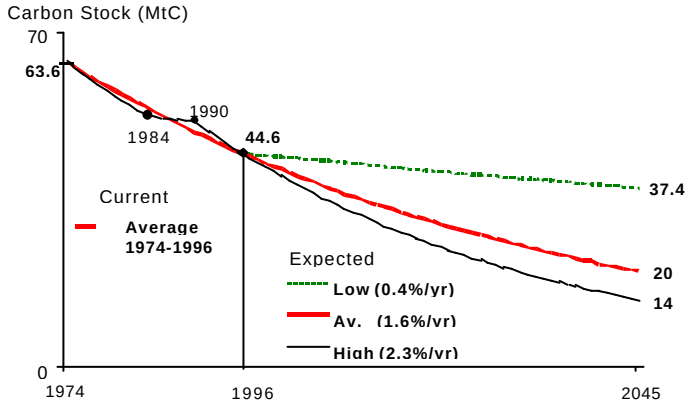
6

Baselines

- Project GHG accounting requires a without-project baseline
- No standard methods exist for setting baselines
- Approaches include:
  - project-specific vs. generic baselines (regional/benchmarks)
  - fixed or adjustable baselines
- Tests for additionality: technological, institutional, financial

7

Historical and projected carbon storage in SE Mexico Regional Approach



8 .

Permanence

- Carbon capture in LULUCF projects is potentially reversible
  - Fundamental difference with energy
- There are methods to tackle the problem:
  - **Debit the released amount**
  - **Replace it with a new project**
  - **Claim partial credit to begin with**
  - **Create buffer zones at the start of the project**
  - **Adequately address SD concerns**

9

Permanence: Accounting Approaches

- **Project runs in perpetuity: -- Carbon stock created or emissions avoided are locked in forever**
  - **Carbon stock released for any reason may be accounted for by**
    - **Debiting the released amount**
    - **Replacing it with a new project**
    - **Claiming partial credit to begin with**
      - **Creating buffer zones at the start of the project**
- **Tonne -year approach :-- Projects should be maintained until they counteract the effect of an equivalent amount of avoided GHG emissions**

10

Leakage

- **Leakage is the displacement of emissions outside the project boundaries**
- **Originates when projects reduce access to land, food, fiber, fuel and timber resources without offering alternatives**
- **Might be difficult to estimate in some cases (exports)**
- **There is "positive leakage" → adoption of good options spread beyond project boundaries**
- **Leakage may be quantified by**
  - **Monitoring key indicators of leakage, e.g., timber or agricultural output, movement of dwellers**
  - **Standard risk coefficients developed for project type and region**

11

Alternatives to cope with Leakage

- Increase availability of displaced resources (multicomponent projects)
- Leakage may be offset through
  - Buffer zones as in the PAP project in Costa Rica
  - Reducing the estimated carbon benefits as in the Reduced Impact Logging (RIL) Project in Malaysia.

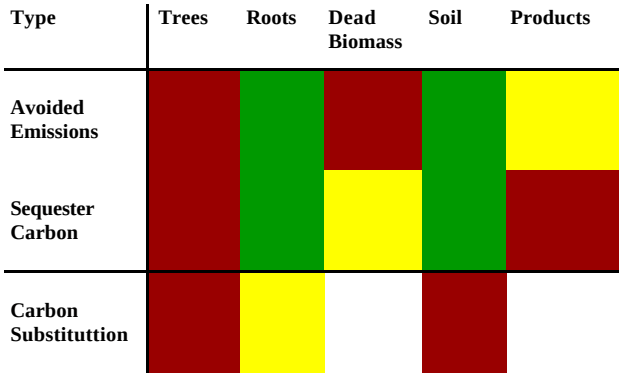
12 .

Measurability of GHG benefits

- There are several carbon pools -- live and dead biomass, soil, and wood products
  - Relative importance depends on the type of project
- Techniques and tools exist to measure carbon stocks in project areas relatively precisely depending on the carbon pool
- More experience is needed on project carbon accounting
- Qualified independent third-party verification could play an essential role in ensuring unbiased monitoring

13

Carbon Measurement Needs



Red- needs to be measured; Green - recommended
Yellow- may be necessary

14

Project Risks

- There are natural and human caused risks
  - Fires, extreme weather events, and pests
  - Political and economic risks that are common to all projects
- Risk could be addressed through
  - Good practice management systems, diversification of project activities and funding sources, self-insurance reserves, involvement of local stakeholders, external auditing, and verification
  - Standard insurance services, regional carbon pools, and portfolio diversification

15

Associated Impacts and Sustainable Development

- **Site-specific experience exists on socioeconomic and environmental impacts of LULUCF projects**
- **Critical factors that affect contributions of LULUCF projects to sustainable development include:**
  - **Extent and effectiveness of local community participation**
  - **Transfer and adoption of technology**
  - **Capacity to develop and implement guidelines and procedures**
- **Above factors can alleviate concerns about project permanence**

16

Chapter 6, Implications of the Kyoto Protocol for the reporting guidelines

Presented by Justin Ford-Robertson, Forest Research, New-Zealand

Implications of the Kyoto Protocol for the Reporting Guidelines

forest research

Justin Ford-Robertson
(on behalf of Chapter 6 authors)

1

Revised 1996 IPCC Guidelines

- Guidelines written for reporting national GHG Inventories under UNFCCC
  - Chapter 5 on LUCF
- Annual emissions reporting
- 3 components:
  - Reference manual
  - Workbook
  - Reporting Instructions

2

Reference Manual

- Encourages comprehensive accounting of all pools affected by anthropogenic activities
- Covers all pools (main LUCF activities)
- Does not differentiate between *direct* and *indirect human induced*
- Feasible to estimate changes in AGB and BGB, soil, litter and wood products

3

Workbook

- Accounting methods and default data for a sub-set of pools
  - AGB, 0.3m of soil
- Does not give methods for other pools
  - BGB, wood products, deep soil C
- Assumes stock of harvested wood products is not increasing
- Soil C pool and other pools are not linked

4 .

Reporting Instructions

- Definitions of activities
- Tables to report emissions and removals of GHGs

5

Guidelines for National and Project accounting

- Guidelines also for reporting National Inventories under Article 5.2 of Protocol
- Adequacy for purpose eg:
  - definitions
  - data
  - reporting tables

6

Afforestation, Reforestation, Deforestation

- Definitions of ARD are in the Guidelines
- Guidelines may need modification if:
  - other definitions are adopted,
  - additional C pools (new workbook tables)
  - reporting of ARD for AGB and BGB needs to be made geographically explicit

7

ARD Issues?

- Guidelines do not apply *"since 1990"* clause
  - assess changes from annual data
- Guidelines do not ensure consistency in accounting due to flexibility in definitions
  - acceptability of default data?
  - acceptability of 'levels' of complexity?

8 .

Additional Activities

- Guidelines could capture most additional activities
- Some pools not specified by workbook
- Associating changes in pools with activities
- Baselines and additionality may be added

9

PROJECTS

- Guidelines not intended for projects
- Similar data and reporting needs
- Additional features may include:
  - project location and boundaries
  - leakage
  - baselines/additionality
  - socio-economic impacts
  - biodiversity impacts
  - double counting

10

The ton-year index as a basis for carbon accounting of forestation projects under the Climate Convention

Kim PINGOUD, Riitta KORHONEN, and Ilkka SAVOLAINEN

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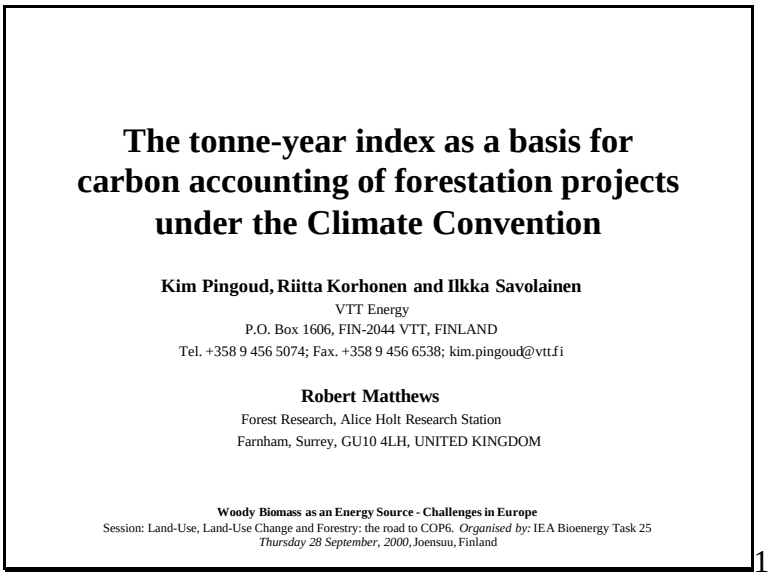
ABSTRACT

Carbon can be sequestered from the atmosphere in forests in order to lower the atmospheric carbon dioxide (CO_2) concentration. Ton-years of sequestered carbon have been suggested as a index to account for carbon sequestered in forest-based projects with finite duration. Simple case studies are presented here that illustrate how the ton-year approach can be contrary to the objective of stabilising atmospheric CO_2 concentrations as expressed in the UN Climate convention. The example cases are closely related to the IPCC estimates of global forestation potentials to the year 2050. Calculations show that a ton-year index for a forestry project can in certain circumstances indicate that carbon sequestration helps in the mitigation of climate change even when the impact of the project is an increase in the atmospheric CO_2 concentration. The use of a ton-year index is also likely to overstate and encourage projects and policy measures aimed at permanently maintaining enhanced stocks of carbon in forests, while understating and discouraging projects and measures aimed at reducing dependence on fossil energy sources through enhanced supply of bioenergy. However, model simulations demonstrate that measures involving replacement of fossil energy supplies with renewable bioenergy sources are more effective at achieving a long-term reduction in atmospheric CO_2 concentration. It is concluded that use of a ton-year index may result in inappropriate allocation of resources to meet the objective of the convention.



1

Carbon accounting principles for GHG sinks and sources in terrestrial ecosystems

State-of-the-art:

- human-induced activities (ARD, additional?) not clearly defined
- accounting rules have not been specified or agreed
- rules and principles are debated among scientists, governmental officials and environmentalists
- key contribution IPCC Special Report on LULUCF accepted by governments in May 2000

2

In this presentation:

evaluation of the tonne-year index as a measure of cooling impact in the long-term, approximated by the impact on the atmospheric CO_2 concentration

(remembering that its stabilisation is the ultimate objective of the UNFCCC)

3

The tonne-year approach

- motivation: to promote positive contribution to C sequestration made by short duration forestry projects
- particular attention in the IPCC Special Report on LULUCF
- basic idea: to give credit for each year that the sequestered C stock is maintained

4

Tonne-year based index as a measure of cooling impact

Carbon-crediting index $\boldsymbol{Q_1}$ (unit = tonnes of C):

$$Q_1(t) = \frac{1}{t}\int_{t_0}^{t} C_S(t)\,dt$$

$$= \left(\int_{t_0}^{t} C_S(t)\,dt \Big/ \int_{t_0}^{t_0+t} (1\,tonne\,C)\,dt \right) \times 1\,tonne\,C$$

Above formula: tonne-yrs of the project ***divided by*** tonne-yrs of 1 t carbon sequestered 'permanently' for t years

$Q_1(t)$ = carbon sequestration tonne-year index for year t (tonnes),
t_0 = year in which project is commenced,
$C_s(i)$ = the additional carbon stock in biomass attained by the project in year t,
t = 'equivalence time' (years).

By convention, the indefinite accumulation of $Q_1(t)$ may be restricted by capping the value of $Q_1(t)$ at the value attained at the end of the finite time frame of t years.

5 .

Comparison: Global warming potential (GWP) factor as a measure of cooling impact

Cumulative radiative forcing or absolute global warming potential (AGWP) of a forestation project (here actually the *cooling* impact) is proportional to the integral:

$$AGWP(t) \cong \int_{t_0}^{t} C_A(t)\,dt$$

$C_A(t)$ = carbon stock **absent from the atmosphere** due to the forestation project
Note: For calculating C_A a model describing the dynamics of carbon exchange between the atmosphere and oceans is needed

6

GWP_{100} factor of a forestation project as a function of time ($t_0 \le t \le t_0 + 100$ yr) :

$$GWP_{100}(t) = AGWP(t)/AGWP_{1\ tC\ permanent}(t_0+100\ yr)$$

Above formula: tonne-yrs of carbon absent from the atmosphere due to the project *divided by* tonne-yrs of carbon absent from the atmosphere due to 1 tC sequestered at t_0 'permanently' for 100 yrs

Carbon-crediting index Q_2 on the basis of the GWP_{100} factor:

$$Q_2(t) = GWP_{100}(t) \times 1 \text{ tonne C}$$

Conclusion: when *t* = 100 yr the tonne-year index Q_1 is a fair approximation for the more correct GWP_{100}-based index Q_2

Neither provides incentives for sustainable solutions?

7

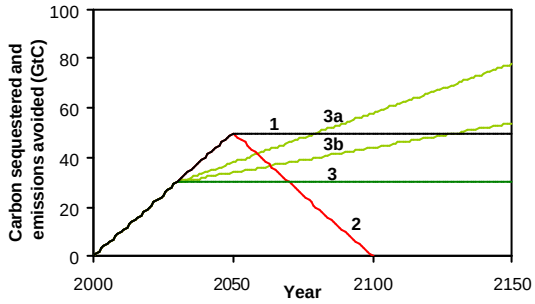
Illustrative test example:
Hypothetical global forestation and bioenergy scenarios

- loosely based on global forestation scenarios presented in the IPCC Second Assessment Report (SAR); they originate in the study of Nilsson and Schopfhauser (1995)
- bioenergy scenarios base on the mean annual increment of the potential plantations between 2030 and 2100; assumed that stemwood converted into energy replacing light fuel oil

8

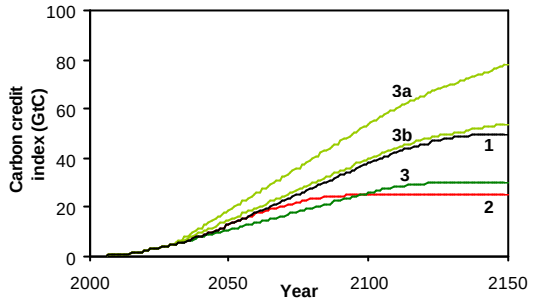
The carbon sequestration scenarios

Note: 3a and 3b include emission reductions due to bioenergy substitution for fossil fuels



9 .

Carbon credits given by the tonne-year based index Q_1



10

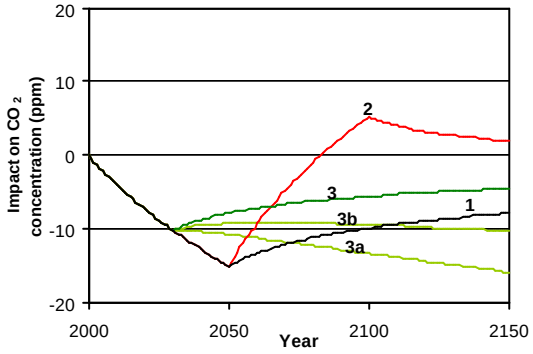
Impacts of the scenarios on the atmospheric CO_2 concentrations

- Simplified global-scale model of the exchange of carbon between the atmosphere and oceans, called REFUGE (Korhonen et al. 1993) used in the calculations
- REFUGE is an exponential-term approximation of a non-linear three-dimensional ocean model due to Maier-Reimer and Hasselmann (1987); assumption: initial CO_2 concentration increased by 25 % from pre-industrial levels
- Calculations based on a pulse response function* describing the impact of an emitted CO_2 pulse on the atmospheric concentration

*$F[CO_2] = 0.131 + 0.201 \exp(-t/362.9) + 0.321 \exp(-t/73.6) + 0.249 \exp(-t/17.3) + 0.098 \exp(-t/1.9)$
F = fraction of emitted CO_2 remaining in the atmosphere
t = time since emission in years

11

Impacts of the scenarios on the atmospheric CO_2 concentrations



12

Conclusions

- **Tonne-year crediting gives permanent credit even if C stock is lost**
- **Ultimate objective of the UNFCCC to stabilise the CO_2 concentrations**
- **Temporary sequestration can even increase the CO_2 concentration in the long term and be in contradiction with the ultimate objectives of the UNFCCC**
- **Tonne-year indices may result in inappropriate allocation of resources to meet its objectives**

13 .

An Alternative Procedure Of Accounting For Land-Use Change And Forestry Activities Under The Kyoto Protocol

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ABSTRACT

The Kyoto Protocol was adopted in order to reduce the net emission of greenhouse gases to the atmosphere. That included management of the biosphere. However, the wording that has been adopted is very difficult and costly to implement, and may ultimately make it impossible to cost-effectively include biosphere management to reduce net greenhouse gas emissions.

An alternative scheme is proposed here to more effectively deal with the anthropogenic component of carbon emissions from the biosphere. It would categorise the terrestrial biosphere into different land-use types, with each one having a characteristic average carbon density determined by environmental factors and management. Each transition from one land-use type to another, or a change in average carbon density within a specified type, due, for example, to changing management, would be defined as anthropogenic. This change would be credited or debited to the responsible nation. To calculate annual credits and/ or debits, a characteristic further time course for each possible land-use transition needs to be defined, and the annual debit/ credit is then calculated as the change in carbon density multiplied by the land area involved and divided by the relevant time constants.

We believe that this scheme would be simpler and less costly to implement than one based on the current wording of the Kyoto Protocol. It would also avoid undue credits or debits because credits and debits could only accrue due to identified anthropogenic components of biospheric carbon changes. Carbon fluxes that are due to natural variation, on the other hand, would not result in credits or debits. It would thereby only reward and encourage those land-use changes that would lead to ultimate net increases in carbon storage.

A practical procedure of accounting for LUCF activities under the Kyoto Protocol

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1

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T.P. Singh, India
IPCC Special Report on LULUCF

Thanks also to:
Mark Howden, CSIRO Wildlife and Ecology
Ian Galbally, CSIRO Atmospheric Research

2

Outline

- Problems with biosphere accounting
- Alternative proposal
- Examples

3

Problems with definitions

accounting rules

data availability

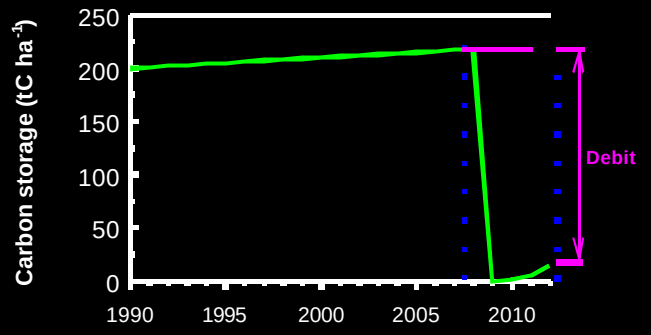
costs

4 .

Using the FAO definition...

Count from start of commitment period:

Carbon loss during harvest



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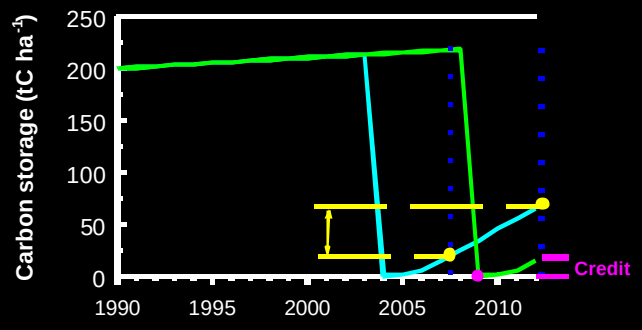
Still using the FAO definition...

Count from time of reforestation:

Carbon 'GAIN' during harvest



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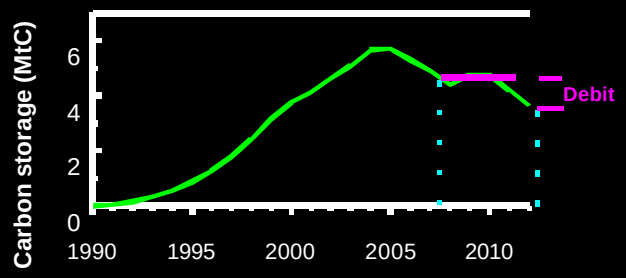
Carbon storage in Australian short-rotation plantations planted 1990- 2000



Assumes that 50% of plantations are short (10-year) rotation or medium (15 year) rotation stands

7

Problems with definitions

accounting rules

data availability

costs

8 .

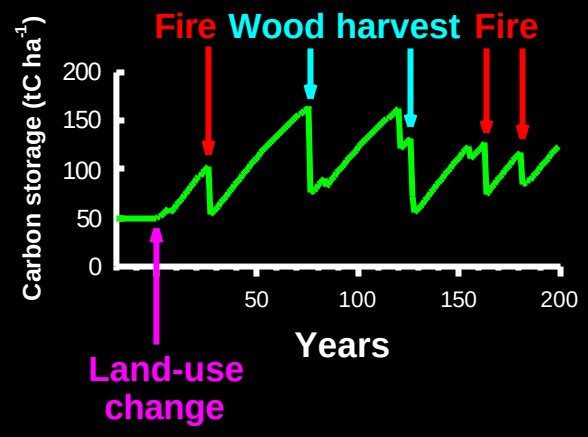
Can vegetation management for greenhouse abatement ever be operationalised?

Management of the biosphere can only have lasting impact by replacing low carbon-storage potential land-use types with types with higher carbon-storage potential.

Actual carbon storage in the biosphere is affected by anthropogenic and natural factors. In assigning credits/ debits, only the anthropogenic factors should be considered.

