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The Political and Economic Costs of a Fully Verifiable Kyoto Protocol

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The Political and Economic Costs of a Fully Verifiable Kyoto Protocol

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Abstract

Until now policy makers and researchers considered the problem of uncertainty and verification to be of minor importance for the Kyoto process. However, the first studies that recently appeared on uncertainty estimation of carbon accounting reveal that uncertainties of the reported emissions on the country level are large. In an environment of such large uncertainties, verification of emission reductions must be viewed as a crucial mechanism to secure the very functioning of the Protocol.

There are at least four reasons why verification is important:

1. The political cost of no-verification is potentially very high. Under no-verification in 2012 we will have little trust in our knowledge of (a) What we did, and (b) Who did what between 1990 and 2010?
2. The Kyoto Protocol requires verifiability for *inter alia* trade (Article 17), hence overall country emissions must be verifiable; and
3. Non-verifiable emission reduction claims could lead to misconduct, putting the entire market process in danger. The reasons for this are:
   - Asymmetric gains from biased reporting could lead to market disintegration;
   - Kyoto provides perverse incentives to preserve and enlarge the “shadow carbon economy”; and
   - Uncertainty of supply of emission reductions leads to less predictable market conditions and economic efficiency losses.
4. Scientific proof of the true environmental benefits of the Protocol is at least delayed.

Since the issue of uncertainty has been ignored for a long time, the institutional basis for verification is still very weak. Currently, the institutional set-up is such that we face a situation where:

- there are no rules and instruments to secure verifiable emission reduction claims; and
- a sufficiently strong and independent body to police uncertainties is not installed.

In this paper, we provide a set of tools to strategically deal with the problem of uncertainty and verification under the Kyoto Protocol. We do this by:

- providing an overview of the instruments to deal with verification (no-, trend-, level- and top-down/bottom-up verification under PCA and FCA);
- compute costs scenarios for those instruments under various flexibility scenarios; and
- providing a short discussion on practical steps and crucial decisions to be made that lead to a more verifiable Protocol.

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The Political and Economic Costs of a Fully Verifiable Kyoto Protocol

Michael Obersteiner, Matthias Jonas and Sten Nilsson

Concern

Will Kyoto be Unverifiable?

There has been quite a lot of discussion on uncertainty in general, but very little discussion and work has been performed on the uncertainty of the "hard facts" — emissions to the atmosphere.[1] Only recently, have national assessments of uncertainty of GHG emissions become available (Rypdal and Zhang, 2000; Nilsson *et al*., 2000; Eggleston *et al*., 1998). Nilsson *et al*. (2000) concluded that given the uncertainties (of GHG emission inventories) in place, most of the so-called Annex I countries of the Kyoto Protocol will not be able to verify their Kyoto target emissions at the country level. This is due to the fact that the reductions of emissions are small during the commitment period and the uncertainties of the net emissions are large. It follows that without appropriate verification provisions, Annex I countries cannot prove that Kyoto actions improved the atmospheric balance to the extent claimed. Despite the great importance of stable expectations within the Kyoto market, it is the uncertainty related to the "hard facts" that will ultimately determine the success and satisfaction with the Protocol.

Political Costs are Potentially High

There is a danger that policy makers are on the way to making the decision that uncertainty of the true environmental benefits of the Protocol is not important. Verification is not mentioned in the agenda of COP 6 and will, thus, not be thoroughly discussed during this particular conference. However, there might be a significant political cost associated to the decision of no-verification. The sum of Annex I countries, irrespective of CDMs, will physically not be able to verify their joint reduction claim. This might endanger the credibility of Annex I countries in the climate negotiation process and carries the potential to decrease the political momentum of climate actions in the international arena on accession. In addition, it will be impossible

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[1] Victor (1991) identified very early the problem of uncertainty by writing "...it is instructive to separate the ends and means of pollution control. The ends may be agreed upon even in the face of great uncertainty, but in designing the mechanism for achieving those ends uncertainty and complexity can prove to be extreme obstacles. This is especially true when highly quantified strategies such as markets are employed."

to judge how far the countries' true emission reductions deviate from the reduction claims, which will negatively impact the political chemistry among participating countries and might consequently hamper ambitious future actions.

