International Institute for
Applied Systems Analysis
Schlossplatz 1
A-2361 Laxenburg, Austria

Tel: +43 2236 807 342
Fax: +43 2236 71313
E-mail: publications@iiasa.ac.at
Web: www.iiasa.ac.at

Interim Report **IR-01-055**

Muddy Greenhouse Gas Accounting Requires Independent Third Party Certification

Sten Nilsson (nilsson@iiasa.ac.at)
Gary Bull (garybull@interchange.ubc.ca)
Matthias Jonas (jonas@iiasa.ac.at)
Michael Obersteiner (oberstei@iiasa.ac.at) and (oberstei@ihs.ac.at)
Anatoly Shvidenko (shvidenk@iiasa.ac.at)

Approved by

Arne Jernelöv
Acting Director, IIASA

29 October 2001

Contents

Abstract

At the Conference of Parties (COP 6 II) the sinks became a central issue in the Kyoto negotiations. This paper illustrates the uncertainties involved in the greenhouse accounting with respect to sinks. Different assessments, using the same basic data, result in dramatically different results with respect to the sink capacities. In order to achieve the targeted efforts with the sinks in the Kyoto process a new institutional setup is required. An important component of this institutional setup is the introduction of independent third party certification of greenhouse gas accounts and country reports submitted to the UNFCCC Secretariat.

About the Authors

Sten Nilsson is Counselor to the Director and Leader of IIASA's Forestry Project. Gary Bull is Assistant Professor at the Forest Resources Management Department, University of British Columbia, Canada. Matthias Jonas and Anatoly Shvidenko are research scholars in IIASA's Forestry Project. Michael Obersteiner is a research scholar in IIASA's Forestry Project and at the Institute for Advanced Studies in Vienna, Austria.

Muddy Greenhouse Gas Accounting Requires Independent Third Party Certification

Sten Nilsson, Gary Bull, Matthias Jonas,
Michael Obersteiner and Anatoly Shvidenko

1 Background and Objective

The Conference of Parties (COP 6 II) decided in Bonn in July 2001 that anthropogenic greenhouse gas removals by sinks are eligible under the Kyoto Protocol (UN, 2001). Under Article 3.3 eligible activities are human-induced afforestation, reforestation and/or deforestation activities started after 1 January 1990 and finished before the end of the commitment period. Under Article 3.4 afforestation, reforestation, deforestation, revegetation, forest management, cropland management, and grazing land management are eligible during the first commitment period. There is no overall limit on sinks but specific categories will be limited. Cropland, grazing, and revegetation are restricted to claim increased sequestration over 1990 levels. Forest management caps are set for each Annex I country (in total 56.85 million tC). National inventory systems shall ensure that areas of land subject to land-use, land-use change and forestry activities under Articles 3.3 and 3.4 are identifiable and reported in the national inventories. Each party in Annex I shall account for *all* changes in the carbon pools of above-ground biomass, below-ground biomass, litter, dead wood, and soil organic carbon (UN, 2001). In practice, this means that COP 6 II is requesting Full Carbon Accounting.

This paper will use forestry sinks to illustrate the need for a different institutional setup for greenhouse gas accounting and its verification in the Kyoto process compared to the existing proposals by the Kyoto Protocol.

Grubb *et al*. (1999) have outlined the current institutional setup according to the Kyoto Protocol and highlight among other things the following:

> *"Parties in Annex I shall institute national systems for compiling inventories of greenhouse gases no later than a year before the start of the first commitment period.*
>
> *Information submitted under Article 7 shall be reviewed. It builds on the existing Convention system of in-depth review teams coordinated by the secretariat. Experts are to be nominated by parties and perhaps by intergovernmental organizations. Inventories and assigned amounts must be reviewed annually.*
>
> *The expert teams are obliged to report back to the Conference/Meeting of the Parties assessing the implementation of the commitments of the*

> *Party (concerned) and identifying any problems in, and factors influencing, the fulfillment of commitments.*
>
> *The secretariat is specifically tasked with listing the questions raised by the expert reports and submitting the lists to the Conference/Meeting of the Parties for decisions as required."*

For forestry it is specifically stated:

> *"Forestry-related activities shall be reported in a transparent and verifiable manner, reflecting concerns about the uncertainties associated with this sector."*

In the above description of the institutional setup national reports and experts nominated by experts are crucial cornerstones. The suggested system is illustrated in a schematic form in Figure 1.

Victor (2001a, b) identifies a number of key concerns with the current Kyoto Protocol even though he does not specifically mention the institutional framework issue. He points out that with respect to *"sinks — enormous potential for cooking the books — only a monitoring program larger and more intensive than anything ever attempted under international law could settle the inevitable disputes"*. Victor (2001a, b) points out that a consensus is emerging that trading is the key to realize the Kyoto Protocol. In order to create an emission trading system emission permits worth hundreds of billions of dollars have to be established. But uncertain accounting *"will undermine confidence in the value of emission permits and give governments strong financial incentive to cook the books"* (Victor, 2001b). Victor (2001b) also correctly points out that the inaccurately measured fluxes permits cannot be assigned reliably and *"the security of the underlying property rights erodes and with this the efficiency of the trading systems declines"*. He also concludes that on-site inspections would be needed for the accounting (even for fossil fuels in countries with doubtful accounting) in order to get a reliable trading system established under the Kyoto Protocol and for compliance. Kopp (2001) states that with no strong legal or economic incentives for compliance some parties to the Protocol will choose not to comply if the costs of verification are too high.