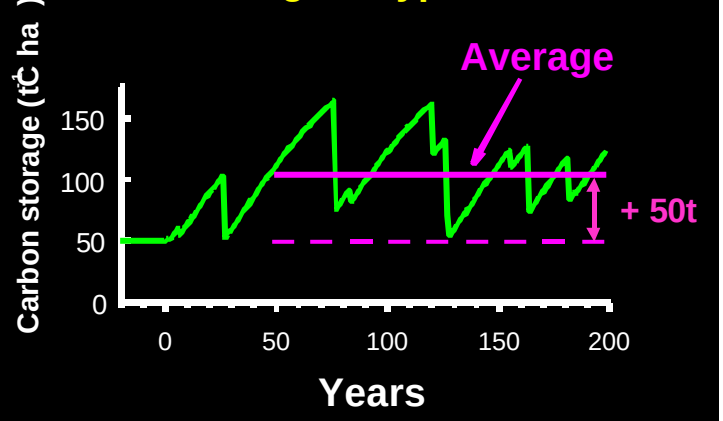
9

Carbon storage in typical forest



10

Carbon storage in typical forest



11

The proposal:

- Sub-divide biosphere into different land-use types.
- Establish characteristic carbon storage potential for each land-use type.
- Give credits/ debits for conversion between land-use types with different carbon storage potential.
- Give credits/ debits for human-induced change of carbon storage within land-use types.

12 .

Calculating potential C storage

Potential C density =
Equilibrium C density x Land use factor

Potential C density is long term average carbon density
Equilibrium C density is natural carbon density (constant)
Land use factor is C density relative to equilibrium, for each land use

Potential C stock = Area x Potential C density

13

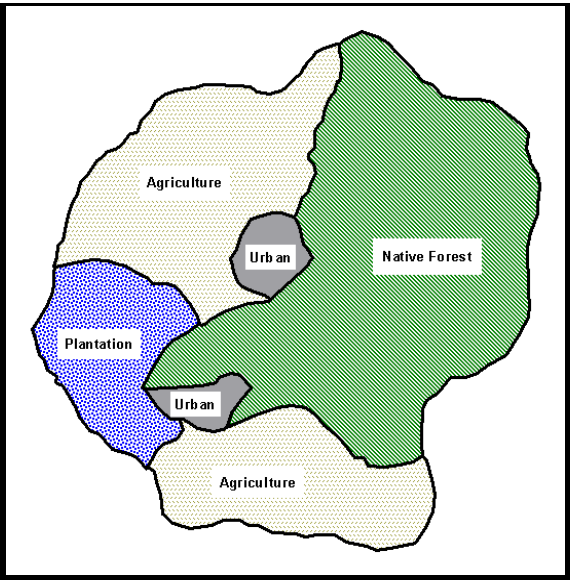
Expressed as equations:

$$C_{pot} = C_{eq} \cdot f_{lu}$$

C_{pot} = potential average carbon density
C_{eq} = equilibrium carbon density
f_{lu} = land-use factor

$$\text{Carbon stock} = \text{å } A_i \cdot C_{pot(i)}$$

14



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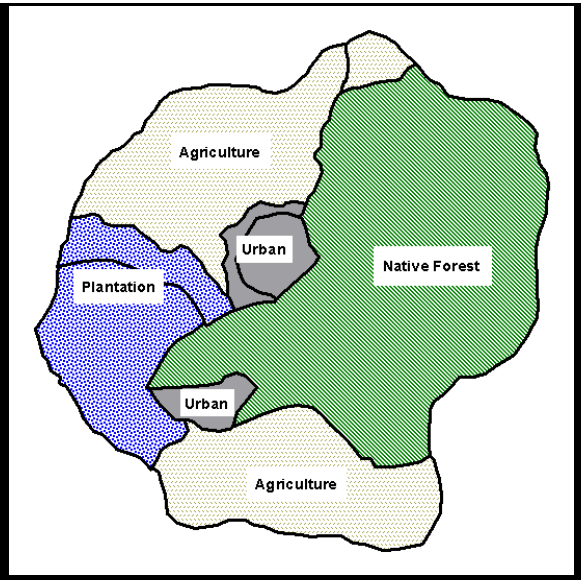
Type	Area (ha)	Equ C density (tC ha^{-1})	Land use factor	Total C (MtC)
Forest	500,000	500	1.0	250.0
Plantation	100,000	500	0.75	37.5
Agriculture	350,000	500	0.4	70.0
Urban	50,000	500	0.1	2.5
Total	1,000,000			360.0

16



17

Example I: Area changes

Type	New area	Area change	Equ C density (tC ha^{-1})	Land use factor	New C (MtC)	C change (MtC)
Forest	495,000	-5,000	500	1.0	247.5	-2.5
Plantation	110,000	+10,000	500	0.75	41.25	+3.75
Agriculture	340,000	-10,000	500	0.4	68.0	-2.0
Urban	55,000	+5,000	500	0.1	2.75	+0.25
Total	1,000,000				359.5	-0.5

18

Example II: Carbon density changes due to direct human action

Forest: More access roads (-0.5%)

Plantation: Shorter rotation (-1.0%)

Agriculture: Minimum tillage (+1.0%)

Urban: More trees (+0.1%)

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Example II: Carbon density changes

Type	Area	C_{eq} (tC ha^{-1})	new factor	change in factor	New C (MtC)	C change (MtC)
Forest	500,000	500	0.995	-0.005	248.75	-1.25
Plantation	100,000	500	0.74	-0.01	37.0	-0.5
Agriculture	350,000	500	0.41	+0.01	71.75	+1.75
Urban	50,000	500	0.101	+0.001	2.525	+0.025
Total	1,000,000				360.025	0.025

20

Example III: Change in equilibrium carbon density

Suppose climate change reduces soil carbon so that total carbon storage potential diminishes by 1% every five years.

No credits or debits to be given.

21

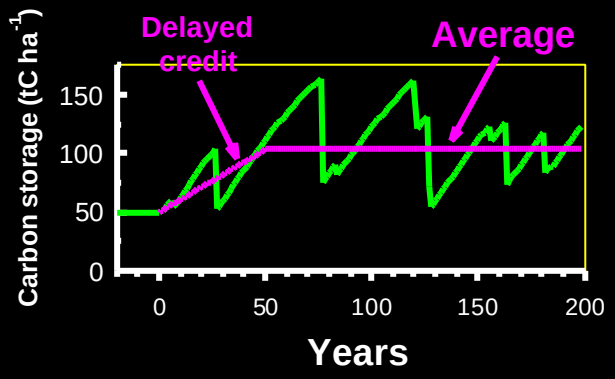
Delayed crediting/ debiting

3 Options

1. Detailed change matrix
2. 50-year linear delay
3. 50-year linear delay for increase; 10-year linear delay for decrease

22

Carbon storage in typical forest



23

Verification

Data requirements

- **Area estimates**
  - remote sensing
  - planning information
  - spot checks
- **Potential average carbon density**
  - stratified sampling
  - general scientific understanding
  - statistics
  - spot checks

24

Conclusions (1)

- Biosphere carbon management difficult and costly to implement
- Alternative scheme is simpler and more directly in keeping with the aim of accounting for anthropogenic effects on the biosphere.

25

Conclusions (2)

- Credits/ debits mainly related to change in area under different land-use types.
- Human-induced changes in carbon density within land-use types should also lead to credits/ debits.
- Carbon fluxes from natural causes, either short-term or long-term, should not generate credits/ debits.

26

Full paper available at:

http://www.ffp.csiro.au/publicat/pdfs/alternative_kyoto.pdf

27

Carbon accounting methodologies — a comparison of real-time, tonne-years, and one-off stock change approaches

P. Maclaren and Justin Ford- Robertson[1]

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Rotorua, New Zealand
jfr@forestresearch.co.nz

ABSTRACT

Trading in carbon credits from afforestation and reforestation is foreshadowed by the Kyoto Protocol. Human-induced sinks can compensate for human-induced emissions, but given ongoing combustion of fossil fuels, there needs to be an ongoing contribution from sinks. Because forests are sinks only when they are expanding in area or carbon density, and because there is a limit to the quantity of growing stock per unit area, afforestation must be continuous. Given a limited global area of plantable land, this cannot continue in perpetuity. Even if 500 million hectares of land were afforested worldwide, and resulted in a one-off increase in carbon-density of 100 tonnes/ha, this amounts to only 50 Gt C removed from the atmosphere. The IPCC Second Assessment Report examined scenarios of carbon accumulation from 1991-2100 of 630-1410 Gt C, so it can be seen that the potential contribution of afforestation is very small. Forest sinks are a popular topic in the current decade because they are seen as being a relatively low-cost first step to reduction of net greenhouse gas emissions.

Before trading in carbon sinks can eventuate, however, numerous technical difficulties have to be resolved including the acceptance of a standard method of carbon accounting. The concept of "tonne-years", whereby the quantity of carbon sequestered is multiplied by the time it is out of atmospheric circulation, appears to be gaining credence in international fora. This concept is flawed and threatens to undermine the "stocks" based accounting approach that is built into the Kyoto Protocol. A preferable approach is to accept that afforestation is merely the reverse of deforestation, and is a one-off movement of carbon from the atmosphere to the earth's surface. Carbon credits could be a one-off payment made to a land owner who undertakes to change the long-term carbon density of a piece of land and to retain that increased carbon density in perpetuity.

New Zealand Forest Research Institute Limited

Carbon Accounting Methodologies

forest research

Piers Maclaren and
Justin Ford-Robertson

1

Introduction

- Fundamentals of C sequestration
- Carbon credits
  - Real-time accounting
  - Tonne-year accounting
  - Carbon density accounting
- Summary

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2

Sink/source definitions

- Sink - any process, activity or mechanism which removes a GHG, an aerosol or a precursor of a GHG from the atmosphere.
- Source - any process or activity which releases a greenhouse gas (GHG) or a precursor of a GHG into the atmosphere.

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3

Carbon Source

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4 .

Carbon reservoir

- A component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored

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5

Carbon reservoir

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6

Carbon reservoir

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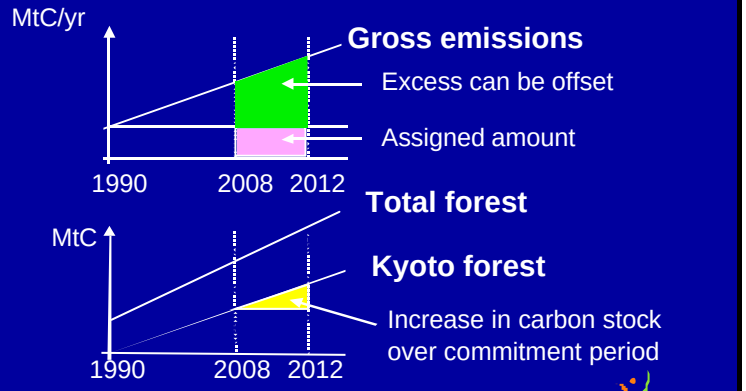
7

Kyoto Protocol: Gross Emission/Net Sequestration



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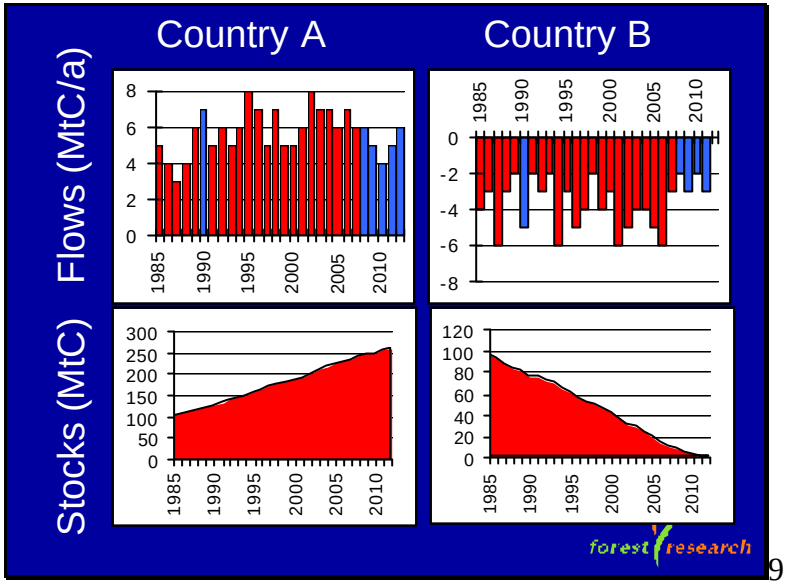
Country A
Country B
Flows (MtC/a)
Stocks (MtC)
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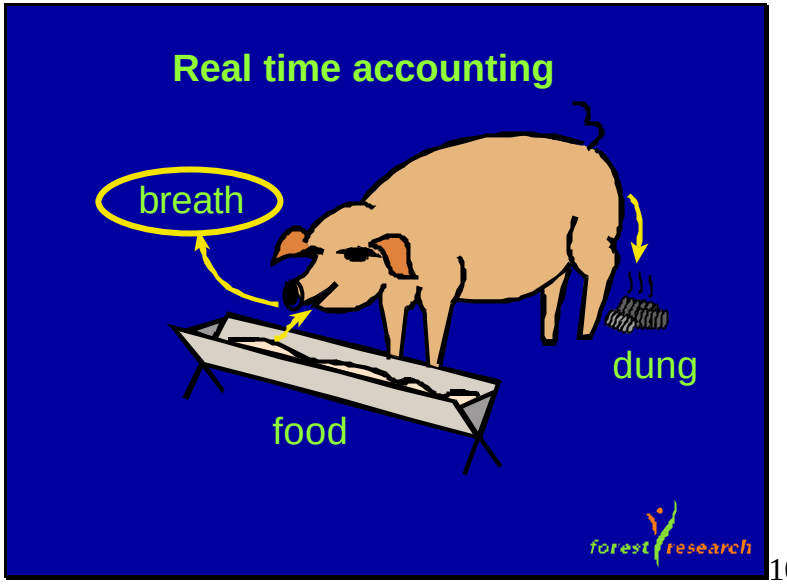
Real time accounting
breath
dung
food
forest research

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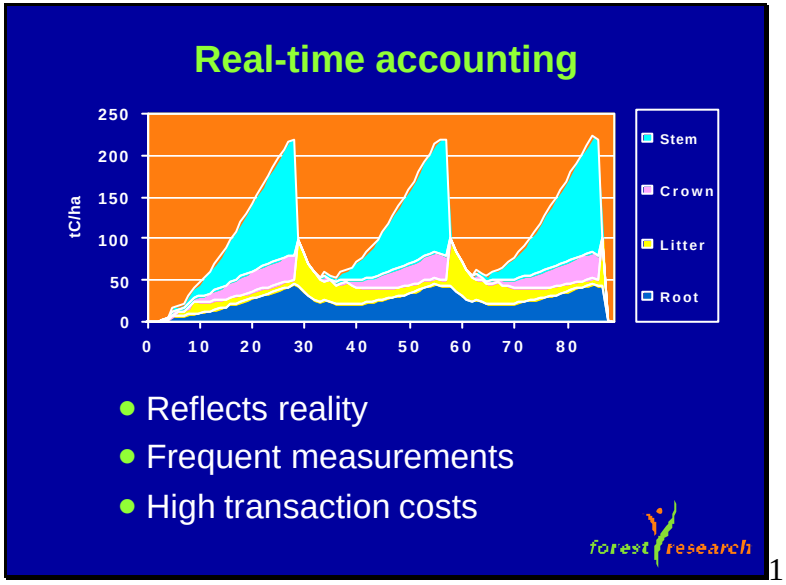
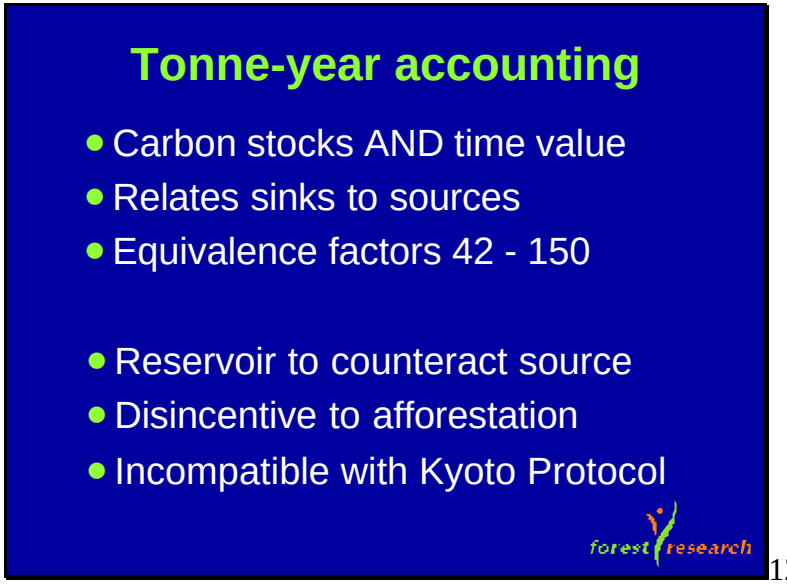

Real-time accounting
tC/ha
Stem
Crown
Litter
Root
Reflects reality
Frequent measurements
High transaction costs
forest research

11


Tonne-year accounting
Carbon stocks AND time value
Relates sinks to sources
Equivalence factors 42 - 150
Reservoir to counteract source
Disincentive to afforestation
Incompatible with Kyoto Protocol
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12 .

Tonne-year accounting

- Assume 50 year equivalence
- Sequestration to offset 1 tC emissions
  - 50 tC for 1 year = 1 tC for 50 years
- No penalty for biomass removal
- Continued use of same land/crop
- Potentially includes agricultural crops

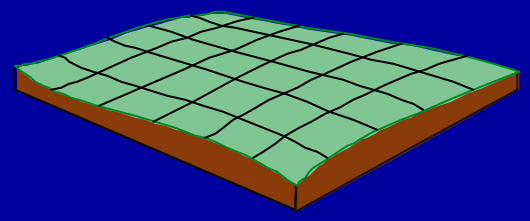
13

Carbon density accounting

- Afforestation mirrors deforestation and fossil fuel use
- Simple measurement and auditing
- Limited transactions
- Credits in arrears up to long-term average
- No transactions at harvest
- Debits for deforestation (equal credits)

14

Year 0



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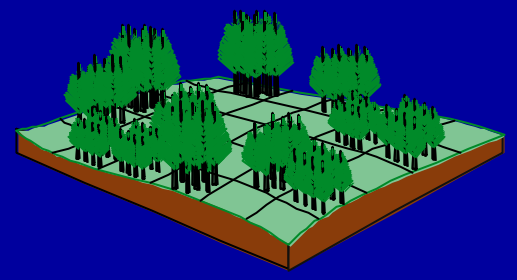
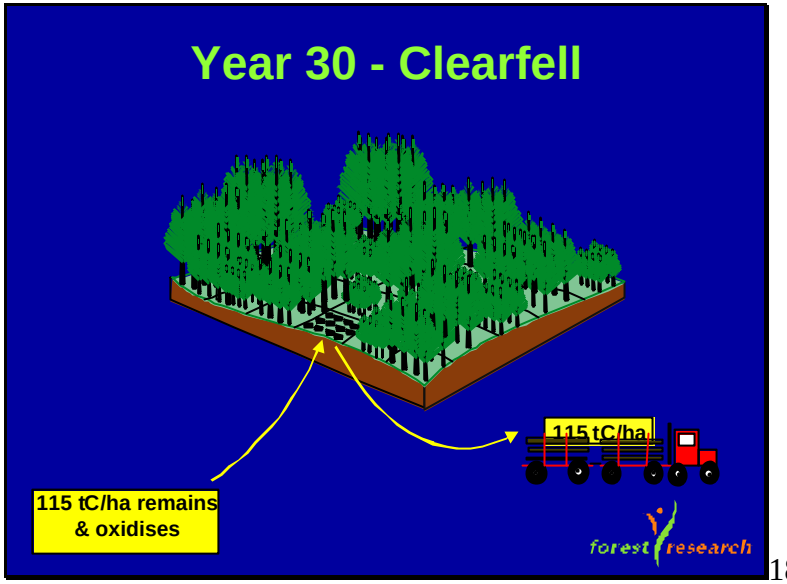
Year 10



16


Year 20
forest research

17


Year 30 - Clearfell
115 tC/ha
115 tC/ha remains & oxidises
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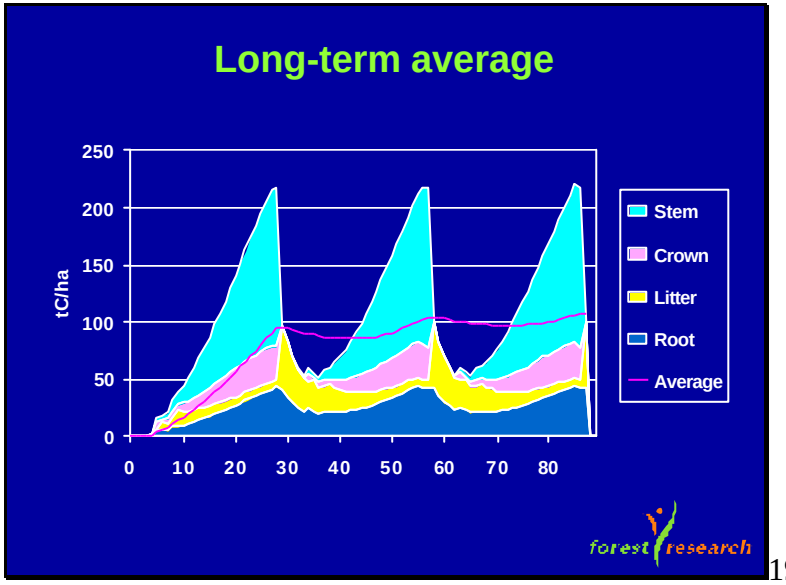
18


Long-term average
tC/ha
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
Stem
Crown
Litter
Root
Average
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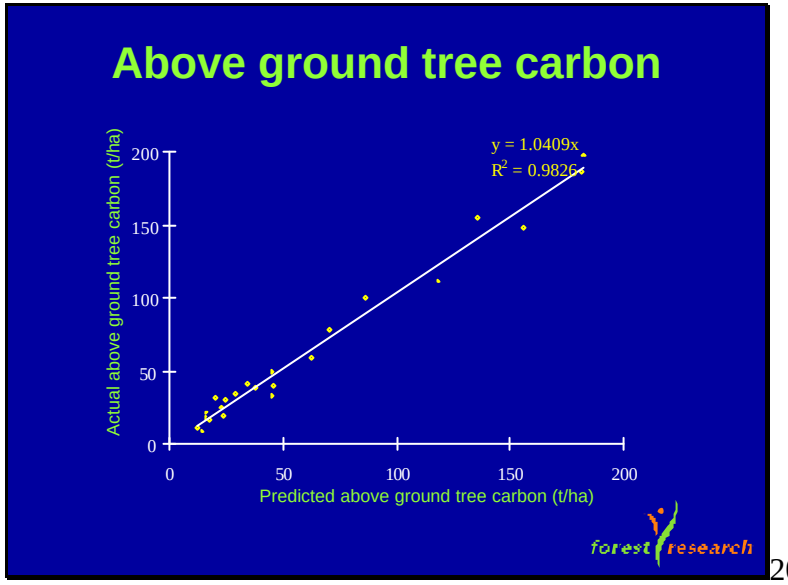
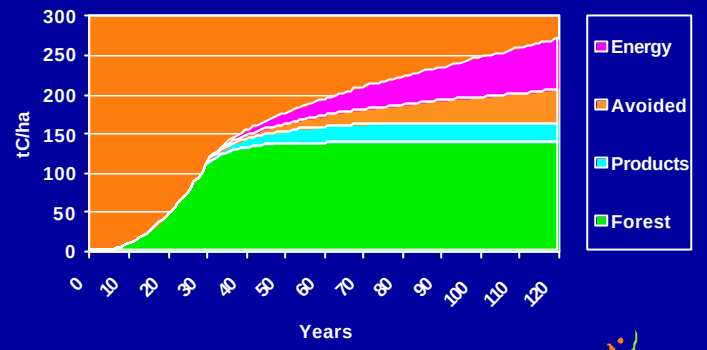
19


Above ground tree carbon
y = 1.0409x
R2 = 0.9826
Actual above ground tree carbon (t/ha)
Predicted above ground tree carbon (t/ha)
0
50
100
150
200
forest research

20

Long term benefits of sinks



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21

Summary

- Stock-based accounting preferred
- Real-time accounting impractical
- Tonne-year accounting flawed
- Carbon density accounting simple
- Sinks merely a step towards sustainable bioenergy

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22

Effectiveness of LULUCF carbon accounting methodologies in supportingclimate-conscious policy measures

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Tel. +44 1420 526235; Fax. +44 1420 23450; r.matthews@forestry.gov.uk

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Tel. +44 1597 860308; Fax. +44 1597 860381; heaton@UWEcoCen.demon.co.uk

ABSTRACT

Any methodology accounting for sinks and sources of carbon arising from land use, land use change and forestry activities needs to reconcile and address a number of scientific and political aspirations. Apart from a basic need for physical and logical consistency, the accounting system needs to directly support the ultimate policy goal of stabilising atmospheric greenhouse gas emissions, as well as ensuring equitable treatment of participating nations that have very different levels of vegetation cover and fossil fuel consumption. In addition, potential for conflict with international conventions on protection of forests and biodiversity must be avoided. There may also be a need to provide a system that can deliver consistent results and statistics at project level and national level.