It must be clearly understood that the Kyoto Protocol is on the management of a global common resource. Monitoring the contributions and use of this resource is, to our mind, a very fundamental precondition for the functioning of any rules governing the management of the resource.

The Text of the Kyoto Protocol Contains Inconsistencies with respect to Verification

Article 17 of the Kyoto Protocol already foresees problems relating to uncertainty by stating "*The Conference of the Parties shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emissions trading*". Similar concerns on the verifiability of Kyoto actions are stated for the other flexibilities (JI, CDM) and sink activities in the Protocol. Most interesting, however, is that verification is not mentioned in the formulation of the overall Kyoto target in Article 3.1. At least for reasons of consistency verification should be mentioned in the formulation of the overall targets. Trading of emission reductions can only be verifiable if countries' overall carbon accounts are verifiable. In this respect, the text of the Protocol misses a hierarchical logic, because verifiable amounts for emission trading must *per definition* be based on verifiable national accounting.

Lack of Verifiability Leaves Room for Misconduct

The uncertainty of whether a claim of a ton of emission reduction is really 1000kg or only 750kg has important implications for carbon trading. There is a danger that large uncertainties of national GHG accounts[2] invite false reporting of emission reduction figures triggering an inflation of emission reduction claims. Mechanisms of misconduct can range from preserving or expanding unreported (unmonitored) segments of the GHG economy of mostly fossil fuels and biomass burning all the way to ignoring leakages from biological sinks. Massive misconduct could finally lead to a disintegration of the market or at least to major frustration with the process due to asymmetric gains from intentional biased reporting. In addition, there is a danger that due to the lack of verification Kyoto provides additional incentives to push more of the

---

[2] Thorough national studies evaluating uncertainties were conducted for only a few countries like the UK, Norway and Russia. Norway shows a trend uncertainty for CO_2 of ±5%. Norway's level of uncertainty of all GHGs was estimated to be ±21% in 1990 and ±17% in 2010. Levels of uncertainty of Australia's GHG emissions data vary from 10% for CO_2 emissions of the energy sector (10% actually being the lowest margin) to 100% and more for methane emissions for some sectors (Jepma, 2000). Also, an extensive 1999 review of the UK's second national communication states in a final note: " *'The results obtained indicated that while the uncertainty of the annual emissions on a CO_2 equivalent basis was estimated at ±18.5 per cent, the uncertainty of the emission trend for 1990–2010 was estimated at a 4 per cent with a confident of 95 per cent.'* And a final example: our own *back-of-the-envelope* calculation based on the 1996 review of the Netherlands' national communication led us to conclude that an overall 12.5% error margin could then not be ruled out; this margin has now come down to about 5%." However, all of these studies did not assess biases and were not assessed in an all-encompassing FGA framework.

(carbon) economy into the unobserved sector through increased black market premiums. It is, thus, paramount to implement an appropriate verification mechanism for the mutual recognition of emission reductions under the Kyoto Protocol.

Uncertainty Creates Unstable Expectations and Economic Efficiency Losses

Stable expectations are produced only when actions by other market participants become predictable (i.e. no room for misconduct). A complete set of coherent existing rules, long term and credible strategies and targets, and verifiable outputs are the key ingredients for stable expectations for market participants. A lack of stable expectations and a lack of credibility in the process per se produces an environment where market participants will look for short term fixes rather than true commitments for long-term structural and technological change. Uncertainty on the supply side of emission reductions that are going to be available for trading lead necessarily to increased coordination costs and unstable and wrong expectations.

Uncertainty creates efficiency losses with respect to the ultimate goal of decreasing emissions to the atmosphere. This is due to the fact that without a crisp knowledge of the effectiveness of a Kyoto measure resources are likely to be allocated in an inefficient way. Without a verification tool at hand it is impossible to compare Kyoto actions with respect to their environmental benefits.

Goal

What Counts is What the Atmosphere Sees

The climate is changing. Human and natural emissions of GHGs are the major cause. The United Nations Framework Convention on Climate Change states "*The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*". The Kyoto process was initiated to set specific targets for emissions of GHGs from industrialized countries, together with an array of flexibilities for implementation. Thus, the central issue is the verification of the true environmental benefits as indicated in the above statement by the UNFCC. It would not appear sensible to start an ambitious international process without verifying the very achievements of this process. The aim of the process must thus be that anthropogenic climate actions become verifiable with respect to the emission reductions to the atmosphere.

