First COOL Global Dialogue Workshop

RIVM, Bilthoven, The Netherlands

4 – 6 July, 1999

Report

by

Ursula Fuentes / Marcel Berk

Introduction

On 4-6 July 1999, the First COOL Global Dialogue workshop was held at RIVM in Bilthoven, the Netherlands. The workshop was organised by the National Institute of Public Health and the Environment (RIVM) as the first in a series of four to be organised from 1999 to 2001. The workshops are part of the COOL project (Climate OptiOns for the Long term), which is funded by the Dutch National Research Programme on Global Air Pollution and Climate Change (NRP).

The two aims of the COOL project are:

- To investigate options for a long-term climate policy strategy in the Netherlands in an international context,
- To contribute to the development of methods for participatory integrated assessment.

The COOL project organises dialogues in which policymakers, stakeholders, and scientists assess options for long-term climate strategies. The project incorporates three levels:

- The National Dialogue concentrates on options to enable emission reductions of up to 80% by the middle of the next century.
- The European Dialogue explores long-term policy options for Europe-wide reductions in greenhouse gas emissions, focusing on two economic sectors (energy and transport).
- The Global Dialogue is primarily directed at stakeholders involved in the UNFCCC process, including representatives from environmental and industrial NGOs.

The COOL Global Dialogue sub-project aims at exploring long-term (30-50 years) international climate policy options and their implications for medium-term policy development (second and third commitment periods of the Kyoto Protocol), by means of a series of international science-policy workshops. The project builds upon extensive experience with previous science-policy dialogue workshops, organised both prior to and after the adoption of the Kyoto Protocol (Delft Process 1995-1997, van Daalen *et al*, 1998; Kassel workshops 1998, Onigkeit et al., 1998; Onigkeit and Berk, 1999). Central to the COOL Global Dialogue is a policy-driven utilisation and development of scientific knowledge.

Set-up of the First COOL Global Dialogue Workshop

The programme of the first workshop was based on the policy questions that were identified during the previous Kassel workshops. On this basis, the following issues were chosen for the first workshop:

- New IPCC baseline scenarios,
- Impacts of Annex-I-countries' activities on developing countries,
- Broadening participation in the Global Climate Regime,
- Land-use change and forestry in climate policy,
- Mitigation and Stabilisation Scenarios.

The workshop started with an introductory diner to welcome the participants and to provide them with more information about the COOL project and the workshop programme. The next two days were used for 3-4 hour sessions dealing with each of the selected issues. All sessions started with one or more presentations by scientists, followed by a general discussion moderated by the chair of the session. Central to the set-up of the workshop is the purpose of having ample room for discussion to give policymakers the opportunity to request clarification (e.g. regarding model assumptions, uncertainties, reliability of results), to discuss policy issues (policy relevance, normative aspects), and, finally, to request for additional or new analyses or model modifications.

Participants were divided into an inner circle, formed by the policymakers, and an outer circle, formed by the scientists, in order to give policymakers the priority in discussions.

As part of the session on broadening participation in the Global Climate Regime, a special session with the interactive computer model FAIR was organised. This session consisted of a moderated tour for an understanding of the model and to explore and evaluate policy options in an interactive way.

At the end of the workshop, one session was devoted to identify new policy questions and the need for new analyses as a basis for the preparation of the second workshop. This report provides summaries of the presentations and discussions during each of the sessions. In addition, it contains a list of new priority policy questions for further research and analyses and the results of the evaluation of the workshop. In the reports on the discussions names of participants have been deliberately left out to ensure open discussion during future dialogue workshops. The list of participants and the programme of the workshop have been included as annexes to this report.

Session I: New IPCC Reference Scenarios

The first session, on the new IPCC Reference Scenarios, was chaired by *Bert Metz (RIVM).* It started with a presentation by *Bert de Vries (RIVM)* on the new IPCC Reference Scenarios, with a focus on the scenarios calculated with the IMAGE and TIMER models at RIVM. The presentation is summarised in Section 1. The discussion following presentation is summarised in Section 2.

1 The New IPCC Reference Scenarios

1.1 Introduction

Bert de Vries presented the new IPCC Reference Scenarios, which will be described in the IPCC Special Report on Emission Scenarios (SRES). These are scenarios with no explicit climate mitigation policy, but different assumptions with regard to economic growth, population growth, social development, energy and technology development, policies (including environmental policies) and other driving forces.

New IPCC baseline scenarios are needed to replace the IS92 scenarios, because a number of decisive trends have changed in the meantime (e.g. developments in economies in transition as well as in the Asian „Tiger“ countries, estimates of sulphur emissions). The SRES scenarios should also show a wider variety of options regarding future development, e.g. of convergence or divergence between North and South, or options of carbon intensity.

Four scenario families have been distinguished, which can be ordered in a matrix as follows:

	Open world with high degree of convergence	**Closed world with cultural, technical, and economic heterogeneity**
Limited, free-market orientation on environmental and social issues	A1 („Golden Economic Age“)	A2 („Divided World“)
Strong and explicit orientation on sustainability and equity issues	B1 („Sustainable Development“)	B2 („Regional Stewardship“)

Each scenario family is characterised by a common storyline. Different modelling groups have calculated a number of scenarios for each of the scenario families. For each of the families, one scenario has been chosen as the marker scenario. With the IMAGE model, scenarios A1 and B1 have been calculated. The IMAGE B1 Scenario is the marker scenario for the B1 family. There is no business-as-usual scenario in the sense of one “best-guess” or most likely scenario.

The scenarios cover a broad span of values for main driving forces: The population growth is higher in the heterogeneous world (A2, B2) than in the convergent world (A1, B1), where world population decreases after 2050. The per-capita income is much higher in the convergent world than in the heterogeneous world, GNP in 2050 is twice as high as in the IS92a Scenario, whereas it is lower in A2 than in IS92a.Technology development is faster in the convergent world (A1, B1) than in the heterogeneous world (A2, B2).

Indicative first calculations of greenhouse gas concentrations and radiative forcing show that SRES scenarios portray generally higher radiative forcing compared to the IS92a scenarios, despite the lower GHG emissions range, because of the lower sulphur emissions range in the second half of the 21st century. In general, a decrease in sulphur emissions is expected for all storylines from about 2020-2050 on, because abatement measures are expected to be undertaken even at rather low income levels, as present trends in China confirm.

1.2 IMAGE B1 Scenario

After a short introduction into the models IMAGE and TIMER, the IMAGE B1-Scenario, which is the marker scenario for the B1 Family, was presented in more detail.

The population is assumed to grow to 9 billion up to 2050, and decline thereafter to 7 billion up to 2100. Economic growth is mainly based on capital accumulation and increase in factor productivity. Energy use saturates at rather low levels, in contrast to A1, where it saturates at higher levels, or not at all. In B1, less physical activity is related to economic activity („dematerialisation“).

In the IMAGE-B1 Scenario, it is assumed that the use of coal is largely avoided for environmental reasons (but not as climate-mitigation measure), which implies rather low emissions (1200 GtC cumulative emissions by 2100).

The extent of agricultural land decreases in the long term, because of the decrease in world population and because of technological progress.

Altogether, this scenario leads to an equivalent carbon dioxide concentration of 600 ppmv by 2100. The global mean temperature, which was calculated with the meta-IMAGE model, is 1.4 degrees higher than in 1990, in contrast to A1 (2.5 degrees).

1.3 Conclusions

Bert de Vries concluded that the SRES Scenarios provide for explicit consideration of qualitative and quantitative aspects of future developments with a diversity of modelling tools. However, the storylines are partly inconsistent, because the social, economic, and engineering modelling have only been integrated to a limited extent. He reported that the B1 Scenario has been criticised for making it difficult to distinguish between a reference (no-mitigation) scenario and a climate-policy scenario. But he stressed that the B1 Scenario still leads to equivalent carbon dioxide concentrations that are too high.

Finally, he concluded that the reference scenarios are meant to define the context and frame for climate change policies. These policies will be different in a B1 world, which is characterised by risk aversion, than in the A1 world, which is a rich high-tech world, where market-oriented solutions will be preferred.

2 Discussion

The discussion focused on how policymakers could use the SRES scenarios, and the possibility of choosing one of the reference scenarios as a business-as-usual scenario. Some participants stressed that policymakers would tend to choose one of the scenarios, even if no probabilities are given for them, and although the SRES scenarios are explicitly designed to be used in their totality. In particular, the applicability of the B1 scenario as a business-as-usual scenario was questioned.

The plausibility of assumptions behind different scenario families was discussed, e. g. the fast saturation and voluntary decline in coal use in the Image-B1 scenario. Some policymakers doubted that a world without worries about climate change could be a world without coal. Especially the plausibility of the B1 storyline was questioned, e.g. the very high use of biomass, which would lead to problems with biodiversity conservation, and thus contradict the assumption of sustainability being a predominant value. Apart from inconsistencies within a storyline, the storyline of B1 itself was criticised as not realistic; e.g. the possibility of a fast switch towards sustainability orientation as is assumed in B1 was questioned for Latin America.

On the other hand, participants stated that many different future developments are possible and imaginable. Technological learning rates could be very high, and the autonomous force of technology was said to have been underestimated in the IS92 scenarios.

The question was raised if it was possible to focus on common features in all four scenario families. In this context, it was noted that that the SRES scenario do not diverge considerably up to 2050.

Furthermore, the issue of regional impacts of climate change related to the emission scenarios was raised, as these impacts could lead to costs that are not taken into account in the scenarios. This question is also related to the problem that different scenarios within a family lead to differing emission pathways, and that not the high emission cases were chosen as marker scenarios. This rose the question which scenarios are going to be used by GCM to model the climate change. With regard to the environmental impact of the scenarios, it was stressed that the radiative forcing in all cases exceeds the IS92a case in the first part of the century, which implies higher rates of warming.

Finally, the inconsistency of the SRES scenarios with short-term projections of parties to the FCCC was discussed, as parties to the FCCC have submitted projections up to 2020, which show higher emissions than the SRES scenarios. Also the inconsistency between the optimistic technology assumptions behind the SRES scenarios on the one hand and the high cost estimates often given for technological mitigation options by the same modelling groups on the other hand was noted.

Session II: Impacts of Annex-I actions on developing countries

The second session, chaired by *Bert Metz (RIVM)* was devoted to the economic impacts of mitigation policies and measures in Annex-I countries on developing countries. *Hans Timmer (CPB)* gave an overview of the results of the IPCC WG III expert meeting on Economic Impacts of Measures and Policies taken by Annex B countries on developing countries (The Hague, May 1999). This presentation is summarised in Section 1. *Jean-Charles Hourcade (CIRED)* opened the discussion with some commentary remarks to the presentation (Section 2).

1 Overview of results of IPCC expert meeting

Hans Timmer presented an overview of results of the IPCC WG III expert meeting on economic impacts of Annex-I activities on developing countries. He focused on a discussion of relevant mechanisms and ideas, rather than on numerical outcomes, as these differ substantially from model to model. In addition, he stated that macroeconomic impacts of Annex-I actions on developing countries in terms of GDP losses are expected to be in the range of 1 to 2%, at most 5% for oil-exporting countries. These losses are relatively small, as GDP will double in the same timeframe. He noted that for a long-term perspective, GDP was not the correct measure to value economic impacts.