A number of carbon accounting methods, with special reference to forestry systems, have been developed and articulated in the scientific literature including so-called 'one-off' accounting, annual or periodic accounting and the 'tonne-year approach'. Variants of these methodologies that are very different from each other may be specified, depending on the definition of system boundaries, so-called 'baselines' and the treatment of 'additionality'. The different methods may also use changes in vegetation-based carbon stocks or modelled impact on atmospheric carbon dioxide concentration as the fundamental unit of measurement.

This paper presents an analysis and evaluation of different accounting methodologies for the forestry sector, with particular focus on their likely impact at national and international level. The analysis is based on simplified 'thought experiments' using a hypothetical world comprised of four 'model' countries that vary in land area, percentage forest cover and consumption of fossil fuels. The relative impact of alternative methodologies on the potential carbon credits or debits accrued by the four model countries is assessed and compared with the actual impact on atmospheric carbon dioxide emissions over 100 years. An assessment is made of the effectiveness of different methodologies in underpinning alternative policy measures to stabilise greenhouse emissions at the national and international level. Policy measures considered include forest protection, expansion of forest cover and increased use of renewable bioenergy. Results suggest that simple accounting systems can be just as effective as elaborate accounting systems in supporting national efforts to meet emissions targets and equitable treatment of participants. The principle of this simple analysis of a model system is transferable to the real world and to a more detailed level of geographical and ecological definition.

EFFECTIVENESS OF LULUCF CARBON ACCOUNTING METHODOLOGIES IN SUPPORTING CLIMATE-CONSCIOUS POLICY MEASURES

Robert Matthews
Forest Research UK
Rebecca Heaton
Cardiff University

1

THE KYOTO PROTOCOL

- Aims to meet the UNFCCC objective to reduce concentrations of greenhouse gases in the atmosphere.
- Specifically includes vegetation-based sinks and sources, caused by Land Use, Land Use Change and Forestry (LULUCF).
- Commits 'Annex I' (generally industrialised) nations to specified, percentage-based reductions in anthropogenic greenhouse gas emissions.
- Tries to develop a role for non-Annex I (generally developing and transitional) countries (Clean Development Mechanism).

2

THE KYOTO PROTOCOL

This requires:

- Value of emissions for a reference year (1990) on which to base the percentage reductions (Article 3.7).
- Reliable annual estimates of fossil fuel emissions in years after 1990.
- Reliable annual estimates of LULUCF sinks/sources in years after 1990.
- Rules for deciding which LULUCF sinks/sources to include (Articles 3.3 & 3.4).

3

THE KYOTO PROTOCOL

- Estimation of fossil fuel emissions is relatively easy to define and agree.
- Estimation of LULUCF emissions is very complicated.
- IPCC Special Report on LULUCF has been commissioned to give advice.
- Stops short of a practical evaluation of the consequences for participating countries of different accounting methodologies.
- Opportunity needs to be seized.

4 .

OBJECTIVES OF THE STUDY

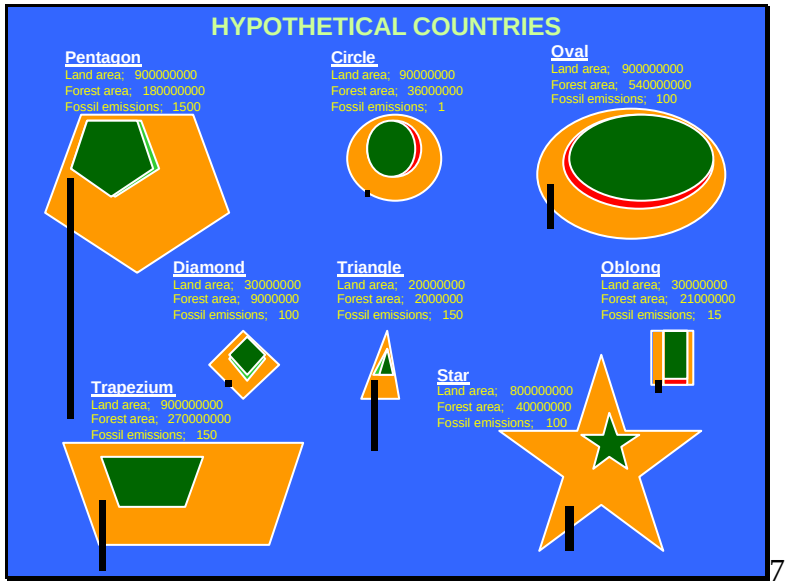
- To evaluate the impact of different LULUCF accounting methods on the reduction estimates reported by participating countries.
- To evaluate the effectiveness of different methods in achieving the UNFCCC and Kyoto objectives.
- To evaluate the impact of inclusion of LULUCF projects under the CDM.

5

METHODS

- Definition of model countries with different fossil fuel emissions and LULUCF sinks/sources.
- Limit analysis to emissions, sinks and sources of carbon.
- Limit LULUCF to forestry - define land in terms of
  - unexploited forest areas
  - exploited forest areas
  - non- forest areas.

6



7

METHODS

Initial position in 1990

- Assume all unexploited forest is ‘old growth’.
- Define age class structure for exploited forests.
- Use CARBINE for estimation of 1990 forest carbon stocks and projections for future years.
- Limit representation of forests to one species and one growth rate each for unexploited and exploited areas - same for all countries.

8 .

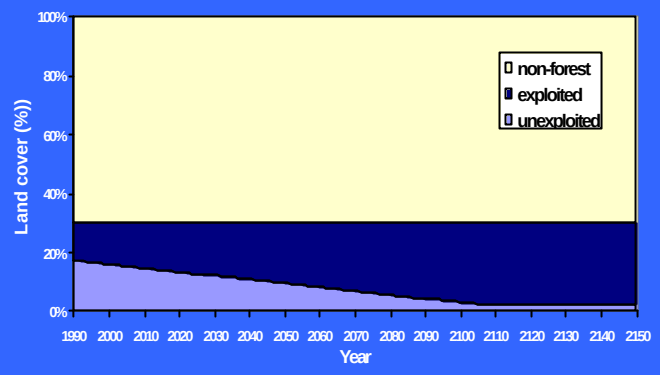
METHODS

Business As Usual (BAU) projection

- Projection period from 1990-2150.
- For 1990 define rates of change between land classes.
- Assume 1990 rates apply for projection period.
- Constrain:
  - forest area to minimum and maximum percentages of national land area
  - unexploited forest area to minimum percentage of national land area

9

Projected land cover in country Trapezium, BUSINESS AS USUAL



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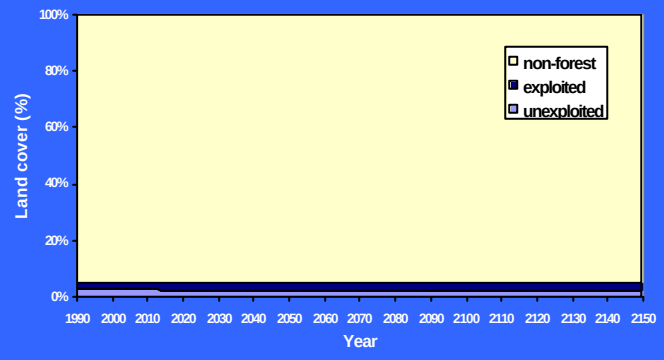
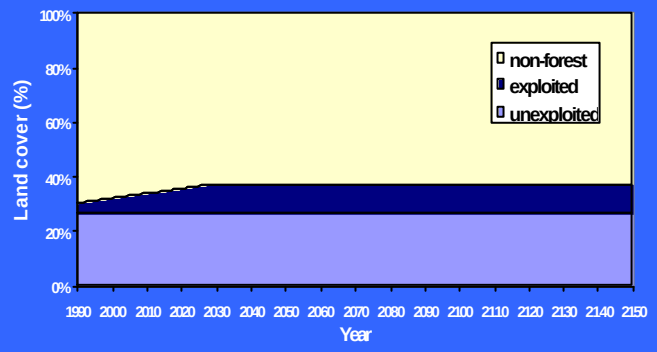
Projected land cover in country Star, BUSINESS AS USUAL



11

Projected land cover in country Diamond, BUSINESS AS USUAL



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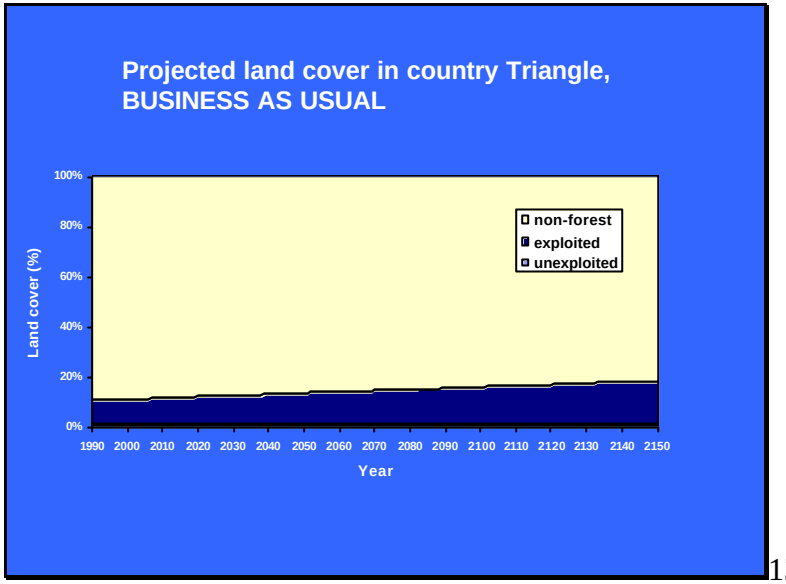
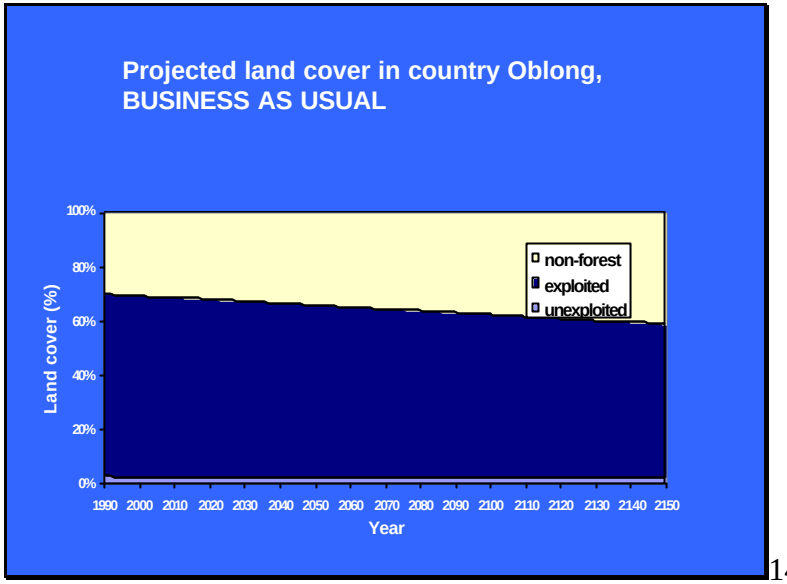
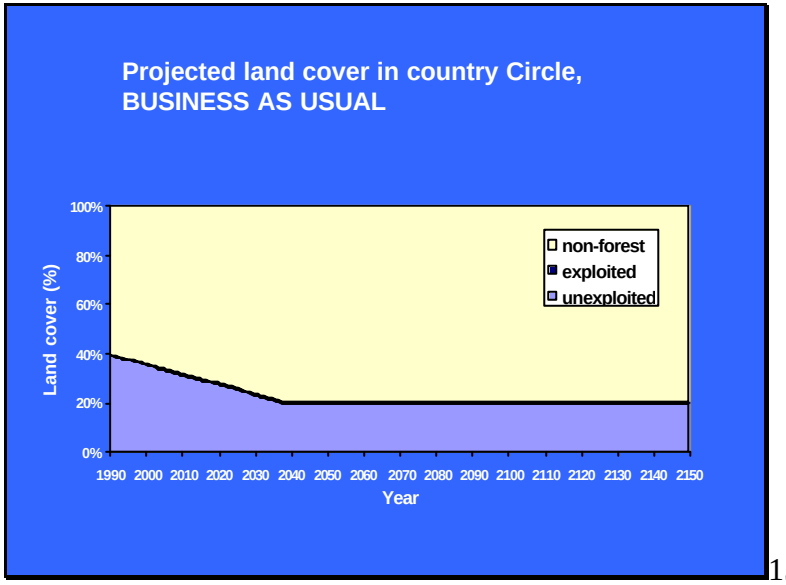

Projected land cover in country Triangle, BUSINESS AS USUAL
Land cover (%)
100%
80%
60%
40%
20%
0%
non-forest
exploited
unexploited
1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100 2110 2120 2130 2140 2150
Year

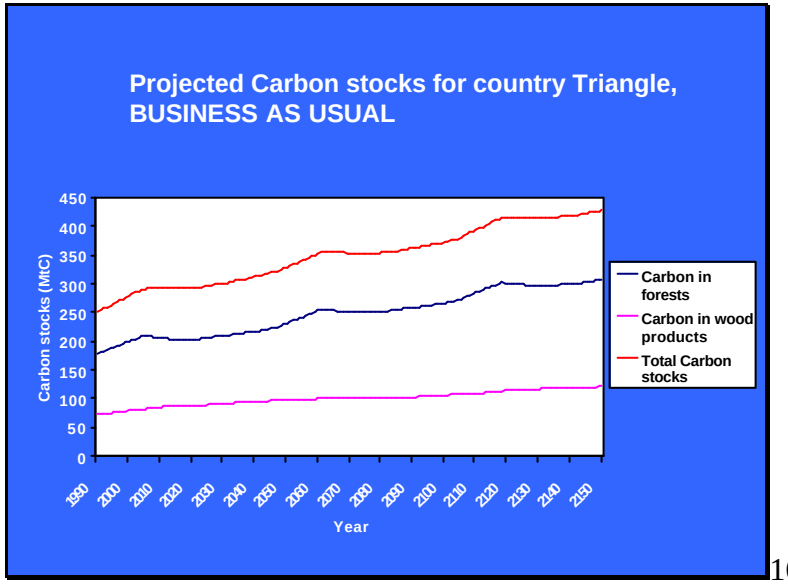
13


Projected land cover in country Oblong, BUSINESS AS USUAL
Land cover (%)
100%
80%
60%
40%
20%
0%
non-forest
exploited
unexploited
1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100 2110 2120 2130 2140 2150
Year

14

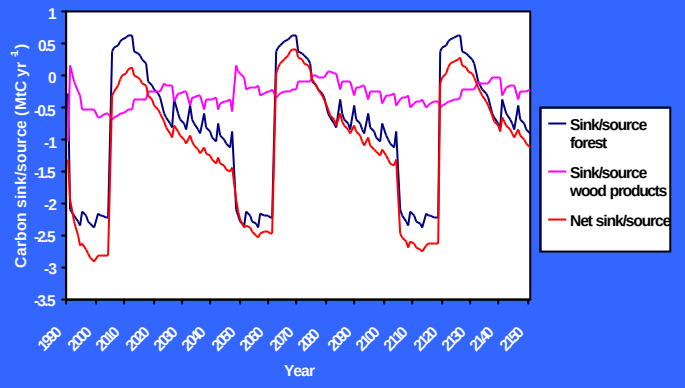

Projected land cover in country Circle, BUSINESS AS USUAL
Land cover (%)
100%
80%
60%
40%
20%
0%
non-forest
exploited
unexploited
1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100 2110 2120 2130 2140 2150
Year

15


Projected Carbon stocks for country Triangle, BUSINESS AS USUAL
Carbon stocks (MtC)
450
400
350
300
250
200
150
100
50
0
Carbon in forests
Carbon in wood products
Total Carbon stocks
1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100 2110 2120 2130 2140 2150
Year

16

Projected Carbon sink/source for country Triangle, BUSINESS AS USUAL



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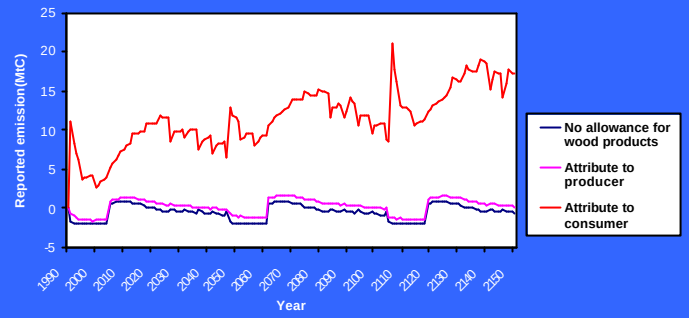
Projected Carbon sink/source for country Triangle, BUSINESS AS USUAL



18

METHODS

Accounting Rules

- Wood products:
  - don't include
  - attribute to consumer
  - attribute to producer
- Baselines:
  - zero
  - reference emission for 1990
  - CARBINE projection for 1990
  - CARBINE projection for BAU

19

METHODS

Accounting Rules and periods

- 1990 reference value
  - Net-net
  - Gross net
  - Article 3.7
- Accounting periods:
  - 2008-2012
  - 2013-2017
  - 2028-2032
  - 2058-2062
  - 2108-2112
  - 1990-2150

20

METHODS

LULUCF accounting indices

- Real time
- One-off
- Simple Kirschbaum *et al.*
- Kirschbaum *et al.*
- Tonne-year
- Jackson

21

METHODS

Scenarios (fossil fuel)

- BAU
- increase
- decrease
- increase then decrease
- decrease then increase

22

METHODS

Scenarios (LULUCF)

- BAU
- Increased deforestation
- Afforestation for sequestration
- Afforestation for substitution
- Increased deforestation, later reversed
  - by afforestation for sequestration
  - by afforestation for substitution
- Afforestation for sequestration, later reversed
- Conservation of exploited forests
- Exploitatation of unexploited forests

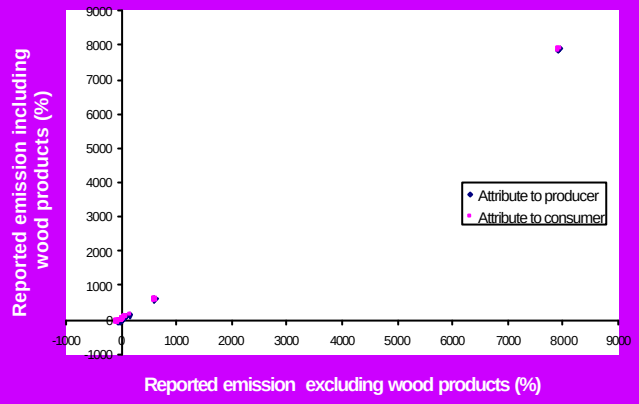
23

RESULTS

- Output is comprehensive and massive.
- Case for meta-analysis?
- Here are some examples …

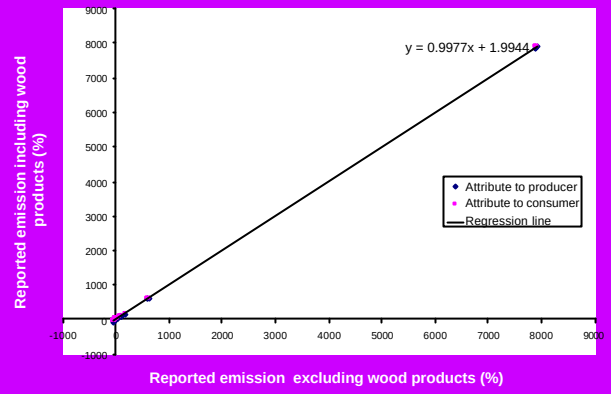
24

Accounting for wood products (BAU, real time index, all countries,base lines and reference values, first commitment period).