The lack of a verification tool makes it impossible to assess the effectiveness of emission reduction or sink activities with respect to the ultimate goal of improving the atmospheric balance. Thus, for making Kyoto operational a verification tool is instrumental.

How to go about Verification

Instruments for Verification

The present verification provisions and the currently installed institutions needed for meaningful verification are by far not sufficient to guarantee compliance with the Protocol's requirements on verification. Furthermore, the Protocol is silent on the mode of verification.

Currently, the scientific and technological basis is too weak to measure the factual environmental benefits to the atmosphere. There is still a long way to go for scientific proof of the environmental benefits from Kyoto actions. Among other things the accuracy and precision of measurements must significantly be improved (MPI, 1999). It is up to the policy makers to define the path in order to reach the ultimate goal of fully verifiable climate actions, where top-down measurements agree with bottom-up approaches to estimate emissions.

Table 1 gives an overview of the currently available instruments that will help to make Kyoto and post-Kyoto actions verifiable with respect to its contribution to an improved atmospheric balance.

Table 1: Overview of instruments for verification of Kyoto actions

	PGA	**FGA**
No verification	We do not know what we did and Do not know who did what	We do not know what we did and Do not know who did what
Trend verification	Verify the rate of emission reduction, but biases are still likely	Verify the rate of emission reduction and biases are minimized as must as possible
Level verification	Verify that 2010 emissions are different from 1990 emissions by some amount, Biases are still likely	Verify that 2010 emissions are different from 1990 emissions by some amount, Biases are minimized as much as possible
Top-down/bottom-up verification	Verify fluxes from the fossil fuel system	Verify all fluxes

As shown in Figure 1 there are three types of verification: (1) No verification (2) Trend verification[3] and (3) Level verification.[4] The goal of level verification is to verify that the emission levels in 2010 are different from those in 1990, whereas trend verification concerns the verifiability of the rate of emission reduction. Verification is intimately linked to the apparent uncertainty. Assessments of uncertainty of projects or of emission reduction claims on the country level can be made within Partial Greenhouse Gas Accounting (PGA) or Full Greenhouse Gas Accounting (FGA).[5]

The most straightforward way to make sure that a country or project complies is by undershooting. In the case of trend verification, with some probability limit the reported emission reduction rate is not allowed to be greater than the target rate (see the probability functions in Figure 1). Another way to look at the problem is that we require reducing a country's emission reduction claim by some uncertainty factor.

From Table 1 it follows that there is a wide range of different qualities of verification. Policy makers will have to decide what kind of verification is necessary to keep the process in full swing. In summary policy makers have to decide on three things:

1. What type of verification is needed (No-, Trend-, Level- Top-down/bottom-up verification).
2. How are the uncertainties assessed — under PGA or FGA.
3. Empirical confidence interval of the statement.

The specific provisions on these three items with respect to verification should be defined in Article 3.1 of the Kyoto Protocol.

Implications of Level and Trend Uncertainty

Based on our empirical research we can conclude that (see graphical representation of the problem in Figure 1),

"Even if Parties claim compliance with their Kyoto targets, most Parties will be unable to verify that their 2010 emissions are different from their 1990 emissions. However, compliance with the target, if interpreted as a certain average net emission reduction rate, can still be made verifiable".

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[3] Trend verification for a 5% reduction target requires in probabilistic terms for a 95% confidence interval: $P(1-\frac{X_{2010}-X_{1990}}{X_{1990}}=0.95)\geq 0.95$.

[4] Level verification for a 5% reduction target requires in probabilistic terms for a 95% confidence interval: $P(X_{1990}0.95=X_{2010})\geq 0.95$.

[5] An example of a partial carbon account would look at a Kyoto forest's above ground biomass. Whereas a FCA would look into below and above ground biomass. A FCA on a sufficiently large spatial scale would help to even detect leakage from the FCA-ed Kyoto forest. A comparison of a global FGA with global atmospheric measurements would be the ultimate check for biases in FGAs. It follows that there is a continuous scale of quality in the measurement of uncertainties along different accounting systems.