He then discussed results of the expert meeting regarding carbon leakage and CDM as a first step into a global trading regime.

He discussed the following determinants of carbon leakage (i.e. increased emissions in developing countries as a result of the limitation of emissions in Annex-I countries due to the Kyoto protocol):

- the relative magnitude of non-Annex-I country economies (export potential, domestic absorption potential),
- the degree of globalisation of energy markets and other markets, and
- the price elasticity of energy supply.

He noted that one of the important leakage channels is the transition of high-energy demand production to non-Annex-I countries.

The leakage rate will increase to about 20-25% in 20 years and much more in subsequent years, according to most models.

Although a global market could be more efficient, the conclusion drawn from the expert meeting was that it could introduce new financial instabilities in the global market, so that a limited number of participants in the first step is desirable.

Intertemporal trade could also be preferred from an efficiency point of view, nevertheless, it could lead to an unequal intergenerational burden sharing, so that the exclusion of intertemporal trade was concluded to be preferable.

CDM was considered as a first incomplete step of increasing participation. Because of institutional problems (monitoring, assessment of baseline, barriers and restrictions, inability to enforce contracts, not well developed markets), he concluded that CDM could be an undesirable first step into a global market.

2 Discussion

In his comment to the presentation given by *Hans Timmer*, *Jean-Charles Hourcade* stressed the limitation of the macroeconomic models used to assess impacts on developing countries. He noted that they do not take into account monetary policy: A decline in the rates of change of currencies in developing countries would reduce the effect of losses of GDP as well as the leakage effect. He stressed that heavy industry only contributes 25% of emissions, and only 15% of these will suffer an increase of production costs.

In contrast to the assessment by *Hans Timmer*, he pointed out that even losses of 2% of GDP might be an important figure for policymakers.

With regard to the discussion about CDM, he questioned the usually expected large potential of low-cost abatement options in developing countries. The technology gap is, in his opinion, smaller than assumed by models, as these do not take into account feedbacks and changed rates of change of currencies.

In general, he concluded that models are too mechanical, so that their validity for policy conclusions is limited. For example, informal markets are not taken into account, which can react to price increases in the formal sector.

In the discussion on the topic, a participant suggested that applying bottom-up baselines instead of top-down baselines for CDM projects could reduce the risk of leakage. They could even create the opposite of leakage. In his reply, Hans Timmer questioned this conclusion, as the successful conversion of technologies would lead to an increase in income and therefore also in energy use.

Another participant questioned if with an increasing number of countries taking on emission limitations, long run GDP losses could be as large as 1-2 or even 5%. In his reply, Hans Timmer stressed that GDP losses are not the correct measure for the long-term perspective, and that the losses are in fact not large in the long-term for oil-exporting countries. In addition, he noted that different models lead to different results, which also depend on the assumptions about the behaviour of oil-exporting countries (e.g. possible shift to other activities). He also pointed out that even in 20 to 30 years Annex-I countries would still account for 40% of the emissions.

The conclusion of economists that CDM could lead to leakage was received with surprise by some of the policymakers, as other studies showed that the use of Kyoto mechanisms could reduce leakage in comparison to domestic emission reductions in Annex-I countries.

Some participants critisised the presentation did not focus on the impacts on developing countries, but on the export of carbon pollution (leakage). Also the optimistic assessment of market mechanisms was questioned, as they have not yet emerged inside the Annex-I countries. The suggestion was made to create markets inside the US or the EU, and to focus on the home reductions in Annex-I countries. In his reply, Hans Timer pointed out that there is no general market optimism amongst economists, since markets only work if the right institutions are in place.

Session III: Broadening Participation

The third session dealt with the broadening participation in the Global Climate Change Regime. In the first part of the session, chaired by *Bill Moomaw (*Tufts University*), a* series of presentations was given on the topic, starting with an introduction by *Bert Metz.* His overview presentation (Section 1) was followed by presentations by *Joyeeta Gupta (IVM)* on options for developing countries (Section 2), by *Carsten Helm (PIK)* on the application of fairness criteria to the allocation of climate protection burdens (Section 3), and by *Marcel Berk (RIVM)* on the FAIR model (Section 4). The general discussion that followed the presentations is summarised in Section 5.

In the second part of the session, policymakers were divided into two groups to participate in an interactive session with the FAIR model. The results of these sessions are described in Section 6.

1 Overview

Bert Metz (RIVM) gave an overview over the issue of broadening participation in the Global Climate Change Regime. Equity issues are not only relevant for mitigation policies, but also for the decision making procedures, as well as regarding impacts and adaptation.

Consideration of equity with regard to mitigation has to be discussed considering that stabilisation of carbon dioxide concentration can only be achieved reducing global emissions significantly under the current values, which is impossible to achieve by reducing Annex-I emissions only.

Decision-making has to be based on equity, but also on efficiency and political feasibility, which should be distinguished from equity. He noted that emissions permit trading leads to the most efficient situation irrespective of the initial allocation.

He gave an overview of present literature on equity issues in climate change policy, distinguishing between allocation-based, outcome-based, and process-based equity criteria.

2 A Multi-Stages Approach: Options for Developing Countries

In her presentation, *Joyeeta Gupta (IVM, Amsterdam)*, discussed possible options for developing countries in the post-Kyoto negotiations. She noted that hitherto, developing countries have mostly adopted defensive approaches, reacting to the agenda defined by industrialised countries. In contrast, she suggested a strategic, constructive approach that could be seen as the developing countries' 'meaningful' contribution to solve the problem. However, developing countries face the problem that a constructive proposal is likely to be broken down in the course of negotiations, due to the inherent weakness of the developing countries' negotiation process.

She suggested the following possible approaches for developing countries to define meaningful participation as part of a constructive, strategic approach:

- The *'cool-air' approach:* the most vulnerable countries that emit less than a minimum emission level should be entitled to some benefits, including the right not to be subject to any commitment under the treaty, and or the right to trade the unused portion of their emissions.

- The *'cool'-indicator approach*: Developing countries could adopt indicators such as the percentage of government expenditure spent on climate change related adaptation and mitigation, or the phase out of subsidies on fossil fuels.
- *Policies and measures approach:* Middle and high income developing countries could offer to report on policies and measures that take climate change into account.
- *Participation in CDM:* Developing countries could participate in the regime by participating in CDM, including the demand driven identification of projects.
- *Grace period:* developing countries could get a grace period before legally binding objectives become valid.
- *Flexibility tax:* a percentage of the proceeds of all flexibility instruments could be set aside to fund adaptation activities.
- *Assistance indicator*: a GDP-related indicator of the assistance provided by industrialised countries, for example under Art. 10 of the Kyoto Protocol.
- A *Fine* for non-complying countries could finance a technology cooperation fund.
- Participation of India and China as *observers at G7* meetings.

This would result in a policy framework with a phased approach: Developing countries would gradually move from one level of participation to the next, according to the increase in their per-capita income and emissions levels (see Table 1) She concluded that this so-called LIMP-approach (Leadership Includes Meaningful Participation) could lead to a paradigm shift in that it breaks the deadlock formed by the South waiting for the North to act and some industrialised countries waiting for key developing countries to show ‘meaningful participation’.

Table 1: Articulating "common but differentiated responsibilities". Legend: LBC - legally binding commitments; LBRC - legally binding reduction commitments; LBSC- legally binding stabilisation commitments. LDC – less-developed countries; MIC – middle-income countries; HIDC – high-income developing countries. Source: Gupta, J. (1998).

The approaches	**Cool air**: Operative until the minimum emission per capita level is arrived at	**Indicators:** Operative for all parties	**Menu of PAM:** Operational when income and emissions are at the middle level	**Grace period** from the moment that critical per capita emission levels are reached	**LBC**: operative from the end of the grace period	**LBRC**: operative from no later than the moment the maximum per capita emission level is reached	**LBSC**: operative when an acceptable per capita level is reached
LDC (incl. AOSIS); emissions below min. Level; ↓	Applies	applies					
LDC (incl. AOSIS) ↓ →		applies					
MIC ↓ →		applies	Applies				
HIDC → ↓		applies	Applies	Phase 1 2004-2012 + ad hoc assistance to DC	Phase 2 2012-2020 targets + flex. tax + help indicator	Phase 3 2020-2032 targets + flex. tax + help indicator + non-compliance fines	Phase 4 after 2032 targets + flex. Tax + help indicator + non-compliance fines
Annex I			Applies	Phase 1 1990-2008 + ad hoc assistance to DC	Phase 2 2008-2012 targets + flex. Tax + help indicator	Phase 3 2012 - 2022 ? targets + flex. tax; + help indicator + non-compliance fines;	Phase 4 after 2022 targets + flex. Tax + help indicator + non-compliance fines

3 Applying Fairness Criteria to Allocation of Climate Protection Burdens

Carsten Helm (PIK, Potsdam), presented an equity approach which focuses on the fair division of the gains from exchanging initial entitlements, which arise from differences in marginal abatement costs, instead of focusing on the initial allocation of tradable entitlements or on the fair outcome of a climate protection strategies.

He started by setting minimum standards of equity that are widely recognised and can be used as “knock-out” criteria, to exclude policy options which are widely regarded as inequitable. Formulating these minimum standards of equity as axioms, a solution set can be derived (“the tolerable equity window”) that satisfies all these criteria simultaneously.

The equity principles for which there exists widespread support in the literature are

- *Pareto Optimality*: If you can make someone better off without worsening your own position, this should be done.
- *Individual rationality*: Each agent should be guaranteed at least the utility from consuming his entitlement (or fair share) to the common resource.
- *Resource monotonicity*: If the common resource grows, each agent should be at least as well off as before.
- *Population monotonicity*: If the number of agents entitled to the common resource increases, no agent should be better off than before.
- *Stand-alone criterion*: No actor shall be better off than from the sole consumption of the whole common resource.
- *Envy freeness*: An allocation from equal entitlements is envy-free if no agents prefer the allocation of any other agents to his own.

He showed that monotonicity, the only allocation that is compatible with all these minimum standards of equity is the one where ‘the South’ (that is, the group of agents whose emission entitlements exceed their business-as-usual emissions) participates in emission abatement, but is fully compensated for its abatement costs. In contrast to most authors, he noted that it is not obvious that the allocation of gains from the exchange of emission permits should be governed by the market: If the market of tradable permits allocates the gains of exchanging initial entitlements, the result is not necessarily equitable, as it can violate one or more of the minimum equity standards.

In particular, he concluded that the application of fairness criteria on the allocation of gains from emissions trading can have as important implications for burden sharing in the climate change regime as the specification of the initial entitlements.