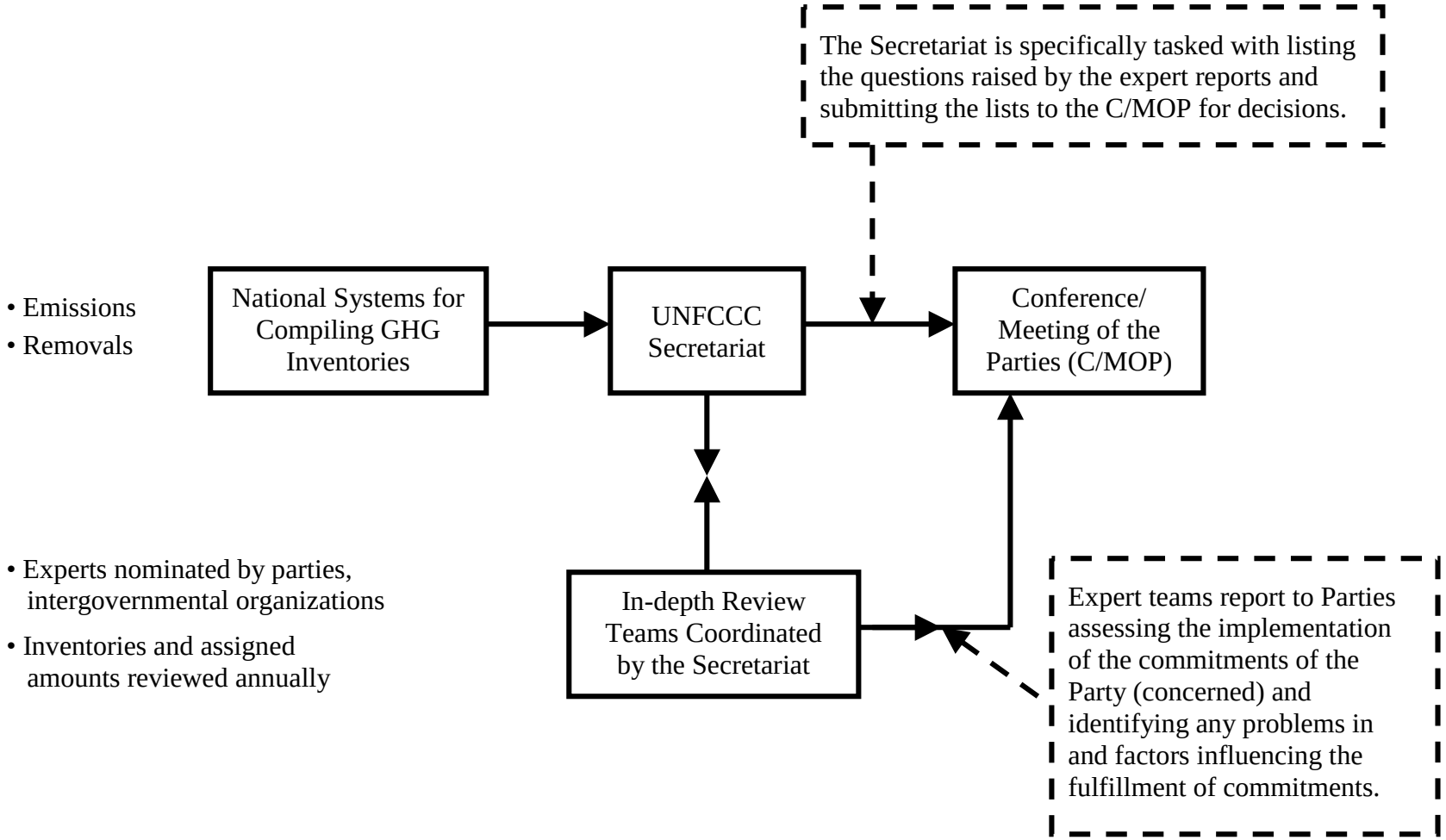

Figure 1: Institutional Framework for Verification and Compliance According to the Kyoto Protocol. Simplified Scheme.

2 TBFRA–2000

The institutional framework for verification of greenhouse gas accounting and verification outlined in Figure 1 within the framework of the Kyoto Protocol can already be validated. The validation can be carried out through the so-called TBFRA–2000 (Temperate and Boreal Forest Resource Assessment year 2000) carried out by the United Nations (UN, 2000a). In this assessment, the basic data was collected from officially designated national correspondents by means of a questionnaire. The original country data was collected on the basis of national definitions and measuring and sampling techniques, which were validated and adjusted to international standards by experts at the UN Secretariat. Experts were brought into the Secretariat to assess the carbon cycle and balance based on the data delivered by the national correspondents (UN, 2000a). The carbon balance of woody biomass was assessed for the fifty-five countries covered by TBFRA–2000 on "forest and other wooded land". FAO released a press release on 15 March 2001 stating, *"The UN Food and Agriculture Organization's Forest Information System, based on its Forest Resources Assessments, could become a tool for assessing the changes in forest carbon stocks, under the Kyoto Protocol"* (FAO, 2001).

2.1 Russia

Russia has some 20% of the world's forests both from area and growing stock volume points of view (UN, 2000a). With proper management the Russian forests could play an important role within the Kyoto Protocol framework and many countries are looking towards Russia for trading of carbon permits.

The TBFRA–2000 report (UN, 2000a) presents the carbon balance for woody biomass on forest and other wooded land as an annual average for 1988–1993 (1990 base year for the Kyoto Protocol). The results are presented in Table 1 together with results from Shvidenko and Nilsson (2001), which are also based on the same basic official inventory information as in TBFRA–2000.