25

Accounting for wood products (BAU, real time index, all countries,base lines and reference values, first commitment period).



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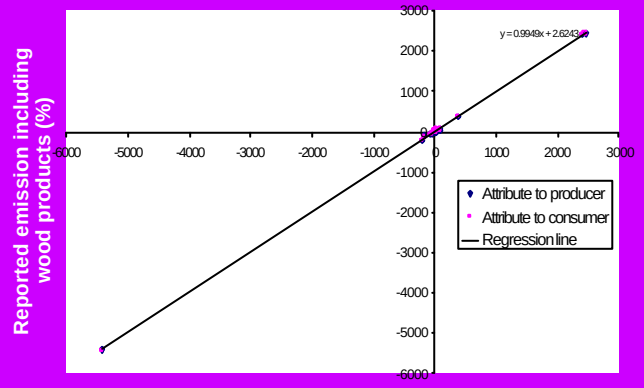
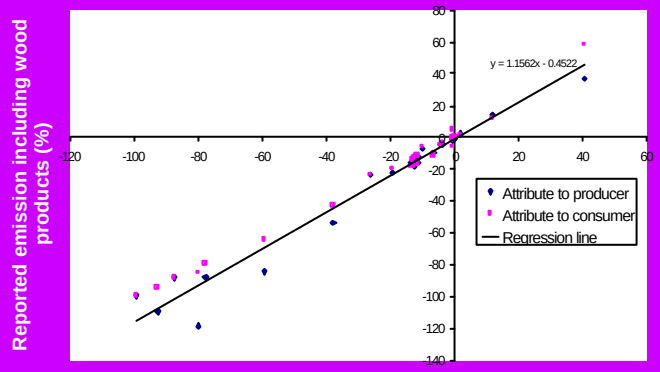
Accounting for wood products (BAU, real time index, all countries,base lines and reference values, period 1990-2150).



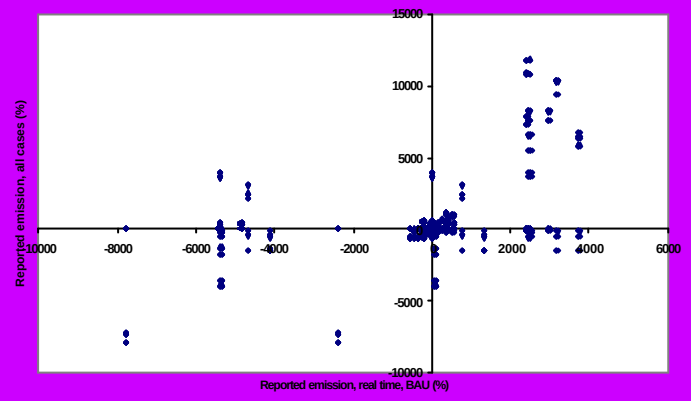
27

Accounting for wood products (BAU, Jackson index, all countries, base lines and reference values, first commitment period).



28

Comparison of reported emission reductions for different accounting indices against reference index (BAU, real time, all countries, base lines and reference values, first commitment period).



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CONCLUSIONS

- If LULUCF is to be included in the Kyoto Protocol, the accounting procedures can, indeed must, be kept as simple as possible, otherwise anomalous results and perverse incentives will arise.
- The potential role of bioenergy also needs to be safeguarded.
- Carbon sequestration in wood products not important at global level, of marginal importance for some countries.

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LIMITATIONS AND WEAKNESSES OF ANALYSIS

- Simplified forest structure underestimates differences between one-off and Kirschbaum *et al.* - scope for improvement.
- Trading in wood products over simplified - probably not important for sequestration, but needs improvement for substitution.
- Countries and scenarios artificial.
- Easy to get lost in detail - need to remember why we're doing this!

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STRENGTHS AND POTENTIAL OF ANALYSIS

- Analysis comprehensive and flexible.
- Analysis could be applied to real countries.
- Could combine with a model like REFUGE to estimate actual impact on CO_2 concentration.
- Results could be used to inform directly the deliberations and negotiations of the COP.

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Trees as carbon sinks and sources in the European Union

Liski J[1)]*, Karjalainen T[1)], Pussinen A[1)], Nabuurs G-J[2)] & Kauppi P[3)]

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[2)] Institute for Forestry and Nature Research, Postbus 23, NL-6700 AA, Wageningen, The Netherlands
[3)] Department of Limnology and Environmental Protection, P.O. Box 27, FIN-00014 University of Helsinki, Finland

ABSTRACT

The carbon (C) sinks and sources of trees that may be accounted for under Article 3.3 of the Kyoto Protocol during the first commitment period from 2008 to 2012 were estimated for the countries of the European Union (EU) based on existing forest inventory data. Two sets of definitions for the accounted activities, afforestation, reforestation and deforestation, were applied. Applying the definitions by the Food and Agricultural Organization of the United Nations (FAO), the trees were estimated to be a C source in 8 and a C sink in 7 countries, and in the whole EU a C source of 5.4 Tg year^{-1}. Applying the definitions by the Intergovernmental Panel of Climate Change (IPCC), the trees were estimated to be a C source in 3 and a C sink in 12 countries, and in the whole EU a C sink of 0.1 Tg year^{-1}. These estimates are small compared with the C sink of trees in all EU forests, 63 Tg year^{-1}, the anthropogenic CO_2 emissions of the EU, 880 Tg C year^{-1}, and the reduction target of the CO_2 emissions, 8 %. In individual countries, the estimated C sink of the trees accounted for under Article 3.3 was at largest 8% and the C source 12% compared with the CO_2 emissions.

Key words:

Kyoto Protocol, Article 3.3, carbon sink, carbon source, stock change, forest, CO_2 emission, afforestation, reforestation, deforestation.

Trees as carbon sinks and sources in the European Union

Jari Liski[1)], Timo Karjalainen[1)], Ari Pussinen[1)], Gert-Jan Nabuurs[2)] & Pekka Kauppi[3)]

[1)] European Forest Institute, Joensuu, Finland
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[3)] Department of Limnology and Environmental Protection, University of Helsinki, Finland

E U R O P E A N F O R E S T I N S T I T U T E 1

Outline

1 Introduction
- "Kyoto forests" (Article 3.3)

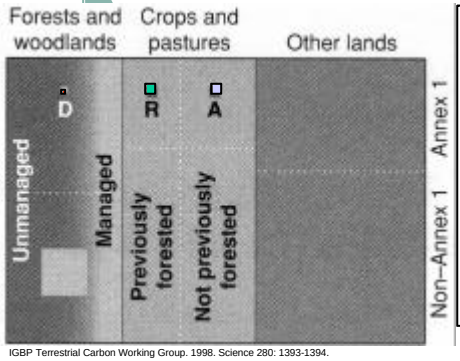
2 Material and methods
- definitions, calculations, data

3 Results
- whole EU, countries
- area, carbon
- ARD lands, all forests, CO2 emissions

4 Summary and Conclusions

E U R O P E A N F O R E S T I N S T I T U T E 2

Kyoto forests



IGBP Terrestrial Carbon Working Group. 1998. Science 280: 1393-1394.

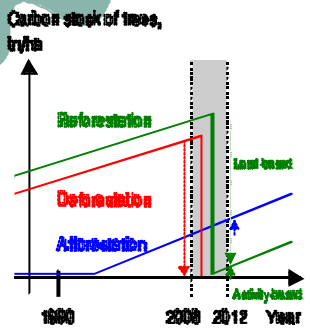
Objectives of the present study
to estimate in EU countries
•the area of the ARD lands
•the carbon balance of trees on the ARD lands

to relate the area and the balance to
•all forests
•CO_2 emissions

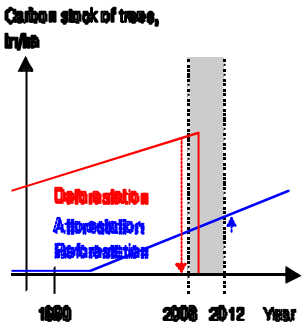
E U R O P E A N F O R E S T I N S T I T U T E 3

Applied definitions of ARD

FAO

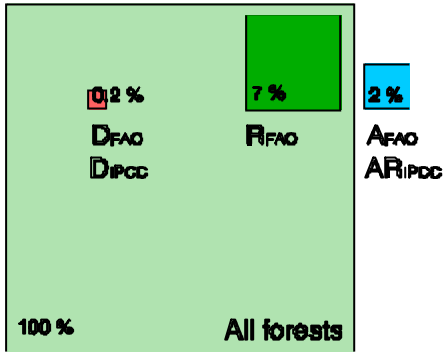


IPCC



E U R O P E A N F O R E S T I N S T I T U T E 4 .

Forest and ARD areas in the EU



Liski, J. *et al.* 2000. Trees as carbon sinks and sources in the European Union. Environmental Science & Policy 3: 91-97.

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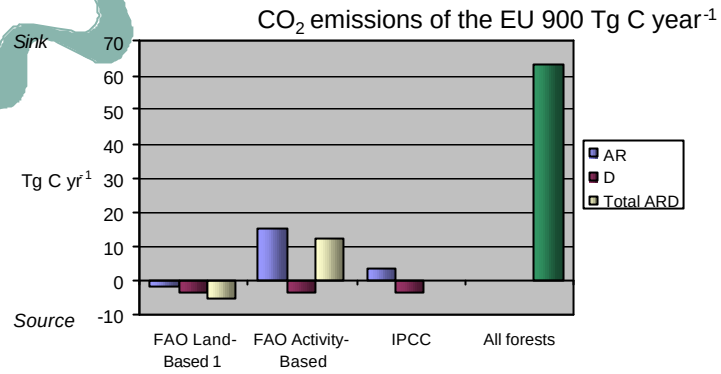
Carbon balance of trees in the EU



Liski, J. *et al.* 2000. Trees as carbon sinks and sources in the European Union. Environmental Science & Policy 3: 91-97.

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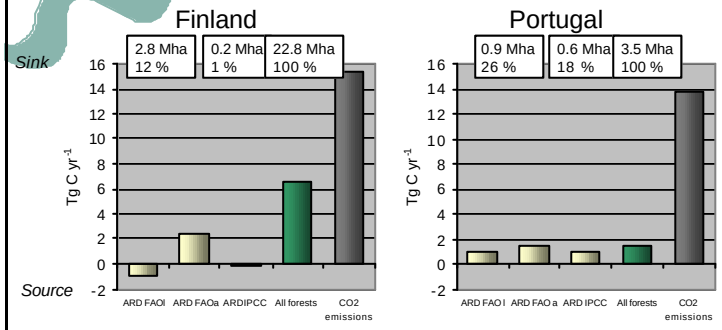
Carbon balance of trees in different countries



Liski, J. *et al.* 2000. Trees as carbon sinks and sources in the European Union. Environmental Science & Policy 3: 91-97.

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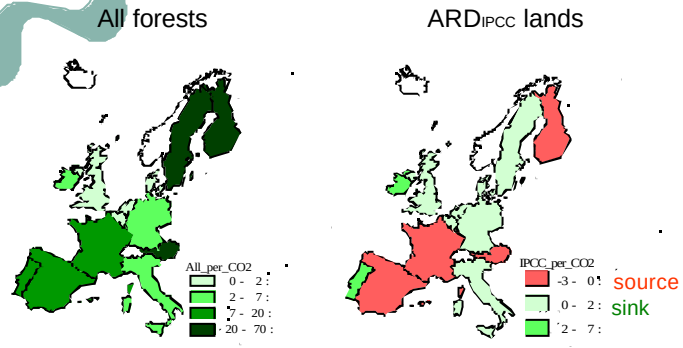
Carbon balance of trees per CO_2 emissions



Liski, J. *et al.* 2000. Trees as carbon sinks and sources in the European Union. Environmental Science & Policy 3: 91-97.

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Summary

In the whole EU

- the area of the ARD lands 2 to 9 % of all forest area
- trees on the ARD lands a sink, a source or neither
- the sink or the source on the ARD lands at largest up to a few % of the carbon sink of trees in all forests and a few ‰ of the CO_2 emissions
- the carbon sink of trees in all forests 7 % of the CO_2 emissions

In individual countries

- where the carbon sink of all trees is small, much of it can be on the AR lands
- where the carbon sink of all trees is large, little of it is on the AR lands

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Conclusions

The carbon balance of trees on the ARD lands

- the sink as large as the targeted emission reduction in a few countries, considerable source in a few others
- Article 3.3 may be relevant in these few countries for the management of these lands, probably <1-2 % of EU forests

The carbon sink of trees in all forests

- as large as the targeted emission reduction of the EU
- a result of the expansion of biomass on the existing forest area
- therefore, not accounted for under Article 3.3
- Article 3.3 irrelevant for its management
- may become accounted for under Article 3.4 (“additional activities”)

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Domestic options for carbon management

Doug Bradley, Domtar Inc, Canada

Domestic Options for Carbon Management

Task Force 25
Joensuu, Finland
Sept 28, 2000

Doug Bradley
Domtar

1 1

Kyoto- In vs Not yet in

IN KYOTO			NOT YET IN KYOTO
Fossil Fuel Reduction		Carbon Sequestration	
Energy Efficiency	Fuel Switching (Biomass for fossil fuel)	Afforest., Reforest Deforestation	Other Forestry, Agricultural Activities
Reduce fossil fuel	Reduces fossil fuel	Sequesters carbon (defn. - Article 3.3)	Sequesters carbon (negotiated- Article 3.4)

Examples:

-Fuel efficient motors
-Waste heat capture
-Prod'n enhancemt
-Improved Maint.

-Wood waste cogen
-Black liquor integrated gasific. and combined cycle cogen

-Planting on poor agric. land
-Reducing deforestation

Forestry:
-Pest and disease control
-Fire control
-Commercial thinning
-Juvenile Spacing
-Tree Improvment
- Reduc. impact logging

Agricultural:
-Reduced tillage
-Manure management
-Shelterbelts

2 2

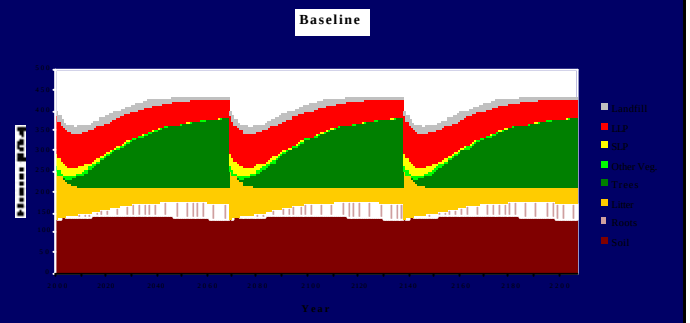
Carbon Impacts of Emission Reduction Activities

	Initial	Long Term
Forestry:		
Juvenile spacing	emission	sequestr.
Pest spray	sequestr.	sequestr.
Tree Improvement	sequestr.	sequestr.
Commercial thinning	emission	sequestr.
Fertilization	emission	sequestr.
Other:		
Landfill Incineration	emission	sequestr.

3 3

Natural Jack Pine Forest (Baseline)

Forest and Products Carbon Pools
Gorcam model



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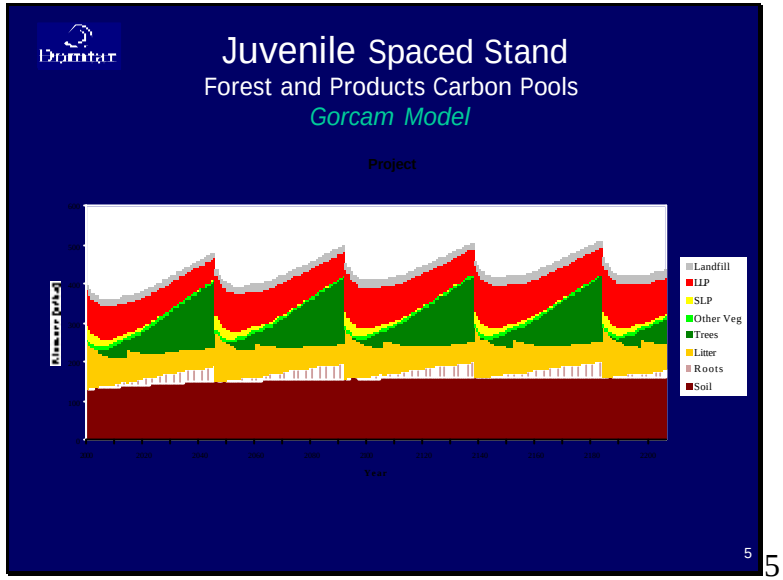
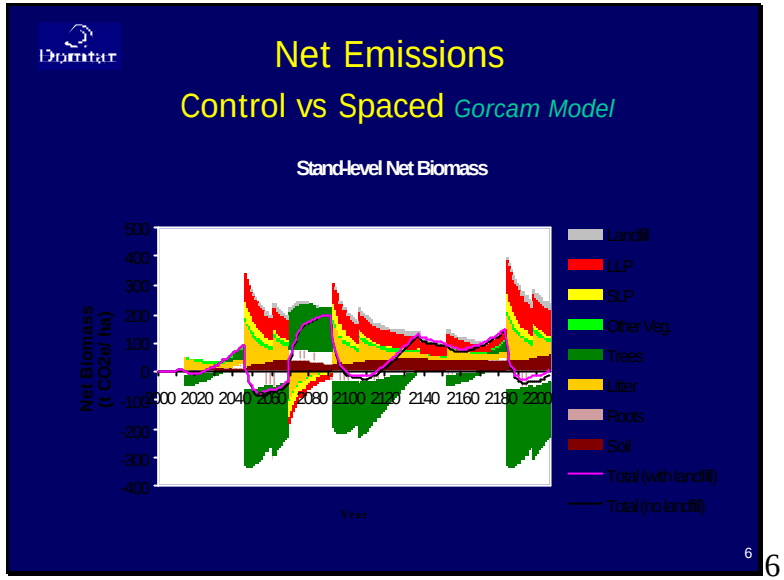
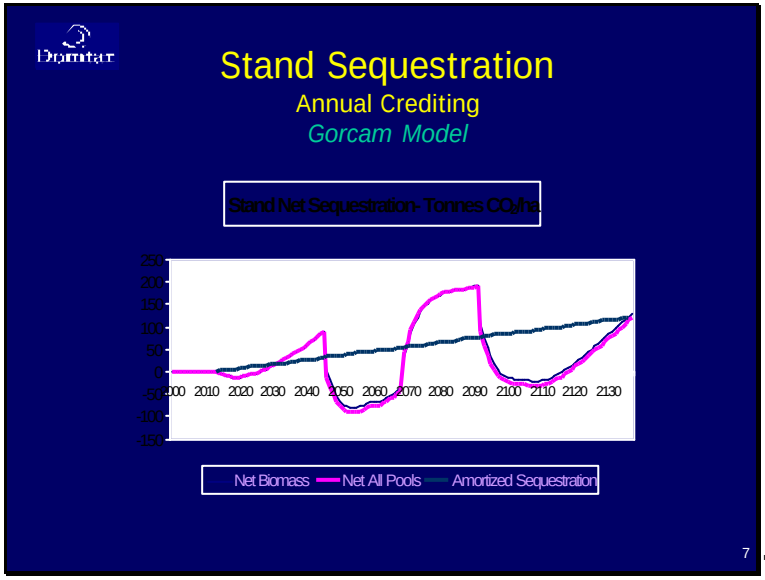

Domtar
Juvenile Spaced Stand
Forest and Products Carbon Pools
Gorcam Model
Project
Landfill
LLP
SLP
Other Veg
Trees
Litter
Roots
Soil
Year
5

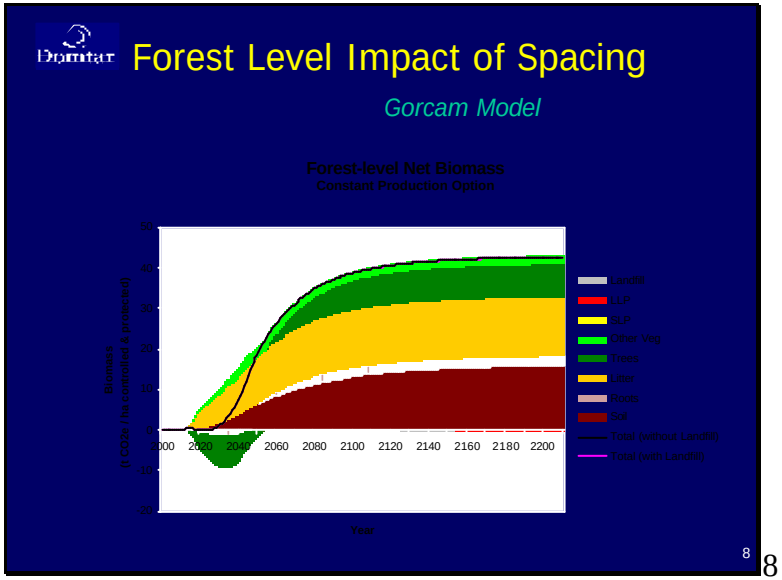
5


Domtar
Net Emissions
Control vs Spaced Gorcam Model
Stand-level Net Biomass
Net Biomass (t CO2e/ ha)
Landfill
LLP
SLP
Other Veg.
Trees
Litter
Roots
Soil
Total (with landfill)
Total (no landfill)
Year
6

6


Domtar
Stand Sequestration
Annual Crediting
Gorcam Model
Stand Net Sequestration- Tonnes CO2/ha
Net Biomass
Net All Pools
Amortized Sequestration
7

7


Domtar
Forest Level Impact of Spacing
Gorcam Model
Forest-level Net Biomass
Constant Production Option
Biomass (t CO2e / ha controlled & protected)
Landfill
LLP
SLP
Other Veg
Trees
Litter
Roots
Soil
Total (without Landfill)
Total (with Landfill)
Year
8

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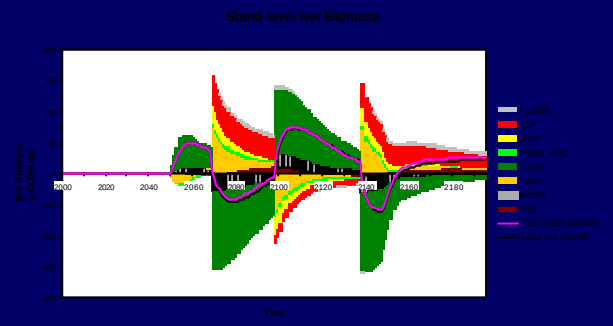
Bud Worm Spray Program

Gorcam Model



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Early Crediting

Can governments become "carbon managers" using an early crediting system, for the long term good of the atmosphere?