4 An Exploration of Options with the FAIR model

In his presentation, *Marcel Berk (RIVM, Bilthoven)* gave an overview over the model FAIR (Framework to Assess International Regimes for burden sharing), which aims at providing support in evaluating options for international burden sharing. The model relates burden sharing schemes to global climate protection targets and calculates the respective regional emission permits. It is based on the meta-IMAGE simple climate model and can be used interactively.

Three different approaches of defining burden-sharing schemes are included in the model:

- *Increasing participation*: Parties involved in the burden sharing gradually increase their participation according to participation rules, such as per-capita emissions, or the contribution to global warming.
- *Convergence*: All parties participate in the burden-sharing regime with e.g. per capita emission permits converging over time.
- *Triptych*: different burden sharing rules are applied for different sectors (e.g. convergence of per capita emissions in the domestic sector, efficiency and decarbonisation targets for the industry sector and the power generation sector).

Some examples of these different approaches were shown as an introduction to the interactive session.

5 Discussion

The discussion focused on the feasibility of the presented burden-sharing schemes. It was stated that the rules applied in the FAIR model require ex ante knowledge of the baseline scenario, which makes the problem practically unsolvable. Therefore, a more outcome-based solution or the approach presented by Carsten Helm could be more realistic. On the other hand, an approach based on compensation was also criticised as not being feasible.

Apart from the definition of the baseline, the uncertainty in determining costs poses a problem for the application of burden-sharing schemes. It is also mentioned that costs of damage and adaptation are not considered in FAIR, although they pose a probably even larger equity problem.

One participant suggested that parties agree on one model to calculate costs (e.g. for compensation). Given the great variety of models and possible assumptions others questioned the possibility to agree on one model.

The political feasibility of results of the FAIR model was questioned, because a variety of burden-sharing schemes derived from general equity criteria imply that the USA has to reduce their emissions substantially in the short term. Therefore, it was suggested that the discussion should focus on *opportunities* offered by taking on legally binding targets, instead of the sharing of a burden. Political feasibility could also be integrated as a parameter e.g. in the FAIR model. A broader set of criteria for participation in legally binding obligations should be considered, such as technological participation (e.g. efficiency standards), which could create positive incentives. In this context, it was pointed out that these standards should not imply any conditionality being imposed on developing countries, so that they should be able to choose among possible criteria.

It was stated that equity considerations should be separated from national interests in the negotiations. First, parties should agree on equity principles, then the implementation should be negotiated. On the other hand, others noted that climate change negotiations should not be used as a vehicle to solve all equity problems.

Some policymakers advocated for the need of an agreement on general principles to define which countries should take on targets when. One example could be the participation rule of per-capita emissions reaching the world average level, which could be acceptable e.g. by China.

In addition, the need for stepwise, intermediate approaches to bridge the gap between the Kyoto Protocol and long-term goals including equity considerations was expressed. It was stated that incentives are needed not only for broadening participation, but also for deepening participation among Annex-I countries.

6 Interactive session with the FAIR model

The policymakers were divided into two groups to participate in interactive sessions with the FAIR model.

6.1 Group A

Moderator: *Bert Metz* (RIVM), operator: *Michel den Elzen* (RIVM), rapporteur: *Joyeeta Gupta (IVM).*

Participants: *Ivo de Boer, Harald Dovland, Jesper Gundermann, Rosa Morales, Rezki Lounnas, Atiq Rahman, Rolf Sartorius, Denis Tirpak, Hans Timmer, Janina Onigkeit*

The participants explored different options for defining increasing participation, assuming that the 550-ppm-concentration level should be reached, and using the IS92A as the reference scenario. Different percentages of the per-capita income in Annex-I countries used as threshold for participation in the burden-sharing regime were explored, combined with different burden-sharing keys that define the shares of the emission reductions within the group for participating regions. Examples for burden-sharing keys explored are per-capita emissions or the per-capita contribution to temperature increase. This exercise showed that a high threshold of participation could force developed countries to reduce their emissions by 100%. Under any combination explored, the USA and the EU have to reduce their emissions substantially within a few decades, even if countries like China and India step into the burden-sharing group in this timeframe.

It was suggested to add other criteria for participation and burden sharing e.g. GDP elasticities. Finally, the triptych approach was introduced. Three different sectors were examined – domestic emissions, electricity and industrial emissions. No stabilisation target is given for this bottom-up approach. Different effectivity requirements and decarbonisation rates were explored. If efficiency improvement requirements were strengthened, global emissions can be reduced substantially. If the decarbonisation rate required is elevated, global emissions can be reduced earlier.

The following conclusions were drawn from this interactive session:

- The convergence approach (based on per-capita emissions or per-capita contribution to global warming) leads to unrealistic results.
- The Kyoto targets fall far short of what is needed and that valuable time has been lost.
- If India and China came on board immediately, and the developed countries reduced their emissions at relatively low level, then Indian and Chinese per capita emissions would have to remain at roughly the same level.
- It is noted that mitigation costs are not taken into account in FAIR.
- The presentation of the model did not give enough emphasis on the decarbonisation aspects.

6.2 Group B

Moderator: *Ferenc Toth*, operator: *Marcel Berk*, rapporteur: *Ursula Fuentes*

Participants: *Jean-Jaques Becker*, *John Drexhage*, *Bill Hare*, *Jim MacKenzie, Leo Meyer, Mark Mwandosya, David Warrilow, Ye Ruquiu, Jaap Jansen*, *Dian Phylipsen.*

The different steps in the FAIR model were shown and illustrated. The new IPCC A1 Scenario was chosen as the reference scenario, because it has more realistic sulphur projections.

The relationship between the choice of a concentration target and climate sensitivity was discussed: 550 ppm might be an acceptable target if the climate sensitivity is low, but not if it is high. In the end, the group agreed on looking at the 550-ppm concentration level.

Within the increasing participation mode, the relevance of an income threshold was discussed, as well as the criteria for the choice of a threshold. It was suggested to look at the distribution of incomes within Annex B. Different examples show that only a low threshold leaves enough leeway for emission reductions. In addition, the implications of choosing dynamic criteria (instead of fixed thresholds) were discussed.

Within the convergence mode, the possibility of other criteria for convergence (apart from per-capita emissions) was discussed, such as emissions per GDP, emissions related to the Human Development Index, or a combination of indicators. In addition, the possible inclusion of more gases (Kyoto basket) and of sinks into the definition of the burden sharing was discussed.

Session IV: LULUCF in climate policy

The Session on Land-use change and Forestry in climate policy was chaired by *Leen Hordijk (WAU).* After an introduction into the session by *Ursula Fuentes (RIVM), Rik Leemans (RIVM)* gave an overview over the role of the terrestrial biosphere in the global carbon cycle. *Michael Sonntag* and *Janina Onigkeit (*both *University of Kassel)* presented preliminary results of Scenarios with the IMAGE model assessing the potential contribution of carbon plantations to stabilise the atmospheric carbon dioxide concentration.

1 Introduction

In the introduction to the Session, *Ursula Fuentes (RIVM)* gave an overview over the open questions to be resolved regarding the inclusion of land-use change and forestry activities in the Kyoto Protocol, based on her previous work with the German Advisory Council on Global Change (WBGU). Open questions with regard to Article 3.3 of the Kyoto Protocol include the definition of the activities (afforestation, reforestation, deforestation) to be accounted for, as well as the distinction of direct human-induced activities from others, and the definition of verifiable changes in carbon stocks. In particular, the inclusion or exclusion of soil carbon is relevant, as a large part of the carbon stored in forests is found in the soil, especially in high latitudes (see Figure 1). Also the consideration of harvested products is an open question.

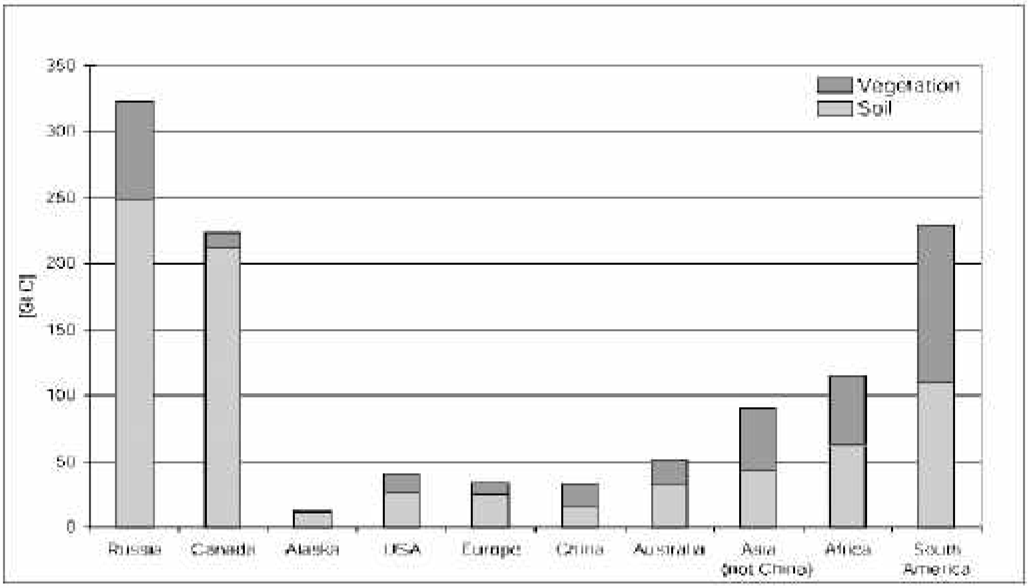

Figure 1: Distribution of carbon stocks in forests by country/region. Source: WBGU (1998)

The different time-scales involved in reducing emissions from fossil fuel burning versus emission and sequestration in forests raise questions regarding the permanence of sequestration. The time-scales involved in measuring carbon stock changes give rise to questions regarding e.g. possible perverse incentives such as to clear-cut primary forests (with high carbon content) and replace them with secondary forests or plantations (with far lower carbon content but higher sequestration rates e.g. during the commitment period).

To introduce the following presentations, she presented the priority policy questions that had been identified at the Kassel workshops (Onigkeit et al., 1998; Onigkeit and Berk, 1999) focussing mainly on the medium and long-term policy debate:

- What are the long-term consequences of the carbon offset approach?
- What are the policy implications of the biosphere shifting from a carbon sink to a carbon source?
- What are the (long-term) consequences of different definitions of the carbon sink issue of the Kyoto protocol?

The following presentations were meant to give some scientific input to address these questions.

2 *The Role of the Terrestrial Biosphere in the Global Carbon Cycle*

The purpose of *Rik Leemans'* presentation was to provide a broad context to the discussion on the role of the terrestrial biosphere in mitigating climate change, particularly for the discussion of the policy implications of the biosphere shifting from a carbon sink to a carbon source. He particularly focused on the response of the terrestrial biosphere to changes in CO_2 concentrations and climate change.