Table 1 reveals some major differences in spite of the fact that the basic forest information in both cases should be based on the same data, namely the Russian official forest inventory (State Forest Account). Areas of forests and other wooded lands reported by TBFRA do not make any sense. According to the TBFRA definition forests include closed forests, i.e., *"land with tree cover (or equivalent stocking level) of more than 10%"* and areas *"which are temporarily unstocked as a result of human intervention or natural causes but which are expected to revert to forest"* (UN, 2000a:386). This means that all forest land (Russian terminology) of 886.5 million ha should be included. But TBFRA is reporting 816.5 million ha. With the employed TBFRA definition there is no difference between "forests" and "forests and other wooded land" with respect to Russia. There are major differences between the TBFRA (UN, 2000a) conversion/expansion factors from wood volumes to biomass and the Shvidenko and Nilsson (2001) estimates. The first is based on aggregated simple conversion factors and the latter on detailed inventory information. For further details on these differences see Shvidenko and Nilsson (2001). The TBFRA data on increments (which are not fully assessed by the Russian inventory) leads to some

unrealistic TBFRA conclusions: (1) gross annual increment (average per ha) on other wooded land is twice as big as in closed forests: 3.21 m^3/ha^{-1} and 1.63 m^3/ha^{-1} respectively (UN, 2000a:189), and (2) the net annual increment provides accumulation of carbon in growing stock on other wooded land and in trees outside forests of +37 and +41 million tC yr^{-1} respectively. It is also clear that the Russian correspondents underestimated mortality in the Russian forests by 2–2.5 times.

Table 1: Comparison of the annual average carbon balance 1998–1993 of woody biomass on forest and other wooded land in Russia based on TBFRA–2000 (UN, 2000a) and Shvidenko and Nilsson (2001).

	TBFRA–2000 (UN, 2000a)	**Russian Inventory** (Shvidenko and Nilsson, 2001)
"Forests"	816.5 million ha (probably includes unforested areas, but probably excludes sparse forests of 62.1 million ha)	763.5 million ha (closed forests)
"Forests and other wooded land"	886.5 million ha	886.5 million ha (forest land)
"Growing stock" on "Forests"	85.49 billion m^3[a]	80.68 billion m^3
"Gross annual" increment of wood		
• Forests	1.62 m^3/ha^{-1}	2.46 m^3/ha^{-1}
• Other wooded land/unforested area	3.21 m^3/ha^{-1}	0.20 m^3/ha^{-1}
"Biomass expansion factor above-ground tree biomass from wood volume"		
• Forests	0.26 tC/m^3	0.30 tC/m^3
• Other wooded land	5.1 tC/m^3[b]	0.33 tC/m^3
"Total increment" of wood		
Gross growth	1328 million m^3 yr^{-1}	1880 million m^3 yr^{-1}
Natural losses/Mortality	359	914
Net growth	969	966
Average carbon sequestration in 1988–1993	429 million tC yr^{-1}	-9 million tC yr^{-1} (official inventory) +38 million tC yr^{-1} (restored official inventory)

[a] Including "large branches", which are not defined by TBFRA.
[b] Assessed for 1993.

The final result is that TBFRA (UN, 2000a) estimates the average yearly carbon sequestration in woody biomass at 428 million tC yr^{-1} in Russia and the Shvidenko and Nilsson estimate is a source of -9 million tons (official inventory) and a sink of 38 million tC yr^{-1} (restored official inventory). Thus, a difference of some 400 million tC

yr^{-1}. An overestimate of the forestry sink capacity by about 400 million tC yr^{-1} corresponds to *some 75%* of the total net emissions of C (all sources) in 1990 in Russia (527 million tC yr^{-1}) based on full carbon accounting (Nilsson *et al.*, 2000).

The above can be compared with the *Second National Communication of the Russian Federation under the Framework Convention on Climate Change* of 10 June 1998, which is also based on the official forest inventory data. For 1990, the Second National Communication reports a sequestration of 243 million tC yr^{-1} in forest biomass on closed forests and 19 million tC yr^{-1} in the remaining part of the *forest fund*, which is larger than "other wooded land" used in TBFRA. This makes in total a sequestration of 262 million tC yr^{-1} in 1990. An interesting observation is that the Secretariat of the Framework Convention on Climate Change carried out an in-depth review of the Second National Communication of the Russian Federation in 2000 (UN, 2000b). This in-depth review has no questions whatsoever on the reported carbon balance for the Russian forests.

With respect to the TBFRA study (UN, 2000a), it can be concluded that the national correspondents provided very free manipulations of the official reported forest inventory data and estimated other indicators, not defined by the official Russian inventory, in an unsatisfactory manner. This can be a result of misunderstandings by the correspondents of questionnaires and definitions used by the TBFRA Secretariat. It is also clear that the experts used by the TBFRA Secretariat for the carbon assessment were not able to detect the mistakes and, in addition, they also misinterpreted other Russian data in the succeeding steps of the carbon assessment.

It is also obvious that the Second National Communication did not use the reported official forest inventory data. If this had been done the Communication would have presented a different result. In a similar way, it is also clear that the expert team carrying out the in-depth review (UN, 2000b) was not able to detect the mistake.

2.2 Canada and Australia

The TBFRA study (UN, 2000a) states that the carbon balance for Canada with respect to total woody biomass in 1994 on forest and other wooded land (417.6 million ha) constitutes a net *sink* (after harvest) of 92.7 million tC yr^{-1}. Kurz and Apps (1999) have studied the Canadian forest carbon balance for many years and have published a 75-year retrospective detailed analysis of the carbon fluxes. For a forest area of 404.2 million ha they assess the annual average flux, for the period 1990–1994, of the total forest biomass to be a net *source* of 36.8 million tC yr^{-1}. During the studied 75-year period, the Canadian forest biomass turned from being a substantial sink to a source with a peak in the source capacity in the second half of the 1980s. Kurz and Apps (1999) claim that disturbances of fires, insects and harvesting played a major part of the abrupt change in the forest's role from a sink to a source. It seems plausible that the TBFRA study has seriously underestimated the impact of the disturbances in the assessment (in a similar way as for Russia). The difference in the assessment between the two studies is some 130 million tC yr^{-1} in the fluxes, which is rather remarkable due to the fact that both studies are using the Canadian National Forest Inventory as a basis.