How would the system work?

What incentive would it provide?

10

10

Early Credit to a Juvenile Spacing Program

(tonnes CO_2e)

	2000-10	2010-20	2020-30
Actual Sequestration	(5)	25	40
Credits	5	15	40
Net	(10)	10	0

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Example of Early Crediting System

	1990	2000	2010	2020	2030
Emissions	604	700	764	764	764
Forestry Offsets					
Spacing		0	2	(25)	(40)
Thinning		0	3	(8)	(14)
Tree Improve		0	(2)	(24)	(44)
Pest Control		0	(6)	(6)	(6)
		0	(3)	(63)	(104)
Net Emissions	604	700	761	701	660

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Carbon Management via Incentives (amortization)

	2000-05	2005-10	2010-15	2015-20	total
Base Emissions	700	720	690	640	2750
With Amortization:					
Credits given	-10	-10	-10	-30	-60
Book Emissions	690	710	680	610	2690
Actual reductions	0	-10	-20	-30	-60
Actual Emissions	700	710	670	610	2690

13 13

Risks of Early Crediting

- Issuing credits if forests don't count in Kyoto II
- Issuing credits where benefits are over-estimated
- Issuing credits where benefits never happen
- Excess credit liability

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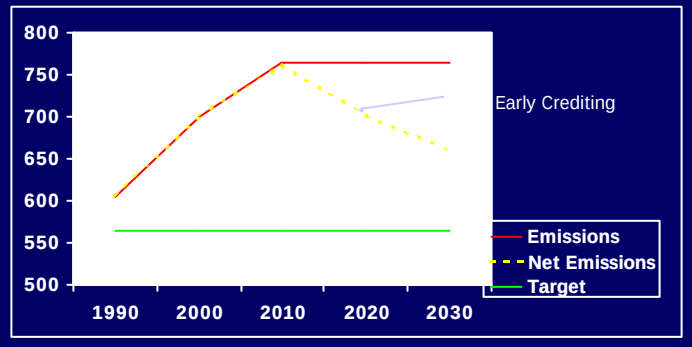
Benefits to Early Crediting

- Implement many more projects than would otherwise happen
- Wider range of options to reach Kyoto targets
- Allows least cost solutions
- Doesn't cost government money, just paper credits
- Government becomes manager of carbon

15 15

Countries Net Enissions



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Addressing COP6 Decisions on Agricultural Soil Carbon Accumulation

Susan Subak

American Association for the Advancement of Science Fellow
Office of Atmospheric Programs, U.S. Environmental Protection Agency

ABSTRACT

The Kyoto Protocol introduces the possibility that changes in carbon stock on agricultural and forest land and soils may be counted against countries' commitments to reduce their greenhouse gas emissions. Including activities related to land use change and forestry in the international climate change agreement may stimulate new incentives for soil-conservation practices domestically. However, a primary criteria for their inclusion relates to the level of accuracy and transparency with which carbon stock changes can be assessed. Parties will also be concerned with the wider environmental impact of different sequestration practices, and the impact of offsets on overall emissions targets. This paper examines these issues for agricultural soils, considering recent research in temperate regions. It is argued that incentives for carbon sequestration practices may need to be implemented independently of actual stock changes because farm-level soil monitoring would be very costly. Priority should be given to establishing incentives for cover crops and to expanding conservation tillage programs. These activities provide a range of ancillary environmental benefits. In contrast, improvements in biomass yield tend to rely on higher fertilizer inputs with their related environmental costs. Carbon accumulated through any of these activities is easily lost if the practices are discontinued, and so assessment procedures are needed that would avoid overestimating sequestration. Annual accumulation in agricultural soils could be equivalent to about 10% of Annex I carbon dioxide emissions, and therefore options for limiting sink credits from soils should be considered.

ADDRESSING COP6 DECISIONS ON AGRICULTURAL SOIL CARBON ACCUMULATION

Dr. Susan Subak
Fellow, American Association for the Advancement of Science

Based at: Office of Atmospheric Programs
U.S. Environmental Protection Agency
Washington DC

subak.susan@epa.gov

In the United States, a strong constituency for including agriculture soils in the Kyoto Protocol

A. Support among U.S. "Conservatives"
Midwestern farmers and Republican Members of Congress have been supporting the idea of rewarding carbon sequestration on American farmland, although potential is small (~ 0.1 t C/ha/year for conservation tillage; ~ 0.3 t C/ha/year for cover crops)

B. Some support among U.S. environmental organizations
Viewed as environmentally beneficial because practices that sequester carbon in soil tend to prevent soil erosion and reduce requirements for fertilizer. Viewed to be less of a loophole than forests because potential sequestration is relatively small for Annex I.

Considerations for COP6 and Beyond: Additionality Verifiability Reversibility Indirect Effects

Sources and Sinks of Carbon from Agricultural Soils

	Sources	**Sinks**
Transformations	• Croplands from wetlands • Croplands from grasslands • Croplands from natural ecosystems	• Set-aside (to grassland or woodland)
Production	• Lower residue yield (may be due to fertilizer inputs or genetic improvements) • Change to crop types with lower biomass levels • Lower lignin content crops • Longer fallow	• Higher residue yields • Change to crops with higher biomass levels (agroforestry or certain crop switching to e.g. from soybeans to corn) • Higher lignin content crops • Shorter fallow
Soil conservation	• Intensive till • Residue (straw) sales • Stubble burning	• No-till or minimum till • Residue incorporation into soils • Cover crops (inter-row with perennials; or winter cover for annuals) • Control of soil water
Other	• liming	• Animal manure or sewage sludge storage

Other Environmental Impacts of Agricultural Management

	Positive	Negative
Crop and residue yield increase through fertilizer inputs		• Nitrous oxide emissions from nitrogen fertilizers (Mosier et al., 1995) • Fossil fuel energy inputs to produce nitrogen fertilizer • Reduced soil uptake of methane after nitrogen fertilizer use (Stendler, 1989; Bronson and Mosier, 1993 cited in Paustian 1995) • Methane emissions related to organic fertilizer application • water pollution
Soil conservation practices		
Cover Crops	• Nitrogen-fixing crops especially reduce requirements for fertilizer • Some species can reduce requirements for pesticides (Pan, 1999) • Reduce emissions of particulates by reducing wind erosion	
No-till	• Reduces soil erosion • Reduces fertilizer consumption • Reduces fossil fuel emissions from tractors • May reduce nitrous oxide emissions (Li, et al., 1996)	• May reduce the rate of methane consumption (Cole et al., 1993) • Increased herbicide use • May increase nitrous oxide emissions (Cole et al., 1993)

1. Additionality: Can Business-as-Usual tons be identified?
   - A. In excess of 1990 sequestration
   - B. In excess of 1990-2008 trend
   - C. Best practices applied to any activity
   - D. Best practices defined as certain activities (e.g. cover crops)

US additionality test in the CDM (September 2000):

"the project activity achieve a level of performance…that is significantly better than average compared with recently undertaken activities or facilities"

Lands under no-till in the USA increased by more than four-fold between 1989 and 1997

Carbon Uptake in Agricultural Soils: Recent Estimates

USA	9 MT (net)	1998	US Inventory (Eve et al., 2000)
	9 - 24 MT C/yr (net)	2008-2012	Business as Usual: August 1, 2000 submission
	~ 50 MT C/yr	potential	Donigian et al., 1994
	~ 30 MT C/yr	recent extr.	Buyanovsky and Wagner, 1998
Europe	---------	2008-2012	August 1, 2000 submission
	43 MT C/yr	potential	Smith et al., 1998
FSU	340 MT C/yr	potential	Kolchugina et al., 1995

2. Verifiability: Will the uncertainties be manageable?

A. Site (farm) specific sampling and verification?
B. Model-based analysis with some sampling

Monitoring

Farms in USA	~ 2 million
Total Cropland	~100 million hectares
Sampling frequency in 1990s	1 in 60 hectares
Recommended frequency for basic soil tests	1 in 2-8 hectares
Estimated % of farms survey in the 1990s	< 10%
% of farmers now taking own samples	1-2%
Estimated cost per sample	$50-$75
Cost for sampling every 10 hectares in 2008, 2012	>$1 billion
Cost per tonne sequestered assuming 30 MT C accumulation	$33/tonne

3. Reversibility: Approaches for addressing reversal of soil sequestration
    A. Expiring Tons
    B. Stock Change - Liability, with insurance
    C. Ton-Year Accounting

    Probably the same considerations exist as for forests: Liability, availability and rates of insurance, uncertainties for future CER prices.

4. Indirect Effects: Can human induced effects be separated from natural effects?
    A. Control plots to sites
    B. Adjustments based on model factors, i.e. crop type, regional climate

    Possible that adjustments for indirect effects exclude agricultural crops because of minor implications for total uptake term

Recommendations for Further Research

1. Better research on residue yields needed
2. Research on the non-carbon impacts of agricultural soil activities
3. Continued research on indirect effects (temperature, CO_2 fertilization etc.)

Components of an Incentive Program

1. Include farms that are not considered “highly erodible”
2. Provide incentives for increasing residue, rather than crop yields
3. Encourage long-term, rather than short-term, activities
4. Provide incentives for establishing and maintaining cover crops
5. Continue programs to encourage conservation tillage

Measuring and marketing carbon sequestration in planted forests in New South Wales, Australia

Annette Cowie and Keith Lamb
State Forests of New South Wales, Australia.

ABSTRACT

The Kyoto Protocol to the Framework Convention on Climate Change has established carbon as a tradeable commodity, offering financial returns from "carbon credits" to increase management flexibility and profitability of forestry. Australia has large areas of agricultural land suitable for developing Kyoto compliant plantations, where reforestation can provide multiple environmental and social benefits including amelioration of dryland salinity, biodiversity enhancement and diversification of rural incomes. Consequently, the NSW State Government has taken action to facilitate the expansion of planted forests, including legislative reforms to support bilateral contractual carbon trades and a proposed derivatives market for trading carbon credits.

State Forests of NSW, a government-owned trading enterprise, has attracted new investment in Kyoto compliant forests from companies wishing to take early action in anticipation of enforcement of emissions controls. Investors retain the rights to the wood and carbon arising from the new forests and hedge the speculative carbon right against the conventional wood-based returns from existing industry.

To support carbon trading, State Forests has developed a draft Carbon Accounting Standard that allows carbon credits to be quantified in a transparent and verifiable manner. The draft Standard takes a qualitative systems approach to limit the exposure of growers to the risk of overselling, specifying three levels of certification to reflect different levels of sophistication and investment in carbon accounting. Further developments will see the standardisation of procedures for quantitatively appraising uncertainty in forecasts.Verification and certification of tradeable carbon will then be appraised on growers' management competence and risk handling procedures.

State Forests' carbon accounting system for hardwood (eucalypt) plantations is based on conventional inventory and modelling systems for wood production, and tracks the carbon stocks in above and below-ground tree biomass, understorey, litter and soil pools. Current research is focussed on efficient derivation of biomass allometrics, soil carbon dynamics under afforestation and management of forests for joint carbon-wood production.

Financial modelling reveals that incorporating a market price for carbon into the joint carbon-wood production possibility frontier increases NPV. Forward selling will alleviate early negative cash flow, although the buy price is likely to include a discount for the cost of long term capital investment (up to 2012), and the risk of non-ratification by Annexe B countries. Profits will be higher for those who can distribute the growing costs between wood and carbon, however growers will face the risk of adverse movements in the carbon-wood price ratio.

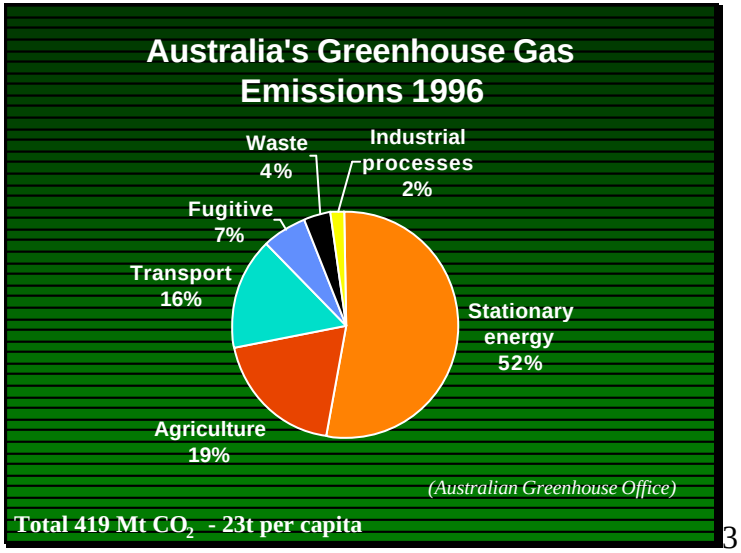
A key issue is the handling of risk and uncertainty as the greenhouse policy agenda evolves. Forestry is low-risk financially efficient option for directing greenhouse-related investment until the accounting rules are agreed and the Kyoto Protocol enters into force. Success of the carbon trading market will depend on confidence in the product that is underpinned by a sound knowledge of forest carbon dynamics, defendable carbon accounting procedures and competent forest management.

1

Content

- Carbon trading in NSW
- Carbon accounting - project scale
  - monitoring carbon sequestration in NSW plantations
- Creating a carbon credit product
  - Carbon accounting standard
- Marketing sequestered carbon
- Managing for carbon and wood production

2



3

Opportunities for Forestry

- Carbon trading from conventional planted forests
- Environmental, rehabilitation planting
- Timber as a greenhouse-friendly building product
- Biomass for bioenergy, substituting for fossil fuels

4 .

Bioenergy options for forest biomass

- stand-alone
- co-firing with coal
- supplementing bagasse
- ethanol
- charcoal for metallurgical processes

5

National

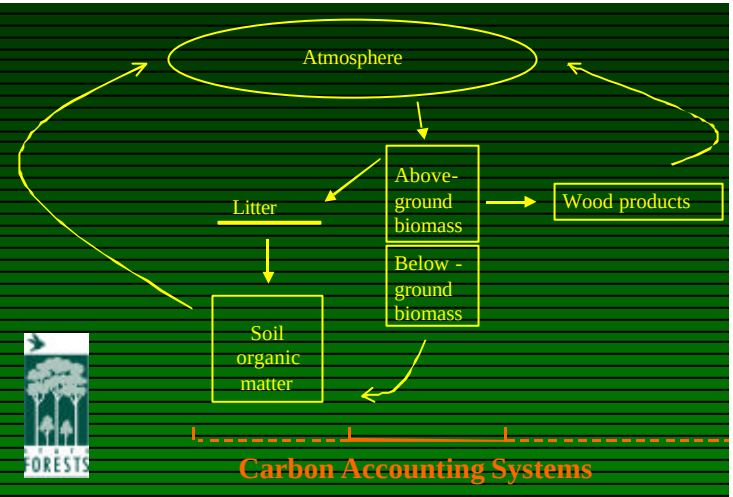
- National Greenhouse Strategy
- Australian Greenhouse Office
  - National Carbon Accounting System
  - Determining 1990 baseline emissions
- Renewables legislation

6

NSW - State Forests Carbon Trading Activities

- Carbon Rights Legislation Amendment Act 1998
  - legal recognition of ownership and trade of carbon rights
- First Australian carbon trades
  - Pacific Power, Delta Electricity
- Carbon trade with Tokyo Electric Power Co
- Sydney Futures Exchange
  - Carbon Accounting Standard

7



Measuring Carbon Sequestration in Forests

8 .

Measuring Carbon Sequestration in Forests

- measuring and modelling procedures linked to existing wood production management systems
- expansion factors for other major carbon pools
- new approaches using process-based models

9

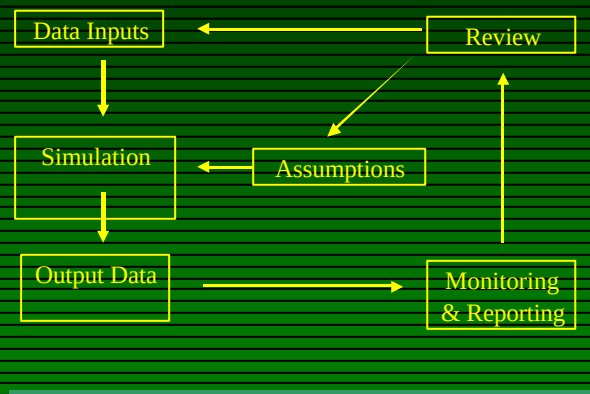
Key features of a carbon accounting system:

- robust and cost effective
- transparent
- compatible

Carbon accounting systems will be scrutinised.

10

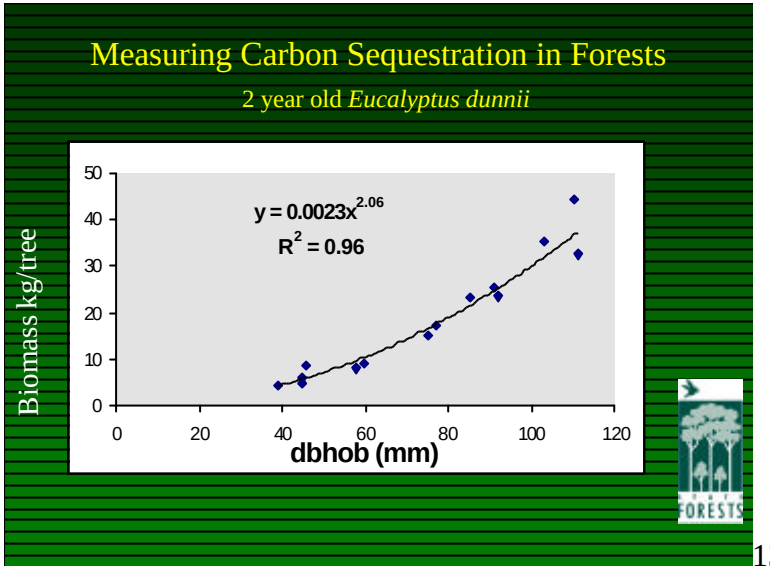
Components of a Carbon Accounting System



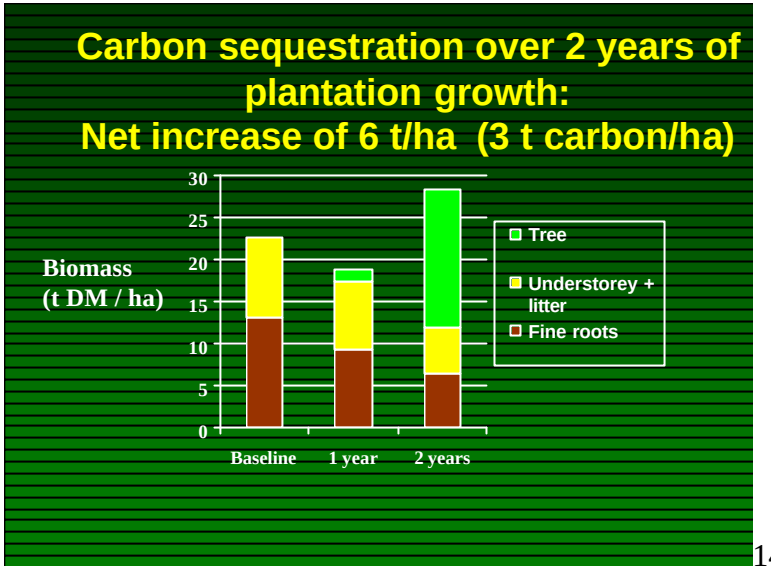
11

Biomass measurement in *E. dunnii* plantation
Aim: To develop allometric equation relating biomass to standard inventory measurements.

12 .