The terrestrial biosphere is both a source and a sink of carbon in the atmosphere. Presently, the terrestrial biosphere as a whole constitutes a net sink, the magnitude of which is not precisely known. This is not a steady situation, but is influenced by climatic conditions, atmospheric CO_2 concentrations, and land use. An increase in atmospheric CO_2 concentrations has both direct and indirect effects. It directly enhances plant growth due to CO_2 fertilisation and increased water-user efficiency (WUE). WUE also influences vegetation structure and patterns. Indirectly, via a change of climate, it changes growth levels, decomposition rates, vegetation patterns, and disturbance regimes (e.g. forest fires). Overall, the role of the biosphere in carbon sequestration will be influenced by the following major relationships (c.f. Walker, B., W. Steffen, pp 32.):

- A warming climate will result in exponentially increasing levels of respiration and decomposition.
- A warming climate will tend to enhance growth, but there is an optimum beyond which productivity will decrease again.
- Increasing CO_2 concentrations enhance plant growth through CO_2-fertilisation but this process saturates.
- Increasing intensity of land use reduces the amount of carbon stored on land.

In addition, the probably increasing magnitudes of disturbances have consequences for the carbon cycle: CO_2 is rapidly released during and shortly after a disturbance, followed by a slow recovery period.

As a result it can be expected that the biosphere will show a non-linear response to an increase in CO_2 concentrations and climate change. An important question is if or how long the biosphere will remain functioning as a net sink of atmospheric carbon.

Present (dynamic) global vegetation models (DGVM) are not yet really able to provide a proper answer on this question. In a recent inter-comparison of 6 different DGVM, all models show a decline in net ecosystem productivity (NEP) after an initial increase until 2050. Only one model simulates an overshoot of NEP, leading to a net release from the biosphere. (Walker et al., 1999)

However, these models still leave out an important human factor, land use. Land-use change has had and will have a significant impact on the carbon cycle (e.g. deforestation). Conversion of forests into pastureland generally leads to a decrease of aboveground biomass, but sometimes to an increase in below ground biomass; conversion to arable land decreases both above- and below ground biomass. Simulations with the IMAGE 2 model show that extension (or offsetting) of agricultural land is likely to be a major factor in future land-cover change, particularly in developing regions. Carbon-sequestration policies may also have substantial consequences for land cover in both developed and developing countries due to the need for additional land. The need for land for large-scale carbon plantations may result in additional conversion of natural land in developing regions.

General conclusions:

- The role of the different components of the past global carbon cycle is relatively well known. Problems arrive when local and regional sources and sinks have to be defined.
- The future role of the carbon cycle is uncertain. Initially, NEP will probably increase but over longer time scales this increase could be reduced and NEP could decrease again. A roller coaster effect seems most likely.

- It cannot be ruled out that the biosphere eventually becomes a source. This is strongly a function of land-use intensity, climate change and changes in disturbance regimes.
- Carbon sequestration policies could help to maintain and restore the sink function of the biosphere, but may also result in additional loss of natural carbon sinks

3 The potential contribution of carbon plantations to stabilisation

3.1 The concept: IMAGE model with carbon plantations

The Center for Environmental Systems Research of the University of Kassel has been working on adjusting the IMAGE 2 model for an exploration of the potential contribution of carbon plantations to stabilise the atmospheric carbon dioxide concentrations, in order to address part of the question regarding the long-term consequences of the carbon offset approach.

Michael Sonntag explained key concepts and their implementation in the IMAGE 2 model for researching the issue. It has been assumed that the main reason for establishing a forest plantation as a carbon plantation is the effective sequestration of carbon, with wood production only as a desirable side effect.

To calculate the global potential for carbon plantations, first a selection was made of the areas (0.5° x 0.5 ° grid cells) suitable for growing the selected plantation species. For defining suitable areas for carbon plantations the concept of Surplus Potential Productivity (SPP) is introduced. This concept does not only take into account both the change in above-ground biomass and below-ground biomass, but also the carbon uptake of the natural vegetation which would be replaced by the plantation and the carbon content of the standing vegetation (conversion flux).

It is thus a measure of the net gain in carbon sequestration by replacing existing vegetation with plantation species (based on the average carbon sequestering over the rotation period). The highest (positive) SPP levels are found in areas that are presently not forested. Most forested areas in fact have a negative SPP, implying an overall loss of carbon when replaced by plantations (see Figure 2).

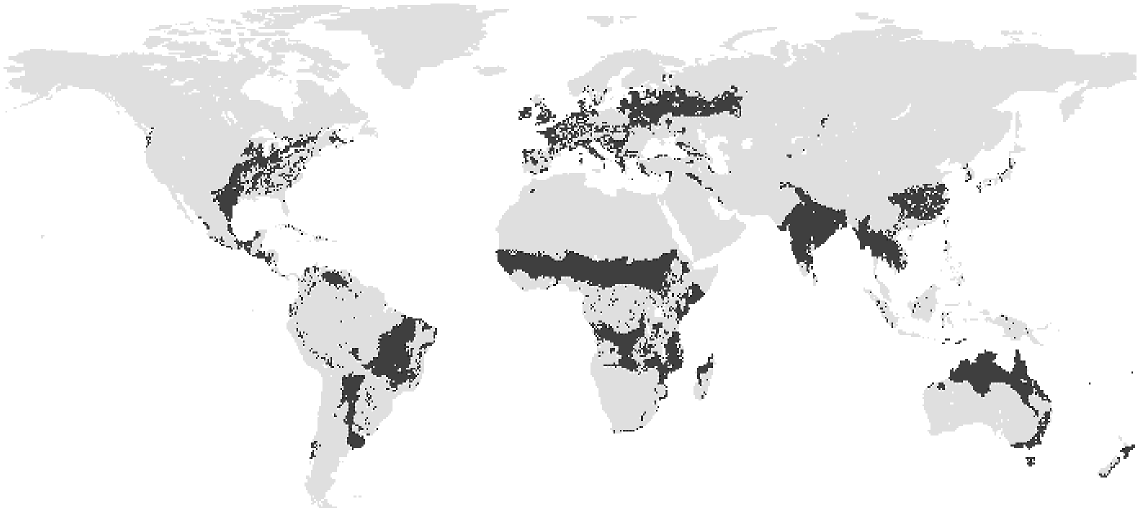

Figure 2: Preliminary result for the selection of suitable areas for carbon plantations, according to the SPP criterion (see text). Most forested areas have a negative SPP (grey) and would thus not be suitable for establishing carbon plantations. Positive SPP (black) can be found in many non-forested areas, which would be suitable for carbon plantations according to this criterion. Source: Michael Sonntag, Kassel University.

Allocation rules in the IMAGE 2 model were adjusted for the actual allocation of carbon plantations, taking into account competing land use demand (e.g. agricultural demand for land). Next, growth and yields of the carbon plantations are calculated. The wood produced in the carbon plantations is added to the IMAGE wood pools (one with a short-term decay time and the other with a long-term decay time, respectively).

For some explorative calculations a carbon sequestration target of 2GtC/year between 1991 and 2100 was chosen. Carbon plantations were assumed to be allowed on land with natural vegetation, abandoned agricultural land and harvested forest areas, with a positive SPP and an aboveground biomass growth (ABG) of more than 1 tC/ha/yr.

As a baseline scenario the new IPCC-A1 scenario was used. To meet the sequestration target, about 10-15% of the land area in Annex-I regions would be needed. Agricultural area only decreases by less than 2% compared to the A1 scenario. The results indicate that the carbon plantations may result in an atmospheric CO_2 concentration in 2100 that is about 50 ppmv lower than the baseline level.

3.2 Scenarios with the IMAGE model

Janina Onigkeit presented preliminary results of some scenario analyses with the IMAGE 2 model exploring the maximum potential contribution of carbon plantations to the stabilisation of CO_2 concentrations in the atmosphere. The new IPCC-A1 scenario (as implemented in the IMAGE 2 model) was used as a baseline scenario, with predefined population and economic growth patterns and derived demands for e.g. energy, food consumption, and agricultural land. Two different scenarios were explored:

1. All natural vegetation classes are allowed to be converted into carbon plantations (scenario 1), and
2. No natural vegetation is allowed to be converted into carbon plantations (scenario 2).

In both scenarios the SPP criterion and a minimum of above ground biomass growth of 1 tC/ha yr. is used to select the areas suitable for conversion. The demand for carbon plantations is met on a global scale without regional restrictions. Moreover, agricultural demand (food production) is secured in both cases. Wood produced at carbon plantations and from converting natural area into plantations (Scenario 1) is used to meet the wood demand.

In Scenario 1, the area of carbon plantations increases to 38 million km^2, or 30% of land cover, by 2100, equalling the amount of land used for agriculture. Natural vegetation is reduced from about 60 to less than 40%. Net Ecosystem Productivity (NEP) of the carbon plantations increases to 8.6 GtC/year by 2100, of which 6 GtC/yr. from areas naturally covered by forest vegetation, and 2.6 GtC/yr. from areas naturally not covered by forest vegetation. In Scenario 2, the area of carbon plantations increases substantially less to about 20 million km^2, or 16% of land cover by 2100, leaving 54% of land cover for natural vegetation. This nevertheless very high percentage of global area allocated to carbon plantations is mostly due to the large agricultural areas that are taken out of production in the IMAGE A1 scenario. Here, Net Ecosystem Productivity (NEP) of the carbon plantations increases to 4.3 GtC/year by 2100. Atmospheric CO_2 concentrations in 2100 are reduced from 750 ppmv in the baseline (IPCC1998-A1) to about 670 ppmv with Scenario 2 and about 625 ppmv with Scenario 1 (see Figure 3).

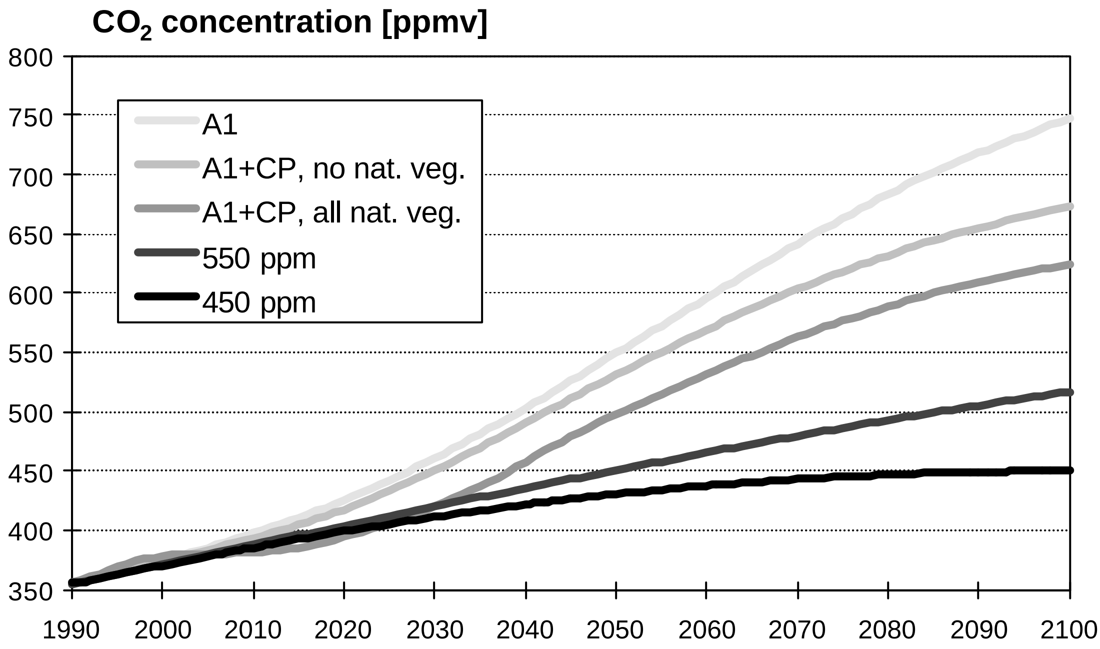

Figure 3: Carbon concentration pathways for different carbon plantation scenarios, as well as for the baseline scenario (A1) and two different stabilisation scenarios (450 and 550 ppm, respectively). Preliminary results with IMAGE 2.1. Source: Janina Onigkeit, University of Kassel.