For Australia, the TBFRA study (UN, 2000a) reports in 1994 a net sink of 42.6 million tC yr^{-1} for total biomass (after harvest) on forest and other wooded land. But the National Greenhouse Gas Inventory of Australia[1] reports for 1990 a net sink of 6.7 million tC yr^{-1}. The corresponding assessments for 1994 and 1999 for both years are 6.3 million tC yr^{-1} (Australian Greenhouse Office, 2001). This corresponds to an overestimate by 6–7 times in the case of the TBFRA study. It should also be pointed out that the assessments of the forest fluxes by the Australian Greenhouse Office (2001) do not include conversion of forests and grasslands, which is treated as a separate subsector and has substantial net emissions. The emissions from this conversion in 1994 and 1999 were 17.9 million tC yr^{-1} and 19.6 million tC yr^{-1} respectively. The Australian Greenhouse Office (2001) concludes, *"high uncertainties remain for this sector [LUC&F] and must be considered in analyses such as the compilation of trends for greenhouse gases in Australia"*.

2.3 Europe

There are different assessments of the forestry carbon budget for Europe. However, they are very difficult to compare. One approach is the UNFCCC and EU Monitoring Mechanisms but, in spite of these mechanisms, for the time being no unique methodology exists within the EU15 to estimate C sinks and sources from land-use and forestry (Löwe *et al*., 2000; JRC, 2000). The TBFRA–2000 (UN, 2000a) study discussed above for Russia also covers Europe. Schelhaas and Nabuurs (2001) have recently published a study on stocks and fluxes of forests in Europe. In addition, there are a number of studies with respect to an atmospheric CO_2 sampling network (e.g., Valentini *et al*., 2000; JRC, 2000). Löwe *et al*. (2000) and JRC (2000) have tried to make a comparison of some of these studies and JRC (2000) concludes that the reporting of carbon sinks and sources in forestry in Europe is not sufficient to fulfill future requirements with regard to the Kyoto Protocol. We have used basic data presented by Löwe *et al*. (2000); JRC (2000), UN (2000a) and Schelhaas and Nabuurs (2001) but have made a number of recalculations in order to be able to make a comparison for a number of European countries (Table 2). A possible comparison covers nine countries and is valid for so-called exploitable forests (non-exploitable forests and other wooded land are not included) and the woody biomass (above- and below-ground) carbon fluxes before harvests (Net Ecosystem Production of the wood part of forest biomass, NEP), and the data cover, on average, the Kyoto baseline of 1990.

The difference in the totals is substantial (about 30%) for the different assessments. The largest total sinks are reported through the UNFCCC and EU Monitoring Mechanisms, which could be expected. The TBFRA–2000 has a 19% lower total estimate and the Schelhaas and Nabuurs study has 23% lower total estimate than reported in the mechanisms. This may indicate an overestimation of the uptake by the mechanisms. If this is a systematic overestimate of the uptake and it would be applied for all EU15 countries, the emissions of 1990 (EU, 1996) and the agreed emission reductions made in Bonn in July 2001 means that just the overestimate in the national reports on forestry uptake corresponds to some 20% of the agreed total emission reductions.

[1] Available on the Internet: http://www.greenhouse.gov.au/inventory/inventory/landuseforestry.html.

Table 2: Woody biomass (above- and below-ground) carbon fluxes (uptake) before harvests on exploitable forests in some countries of Europe around 1990, million tC yr^{-1}.

Assessment / Country	UNFCCC and EU Monitoring Mechanisms based on JRC (2000) and Löwe *et al*. (2000)	TBFRA–2000 (UN, 2000a)	Schelhaas and Nabuurs (2001)
Belgium	1.94	1.35	1.23
Denmark	1.36	1.09	1.18
Finland	27.31	24.12	22.76
France	36.90	27.30	21.11
Ireland	1.87	1.02	1.36
Italy	9.85	6.03	9.94
Portugal	4.16	5.22	2.79
Spain	10.98	9.04	10.63
UK	4.23	4.42	4.76
Total	**98.60**	**79.59**	**75.76**

In some cases, the differences for individual countries are much more dramatic. For France, the two studies outside the mechanisms have 25–40% lower uptake than the sinks reported according to the mechanisms. The TBFRA–2000 study has nearly 40% lower estimate for Italy compared to the mechanism estimate. These illustrated differences would not be acceptable within the Kyoto framework and could not be used in any reliable trading system of permits. It should also be pointed out that the assessments through the atmospheric CO_2 sampling network also shows substantially different results (however, they cannot be directly compared with the studies in Table 2) with the studies discussed here.

2.4 Austria

There are a number of different assessments for Austria and it would be of interest to compare these. In addition to the Löwe *et al*. (2000), JRC (2000), UN (2000a), and Schelhaas and Nabuurs (2001) studies discussed earlier we are also using a study by Weiss *et al*. (2000), the Austrian inventory reports for Annex I Parties to be submitted to the UNFCCC (FEA, 2000), and a detailed case study by IIASA (Jonas and Nilsson, 2001).