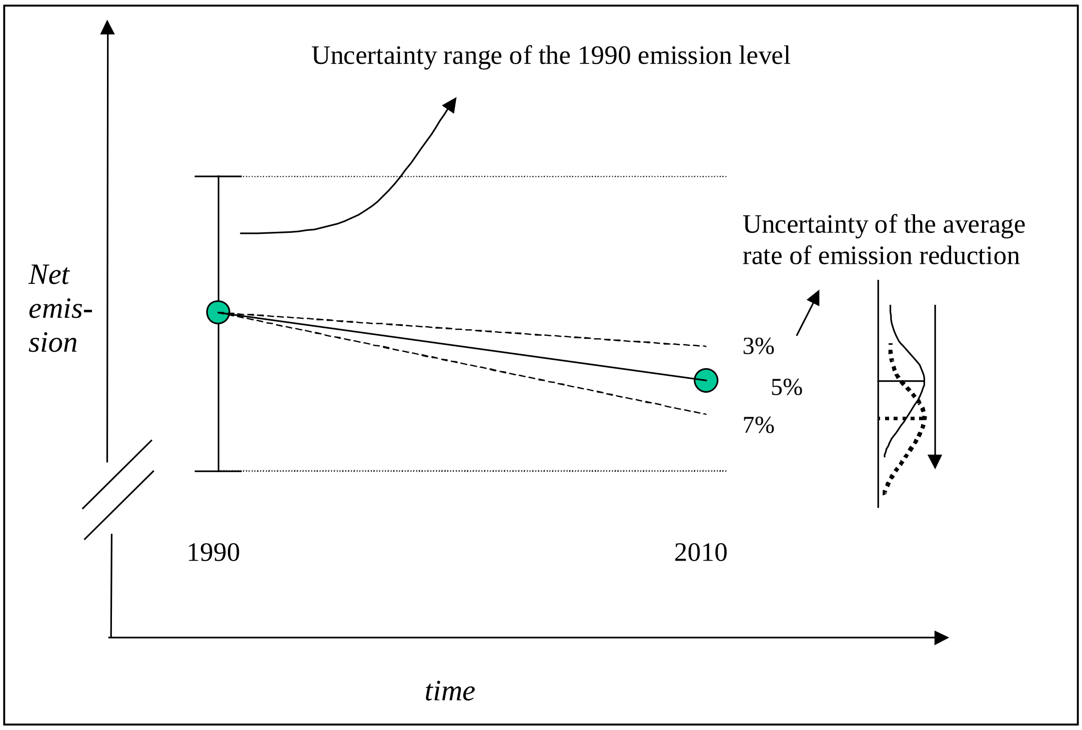

Figure 1: Illustration of level uncertainties and trend verification for a hypothetical case of Country A.

Level Verification: The level uncertainty of 1990 is so large that the 5% emission reduction disappears within the initial band of uncertainty of the 1990 emission level.

Trend Verification: An average rate of 7% emission reduction between 1990 and 2010 would make sure that the following statement holds: Country A achieved at least an average rate of 5% reduction of its emissions with 95% confidence (symbolized by the shifted probability function). Whereas a claim of a 5% emission reduction rate cannot exclude a 3% reduction rate with 95% confidence.

The empirical fact on level verification demand a 2nd Precautionary Principle

The first part of the statement above refers to the empirical fact that the Parties' emission reduction targets are still within the total uncertainty bands. It follows that policy makers will have to adopt, what we call *The 2nd Precautionary Principle (2nd PP).* This principle must assert that the responsibility connected to the non-verifiability of the Kyoto targets *per se* rests with the policy makers. Policy makers, thus, have to take on the risk that we will have to say in 2010 'We do not know what we were doing differently after 1990'. Clearly, this type of risk sharing based on *The 2nd Precautionary Principle* is a necessary precondition to make the Kyoto Protocol operational on the project level.