It is concluded that if carbon plantations may not expand over natural vegetation, the global potential for carbon sequestration is substantially restricted. However, overall productivity in natural areas other than those with natural forest vegetation is generally low.

4 Discussion

In response to the introduction given by *Ursula Fuentes* it was mentioned that it would not be acceptable that countries are made liable for a loss of carbon from boreal forests' soils due to climate change, as Art. 3.3 was clearly restricted to direct human-induced activities.

Regarding *Leemans* presentation it was noted that the magnitude of the carbon fertilisation figures shown are much smaller than those of the reported global carbon fluxes. *Leemans* explained that this is due to the carbon-cycle models: these are very much simplified and are not very accurate. It was asked to what extent the gains of carbon sequestration would be partially offset by an increase in stronger GHG like methane or nitrous oxide. *Leemans* answered that increases of methane was possible from high latitudes through melting of permafrost but that a runaway greenhouse effect was unlikely.

It was asked what is the probability of a "roller coaster effect" in the response of the carbon cycle. *Leemans* clarified that during a recent IPCC-Working-Group-II lead authors meeting the majority view of experts was that the likelihood of a roller-coaster effect was equally likely as a gradual change. It was asked if a future version of IMAGE would be able to explore this issue of the biosphere turning into a source. According to *Leemans* this could be the case with the inclusion of the new climate-ocean sub-system under development (ECBilt) allowing for an improved simulation of inter-annual climate variability and disturbance. However, this new sub-system will not be part of the next version (IMAGE 2.2) planned for the end of 1999.

The presentations by *Sonntag* and *Onigkeit* raised a number of questions for clarification of the concept of Surplus Potential Productivity (SPP) and related to (the carbon in) harvested wood from carbon plantations. It was explained that SPP is not a measure for accounting carbon sequestration like NEP, but primarily for supporting choices regarding the most effective allocation of carbon plantations. It was asked if the IMAGE model has sufficient resolution to estimate the carbon sequestration potential of the various categories under Article 3.3 and 3.4 of the Kyoto Protocol (e.g. agricultural soil carbon). It was replied that the IMAGE model could be used to explore at least the potential order of magnitude, but only at a crude level and with substantial uncertainty. It was considered very helpful if the IMAGE model would be able to say something about the long-term impacts of the inclusion of various activities under the Kyoto protocol. Regarding the negative SPP in the area of boreal forests, it was asked if the increased productivity of managed forests in comparison to natural forests had been taken into account in the parameterisation of the carbon plantations. It was remarked that increased productivity was indeed taken into account, but that SPP included the potential loss of parts of the large carbon stocks of natural vegetation.

Generally, the scenarios were considered to be too academic and too unrealistic. More in particular, the feasibility of carbon plantations in many arid areas was questioned. Especially seasonal fluctuations in the water availability and low sequestration density could pose major obstacles for growing trees. In exploring the potential for carbon sequestration these factors would need to be taken into account. Another remark concerned the implications of the carbon plantations for biodiversity. The scenarios presented would have severe impacts on biodiversity.

It was noted that for a correct analysis also the stock of carbon in the harvested wood should be accounted for. In the present analysis, the major part of this carbon just ends up in two wood pools (with a short and long decay time). A more complete picture would therefor have to include avoided carbon emissions resulting from the possible substitution of wood for fossil fuels and construction materials like steel and cement. It was also mentioned that the huge amount of wood produced would certainly influence the wood market and wood prices.

It was acknowledged that the analyses presented should be interpreted as an exploration of the maximum (technical) potential contribution of carbon sequestration by plantations, rather than as realistic scenarios. An assessment of the economic and social feasibility would be a next step. In future work the areas suitable for carbon plantations could be selected on the basis of a set of criteria. It would certainly be interesting to make explicit scenarios for the use of the harvested wood (e.g. to substitute fossil fuel use and materials). Also, the issue of biodiversity can be taken into account in the IMAGE model.

Session V Mitigation and Stabilisation Scenarios

The Session on Mitigation and Stabilisation Scenarios was chaired by *Joe Alcamo (University of Kassel),* who also gave a short introduction into this field. The first presentation given by *Johannes Bollen (RIVM)* focused on macroeconomic impacts of mitigation scenarios under different burden sharing regimes, including a tradable permit system (top-down approach), while the second presentation given by *Bert de Vries (RIVM)* studied implications of different policy strategies for the energy market (bottom-up-approach) with IMAGE/TIMER scenarios.

1 Economic Analysis of Stabilisation Scenarios with WorldScan

Johannes Bollen presented the evaluation of the economic implications of mitigation scenarios aiming at stabilisation of CO_2 concentration in the atmosphere with reference to the new IPCC baseline A1 scenario. The scenario analyses are based on calculations with the WorldScan model, a global dynamic general equilibrium model, with 11 regions and 12 production sectors. The WorldScan model was used to explore the following 4 scenario variants:

1. Delayed response for stabilisation of CO_2 at 550 ppmv,
2. Early action for stabilisation of CO_2 at 550 ppmv,
3. IPCC-WG-I emission profile for stabilisation of CO_2 at 550 ppmv,
4. IPCC-WG-I emission profile for stabilisation of CO_2 at 450 ppmv.

Starting point of all variants is the implementation of the Kyoto protocol by Annex-I countries allowing for full trade of emission permits within Annex I. Afterwards, the group of countries (regions) abating their emissions to meet a global emission constraint is gradually extended on the basis of a welfare trigger (10.000 US$ income/capita for delayed-response/early-action cases and 2.500 US$ for the WG-I 550/450 cases). After entrance, regions first stabilise their emissions for 10 years before joining a regime for convergence of equal per capita assigned amounts by 2100. The group of countries participating (extended Annex I) ensures that the global emission constraint as defined by the various emission profiles is met, and hence also combat any carbon leakage to the non-Annex-I group.

Results

In the delayed-response scenario high initial emissions are offset by deep emission cuts during the second part of the next century (see Figure 4). The cumulative emissions of both Annex-I and non-Annex-I countries are equal for all stabilisation scenarios. However, during 2010-2050, Annex-I emissions are substantially lower in the early-action and WG-I-550 stabilisation variants than in the delayed-response case. This does not only result from stricter global emission constraints, but also from higher levels of carbon leakage from the abatement group to the non-abatement group that have to be compensated for by sharper reduction of Annex-I regions' emissions. Carbon leakage rates increase especially in the beginning of the scenario period, then stabilise, and eventually decrease as more countries join the carbon abatement group.

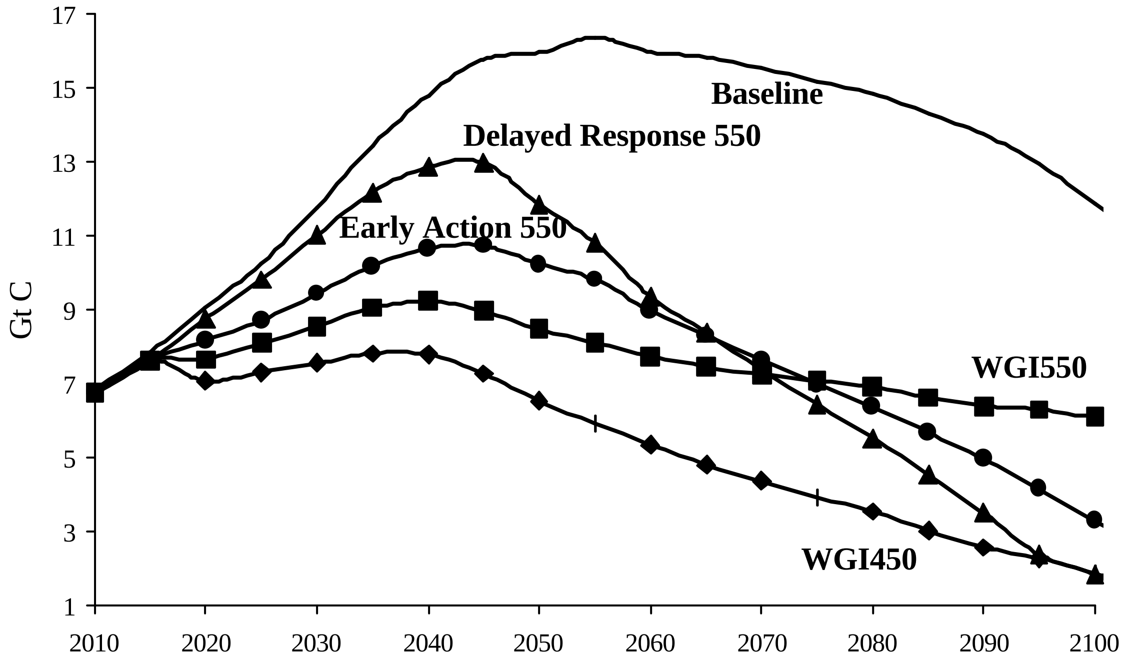

Figure 4: Global Emissions profiles for different stabilisation scenarios as used in WorldScan. In addition, the emissions profile of the baseline scenario is shown. Source: Johannes Bollen, RIVM.

Convergence of per-capita permits of the OECD versus the Rest of the World (Africa, Middle East, and Latin America) would occur around 2085 (see Figure 5). In the delayed-response scenario, all regions will experience a lower permit level compared to the "early-action" stabilisation scenario.