The different studies use somewhat different time periods in the assessments. Löwe *et al*. (2000) and JRC (2000) do not specifically specify the time period used in the 1990s but reflect the first half of the 1990s. The TBFRA–2000 (UN, 2000a) compares data from two time periods and for Austria use 1986–1990 and 1992–1996 respectively. Schelhaas and Nabuurs (2001) use data dated 1986–1990 for Austria (Nabuurs, 2001). Weiss *et al*. (2000) present data for the period 1961–1996. In 2000, the Federal Environment Agency (FEA, 2000) submitted updated Inventory Information according to the Common Reporting format to the UNFCCC for the period 1990–1996. Jonas and Nilsson (2001) use data for the period 1988–1994. It

should be stressed that there are substantial differences in the uptake between individual years. The comparison of the different assessments is based on woody biomass (above- and below-ground biomass) carbon fluxes (uptake) before harvests on exploitable forests (Table 3).

Table 3: Woody biomass (above- and below-ground biomass) carbon fluxes (uptake) before harvest on exploitable forests in Austria, million tC yr^{-1}.

	Above- and Below-ground Biomass					
	Löwe *et al*. (2000) and JRC (2000)	FEA (2000)	Weiss *et al*. (2000)	TBFRA–2000 (UN, 2000a)	Schelhaas and Nabuurs (2001)	Jonas and Nilsson (2001)
1986–1990 (average)			9.5		15.9	
1988–1992 (average)			9.3			
1988–1994 (linear)						10.5
1992–1996 (average)	8.1	8.1	8.3	14.9		

The variation in the assessments presented in Table 3 is huge. The range is between 8.1–15.9 million tC yr^{-1}. We regard the Jonas and Nilsson (2001) study to be the most detailed assessment carried out using different sources outside the basic forest inventory information to verify the latter. The uncertainty range in the Jonas and Nilsson (2001) assessment for 1990 is -1.5 to +2.1 million tC yr^{-1}. The important point to stress is that all assessments use the same basic data, namely the Austrian forest inventory, but end up with a huge variation in the assessments. Thus, in this case the UNFCCC mechanism reports substantial lower sink capacity than the independent studies.

It seems obvious from these comparisons that any assessment of the carbon/greenhouse gas balance (1) has to be evaluated by third party experts having a solid knowledge in carbon and greenhouse gas accounting and knowing the very specifics of the country reviewed, and (2) specific requirements on forest greenhouse gas accounting have to be explicitly formulated and agreed upon by the Parties. Otherwise there will be all kinds of possibilities for the individual countries to, using Victor's (2001b) terminology, *"cook the books"*.

3 Independent Third Party Reviews of Accounts

Every international agreement requires a solid solution on verification and compliance mechanisms and efficient monitoring to discover deviates from the treaty requirements (Cooper, 2000). Anderson (2001) identifies that one "crunch" in this process is how to get efficient monitoring, *"governments are likely to want assurance that their competitors cannot simply ignore commitments"*. He also concludes that sinks can only be understood by specialists. Chayes and Chayes-Hendler (1995)

conclude that most of the apparent deviations from treaty provisions arise from different kinds of ambiguities. Noble and Scholes (2001) make it clear that verifiability, rather than measurability *per se*, may be the key issue with respect to biospheric pools (and other pools) in an international agreement.

There are strong ties between the accounting of greenhouse gases, their uncertainties, reporting to the international mechanisms, verification and compliance. Nilsson *et al*. (2000) have demonstrated that there are substantial uncertainties involved in the current greenhouse gas accounting methods, especially for sinks. Nilsson *et al*. (2001a, b) conclude that a solid verification mechanism is required in order to move the climate process forward. This conclusion is further stressed by the outcome of the Bonn meeting of COP 6 II in July 2001, where forest and land use management were introduced as eligible measures and opened up sink allocations for large "sink" countries like Canada, Russia, and Australia. In order to reach this solid verification mechanism, a full gas accounting with uncertainty assessments is a must (Nilsson *et al*., 2000; 2001a, b). With respect to forestry this view is also strongly supported by the global forest industry (FIA, 2000).

Thus, it is solidly documented that there are substantial uncertainties with the greenhouse gas accounting. This is not only valid for the sinks but also for the energy sectors. There are studies showing that the uncertainties are substantially higher for the energy sector in many countries compared with the general recycled uncertainty figure of ±10% (IPCC, 2000). Other studies show that the uncertainties can be much higher in the energy sector especially in the transition countries (17% Nilsson *et al*., 2000; ±35–60% Parkinson *et al*., 2001).

On top of these accounting uncertainties are the uncertainties connected with reporting to the international mechanisms. In order to come up with a solid verification these uncertainties should be under control. There seems to be widespread acceptance that countries submit their national inventory data for external review. But the "crunch" is how this external review is carried out (Nilsson *et al*., 2001a).

There is also a lack of consensus in the understanding of the term "uncertainty". It is very symptomatic that the IPCC Report "Land-use, Land-use Change and Forestry" (IPCC, 2000) defined "accuracy" and "precision" in a purely statistical way, but did not consider any intrinsic features of the carbon account uncertainties. Any carbon budget (and particularly for forests) is a non-stationary stochastic process with significant irregular variability and evident features of fuzzy systems. This means that classical statistical methods of estimating uncertainties are only applicable at separate and rather limited states of carbon evaluations, at least at the national (regional) level. There are different approaches and suggestions on how to deal with this problem (e.g., Chen *et al*., 2000, Nilsson *et al*., 2000). Nilsson *et al*. (2000) define uncertainty as *"an aggregation of insufficiencies of the full carbon accounting system outputs, regardless of whether these insufficiencies result from a lack of knowledge, the intricacies of the system, or other causes"* and suggest a formal way of estimating accuracy, precision and uncertainties, based on partial involvement of expert estimates and personal (*a priori*) probabilities. Currently, it is not clear what philosophy and methodology would be acceptable for the Parties, but an anticipatory discussion on the problem seems necessary and urgent.