Measuring Carbon Sequestration in Forests
2 year old *Eucalyptus dunnii*
y = 0.0023x^2.06
R^2 = 0.96
Biomass kg/tree
dbhob (mm)
0
10
20
30
40
50
0
20
40
60
80
100
120

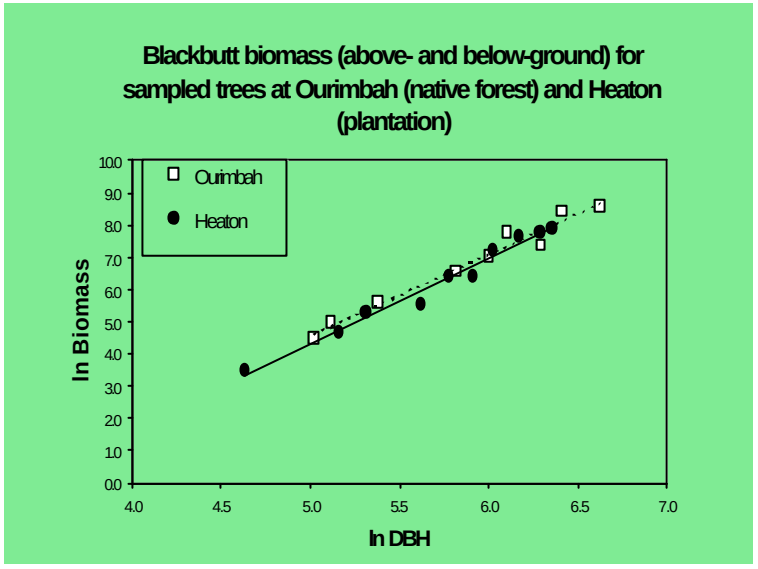
13


Carbon sequestration over 2 years of plantation growth:
Net increase of 6 t/ha (3 t carbon/ha)
Biomass (t DM / ha)
0
5
10
15
20
25
30
Baseline
1 year
2 years
Tree
Understorey + litter
Fine roots

14

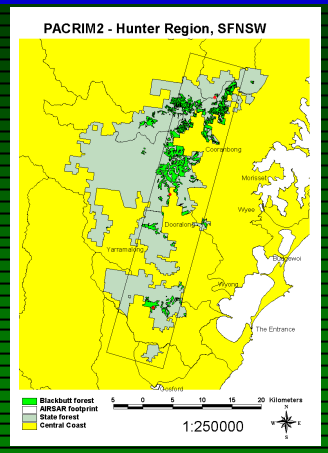

Weighing *E. pilularis*, using 2.5 t load cell, Ourimbah State Forest.

15


Blackbutt biomass (above- and below-ground) for sampled trees at Ourimbah (native forest) and Heaton (plantation)
Ourimbah
Heaton
ln Biomass
ln DBH
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
4.0
4.5
5.0
5.5
6.0
6.5
7.0

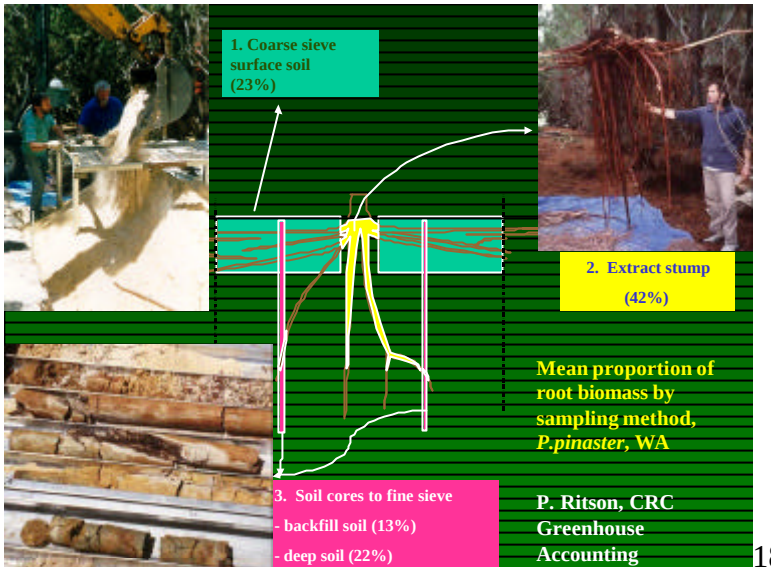
16

Remote-sensing tools to estimate carbon



- species recognition
- area estimation (planted - harvested)
- direct biomass estimation
- height measurements

17

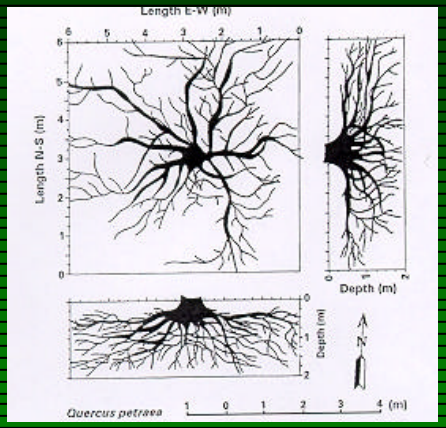


Mean proportion of root biomass by sampling method, *P.pinaster*, WA

P. Ritson, CRC Greenhouse Accounting

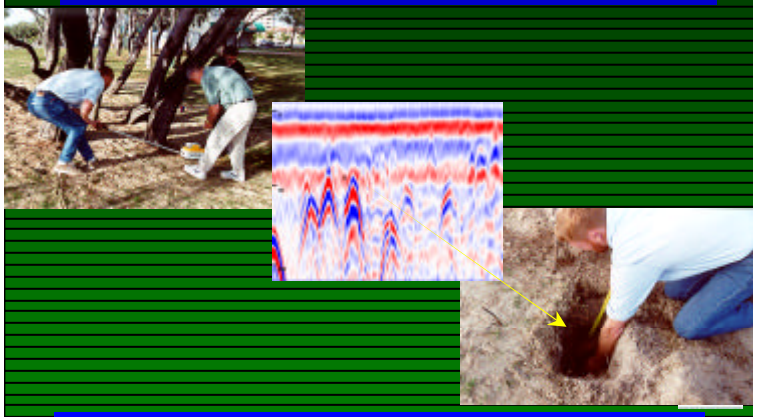
18

Efficient techniques: Ground penetrating radar?



19

Ground Penetrating Radar



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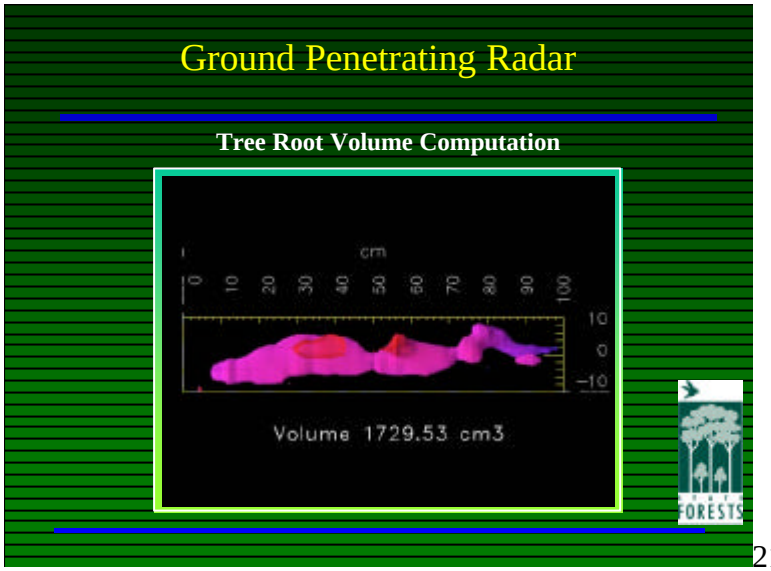
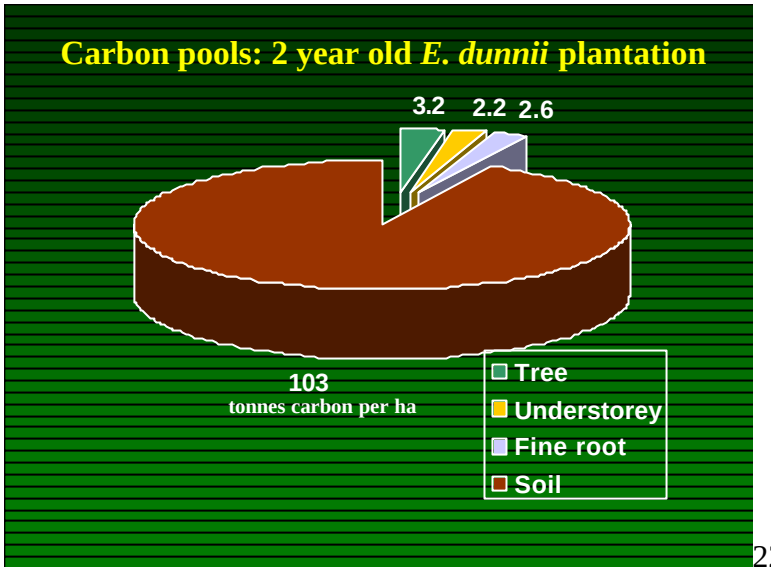
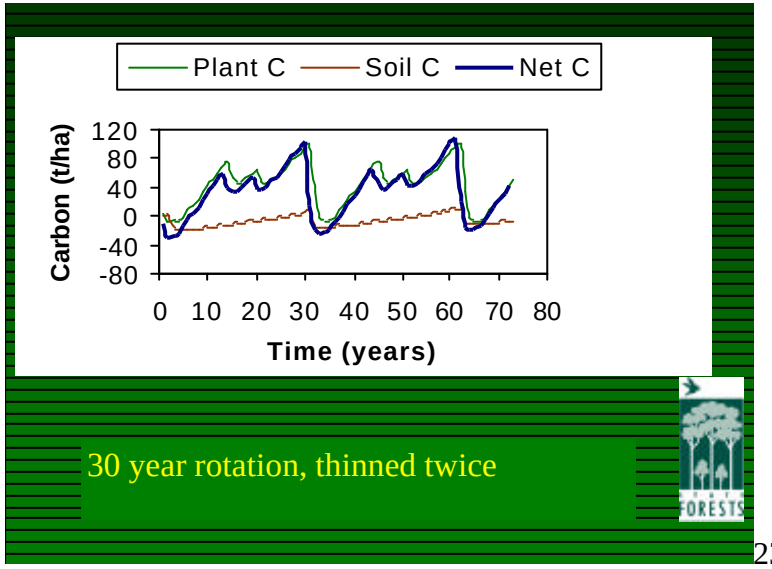

Ground Penetrating Radar
Tree Root Volume Computation
cm
0 10 20 30 40 50 60 70 80 90 100
10
0
-10
Volume 1729.53 cm3

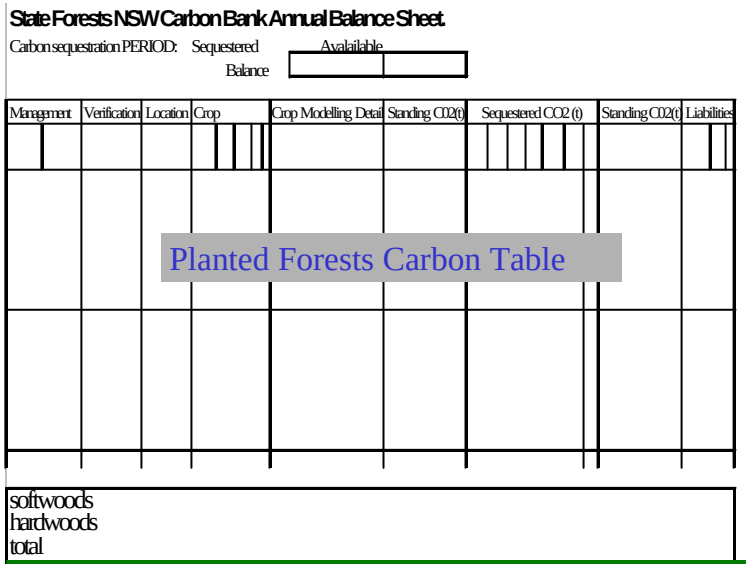
21


Carbon pools: 2 year old *E. dunnii* plantation
3.2
2.2
2.6
103
tonnes carbon per ha
Tree
Understorey
Fine root
Soil

22


Plant C
Soil C
Net C
Carbon (t/ha)
120
80
40
0
-40
-80
0 10 20 30 40 50 60 70 80
Time (years)
30 year rotation, thinned twice

23


State Forests NSW Carbon Bank Annual Balance Sheet
Carbon sequestration PERIOD:
Sequestered
Balance
Available
Management
Verification
Location
Crop
Crop Modelling Detail
Standing C02(t)
Sequestered CO2 (t)
Standing C02(t)
Liabilities
Planted Forests Carbon Table
softwoods
hardwoods
total

24 .

Creating a Carbon Credit Product

Requirements:

- a standardised tradeable carbon mass
- a rigorous carbon trading system

Carbon Accounting Standard

- appraisal of carbon accounting systems by independent verifier
- certification of tradeable carbon mass

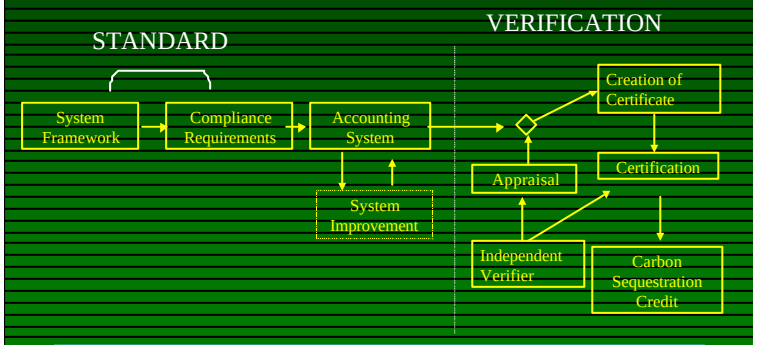
25

Requirements of Carbon Accounting Standard

- open to all on a merit basis
- ensure market confidence
- practical and acceptable to forest managers

26

Creating a Carbon Credit Product



27

Certification

- By independent verifier
- Three levels available:
- 1. Easily achieved at low cost, using default accounting assumptions: 40% tradeable
- 2. Some site specific data and models: 60% tradeable
- 3. Best practice carbon accounting: 80% tradeable

28 .

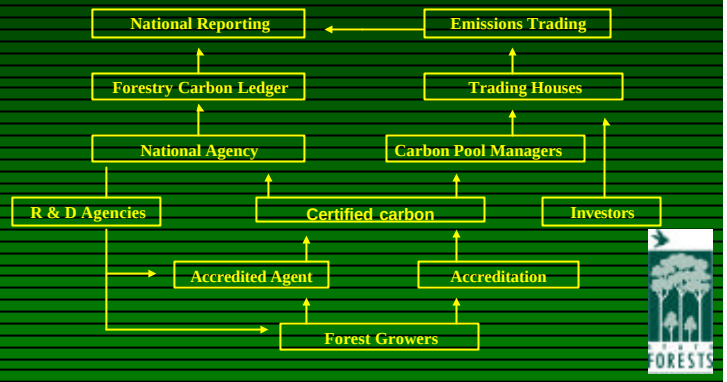
Emissions Trading

- model developed with Sydney Futures Exchange, market based on Article 3.3 Kyoto Protocol
- trading model linking growers to market via pool structure
- tradeable carbon certified under the Carbon Accounting Standard

29

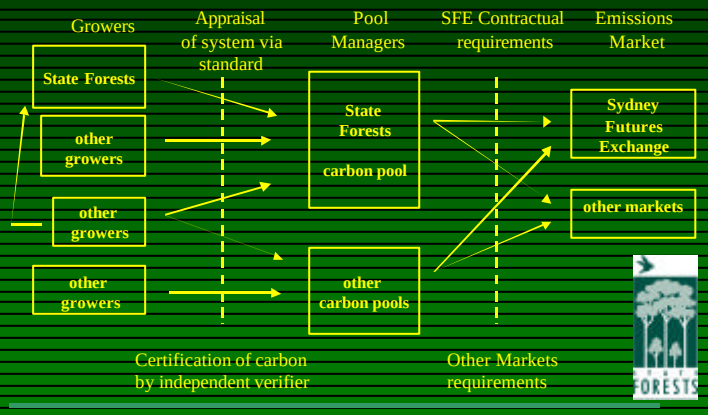
Emissions Trading

Linkages with National Reporting Requirements (NCAS)



30

Emissions Trading - Proposed Model

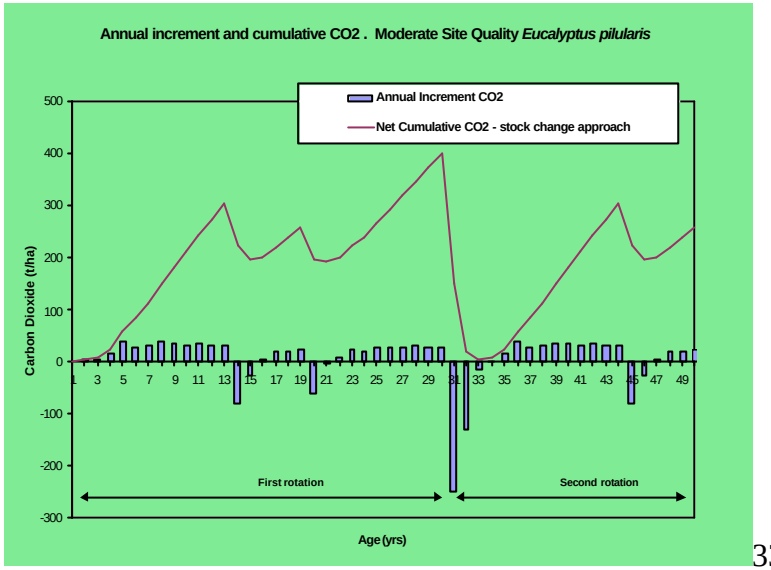


31

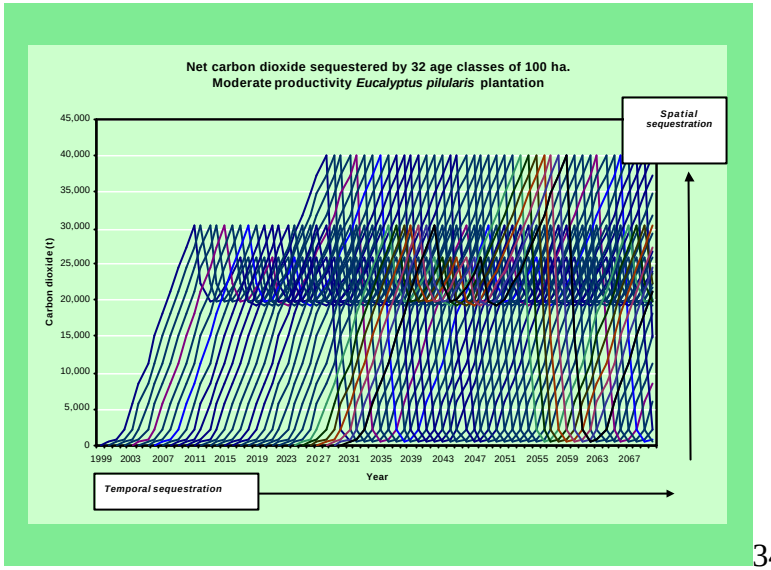
Carbon pool

- Access to market at minimum cost
- Efficient risk management, carbon accounting and certification
- Harvest losses balanced across the pool

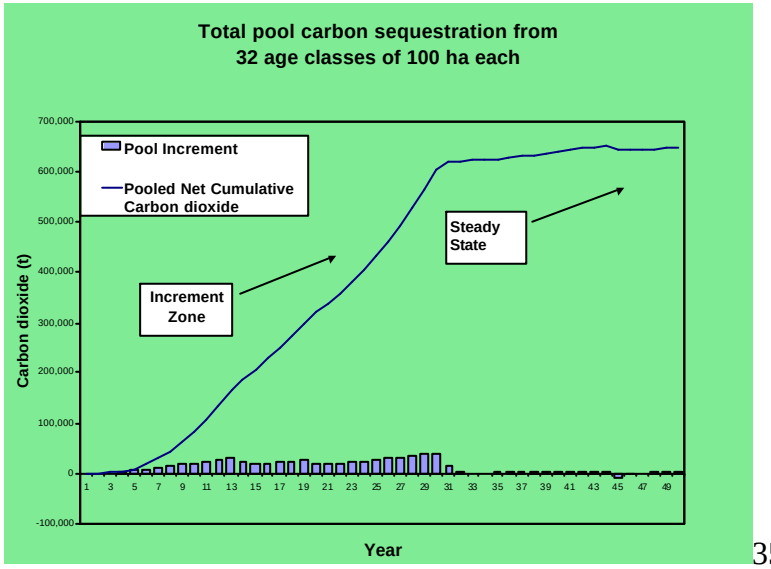
32


Annual increment and cumulative CO2 . Moderate Site Quality Eucalyptus pilularis
Annual Increment CO2
Net Cumulative CO2 - stock change approach
Carbon Dioxide (t/ha)
Age (yrs)
First rotation
Second rotation

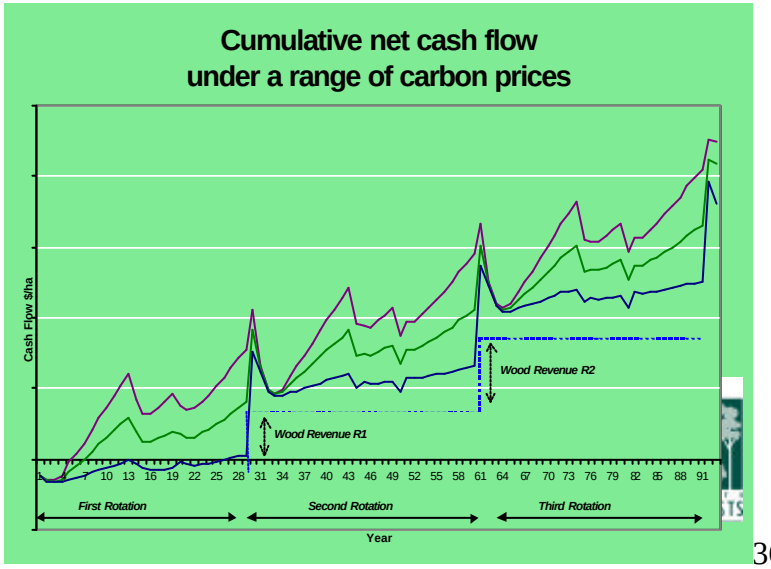
33


Net carbon dioxide sequestered by 32 age classes of 100 ha.
Moderate productivity Eucalyptus pilularis plantation
Spatial sequestration
Carbon dioxide (t)
Year
Temporal sequestration