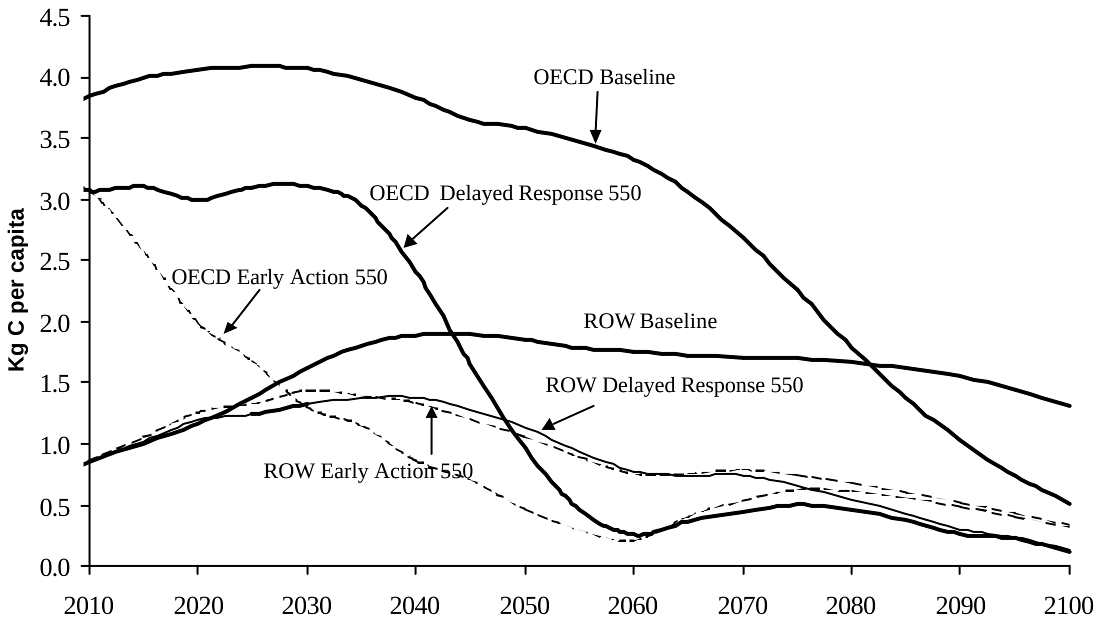

Figure 5: Carbon permits per capita for OECD and 'Rest of the World (ROW)' countries, from 2010 to 2100, for different stabilisation scenarios as well as the baseline scenario. Source: Johannes Bollen, RIVM.

The initial carbon permit price remains low due to trading of "hot air". The levels of the permit price fluctuate strongly, especially in the case of WG-I 550, WG-I 450, and early-action. These fluctuations are caused by the entrance of new regions into Annex I, which every time results in an extension of the carbon permits market. The level of the fluctuations is both determined by the strictness of the global emission constraint, and the timing of the participation of non-Annex-I regions. With the A1-baseline assumptions for per-capita income growth, China and India tend to join Annex I at about the same time, resulting in a large reduction of the carbon permit prices.

The entrance of new regions to the abatement group does not only influence the carbon permit prices, but also has regional income effects. A permit exporter may change to a net importer once one or more new members join the abatement group. Particularly the entrance of large regions like India and China has negative income effects on those regions that were emission permits exporters within the Annex I, like the EEFSU. The general picture that emerges is that the evolving permit market is much more unstable in the early-action case than in the delayed-response scenario. This means that delaying the global response will reduce the chances of resistance or even non-compliance of the “losing” members within the abatement club.

It was concluded that within the A1 scenario stabilisation of CO_2 in the atmosphere at 550 ppmv could be achieved at moderate costs. An early response is negative for Annex I countries, but a delayed response seems negative for non-Annex-I countries. The gradual approach of the entrance of new members to the Annex-I group of countries may lead to favourable effects.

Finally, it was concluded that in the A1 world a delayed response seems globally more beneficial, because there is less chance to overshooting in the medium run, less carbon leakage and overall free riders behaviour, and because the potential negative impacts at the end of the next century may diminish due to discounting. At the same time, delaying action may result in conflicting interests due to income transfers from permit trade.

2 Stabilisation Scenarios with IMAGE/TIMER

Bert de Vries presented mitigation scenarios constructed with the IMAGE/TIMER model, exploring technical and economic aspects of specific energy- and land-use greenhouse gas emissions. He focused on the stabilisation at 450 ppmv, using the IMAGE/TIMER B1 marker scenario as the reference scenario.

The IMAGE/TIMER model is, from the economic point of view, a bottom-up partial equilibrium model, which assesses gross energy system costs and not net macro-economic costs.

Population and economic activity trajectories are exogenous and taken from the IMAGE/TIMER B1 Marker scenario, without any feedback from energy system, land/food system or climate system taken into consideration.

No changes are assumed in some key, story line related parameters, such as the degree of dematerialisation, diet, the conservation supply cost curve, the supply cost curves for coal, crude oil and natural gas, and the labour wages and interest rates.

He presented a few preliminary results, based on first experiments with the IMAGE/TIMER model, focussing on the role of subsidies for energy efficiency investments, and on the effect of a set of policies (carbon tax, quotas, carbon removal and storage) implemented in each region in relation to their distance from the average world per-capita carbon emission. No industrial and land-use related emissions have been considered so far. Effect of subsidies for energy efficiency investments

A first preliminary result indicates that a linear increase of the assumed acceptable pay-back times for energy efficiency investments to twice the values in the B1 scenario (1-8 years instead of 0.5-4 years across regions, sectors and both non-electricity and electricity) would reduce carbon emission with 1-1.2 GtC by the middle of next century. It is assumed that the necessary investments – which gradually increase to an annual 180 10**9 1990 US $/yr. – are made through government support in the form of subsidies. One reason why the costs are rather small is the assumed learning-by-doing: in most sectors and regions it was assumed that the investment costs to save one GJ will decline with 10-30% on each doubling of cumulated investments. The concomitant CO2-concentration in 2100 as calculated with the meta-IMAGE-model is 517 ppmv. Obviously, these results hinge on many underlying developments, such as successful transfer of energy savings technologies and mechanisms to provide the necessary investment funds. The latter will require large skills and financial infrastructure in the presently less developed regions.

Energy savings cause a significant decline in the over-all user costs: less energy is used and hence there is less expenditure on energy. An important aspect is that a large flux of energy supply investments is avoided, both for fossil and non-fossil options. At the same time, this induces mechanisms that tend to counteract carbon emission trends. Fossil fuels are depleted less rapidly and are hence longer available at limited production costs. This in turn slows down the supply investment fluxes but also postpones the learning-by-doing for non-fossil options and hence retards their penetration. In this way, the experiment indicates the possibilities as well as the limitations of energy efficiency improvements and policies in a B1-world.

Reaching the 450 ppmv level

In a second set of experiments world regions have been forced to take action according to their distance to the world average per-capita emissions. Preliminary results indicate that to bring down the CO2-concentration to 450 ppmv in 2100 (according to the meta-IMAGE-model) requires an enormous effort in the presently developed regions. Targeted market shares for biofuels have to be pushed in the OECD-and REF-region to 20-30% of the market within 2-3 decades and, later on, in the less developed regions as well. The targets for non-fossil electric power generation options – some mix of solar photovoltaics, nuclear power, wind power etc. – have to be pushed to 50-60% at equally high rates. On top of this up to 60% of carbon from fossil-fuelled electric power stations has to be removed and stored. A carbon tax has to be introduced which gradually increases to 200 $/tC by 2020-2030 in the OECD- and REF-regions and which continues to rise thereafter to maintain the momentum in carbon emission reduction. Less developed regions with much lower per-capita carbon emissions will only feel the impact of emission reduction schemes by the middle of next century.

These preliminary simulations suggest – without emission trading being considered – that the maximum burden for OECD-Europe, for instance, would amount to 1% of GDP between 2020 and 2030. For India the additional costs might amount also to about 1% of GDP but much later, between 2040 and 2060.

Given these preliminary results, he noted that it seemed next to impossible to aim at a 350-ppmv CO2-concentration stabilisation target by or around the year 2100 in the context of the B1-scenario.

3 Discussion

The discussion mainly focused on the WorldScan analyses and the overall conclusions regarding the attractiveness of the delayed-response scenario. Other issues included the instability of the carbon permit prices due to the graduation approach, the mechanisms of carbon leakage, technological learning and inertia, policy targets and the integration of ecological and economic assessments.

With respect to the instability in the carbon prices it was remarked that in reality they would be much lower due to the existence of the CDM and market anticipation. Due to CDM many cheap options for emission reductions in countries like China and India would already be used before these countries enter the abatement group. This would reduce the price difference between measures in participating and non-participating countries and thus result in smaller economic shock effects. It was replied that the inclusion of CDM would result in higher baseline emissions in non-Annex-I regions, which would have to be compensated for by additional Annex-I-reduction efforts to remain below a global emission ceiling. The reduction in permit-price fluctuations due to CDM could therefore be only limited. It was suggested to include CDM in follow up work.

Another questions concerned the mechanisms behind carbon leakage. *Bollen* explained that the main mechanism is a faster growth of energy intensive sectors in non-Annex-I regions (compared to the baseline) due to lower energy prices. It was remarked that energy prices are not the only factors that determine the location of industries and that there is a great divergence of opinions on the mechanisms and rates of carbon leakage.

The overall conclusion that a delay of action would be more beneficial was questioned on various grounds. The WorldScan analyses do not show the differences in environmental impacts of the delayed response versus the early action scenario. It can be expected that the rates of temperature change are initially much higher in the delayed response case, which will result in different environmental impacts. These costs of delay were not taken into account in the analysis. It was also argued that the comparison of delayed versus early action depends on the envisaged concentration target. As other studies showed, the lower the concentration target, the lower the benefits of a delayed response. Another argument related to system inertia and technological learning. The feasibility of the fast emission reductions in the delayed response scenario was questioned. It was suggested to monitor the rates of change to judge if system inertia is sufficiently accounted for. WorldScan, like most General Equilibrium Models, does not take technological learning into account. This is particularly relevant for the comparison of the delayed-response and early-action scenarios: Without early action there will be little learning which will make strong reductions at a later stage difficult. This may result in a repeated prolonged delay because reduction costs will remain high. It was mentioned that a distinction should be made, here, between actions and abatement: in order to abate later, early action is needed.

Bollen acknowledged the relevance of technological learning, but emphasised that in the A1 Scenario technological diffusion is a much more important factor in global emission reduction. *De Vries* remarked that the TIMER model does take system inertia into account. It can be used to check the plausibility of the WorldScan output. However, regarding the feasibility of the delayed response scenario, he noted that there is much uncertainty about what is possible in an A1 world with much technological change and diffusion. He said there were strong arguments against a delayed response from the point of view of technology dynamics, but that it was hard to prove it with the TIMER model. Some found it worrying if models are not able to support early action.

It was remarked that it was politically problematic to make mitigation options dependent on the baseline scenario, because policy makers decide on the basis of the present, not possible futures.

Other remarks concerned the focus on long-term stabilisation targets. According to some, the focus should be on climate indicators such as warming, rate of temperature change, and sea-level rise, like in the Safe Landing approach. Others felt that scientific uncertainties justify the focus on stabilisation levels. Moreover, the primary focus on stabilisation on just one concentration level, and the particular choice of the 550 ppmv-level was criticised as this level would imply impacts such as those described in the IPCC Second Assessment Report (IPCC, 1996) for a doubling of the carbon dioxide concentration. A number of participants stressed the need for more integrated analysis of both the environmental, technological and economical aspects of different mitigation scenarios. In this respect it was suggested to also pay attention to similar work by other research groups (e.g. ICLIPS). In addition, it was asked to pay more attention to the implications of uncertainties (e.g. regarding the climate system, the impacts, and the stabilisation target) for mitigation strategies, applying appropriate methods to study decision-making under uncertainty (e.g. via stochastic approaches or hedging on different climate targets).