3.1 Independent Third Party Certification

One way of getting reliable validation is to have independent third party certification of the national inventory mechanisms and the national reporting mechanism. Third party certification is already under implementation in forestry with respect to sustainable forest management (CEPI, 2001). We think many lessons can be made from the implementation of certification for sustainable forest management with respect to greenhouse gas verification. We use studies by Bass and Simula (1999), Kanowski *et al*. (2000), Rametsteiner (2000), and Fern (2001) to sketch an outline of a certification system for greenhouse gas accounting and verification.

The original purposes with a certification scheme for greenhouse gas accounting would be: (1) to improve the quality of the accounting and the reporting and decrease the associated uncertainties with those mechanisms, and (2) to provide market advantage in a trading process of greenhouse gas permits. (We concluded earlier that trading is the key option for moving the climate negotiations into implementation.)

Certification can be defined as an established and recognized verification procedure that results in a *certificate* on the *quality* of the *greenhouse gas accounting* and the *reporting* in relation to a *set of predetermined criteria* based on an *independent third party assessment* with rights to do *site inspections*. The *verification* takes place through the *audit*, which is carried out by an independent third party composed of experts on greenhouse gas accounting.

There are a number of bodies involved in the certification. The first is the *standard-setting* body, which establishes the set of predetermined criteria (or certification standards) for the audit. Based on recommendations by the Intergovernmental Panel for Climate Change (IPCC) and clearance by COP, the UNFCCC Secretariat can act as the standard-setting body. The *Accreditation* body recognizes, against published criteria of capability, competence and impartiality, the independent third party certification bodies involved in the auditing. The COPs can act as the accreditation body. The *certification* body is carrying out the auditing and verification of the greenhouse gas accounting and reporting, resulting in the certificate.

3.2 Multiyear Certification Periods

We have illustrated in this paper that there are substantial inter-annual variations in the sink uptake (see also Shvidenko and Nilsson, 2001). However, the inter-annual variations are not only linked to the sinks but also to the swings in the business cycles in the energy and industrial emissions of greenhouse gases. Therefore, the appropriate certification period should be long enough to take care of these variations through averaging. Sandalow and Bowles (2001) have expressed similar views.

3.3 Permanent Court of Arbitration

The existing climate treaty is full of ambiguities, which are bound to cause conflicts between countries and other stakeholders in the climate negotiations. The uncertainties in the existing greenhouse gases and the national reporting illustrated in this paper calls for a body to come up with dispute resolutions. The Permanent Court

of Arbitration (PCA, 2001) has recently proposed a set of optional arbitration rules to be added to the existing rules of the Permanent Court of Arbitration for settlement of disputes connected with the climate convention and the Kyoto Protocol (among other environmental issues) due to the absence of a forum for resolution seeking of conflicts by different stakeholders. The proposal is that the optional rules could be set up as a tribunal under the UNFCCC Secretariat or an *ad hoc* basis.

4 New Institutional Setup

After being through the analysis we can conclude that from a sink point of view there is need for institutional changes within the Kyoto process. However, we have used forestry as a basis for the illustration of problems but the problem identification is also valid for other sectors of the greenhouse gas balance. Based on the findings in this paper we can modify the existing institutional structure presented in Figure 1. This modified structure is presented in Figure 2.

The proposed scheme means that the countries have national accounting systems based on full accounting with uncertainty assessments with linked reporting for the international mechanism. The accounting schemes as well as the reports are going through a certification mechanism including standard-setting, accreditation, and certification bodies as discussed in Section 3.1. The certification body submits the certificate on the accounting scheme and reports to the UNFCCC Secretariat and the C/MOPs. The certification should cover a multiyear period in order to average the inter-annual variations of the greenhouse gas balances. The certification body has the right to make site inspections.

The C/MOPs deal with the certified products in the current mode. Possible conflicts on the accounts and reports are sent to the Permanent Court for Arbitration for settlement.

The proposed structure does not change the current basic structure proposed by the Kyoto process but it will increase the bureaucracy and the costs for the international climate protection mechanism. But we think this is necessary in order to avoid the current mud of greenhouse gas accounting and related national reporting.