Under current conditions trend verification seems to be the most operable mechanism to tackle the uncertainty problem

The second part of the statement refers to verification of compliance in the sense that the target is defined as an average emission reduction rate. In such a situation trend uncertainty is the appropriate uncertainty concept and refers to the change in activities and in emission factors. Trend uncertainty takes into account temporal correlation between uncertainty factors and is thus smaller than level. Note, however, that trend verification does not imply level verification as illustrated in Figure 1. This means that trend verification can only be informative with respect to the emission reduction rate. Following the wording of Article 3.1 suggests that trend verification seems to be the most consistent verification type with the current Protocol.[6]

Estimating the Economic Costs of a Verification Clause under Kyoto

IIASA calculations of the Kyoto market using the CERT model (Kappel and Staub, 2000),[7] which is based on the MIT-EPPA cost functions for CO_2 emission reductions of fossil fuels, and requiring verification indicate that depending on the probability limit and the definition of uncertainty total emission reduction costs will at least increase fivefold, if uncertainties cannot be reduced significantly (see Figure 2). If, however, the total sink (hereafter called Green hot air [GHA])[8] strength is accepted as a direct offset from fossil fuel emissions then verification seems to become cost-neutral. In this case the type of verification is assumed to be trend verification. If we allow full flexibility in the trading mechanism, the world market price is projected to be in the range or lower than the prices predicted under a fossil fuel dominated Kyoto Protocol without verification provisions (uncertainty equals zero). Under such market rules about the same quantity of fossil fuels would be reduced since green hot air comes at almost no costs and in this way 'pays' for the verification of both emission reductions and sinks. Thus, the probability that we provide in total more environmental benefits under the same costs is higher compared to the unverifiable fossil fuel dominated market. Also the

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[6] Article 3 of the Kyoto Protocol calls for trend verification by "...with a view to reducing their [Annex I countries] overall emissions of such gases [listed in Annex B] by at least 5 per cent below 1990 levels in the commitment period 2008 and 2012. Article 24 second paragraph further specifies "For the purpose of this Article, 'the total carbon dioxide emissions for 1990 of the Parties included in Annex I' means that the amount communicated on or before the date of adoptions of this Protocol by the Parties included in Annex I in their first national communication submitted in accordance with Article 12 of the Convention". In other words trend verification will have to be used to verify the emission reduction as already fixed in Annex B. The Kyoto Protocol in its current form does not require a verification of verifiable differences in the levels of GHG emissions.

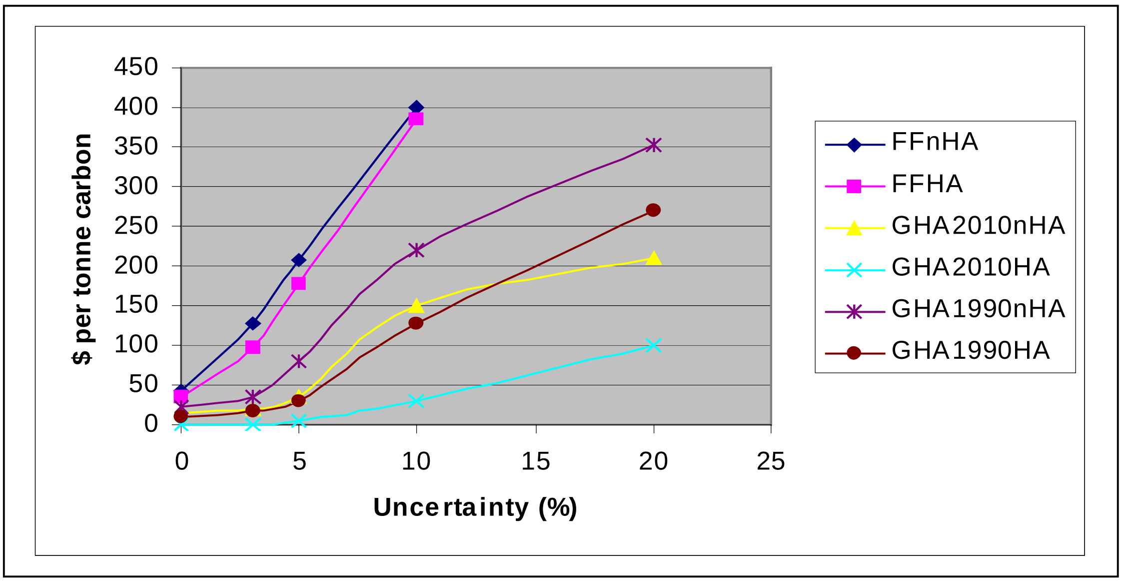
[7] Applying the cost functions of the POLES model the same qualitative results occur (Godal, 2000).