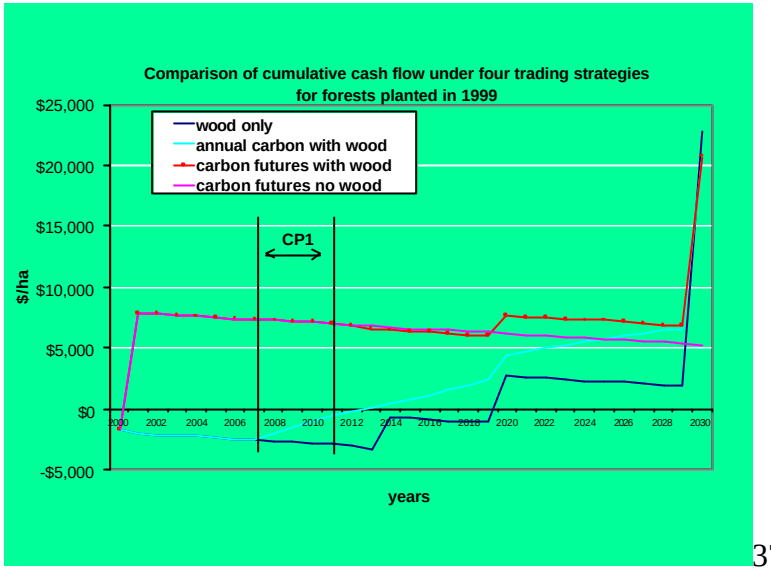
34


Total pool carbon sequestration from
32 age classes of 100 ha each
Pool Increment
Pooled Net Cumulative Carbon dioxide
Steady State
Increment Zone
Carbon dioxide (t)
Year

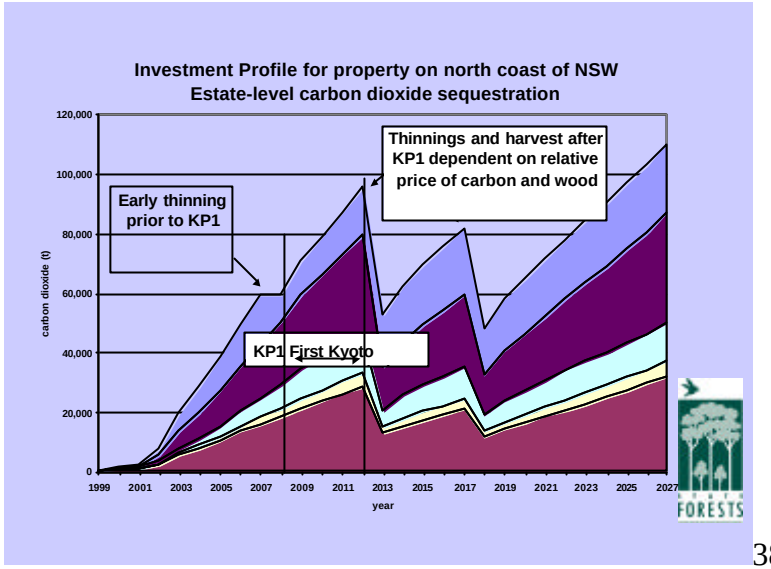
35


Cumulative net cash flow
under a range of carbon prices
Cash Flow $/ha
Wood Revenue R2
Wood Revenue R1
First Rotation
Second Rotation
Third Rotation
Year

36



37



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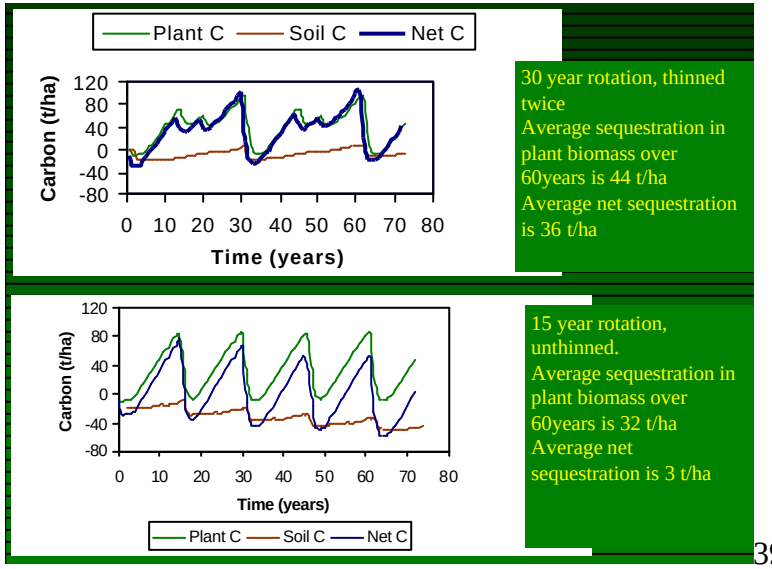


39

State Forests' Carbon Management Strategies

- conventional objectives to optimise return from wood production
- judicial timing of thinning and harvest to optimise return from carbon and wood
- carbon losses at thinning and harvest offset across pool
- large corporate buffer to offset unexpected losses, poor growth performance, uncertainty in models

40

Carbon trading:

- New business opportunity for forestry: carbon sequestration services
- Carbon Accounting Standard creates a standard carbon sequestration product for trading
- Grower chooses level of investment in carbon accounting
- Carbon pool allows participation of small and large growers

41

Challenge: integrated management for carbon and timber production

More information:

- www.forest.nsw.gov.au

42

STATUS OF THE NEGOTIATIONS ON LULUCF

Heikki Granholm
Senior Adviser
Ministry of Agriculture and Forestry
Finland

PERSPECTIVE

	IPCC	**UNFCCC**	**KYOTO PROTOCOL**
1988	Established by WMO & UNEP		
1989			
1990	First Assessment Report	Negotiation Committee	
1991	Development of Guidelines with OECD and IEA		
1992		Signed in Rio	
1993			
1994		Entry into force	
1995		COP-1: • Berlin Mandate	
1996	• Second Assessment Report; • Revised 1996 Guidelines	COP-2 (Geneva)	
1997		COP-3: Kyoto Protocol	Kyoto Protocol • 5% emission reductions • Sinks Art. 3.3, 3.4 & 3.7 • Kyoto mechanisms
1998		COP-4; • IPCC to prepare SR on LULUCF	Buenos Aires Action Plan

	IPCC	UNFCCC	KYOTO PROTOCOL
1999	• National GHG Inventories (Japan)	COP-5 (Bonn)	Preparations towards COP-6
2000	• Good Practice Guidance (excluding LULUCF) • Special Report on LULUCF	COP-6 (Hague)	Decisions e.g.: • Sinks • Kyoto mechanisms • Compliance • Developing countries (FCCC)
2001	• Third Assessment Report • Good Practice Work on LULUCF?	COP-7 (Marrakech) Consideration of "harvested wood products"	
2002		COP-8	Rio +10, entry into force?
2003		COP-9	MOP-1?

UNFCCC AND SINKS

Art 4:

§1. All Parties, ..., shall:

(d) *Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems;*

REVISED 1996 IPCC GUIDELINES AND LUCF

5. Land Use Change and Forestry Category (LUCF)

A. Changes in forest and other woody biomass stocks

B. Forest and grassland conversion

C. Abandonment of managed lands

D. Changes on soil carbon

E. Other

------

4. Agricultural sector

D. Agricultural soils

KYOTO PROTOCOL AND LULUCF

Art 3.3:

- Direct human induced activities: afforestation, reforestation and deforestation since 1990
- Measured as verifiable changes in carbon stocks in 2008 - 2012

Art. 3.4:

- Additional human induced activities related to agricultural soils and land use change and forestry categories

Art. 3.7:

- If LUCF category in 1990 was a net source, LUC included in base year emissions

HAGUE PACKAGE?

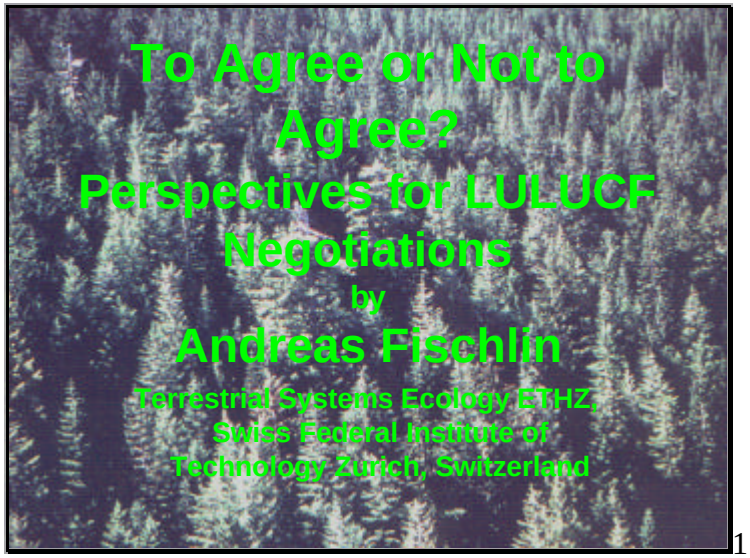
DEVELOPING COUNTRIES: • Technology, capacities • Finance • Adaptation	**KYOTO MECHANISMS:** • JI • CDM • ET
COMPLIANCE: • Liability	**SINKS:** • Art. 3.3, • Art. 3.4, • Art. 3.7

How to ensure emission limitation and reduction target (- 5%) for the first commitment period

- ratifiability/flexibility
- environmental effectiveness
- balanced treatment of all items

To agree or not to agree: perspectives for LULUCF negotiations

Andreas Fischlin, ETH Zurich, Switzerland



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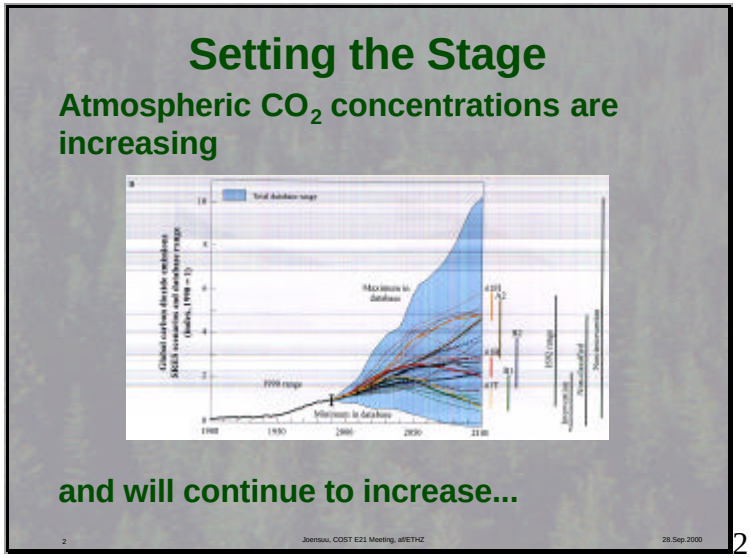

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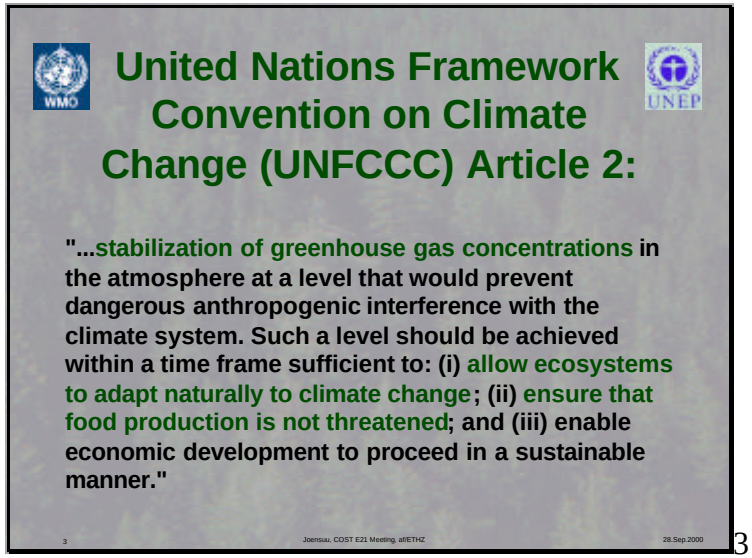

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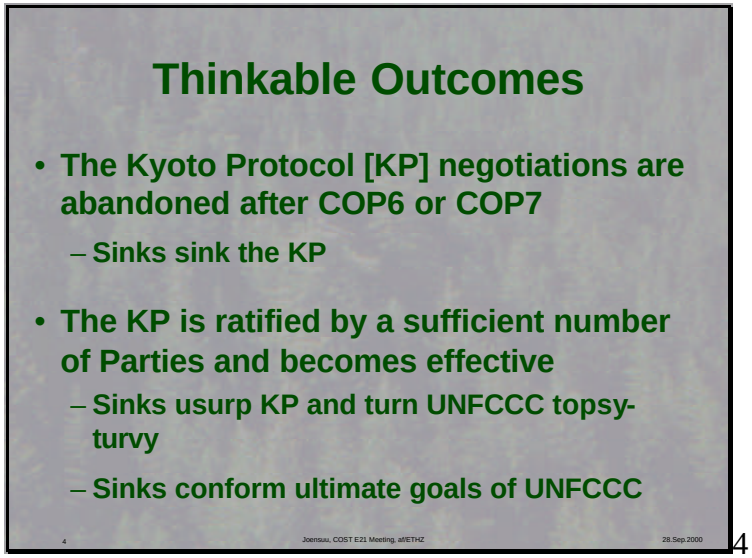

4 .

Critical Issues

- Article 3.3 KP: Definitions of forest, afforestation, reforestation, and deforestation
- Article 3.4 KP: Additional activities like forest management, crop, or grazing land management
- Accounting framework: Full C accounting, Thresholds...

5 Joensuu, COST E21 Meeting, af/ETHZ 28.Sep.2000

5

From LULUCF to Sinks and Why Are Sinks So Important?

- Annex B countries' reduction commitments amount for the first commitment period to 195 Mt C/yr (stabilization since 1990) or ca. 500 Mt C/yr (emission growth extrapolations from current trends " 8% over state 1990)

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6

- According to IPCC SR LULUCF the sink potential for the first commitment period amounts to ca. 500, later 1'100-1'600 Mt C/yr under Art. 3.3 and for the first half of next century 520 (Annex I) or 2'500 Mt C/yr (Annex I&II) under Art. 3.4
- Total: 1'020 - 4'100 Mt C/yr !!

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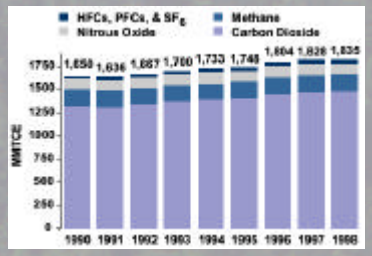
7

Example US of America

- Reduction commitments 7% of 1990 emissions, i.e. 115 Mt C_{eq}/yr



1.3% growth rate => 1'050 Mt C_{eq}/yr (?)

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8 .

Sinks usurp the KP and turn UNFCCC topsy-turvy

- E.g. some Umbrella Group preferences: Land based full C-accounting, broadly defined activities, contiguous commitments periods, claiming C credits for all measurable C stock changes

  <=> e.g. alone for US in 1st cp ~200 Mt C/yr out of "residual terrestrial uptake" (2.3 Gt C/yr)

  <=> emissions ~5% above 1990 level!

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9

Sinks conform to ultimate goals of UNFCCC

- LULUCF projects help to conserve old-growth mature forests
- LULUCF projects reduce net emissions, e.g. by reducing the LUC emissions of ~ 1.9 Gt C/yr or by new sinks (additional relative to BAU developments)

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10

Perspectives?

- KP negotiations won't break down
- But no harmonious happy end either, since sinks are likely to create some licenses to emit
- Other brain twisting surprises turning more than one expectation topsy-turvy
- …

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11

Outlook On the Climate System

- Most interesting times ahead of us and certainly our children...

We can't predict the future, but invent it.

A. Haldane

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12 .

Sinks and the CDM: Status of Negotiations and the Outlook to COP6

Lorenzo Ciccarese[1] and David Pettenella

[1]National Environment Protection Agency, Italy.

The *Clean Development Mechanism* (CDM) - one of the Kyoto Protocol's three mechanisms that would allow transfers or crediting of emission reductions achieved in other countries—does not establish clear confines to the type of projects, if any, that can be conducted. May Annex I Parties credit of "certified emissions reductions" generated through forestry-related projects in developing countries toward achieving (a part of) their emissions reduction commitments? What kind of land-use change and forestry options will be eligible for CDM?

At present, these questions and other complex issues, such as principles, modalities, rules and guidelines for implementation of CDM projects, have not yet been defined.

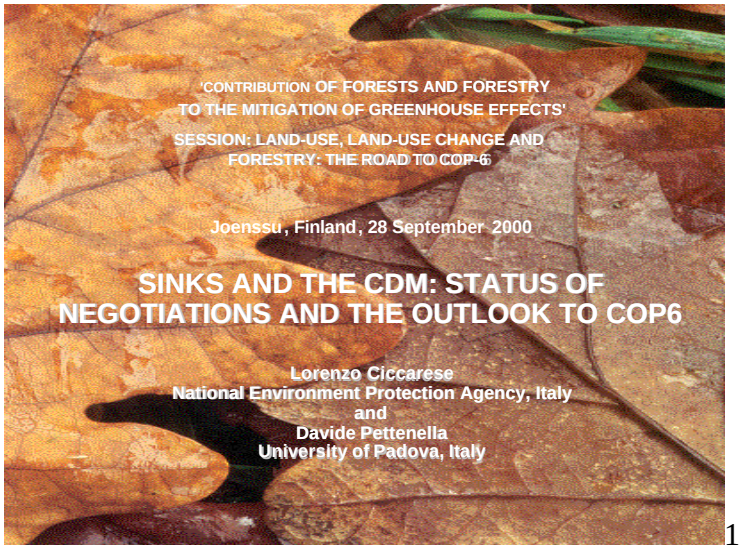
At the CoP-5, a large number of

Parties (especially developing countries) came out in favour of including forestry projects in the CDM; *viceversa*, some Parties and some environmental NGOs were critical, when not hostile. Other Parties and interest groups have only recently, after the release of the IPCC Special Report, which devotes an entire chapter to "project-based activities", started addressing and refining their position on sinks in the CDM.

The presentation examines some of the technical, social and legal aspects that negotiators and experts are focusing and the different positions about the treatments of sinks in the CDM that Parties are preparing to take at CoP-6, next November.

Sinks and the CDM: status of Negotiations and the Outlook to COP6

Lorenzo Ciccarese[1], and David Pettenella. [1]National Environmental Protection Agency, Italy,



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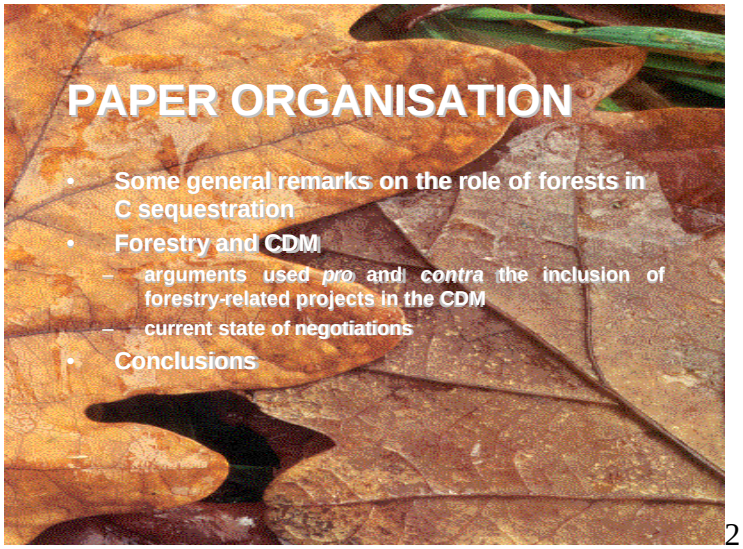

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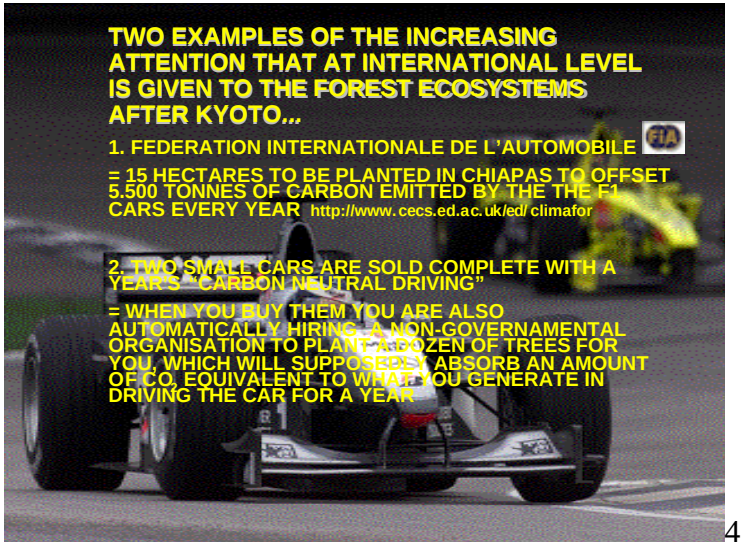