New Policy Questions

At the end of the workshop a new list of priority policy issues for further analysis was produced. This was done in two steps: first a list of about 60 relevant policy questions which derived from the discussion in the different sessions was compiled and extended in a plenary session. In a second step, each participant could attach an equal amount of points (ten) to one or several of the issues on the list. The points given by the policymakers should indicate the priority of the issue, whereas the points given by the scientists should give an indication of the feasibility of the analysis. The following policy questions were given high priority for further analysis in the second phase:

IPCC Reference Scenarios

- Are SRES-Scenarios consistent with short-term projections by parties?
- Are SRES-Scenarios consistent with socio-economic projections? Are the assumptions behind the Scenarios plausible? (Sustainable development, biomass...)

Impacts of Annex-I activities on developing countries

- What are economic and social impacts of Annex-I activities on developing countries?
- What are ecological impacts of climate change and adaptation costs on developing countries (influence of assumptions on post Kyoto)?
- What are the economic impacts on oil-exporting countries?

Broadening Participation in the Global Climate Change regime

- What could make it attractive to take on targets? (no-regrets, financial gains, technological transfer)
- Short-term analyses (20-30 years)/incremental approach/how to narrow the gap
- Incentives for deepening participation of all parties? Which incentives are needed for different groups of countries?

Land use, Land-use change and Forestry

- What are the long-term consequences of Art. 3.3 and 3.4 activities implemented in the first or second commitment period as well as consequences of long-term implementation?
- How can IMAGE be further developed to model the possible transition of the biosphere from a sink to a source? What are the policy implications of the biosphere turning from a sink into a source, including inter alia for the carbon plantations?
- What are the implications of the additional supply of wood from carbon plantations, as well as of increased use of wood on the wood market/substitution of fuel-intensive products?

Mitigation/Stabilisation Scenarios

- Dependence of conclusions regarding e.g. delay versus early action on the stabilisation scenario/level
- Integrated environmental and economic impacts of early vs. delayed mitigation? Influence of delay vs. early action on degrees of freedom (lock-in). Implications for technology development in the north in the context of full where flexibility

Article 2 FCCC

- Adaptation
- IPCC Policy Relevant Scientific Questions
- food production

Evaluation of the Workshop

The workshop was evaluated anonymously via an evaluation form filled in by participants (scientists as well as policymakers). Generally, participants were quite satisfied with the workshops' results. All participants indicated their interest in coming back to the next workshop. The contents and policy relevance of most presentations received on average a good rating by policymakers[i] (see Table 2).

The lowest scores were given for the information provided on the economic impacts of Annex-I activities on developing countries (not well addressed, not very policy relevant) and IMAGE scenarios with carbon plantations (while in principle policy relevant, the specific contents and presentations were criticised). Some indicated that they had expected more attention for developing countries aspects and suggested to invite more policy makers as well as scientists from developing countries. Issues missed were climate impacts and adaptation, costs of adaptation and issues regarding the implementation of the flexible mechanisms.

Table 2: Average rating by policy makers (n=13) of contents, presentation and relevance of the presentations (1= bad, 2= poor, 3= reasonable, 4= good, 5=very good).

Presentation	Contents	Presentation	Relevance
New IPCC baseline scenarios (SRES)	4.2	4.3	3.7
Economic impacts on developing countries	2.9	3.0	3.1
Broadening Participation: Overview	3.8	3.9	4.1
A multi-stages approach	3.8	4.1	3.8
Applying Fairness Criteria to Allocation	3.8	3.8	3.6
FAIR model	3.8	3.6	3.6
LUCF – Introduction	3.9	3.7	4.3
Terrestrial Biosphere in Carbon Cycle	4.2	4.3	3.9
IMAGE carbon plantations – concept	3.1	2.8	3.5
IMAGE carbon plantations – scenarios	3.5	2.9	3.7
Mitigation/Stabilisation Scenarios: Introduction	3.9	4.2	3.9
WorldScan Scenarios	3.6	3.7	3.5

[i] There was not enough feedback to the evaluation from scientists to be evaluated.

IMAGE/TIMER Scenarios	3.9	4.1	3.9
Average	3.7	3.7	3.7

The participants, in general, liked the interactive sessions with the FAIR model, but some participants were unsatisfied with the moderation and explanations given, as well as with the preparation of the session. Moreover, a number would have liked to have more time and to work with the FAIR- model more directly (hands on the tool).

The rating of the quality of the discussions, with regard to content, moderation and time availability, was generally good (see Table 3).

Table 3: Average rating by policy makers (n=11) of contents, moderation and time availability of the discussions in the different sessions (1= bad, 2= poor, 3= reasonable, 4= good, 5=very good).

Session	Contents	Moderation	Time availability
I - SRES scenarios	3.6	3.6	3.1
II – Economic impacts on developing countries	3.2	3.7	3.2
III – Broadening Participation – general discussion	3.8	3.9	3.8
III - interactive Session Group A	4.2	4.3	3.7
III - interactive Session Group B	3.0	2.8	3.6
IV – LUCF	3.5	3.8	3.5
V – Mitigation/Stabilisation	3.6	4.0	3.6

The participants were quite happy with the general set up of the workshop. Some indicated that there was not sufficient time for discussion. Others remarked that the discussion part remained to much as a questioning and answering exercise, so that too little real debate between participants developed. Some did not like the separation of the policy makers from the scientists by an inner and outer circle of tables. Suggestions were made to provide the briefing book materials in advance.

Participants were happy with the location and organisation of the meeting, as well as the workshop facilities. For a next time, it was suggested to have some more communication facilities near the meeting room. Regarding the planning of the meeting policy makers indicated a clear preference of keeping the future COOL workshops detached from FCCC meetings.

References

Gupta, J. (1998), 'Leadership in the Climate Regime: Inspiring the commitment of developing countries in the post-Kyoto phase', *Review of European Community and International Environmental Law*, 7 2 at 178-188.

Onigkeit, J., Berk, M., Alcamo, J. (1998): Workshop Report. Sixth International Workshop on using Global Models to Support Climate Negotiations. Open Questions after Kyoto. Report Number P9806, Center for Environmental Systems Research, University of Kassel.

Onigkeit, J., Berk, M. (1999): Workshop Report. Seventh International Workshop on using Global Models to Support Climate Negotiation. Towards Buenos Aires. Report Number P9901, Center for Environmental Systems Research, University of Kassel.

WBGU (1998): The Accounting of Biological Sinks and Sources Under the Kyoto Protocol -- A Step Forwards or Backwards for Global Environmental Protection? Special Report 1998, ISBN 3-9806309-0-9, http://www.wbgu.de/wbgu_sn1998_engl.html.

Walker and Steffen (1998) (Eds.) *The terrestrial biosphere and global change. Implications for natural and managed ecosystems. A synthesis of GCTE and related research.* IGBP Science No. 1. The International Geosphere-Biosphere Programme, Stockholm, November 1997.

Walker, B., W. Steffen, J. Canadell and J. Ingram (Eds.), 1999. *The terrestrial biosphere and global change: Implications for natural and managed ecosystems*. Cambridge University Press, Cambridge.

Annex

Programme

List of Participants

Programme

First COOL Global Dialogue Workshop - 4-6 July 1999, RIVM, Bilthoven, The Netherlands

Sunday, 4 July 1999 at Hotel Heidepark in Bilthoven

18:00-18:30 *Drinks*

18:30-19:00 **Welcome and Introduction**

Bert Metz (RIVM)
Introduction to the COOL Global Dialogue and to the workshop programme

19.00 **Dinner**

Monday, 5 July 1999 at RIVM, Bilthoven, The Netherlands

9:00-10:30 **Session I: New IPCC Reference Scenarios**

Chair: Bert Metz (RIVM)

Bert de Vries (RIVM)
Presentation of the new IPCC baseline scenarios under preparation
(IPCC Special Report on Emission Scenarios)

Discussion

10:30-11:00 *Coffee break*

11:00-12.30 **Session II: Impacts of activities of Annex-I countries on developing countries**

Chair: Bert Metz (RIVM)

Hans Timmer (CPB)
Summary of main findings of the IPCC Expert Meeting on Economic Impacts of Annex I actions on developing countries, The Hague 27-27 May

Discussion

12:30-13:30 **Lunch**

13:30-15:30 **Session III: Broadening Participation in the Global Climate Change regime**

Chair: Bill Moomaw

Bert Metz (RIVM)
Overview

Joyeeta Gupta (IVM)
Encouraging developing countries participation in the climate change regime: A multi-stages approach

Carsten Helm (PIK)
Applying Fairness Criteria to the Allocation of Climate Protection Burdens: An Economic perspective

Marcel Berk (RIVM)
Global Climate Protection and Equitable Burden Sharing: An Exploration of Options with the FAIR model

Discussion

15:30-16:00 *Coffee break*

16:00-18:00 **Session III (continued): Broadening Participation in the Global Climate Change regime**

Interactive session with the FAIR model (in two groups)

Marcel Berk
Introduction to the interactive session

Moderators: Bert Metz (RIVM), Ferenc Toth (PIK)
Operators: Marcel Berk (RIVM), Michel den Elzen (RIVM)
Rapporteur: Ursula Fuentes (RIVM), Joyeeta Gupta (IVM)

Plenary reporting

20:00 **Dinner**

Tuesday, 6 July 1999

9:00-11:00 **Session IV: Land Use Change and Forestry in Climate Policy**

Chair: Leen Hordijk (WAU)

Ursula Fuentes (RIVM)
Introduction

Rik Leemans (RIVM)
The Role of the Terrestrial Biosphere in the Global Carbon Cycle: Overview of results from IGBP-GCTE research

Michael Sonntag, Janina Onigkeit (University of Kassel)
Sequestration Potential with Carbon Plantations:
Scenarios with IMAGE.
Assessment of the maximum sequestration potential achievable with afforestation under different assumptions regarding competition with other land-use types.
Implications of accounting for different carbon stocks and fluxes.

Discussion

11:00-11:30 *Coffee break*

11:30-12:30 **Session V: Mitigation and Stabilisation Scenarios**

Chair: Joe Alcamo (University of Kassel)

Joe Alcamo (University of Kassel)
Introduction

Johannes Bollen (RIVM)
Economic Analysis of Stabilisation Scenarios with WorldScan, based on new IPCC baseline scenarios (A1, B1).
Macroeconomic Impacts and Effects on Energy Markets of Mitigation/Stabilisation Scenarios under different Burden Sharing regimes and with a system of tradable permits (top-down approach).

12:30-13:30 **Lunch**

13:30-15:00 **Session V (continued): Mitigation and Stabilisation Scenarios**

Bert de Vries (RIVM)
Mitigation/Stabilisation Scenarios with the IMAGE/TIMER model, based on new IPCC baseline scenarios (A1, B1).