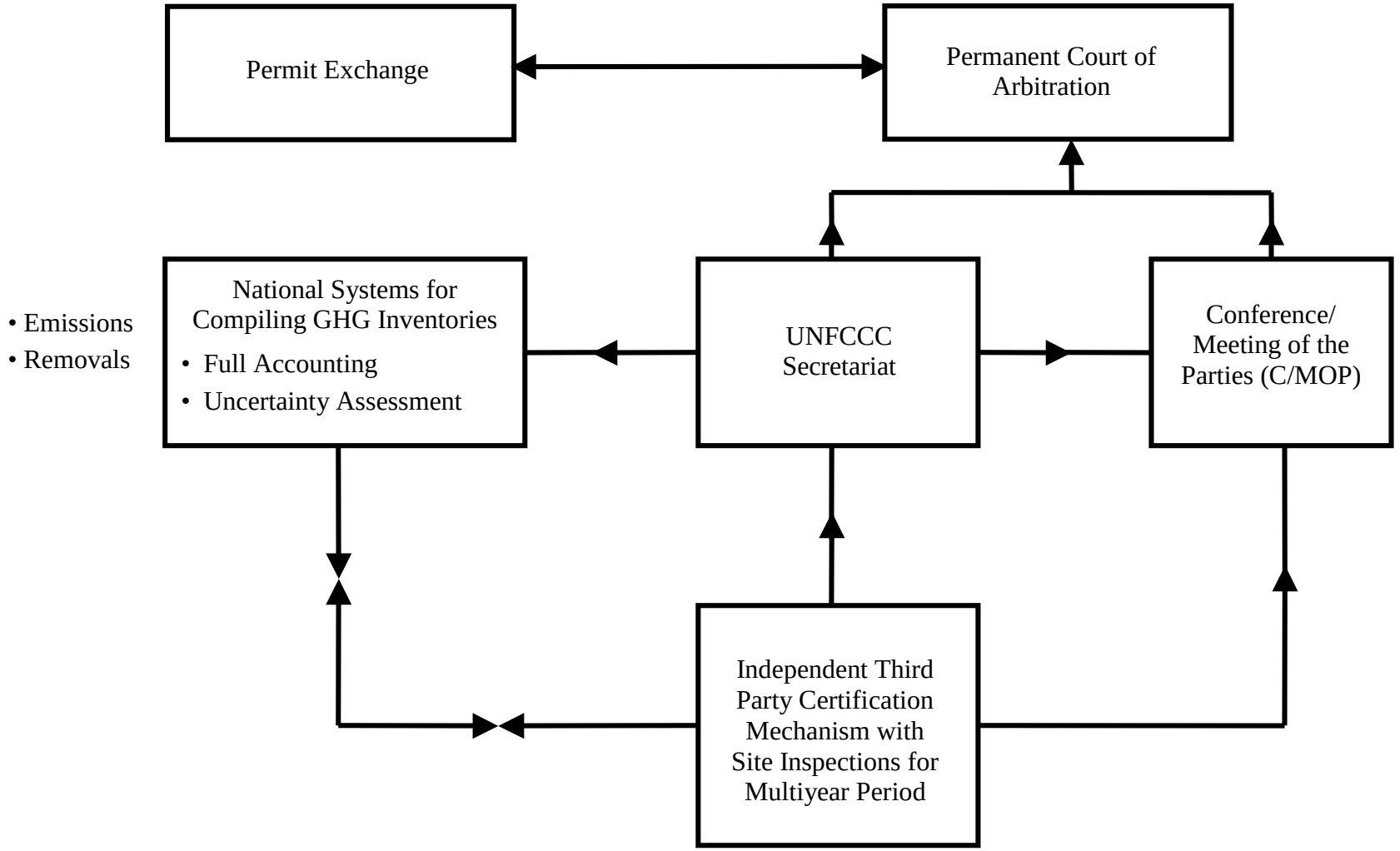

Figure 2: Modified Institutional Framework for Verification and Compliance of Greenhouse Gas Accounting.

References

Anderson, J.W. (2001). Climate Change Diplomacy: The Next Step. *Resources*, Issue 142, Winter, pp. 11–13.

Australian Greenhouse Office (2001). National Greenhouse Gas Inventory. Land Use Change and Forestry Sector 1990–1999. Australian Greenhouse Office, Canberra, Australia.

Bass, S. and M. Simula (1999). Independent Certification/Verification of Forest Management. Paper presented at the World Bank/WWF Alliance Forest Certification/Verification Workshop, Washington DC, 9–10 November 1999. The World Bank/WWF Alliance, Washington DC, USA.

CEPI (2001). Comparative Matrix of Forest Certification Schemes. Reprinted in February. Confederation of European Paper Industries (CEPI), Brussels, Belgium.

Chayes, A. and A. Chayes-Hendler (1995). *The New Sovereignty: Compliance with International Regulatory Agreements*. Harvard University Press, Cambridge, Mass., USA.

Chen, W., J. Chen, J. Liu and J. Cihlar (2000). Approach for Reducing Uncertainties in the Regional Forest Carbon Balance. *Global Biogeochemical Cycles*, Vol. 14, No. 3, 827–838.

Cooper, R.N. (2000). International Approaches to Global Climate Change. *The World Bank Research Observer*, Vol. 15, No. 2, pp. 145–172.

EU (1996). Communication from the Commission under the United Nations Framework Convention on Climate Change. Commission of the European Communities, COM(96) 11 June1996, Brussels, Belgium.

FAO (2001). FAO Forest Resource Assessments and Global Warming. FAO Press Release 01/16. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. Downloaded from and available on the Internet: http://www.fao.org /WAICENT/OIS/PRESSNE/PRESSENG/2001/poen0116.htm.

FEA (2000). Federal Environment Agency (FEA) (Umweltbundesamt), UNFCCC 2000. Available on the Internet: http://reports.eea.eu.int/ Technical Report No. 60/en.

Fern (2001). Behind the Logo. An Environmental and Social Assessment of Forest Certification Schemes. Fern, Moreton-in-Marsh, United Kingdom.

FIA (2000). Climate Change. Meeting the Challenge of Global Climate Change — Views of the Forest and Paper Industry in: New Zealand, Canada, Japan, United States, and Europe. Forest Industry Associations (FIA), Washington, Brussels, Montreal, Tokyo and Wellington.

Grubb, M., C. Vrolijk and D. Brack (1999). *The Kyoto Protocol. A Guide and Assessment.* Royal Institute of International Affairs, London, United Kingdom.

IPCC (2000). Land Use, Land-use Change, and Forestry. R.T. Watson, I.R. Noble, B. Bolin, N.H. Ravindranath, D.J. Verardo and D.J. Dokken (eds.). A Special Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, United Kingdom and New York, USA.