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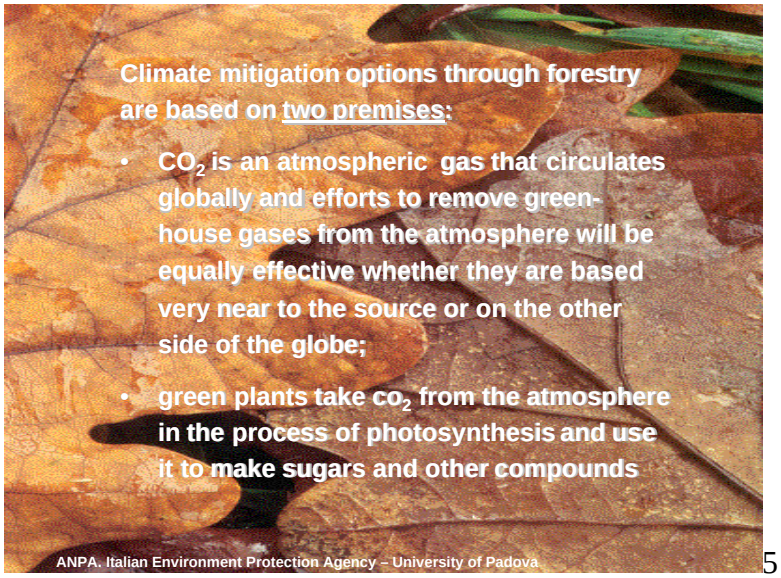
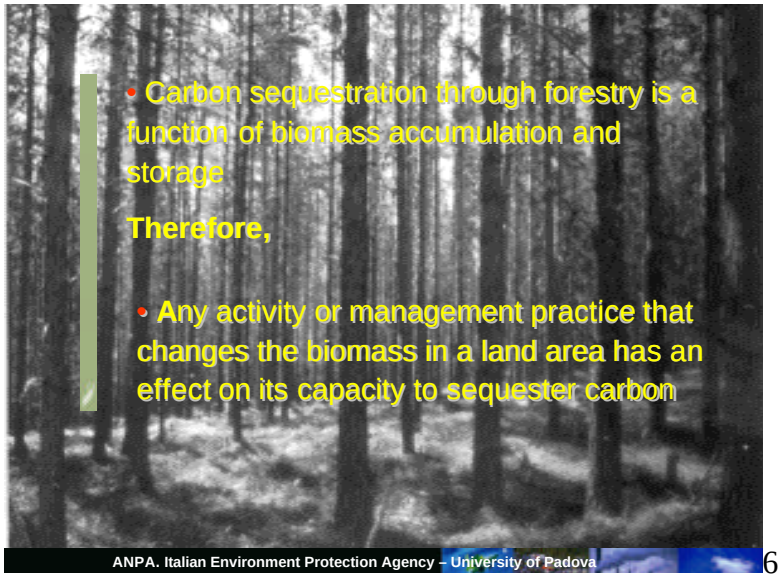
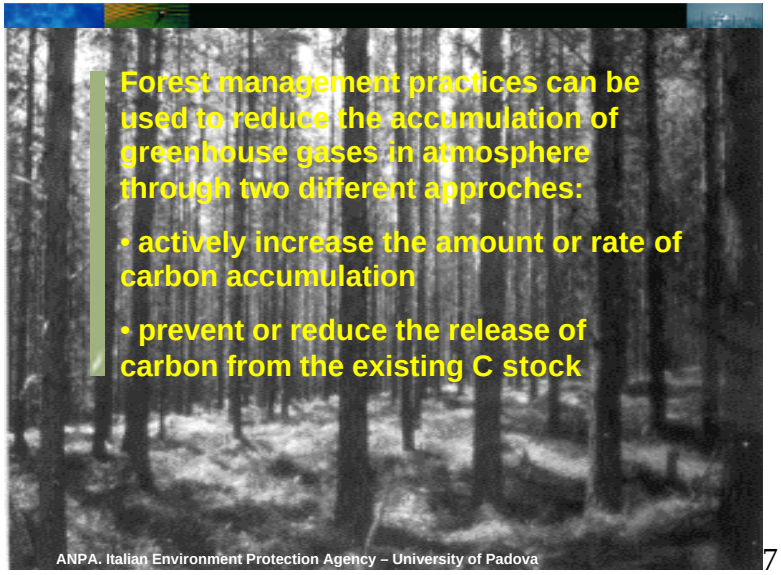

Climate mitigation options through forestry are based on two premises:
• CO_2 is an atmospheric gas that circulates globally and efforts to remove green-house gases from the atmosphere will be equally effective whether they are based very near to the source or on the other side of the globe;
• green plants take co_2 from the atmosphere in the process of photosynthesis and use it to make sugars and other compounds
ANPA. Italian Environment Protection Agency – University of Padova
5


• Carbon sequestration through forestry is a function of biomass accumulation and storage
Therefore,
• Any activity or management practice that changes the biomass in a land area has an effect on its capacity to sequester carbon
ANPA. Italian Environment Protection Agency – University of Padova
6


Forest management practices can be used to reduce the accumulation of greenhouse gases in atmosphere through two different approches:
• actively increase the amount or rate of carbon accumulation
• prevent or reduce the release of carbon from the existing C stock
ANPA. Italian Environment Protection Agency – University of Padova
7


Multifunctionality is characterising almost all forest investments
C sequestration is a joint service associated to many other products and services;
finally,
forest investment costs and the value of (multiple) benefits are varying along with many different social, environmental and economic factors
ANPA ,Italian Environment Protection Agency – University of Padova
8 .

… CARBON SEQUESTRATION IN FORESTRY

A GOOD OPPORTUNITY TO REVISE SOME TRADITIONAL APPROACH TO THE SECTOR:

- HOW TO EVALUATE THE PROFITABILITY OF FOREST INVESTMENTS?
- WHICH POLICY INSTRUMENTS ARE BETTER SUITED TO PROMOTE THE SECTORS?
- WHO ARE THE NEW/TRADITIONAL STAKEHOLDERS?

9

- WHICH ARE THE TRADE-OFFS BETWEEN FOREST POLICIES, ENERGY POLICIES, POLICIES OF INTERNATIONAL CO-OPERATION

Achievement of national GHG emissions targets

National forest policies	Policy for external co-operation	Energy policies
• Natural regrowth • Fires • Increase in C stock in (semi)natural forests • Bio-energy • Wood products	• CDM extended to the forest sector • ET for C in forest biomass	• Optimisation of domestic energy consumption

10

11

ARTICLES OF THE KP THAT CAN REALLY CREATE A MARKET FOR CARBON SEQUESTRATION ARE

Art. 6 ERUs from 'Joint Implementation' projects can be transferred between two Annex I countries.
It explicitly refers to enhancing carbon storage and reducing emissions (but does not specify which kind of projects are eligible).

Art. 12 *The* CDM has the dual mandate to lower the overall cost of reducing GHG emissions in Annex I countries and to support SD initiatives in DC.
The CDM is intended to provide credit—CERs—in DC that can be transferred to Annex I countries to meet their quantified commitment.
There is no explicit mention of LU-LUCF projects

12 .

Carbon sequestration costs ($/ton) in AIJ

Brasil	Plantation (paper)	12%	*-7,2*
	Plantation		*-0,5*
	Plantation		*-14,7*
Thailandia	National Park	10%	1,7~3,3
	Conservation		0,9~5,4
	Eucaliptus plantation		*-3,8~-13,0*
	Teak Plantation		*-2,5~-18,5*
Tanzania	Protected Areas	10%	1,3
	Agroforestry		*-1,8*
	Eucaliptus plantation		0,1
India	National Park	12%	10,4
	Reclamation of degrated forests		*-0,4~-1,8*
	Agroforestry		*-4,5*
	Plantation		*-0,6~-1,6*

In italic: *no regret* investments

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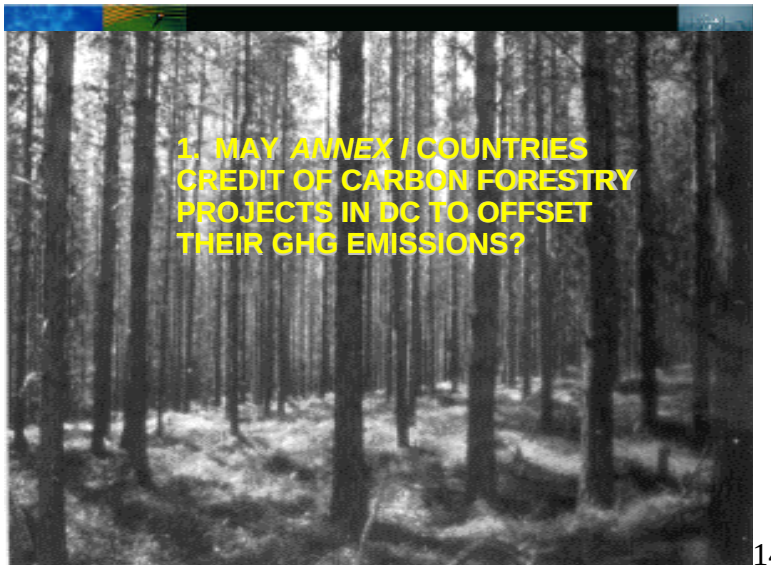

14

CDM AND KEY ISSUES TO BE ADDRESSED

- Will some types of project or sector be disqualified from CDM. Is a "positive list" a solution?
- How would the project baseline be set? To what extent will standardisation and benchmarking be allowed?
- How to interpret additionality?
- Should the host countries determine if the project design id coherent with their SD objectives?
- Which are the authorities and responsabilities of the EB (Art. 12.4)?
- What would the share of the proceeds be towards the adaptation fund?

15

- How to issue CERs? At what intervals?
- What kind of entities would monitor and verify project performance? A single worldwide accreditation body?
- Should the CDM start immediately after the CoP-6? Or should the AIJ pilot phase expanded?
- How to ensuring equitable geographic distribution of CDM projects? How to allocate projects in 'risky' countries?
- Should quantitative ceilings on CERs be introduced? Both for transfers and net acquisitions?

ANPA. Italian Environment Protection Agency – University of Padova

16

The road to CoP6

- Under the BAPA (Nov 1998), Parties set a two-year deadline for preparing the entry into force of the KP (Nov 2000).
- In Bonn(Nov (1999) a negotiating text on flexibility mechanisms emerged.
- Many developing countries remain opposed to the inclusion of sinks into the mechanism.
- Bolivia and Chile, played a particularly up-front role, with clear statement from their Ministers. Followed by other 13 LAC.
- Some African Countries seemed to be shifting positions in favor of inclusion of forests
- Presentation of the IPCC SR (May 2000).
- A workshop in Poznan provided important input (Jul 2000).
- In Lyon (Sep 2000) a consolidated text on principles, modalities, rules, and guidelines on Mechanisms was introduced and discussed.
- The Secretariat gave a presentation of the proposed CDM Reference Manual and on accreditation
- G-77 and China: " forest conservation and reclamation as adaptatioin activities"

17

PROs

THE KP MAKES POSSIBLE TO INCLUDE SINKS INTO ET AND JI. SINKS SHOULD BE INCLUDED INTO CDM TO AVOID DISCREPANCY.

THERE SHOULD BE NO DISPARITY BETWEEN PROJECTS AIMED AT REDUCING EMISSIONS AND ABSORBING EMISSION.

THE CDM COULD PROMOTE «EARLY ACTIONS» FROM 2000 ONWARDS THROUGH ITS BANKING PROVISIONS.

FORESTRY COULD REPRESENT ONE OF THE FEW OPTIONS FOR CONDUCTING CDM PROJECTS IN MANY DEVELOPING COUNTRIES.

SINKS IN CDM COULD PROMOTE SEVERAL ANCILLARY BENEFITS (BIODIVERSITY, RURAL AND LOCAL LIVELY-HOOD DEVELOPMENT).

WHEN SUBJECTED TO SFM, FORESTS CAN CONSISTENTLY CONTRIBUTE TO THE STABILISATION OF CO_2 LEVELS.

SINKS IN CDM COULD PROMOTE LARGE SCALE (RE)AFFORESTATION PROGRAMME TO OFFSET CARBON EMISSIONS.

ADDITIONALITY IS A KEY COMPONENT OF CDM IT CAN BE USED BY DEVELOPING COUNTRIES AND LOCAL LIVELIHOODS TO TAKE THE RIGHT CHOICES AS TO THEIR NATURAL RESOURCES

18

CONs

CARBON SINKS PROVIDE NO-LONG TERM C BENEFITS AND THEY ARE LESS VALUABLE THAN OTHER MEASURES.

METHODOLOGICAL, TECHNICAL AND SCIENTIFIC PROBLEMS.

LEAKAGE IS EXPECTED IN ANY CDM PROJECTS, BUT IT IS OUTSTANDING IN THE CASE OF SINK PROJECTS.

IT IS PROBLEMATIC TO EVALUATE ADDITIONALITY.

LIABILITY AND NON PERMANENCE

RISKS TO THE ENVIRONMENTAL INTEGRITY OF THE KP: THE GREAT POTENTIAL OF SINKS COULD RESULT IN A MASSIVE USE OF LU-LUCF PROJECTS INSTEAD OF PROJECTS AIMED AT BUILDING-UP CLEAN DEVELOPMENT.

LARGE-SCALE FOREST ESTABLISHMENT PROGRAMMES COULD THREAT BIODIVERSITY AND NEGLECT SUSTAINABLE FOREST MANAGEMENT, RURAL AND LOCAL ECONOMIES.

ART. 12 DOES NOT MENTION EXPLICITLY CONSERVATION OR EXPANSION OF BIOLOGICAL SINKS.

19

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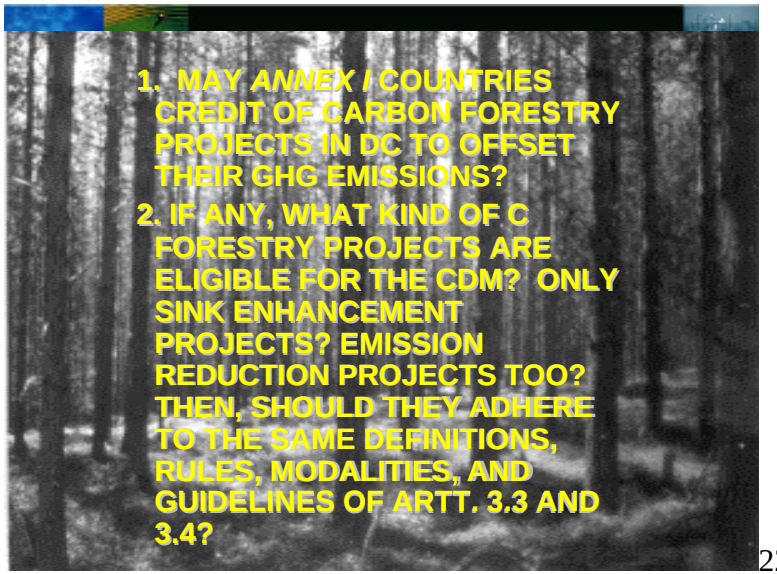


22

THREE SCENARIOS

1. AFFORESATTION AND REFORESTATION

GAINERS: countries that have low forest cover, low degree of pression on the forest resources (G, Irl, UK, USA)

LOSERS: Countries that have high forest cover and that have not convenience to increase them (F,S, N,Can, A).

2. FULL CARBON ACCOUNTING

GAINERS: Western countries, especially the Mediterranean ones, that have natural expansion of forests and natural increase of the growing stock (I, F)

LOSERS: DevCountries that experience reduction of the forest area and of the stocks

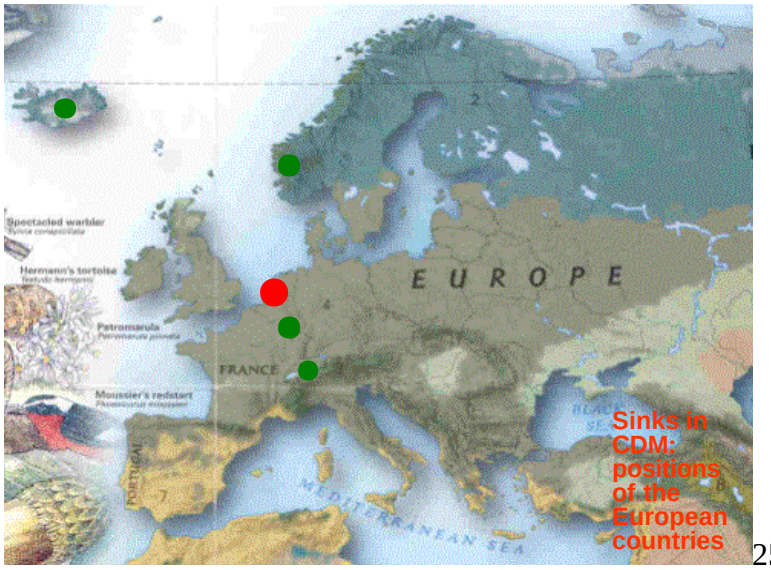
3. FULL CARBON ACCOUNTING ONLY WITHIN THE CDM

GAINERS: Countries that have environmental and social conditions able to protect and expand forests (Brasil, China, ecc.)

LOSERS: *Annex I* countries

23

24 .



25

The way out

- **To address concerns that some *Annex I* countries will use LUCF to avoid cuts in fossil fuel consumption, require a cap on the % of emissions allowed via CDM forestry. This could be a small cap (i.e., 5%) and still allows substantial forestry activity under CDM.**
- **Explicitly include a broad range of forest management and agroforestry activities in the CDM and provide incentives for projects with multiple benefits**

26

The way out 2

- **The determination of project bondaries should be based not on the area of project activities but on the spatial demand driving land-use change and the supply source**
- **The project's time horizon should27 be tied to the minimum plausible amount of time required for carbon to begin cycling out of the atmosphere**

27

The way out 3

- **Require a Social Impact Assessment to ensure that no activities are done that reduce local population rights to land access and use SD. Standards should be consistent with national SD with intnl criteria and indicators, such as SA8000 or AA1000, should be requested**
- **Avoid conditions of discrimination for small-scale projects, by creating guidelines for project design and standardised contracts and introducing other elements that reduce transaction costs**
- **Provide clear guidelines on carbon monitoring requirements at an early stage so that researchers and the private sector can refine cost-effective methods.**

28 .

The way out 4

- Set performance standards that are consistent with best practices, but are comparable with practical expectations based on successes in non-carbon forestry development projects (multifunctionality).

- Consider ton-year accounting as a key element that encourages land managers to produce a carbon commodity as long as it is economically attractive. This will attract larger numbers of projects and will provide an accurate and fair means of accounting and payment for this new commodity.

29

Copies of the paper and of the slides can be downloaded from:
http://www.tesaf.unipd.it/people/pettenella/index.htm

30

IEA Bioenergy

Task 25
Greenhouse Gas Balances of Bioenergy Systems

Final Programme of the session on

Land-Use, Land-Use Change and Forestry: the road to COP6

28 September 2000

Joensuu, Finland

Jointly organized by

European Forest Institute
Torikatu 34,FIN-80100,
Joensuu, Finland

Cost E21

Joanneum Research
Elisabethstrasse 5
A-8010 Graz,
Austria

Task 25 Website: www.joanneum.ac.at/iea-bioenergy-task25

Land-Use, Land-Use Change and Forestry: the road to COP6

Organised by: IEA Bioenergy Task 25 "Greenhouse Gas Balances of Bioenergy Systems"
Co-organised by: COST E21 "Contribution of Forests and Forestry to the Mitigation of Greenhouse Effects"
European Forest Institute (EFI)
University of Joensuu, Faculty of Forestry.

Thursday 28 September, 2000

Moderator: Bernhard Schlamadinger
8.15 Introduction

Session 1: Overview of the IPCC Special Report (15 min pres and 5 min of questions)

8.30 Chapter 2, Implications of different definitions and generic issues
Presented by Gert-Jan Nabuurs, ALTERRA Green World Research, the Netherlands

8.50 Chapter 3, Afforestation, Reforestation, and Deforestation (ARD) Activities
Presented by Bernhard Schlamadinger, Joanneum Research , Austria

9.10 Chapter 4, Additional human-induced activities - Article 3.4
Presented by Gregg Marland, Oak Ridge National Laboratory, USA

9.30 Chapter 5, Project based activities
Presented by Omar Masera, University of Mexico, Mexico

9.50 Chapter 6, Implications of the Kyoto Protocol for the reporting guidelines
Presented by Justin Ford-Robertson, Forest Research, New-Zealand

10.10 Discussion, elaboration of innovative ideas in light of the negotiations

10.30 Coffee

Session 2: Carbon accounting methodologies

11.00 Effectiveness of LULUCF carbon accounting methodologies in supporting climate-conscious policy measures
Robert Matthews[1] and Rebecca Heaton[2], [1]Forestry Commission Research Agency, Wrecclesham, U.K. [2]The Salix Project, University of South Wales, U:K.

11.20 The ton-year index as a basis for carbon accounting of forestation projects under the Climate Convention
Kim Pingoud, VTT Energy, Finland

11.40 A practical procedure of accounting for LUCF activities under the Kyoto Protocol
Miko Kirschbaum et al, CSIRO Forestry and Forest Products, Australia. Presented by Annette Cowie, State Forests New South Wales, Australia

12:00 Carbon accounting methodologies – a comparison of real-time, tonne years and one-off stock change approaches
Piers Maclaren, Forest Research, New Zealand
Presented by 'Justin Ford-Robertson, Forest Research, New Zealand

12.20 Discussion, elaboration of innovative ideas in light of the negotiations

12.40 Lunch.

Session 3 : Land use, land-use change and forestry activities under Articles 3.3 and 3.4

13.40 Trees as C sinks and sources in the EU in light of Kyoto Protocol Article 3.3 and the ongoing negotiations
Jari Liski, European Forest Institute

14:00 Domestic Options for Carbon Management
Doug Bradley, Domtar Inc, Ottawa, Canada

14:20 Adressing COP6 decisions on agricultural soil carbon accumulation
Susan Subak, Environmental Protection Agency, U.S.A.

14:40 Measuring and marketing of C sequestration in planted forests in New South Wales, Australia
Annette Cowie, State Forests New South Wales, Australia

15:10 Discussion, elaboration of innovative ideas in light of the negotiations

15:30 Coffee.

Session 4: Current state of negotiations

16.00 Status of the negotiations on LULUCF
Heikki Granholm, Ministry of Agriculture and Forestry, Finland

16.20 To agree or not to agree: perspectives for LULUCF negotiations
Andreas Fischlin, ETH Zurich, Switzerland

16.40 Sinks and the CDM: status of negotiations and the outlook to COP6
Lorenzo Ciccarese, National Environment Protection Agency, Italy
Davide Pettenella, University of Padova, Italy

17.0 Discussion; elaboration of innovative ideas in light of the negotiations

18.00 End of session.
.

IEA Bioenergy Task 25 and COST E21 Session at the "Woody Biomassas an Energy Source" Conference
"Land-Use, Land-use change and Forestry: the road to COP6"
28 September 2000, Joensuu, Finland.

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