Implications of different policy strategies for the energy market (bottom up approach).

Discussion

15:00-15:30 **New Policy Questions**

Chair: Bert Metz (RIVM)

Identification of new policy questions and need for new analyses

15:30-16:00 *Coffee break*

16:00-16:30 **New Policy Questions (continued)**

Prioritisation of new policy questions and need for new analyses

16:30-17:00 **Evaluation of Workshop Set-up**
Marcel Berk, Ursula Fuentes (RIVM)

Participants

Policy makers / stakeholders

Mr. Jean-Jacques BECKER
Mission Interministérielle de l'Effet de Serre
Ministère de L'aménagement du territoire et de L'environnement
20 avenue de Ségur
75302 Paris 07 SP
France
Tel.: +33 1 42 75 87 14
Fax. : +33 1 47 53 76 34
E-mail: jean-jacques.becker@mies.premier-ministre.gouv.fr

Mr. Yvo DE BOER
Climate Change division
Ministry of Housing, Spatial Planning and the Environment
P.O. Box 30945
2500 GX The Hague
The Netherlands
Tel.: +31 70 339 4386
Fax. : +31 70 339 1310
E-mail: yvo.deboer@dle.dgm.minvrom.nl

Mr. Harold DOVLAND
Ministry of Environment
Myntgaten 2
P.O. Box 8013 Dep.
N-0030 Oslo 1
Norway
Tel.: +47 22 245995
Fax. : +47 22 242755
E-mail: hdo@md.dep.no

Mr. John DREXHAGE
Manager, Climate Change International
Global Air Issues
Environment Canada
11th Floor, Place Vincent Massey 351 St. Joseph Blvd.
Hull Quebec K1A OH3
Canada
Tel. +1 819 682 3158
Fax +1 819 994 0549
E-mail: john.drexhage@ec.gc.ca

Mr. Jesper GUNDERMANN
Danish Energy Agency
Amaliegade 44,
DK 1256 Copenhagen K
Denmark
Tel.: +45 33 92 67 83
Fax. : +45 33 92 68 67
E-mail: jgu@ens.dk

Mr. Bill HARE
Greenpeace International
Keizersgracht 176
1072 DW Amsterdam
The Netherlands
Tel.: +31 20 523 6268
Fax. : +31 20 523 6200
E-mail: bhare@ams.greenpeace.org

Ms. Rosa MORALES
replaced
Ms. Patricia ITTURREGUI:
Commision Nacional de Cambio Climático
Consejo Nacional de Ambiente
Av. San Borja Norte 226
Lima 41
Peru
Tel.: +51 1 225 5370
Fax. : +51 1 941 1999
E-mail: patricia.iturregui@conam.gob.pe

Dr. Jim MacKENZIE
Replaced
Dr. Nancy KETE:
World Resources Institute
Director Climate, Energy, and Pollution Program
10 G Street, NE
Washington, DC 200002
USA
Tel. 202 729 7730
Fax. 202 729 7798
E-mail nkete@wri.org

Mr. Rezki LOUNNAS
OPEC-secretariat
Energy Studies Department
Obere Donaustrasse 93
A-1020 Vienna II
Austria
Tel.: +43 1 21 1120
Fax. : +43 1 216 4320
E-mail: rlounnas@opec.org

Mr. Leo MEYER
Climate Change division
Ministry of Housing, Spatial Planning and the Environment
P.O. Box 30945
2500 GX The Hague
The Netherlands
Tel.: +31 70 339 4407
Fax. : +31 70 339 1310
E-mail: leo.meyer@dle.dgm.minvrom.nl

Mr. Mark MWANDOSYA
Centre for Energy, Environment Science and Technology
B3-16 Tirdo Estate, Morogoro Stores, Oysterbay
P.O. Box. 5511
Dar-es-alam
Tanzania
Tel.: +255 51 666079
Fax. : +225 51 666079
E-mail: Ceest@intafrica.com

Mr. Atiq RAHMAN
Bangladesh Centre for Advanced Studies
House 23, 620, Road No. 10 A (New) Dhanmondi
Dhaka 1209
Bangladesh
Tel.: +880 2 9113682 / 9119823
Fax: +880 2 811344
E-mail: Atiq.r@bdcom.com

Dr. Rolf SARTORIUS
Federal Environmental Agency
P.O. Box. 330022
D 14191 Berlin
Germany
Tel.: +49 30 8903 2511
Fax. : +49 30 8903 2285
E-mail: rolfsartorius@uba.de

Mr. Dennis TIRPAK
FCCC-secretariat
P.O. Box 260124
D-53153 Bonn
Germany
Tel.: +49 228 815 1000
Fax. : +49 228 815 1999
E-mail: dtirpak@unfccc.de

Mr. David WARRILOW
UK Department of Environment
Ashdown House, floor 3/c1
123 Victoria street
London SW 1E 6DE
United Kingdom
Tel.: +44 171 890 5210 / 890 5221
Fax. : +44 171 276 8509 / 890 5219
E-mail: davidw@globatmo.demon.co.uk

Mr. YE Ruqiu
State Environmental Protection Adm.
115 Xizhimennei Nanxiaojie
Beijing 100035
CHINA
Tel.: +86 10 6615 1754
Fax. : +86 10 6615 1762/6491 5281
E-mail: yeruqiu@cenpok.net

Scientists

Prof. Dr. Joseph ALCAMO
Center for Environmental Systems Research
University of Kassel
Kurt Wolters Strasse 3
D-34109 Kassel
Germany
Phone: +49 561 804 3898
Fax: +49 561 804 3176
E-mail: alcamo@usf.uni-kassel.de

Mr. Marcel BERK
National Institute for Public Health and the Environment. (RIVM),
P.O. Box 1
3720 BA Bilthoven
The Netherlands
Phone: +31 30 274 3723
Fax: +31 30 274 4435
E-mail: marcel.berk@rivm.nl

Mr. Johannes BOLLEN
National Institute for Public Health and the Environment (RIVM),
P.O. Box 1
3720 BA Bilthoven
The Netherlands
Phone: +31 30 274 3610
Fax: +31 30 274 4435
E-mail: jc.bollen@rivm.nl

Dr. Michel DEN ELZEN
National Institute for Public Health and the Environment (RIVM),
P.O. Box 1
3720 BA Bilthoven
The Netherlands
Phone: +31 30 274 3584
Fax: +31 30 274 4435
E-mail: michel.den.Elzen@rivm.nl

Dr. Ursula FUENTES
National Institute for Public Health and the Environment (RIVM)
P.O. Box 1
3720 BA Bilthoven
The Netherlands
Phone: +31 30 274 3683
Fax: +31 30 274 4435
E-mail: Ursula.Fuentes@rivm.nl

Dr. Joyeeta GUPTA
Institute for Environmental Studies
De Boelenlaan 1115
1081 HV Amsterdam
The Netherlands
Phone: +31 20 444 9548
Fax: +31 20 444 9553
E-mail: joyeeta.gupta@ivm.vu.nl

Dr. Carsten HELM
Potsdam Institute for Climate Impact Research (PIK)
Telegrafenberg
PO Box 6012 03
14412 Potsdam
Germany
Phone: +49 331 288 2557
Fax. +49 331 288 2600
E-mail: helm@pik-potsdam.de

Prof. Dr. Leen HORDIJK
Environmental Systems Analysis Group
Wageningen Agricultural university
P.O. Box 9101
6700 HB Wageningen
The Netherlands
Phone: +31 317 484919
Fax. +31 317 484839
E-mail: leen.hordijk@wimek.cmkw.wau.nl

Prof. Dr. Jean-Charles HOURCADE
Centre International de Recherche sur l'Environment et le Développement (CIRED)
Ecole des Hautes Etudes en Sciences Sociales
45 bis Av. de la Belle Gabrielle
94736 Nogent sur Marne Cedex
France
Phone: +33 1 43947373
Fax. +33 1 43947370
E-mail: hourcade@msh-paris.fr

Mr. Jaap JANSEN
Netherlands Energy Research Foundation (ECN)
Policy Studies
P.O. Box 1
1755 ZG Petten
The Netherlands
Phone: +31 224 564437
Fax. +31 224 563338
E-mail: j.jansen@ecn.nl

Mr. Eric KREILEMAN
National Institute for Public Health and the Environment (RIVM)
P.O. Box 1
3720 BA Bilthoven
The Netherlands
Phone: +31 30 274 3554
Fax: +31 30 274 4435
E-mail: Eric.Kreileman@rivm.nl

Dr. Rik LEEMANS
National Institute for Public Health and the Environment (RIVM)
P.O. Box 1
3720 BA Bilthoven
The Netherlands
Phone: +31 30 274 3377
Fax: +31 30 274 4435
E-mail: Rik.Leemans@rivm.nl

Dr. Bert METZ
National Institute for Public Health and the Environment (RIVM)
P.O. Box 1
3720 BA Bilthoven
The Netherlands
Phone: +31 30 274 3990
Fax: +31 30 274 4435
E-mail: Bert.Metz@rivm.nl

Prof. Dr. Bill Moomaw
Tufts University
Fletcher School of Law and Diplomacy
160 Packard Avenue
Medford - Massachusetts 02155
Phone: +1 617-627-2732/ 627-3700
Email: wmoomaw@emerald.tufts.edu
Temporarily: bill.moomaw@ivm.vu.nl

Ms. Janina ONIGKEIT
Center for Environmental
Systems Research
Kurt-Wolters-Str.3
34109 Kassel, Germany
Phone +49.561.804. 3072
Fax: +49.561.804.3176
Email onigkeit@usf.uni-kassel.de

Ms. Dian PHYLIPSEN
Department of Science, Technology and Society
Utrecht University
Padualaan 14
3584 CH Utrecht
The Netherlands
Phone: +31 30 253 7604
Fax: +31 30 2537601
E-mail: d.phylipsen@chem.uu.nl

Dr. Michael SONNTAG
Center for Environmental
Systems Research
Kurt-Wolters-Str.3
34109 Kassel, Germany
Phone +49.561.804. 3178
Fax: +49.561.804.3176
Email sonntag@usf.uni-kassel.de

Dr. Hans TIMMER
Netherlands Bureau for Economic Policy Analysis (CPB)
P.O. Box 80510
2508 GM The Hague
The Netherlands
Phone: +31 70 338 3380
Fax. +31 70 338 3350
E-mail: timmer@cpb.nl

Prof. Dr. Ferenc TOTH
Potsdam Institute for Climate Impact Research (PIK)
Telegrafenberg
PO Box 6012 03
14412 Potsdam
Germany
Phone: +49 331 288 2554
Fax. +49 331 288 2600
E-mail: toth@pik-potsdam.de

Dr. Bert DE VRIES
National Institute for Public Health and the Environment (RIVM)
P.O. Box 1
3720 BA Bilthoven
The Netherlands
Phone: +31 30 274 3533
Fax: +31 30 274 4435
E-mail: Bert.de.Vries@rivm.nl