[8] The definition of sinks here refers to the IPCC definition of sinks and should not be confused with total biosphere. When humans alter the biosphere through changes in land use and forestry management practices, they can create a carbon uptake that is an ongoing result of land-use changes in previous decades. Here we follow the logic that carbon uptake from improved land use change and forestry management practices should be regarded as a direct offset of current fossil fuel emissions. In the US the LUC and forestry sink was estimated to be about 24% in 1990 and about 12% in 1998. If we assume that the trend uncertainty of fossil fuels of the US is equal to that of Norway (±5%) and the trend uncertainty of the sinks three times larger (±15%) [there is no study yet on the trend uncertainty of sinks, but level uncertainties were assessed for Russia in Nilsson *et al*. (2000)] then the total uncertainty of the combined system is ± 6.1 %.

incentives to innovate would still prevail under such market rules.[9] Due to large uncertainties on the total sink strength in 2010 the range of possible world market prices for carbon is potentially large.

Market rules allowing for GHA with, however, less flexibility are likely to come at a higher economic cost than a fossil fuel centered Kyoto Protocol without verification clauses. Under such non-flexibility the cost would at maximum be about threefold if uncertainties cannot be reduced given reasonable assumptions on uncertainty levels and given trend verification.

A Kyoto market that includes GHA and does not require verification will with a rather high probability lead to a situation of oversupply of carbon credits. Who should then pay the Annex I countries for their over-fulfillment?



FFnHA: Fossil fuels and no Hot Air.
FFHA: Fossil fuels and Hot Air.
GHA2010nHA: Green Hot Air projected to 2010 + Fossil fuels and no Hot Air.
GHA2010HA: Green Hot Air projected to 2010 + Fossil fuels and Hot Air.
GHA1990nHA: Green Hot Air estimates for 1990 + Fossil fuels and no Hot Air.
GHA1990HA: Green Hot Air estimates for 1990 + Fossil fuels and Hot Air.
Assumptions on GHA can be found in Table 2 in Appendix I.

Figure 2: World market price and levels of trend uncertainty that is penalized under various market rules. In the absence of data it was assumed that trend uncertainties were distributed uniformly among countries.

[9] Experience with innovation systems and environmental performance show that innovation occurs only if long-term goals are clearly and credibly set, which are coupled with consistent current actions of both carrots and sticks. Long-term goals were not yet discussed in a meaningful manner in the Kyoto process. The currently discussed supplementarity restrictions are probably too short-term in their nature and more so are less credible given the actual emission path of many Annex I countries after 1990 and the involved political and economic costs.

Problems with Green Hot Air (GHA)

Disregarding the political dispute on including biospheric measures in the Kyoto Protocol the major obstacles of including GHA and a verification clause into the Kyoto Protocol are:

- Emission reduction — sink ratio can vary substantially across countries.[10]
- A true Full Carbon Account was only performed for Russia. Very few countries assessed uncertainties of fossil fuel emissions with very little knowledge on uncertainties of biospheric measures. No country assessed biases.
- Costs and mode of uncertainty reduction are unknown.[11]
- There are a number of physical parameters to be considered (see Jonas *et al*., 2000).

Separate Accounting from Activities

Uncertainties in GHG accounting are made up of essentially two components. Random errors and biases, where biased reporting can be used for intentional cheating. It is reasonable to assume that the probability of biases decreases with the comprehensiveness of the system analyzed, because we can make consistency checks. It is, thus, indispensable to always monitor the entire GHG system (Full GHG Accounting [FGA]) irrespective of what kind of actions are credited for in the Kyoto mechanism. A FGA should always be the compulsory monitoring system, whereas actions that are the means to get to the target and are subject to the Kyoto market rules have to be accounted for as (a) consistent subsystem(s) (Partial GHG Account [PGA]) within a FGA. Verification should make sure that the acknowledged credit influenced the atmospheric GHG balance in the intended (claimed) fashion. FGA provides the necessary accounting framework and carries the possibility of top-down verification under certain conditions (all countries participate and reporting is unbiased).