Jonas, M. and S. Nilsson (2001). The Austrian Carbon Database (ACDb) Study — Overview. Interim Report. International Institute for Applied Systems Analysis, Laxenburg, Austria (forthcoming).

JRC (2000). Towards a Monitoring System for Biospheric Carbon in Support of EU Climate Change Policies. Poster presented at COP 6 in The Hague, 13–25 November 2000. Joint Research Center (JRC), European Commission, Ispra, Italy.

Kanowski, P., F. Sinclair and S. Bass (2000). Critical Elements for the Assessment of Forest Management Certification Schemes. Department of Agriculture, Fisheries and Forestry, Canberra, Australia.

Kopp, R.J. (2001). An Analysis of the Bonn Agreement. Resources for the Future, Washington DC, USA. Available on the Internet: http://www.weathervane.rff.org /features/feature134.htm.

Kurz, W. and M. Apps (1999). A 70-year Retrospective Analysis of Carbon Fluxes in the Canadian Forest Sector. *Ecological Application*, 9(2), pp. 526–547.

Löwe, H., G. Seufert and F. Raes (2000). Comparison of Methods Used within Member States for Estimating CO_2 Emissions and Sinks According to UNFCCC and EU Monitoring Mechanism: Forest and Other Wooded Land. *Biotechnol. Agron. Soc. Environ.*, Vol. 4, No. 4, pp. 315–319.

Nabuurs, G.J. (2001). European Forests in the 21st Century: Impacts of Nature-oriented Forest Management Assessed with a Large-scale Scenario Model. Alterra Scientific Contributions 2, Alterra Green World Research, Wageningen, Netherlands.

Nilsson, S. A. Shvidenko, V. Stolbovoi, M. Gluck, M. Jonas and M. Obersteiner (2000). Full Carbon Account for Russia. Interim Report IR-00-021. International Institute for Applied Systems Analysis, Laxenburg, Austria. Available at: http://www. iiasa.ac.at/Publications/Documents/IR-00-021.pdf.

Nilsson, S., M. Jonas, M. Obersteiner and D. Victor (2001a). Vertification: The Gorilla in the Struggle to Slow Global Warming. *The Forestry Chronicle*, Vol. 77, No. 3, pp. 1–4.

Nilsson, S., M. Jonas and M. Obersteiner (2001b). COP6: A Healing Shock? An Editorial Essay. *Climatic Change*, Vol. 52, Nos. 1–2 (in press).

Noble, I. and R.J. Scholes (2001). Sinks and the Kyoto Protocol. *Climate Policy*, Vol. 1, No. 1, pp. 5–25.

Parkinson, S., K. Begg, P. Bailey and T. Jackson (2001). Accounting for Flexibility Against Uncertain Baselines: Lessons from Case Studies in the Eastern European Energy Sector. *Climate Policy*, Vol. 1, No. 1, pp. 55–73.

PCA (2001). Optional Rules for Arbitration of Disputes Relating to Natural Resources and/or the Environment. Permanent Court of Arbitration (PCA), June, The Hague, Netherlands.

Rametsteiner, E. (2000). Sustainable Forest Management Certification. Framework Conditions, System Designs and Impact Assessment. European Commission and University of Agricultural Sciences, Vienna, Austria. Ministerial Conference on the Protection of Forests in Europe, Liaison Unit, Vienna, Austria.

Sandalow, D.B. and I.A. Bowles (2001). Fundamentals of Treaty-making on Climate Change. *Science*, Vol. 292, pp. 1839–1840.

Schelhaas, M.J. and G.J. Nabuurs (2001). Spatial Distribution of Regional Whole Tree Carbon Stocks and Fluxes of Forests in Europe. Alterra-rapport 300. Alterra Green World Research, Wageningen, Netherlands.

Shvidenko, A. and S. Nilsson (2001). Dynamics of Russian Forests and the Carbon Budget in 1961–1998: An Assessment Based on Long-term Forest Inventory Data. *Climatic Change* (submitted).

UN (2000a). Forest Resources of Europe, CIS, North America, Australia, Japan, and New Zealand (industrialized temperate/boreal countries). UN-ECE/FAO Contribution to the Global Forest Resources Assessment 2000. Geneva Timber and Forest Study Papers No. 17, ECE/TIM/SP/17, United Nations (UN), New York and Geneva.

UN (2000b). Russian Federation. Report on the in-depth review of the second national communication of the Russian Federation. Secretariat of the Framework Convention on Climate Change. FCCC/IDR.2/RUS, 27 September. United Nations (UN), New York. Available on the Internet: http://www.unfccc.int.

UN (2001). Matters Relating to Land-Use, Land-use Change, and Forestry. United Nations Framework Convention on Climate Change (UNFCCC), FCCC/CP/2001/L11, Bonn, 27 July 2001.

Valentini, R., H. Dolman, P. Clais, D. Schulze, A. Freibauer, D. Schimel and M. Heimann (2000). Accounting for Carbon Sinks in the Biosphere — European Perspective. CarboEurope, European Office, Jena, Germany.

Victor, D.G. (2001a). Climate of Doubt. *The Sciences*, Vol. 41, No. 2, pp. 18–23.

Victor, D.G. (2001b). *The Collapse of the Kyoto Protocol and the Struggle to Slow Global Warming*. A Council on Foreign Relations Book. Princeton University Press, Princeton, New Jersey, USA.

Weiss, P., K. Schieler, K. Schadauer, K. Radunsky and M. Englisch (2000). Die Kohlenstoffbilanz des Österreichischen Waldes und Betrachtungen zum Kyoto-Protocol. Monographien Band 106, Federal Environment Agency, Vienna, Austria (in German).