Capacity Building for Verification

A strong, functioning and credible monitoring agency has yet to be established. Such an agency should be responsible for the assessment of verifiable emissions. The status of independence and the right to conduct verification missions seems to be of great importance. However, some sovereign states will probably refuse inspections on their territory. Joint action on uncertainty and emission estimates would make economic sense. Monitoring costs will probably decrease with increasing scale when countries join forces to decrease uncertainties.

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[10] One would expect that countries will have to renegotiate their targets under such a regime [Jacoby *et al*. (2000) note that the established targets do not follow any rational rule based on country characteristics (e.g., per capita levels). Baer *et al*. (2000) state that adoption of the principle of equal per capita emissions rights could help resolve the objections of both developed and developing countries and ease the path for the community of nations to implement the Kyoto Protocol. Obersteiner *et al*. (2000b) argue that a more practical approach would be to try to form Common Carbon Markets, which would reduce the winner-loser gap compared to the one and only global carbon market].

[11] Kyoto including GHA and demanding verification could turn out to be very cheap if the costs of uncertainty reduction are very small [which they probably initially are (see, e.g., the cost proxy for biosphere uncertainty reduction (Obersteiner *et al*., 2000a))].

The other way to assess uncertainties would be that individual countries report uncertainties and take measures themselves to lower uncertainties under the supervision of the international agency, which would play more the role of a facilitator rather than a watch dog. Under such a scheme credibility would not be fully established. Remaining white spots on the uncertainty landscape should then be assessed, given the best available knowledge employing some rough rule of thumb estimates. Countries that abstain from full scrutiny of their reports will have to live with the verification penalty for the uncertainties that were assessed.

Conclusions

Verification of emission reductions on both the national accounts and project levels is a necessary precondition for the functioning of the Protocol as such and the international carbon market in particular. Verification should apply equally to both fossil fuel and biospheric actions. Uncertainties are so high that without the implementation of a credible verification mechanism other instruments than market instruments must be applied to solve the problem of GHG reduction on an international scale.

Uncertainties are so large that a 2nd Precautionary Principle should be adopted stating that the policy makers carry the responsibilities associated with the problem that in 2012 we will not be able to show that the average 2010 emission levels are different from 1990 levels.

Policy makers should decide on the mode and quality of verification, as outlined in this report, in the very near future to get the process of verification going in a timely manner. The mode and quality of verification will have to meet political, economic and scientific criteria.

Our simulation results give qualitative indication that verification could be implemented in a cost-neutral manner if a broad sink definition would be accepted. Under such market rules and given the same percentage net emission reduction target, the emission reduction of the fossil fuel sub-system of the verifiable combined fossil fuel and sink system would approximately be the same as those of the purely fossil fuel concentrated market without a verification mechanism. This is due to the fact that sinks would 'subsidize' verification of both the energy and sink accounts.

With respect to stable market conditions, verification should mainly be about the elimination of biased reporting. Only within a Full Greenhouse Gas Accounting system can partial accounts be cross-checked for consistency. Such a full accounting system has yet to be built for all Annex I countries. IIASA has established Full Carbon Accounts for Russia and Austria.

Verification, as described in this report, will require strong and credible institutional structures, which are currently lacking.

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Appendix I

Table 2: GHA: Estimated sink strength (IPCC sink definition) in MMTCE according to National Communications (except Canada) for 1990 and 'best' sensible guesses for 2010.

		1990	2010
USA		316	350
JPN		24	30
EEC		66	80
OOC		-52.4	207.6
	Australia	-86	19
	Canada	0	150
	New Zealand	20	25
	Norway	13.6	13.6
EET		57.5	76
	Bulgaria	7	10
	Czech Republic	3	5
	Hungary	2	3
	Poland	35	45
	Slovakia	4	5
	Romania	6.5	8
	Ex-Yugoslavia	-	-
FSU		209.5	390.5
	Russia	150	280
	Ukraine	51	75
	Estonia	1.5	1.5
	Latvia	4	5
	Lithuania	3	4
	Belorussia	-	25
	Other FSU	-	-
TOTAL		620.6	1134.1