

**Options for improving the
treatment of LULUCF in a
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Key words: LULUCF; Kyoto Protocol, Factoring out, forest degradation, peatlands, wetland degradation, symmetry of accounting, sustainable forest management, harvested wood products, biodiversity, full carbon accounting.

ABSTRACT

The Graz Group is a loose affiliation of independent LULUCF experts focused on developing and communicating views and options regarding LULUCF rules, modalities and definitions for the post-2012 global climate change framework. Three major relevant workshops have been held in Graz, Austria. The first led to the publication of the special issue of Environmental Science and Policy on LULUCF, focusing broadly on options for LULUCF post 2012. The second was a workshop on REDD. The most recent workshop, with a focus on LULUCF rules for industrialized countries, held on April 21-22, 2008 with a follow-up discussion at the recent UNFCCC AWGs and Subsidiary Body sessions in Bonn in June, has led to the publication of this working paper.

This working paper describes four major outcomes of the workshop:

- 1. Recommendations to improve accounting of the long-term depletion of carbon stocks through forest and wetland degradation.*
- 2. Discussion of two possible approaches to harnessing the mitigation potential of harvested wood products, while minimizing adverse and unintended effects on biodiversity, forest management and the environmental integrity of the Kyoto Protocol.*
- 3. Presentation of policy-based options for factoring out indirect and natural effects on carbon stock changes, to arrive at estimates of direct anthropogenic effects on carbon stock changes.*
- 4. A characterization of three possible approaches to achieving fuller accounting as well as a list of criteria/questions for assessing the effects of these, and any other, approaches.*

All the options discussed do not necessarily reflect the preferred policy approaches of the authors; they are presented in this working paper as a contribution to the discussion by Parties and other relevant organizations and individuals, in the process leading up to and in Accra, Poznan (COP14) and Copenhagen (COP15).

INTRODUCTION

This working paper is intended to contribute to the exchange of views by Parties as they consider how to address the definitions, modalities, rules and guidelines for the treatment of land use, land use change and forestry (LULUCF) at the National level, in

industrialized countries, in the second commitment period of the Kyoto Protocol. These thoughts are therefore related to LULUCF as it is currently addressed in Articles 3.3 and 3.4 of the Kyoto Protocol. The authors met in Graz, Austria on April 21-22 to develop possible approaches to remedying some of the short-comings with the current definitions, rules, modalities and guidelines for the treatment of LULUCF.

The workshop was guided by a number of principles, i.e., to:

- ensure continuity of activities and a smooth transition of rules from the Kyoto Protocol first commitment period
- take Marrakesh Accords principles for LULUCF¹ into account
- ensure environmental integrity of the post 2012 agreement
- promote Party participation
- ensure completeness of accounting over space and time
- create incentives for improvements within countries
- ensure that rules are practical and politically acceptable

The outcomes of the workshop are presented in seven sections:

1. General accounting method – treating LULUCF like or unlike other sectors?
2. Approaches to achieve fuller accounting
3. Distinct treatment for emissions and removals
4. Factoring out
5. Harvested wood products
6. Forest degradation
7. Peatland degradation

The implications of all of these options on inventories, the scale of LULUCF credits, carbon markets, biodiversity and potential for mitigation would have to be assessed in more detail before definitive recommendations could be made.

1. General accounting methods – treating LULUCF like or unlike other sectors?

The accounting framework for LULUCF in the first commitment period of the Kyoto Protocol was constructed in such a way that LULUCF was kept separate from other sources of greenhouse gas emissions (i.e. was not included in the list of sectors in Annex A of the Protocol). This was necessary to set up the general *gross-net* construct of LULUCF chosen during the Kyoto negotiations to handle forests – for the first commitment period at least. So, for forests, rather than the net emissions or removals from the LULUCF sector contributing to countries' base year emissions (and hence targets) and then national emission inventories during the commitment period, the LULUCF sector just generates additions to or subtractions from the assigned amounts of

¹ United Nations Framework Convention on Climate Change. 2006. Decision 16/CMP.1, Land Use, Land-Use Change and Forestry. In Report of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol on its first session, held at Montreal from 28 November to 10 December 2005: Addendum Part Two: Action taken by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol at its first session. FCCC/KP/CMP/2005/8/Add.3

Parties. So, assigned amount units are calculated from 1990 emissions (by modifying them with a percentage reduction), and then LULUCF comes in as an “ex-post” offset. In other words, LULUCF is not factored into the 1990 base year to set targets.

In any post-2012 climate agreement, it is feasible that this same general approach to accounting could be taken. But it is also possible to treat LULUCF more like other sectors, i.e. incorporate LULUCF emissions and removals along with other sectors on the targets and emissions inventory side. Such a change would require some form of net-net type accounting for forests.

The illustrative numerical example shown in Table 1 below illustrates how these two alternative accounting approaches would differ. In the second and third columns a negative value is a removal and a positive value is an emission. The actual balance of removals and emissions for the example activities is only hypothetical and illustrative.

Table 1: Two optional methods to incorporating LULUCF in an overall emissions agreement: Method 1 is the current method, which treats LULUCF emissions and removals as 'ex-post' debits/credits; Method 2 is an alternative method that includes emissions and removals in the base year/period and commitment period calculation more directly.

EXAMPLE SITUATION	Reference value ¹	Inventory value in the CP ²	Method 1. Accounting as an "ex-post" offset		Method 2. Incorporated in national target and emissions inventory in CP		
			Effect on target (country's assigned amount)	Issued Credits	Effect on target (country's assigned amount)	Effect on emissions inventory	Net Effect (equals target value minus inventory value)
Sustainable forest management in existing forest ³	-100	-120	n/a	20	-100	-120	20
Planting new forests	0	-50	n/a	50	0	-50	50
Emissions from converting natural forests to managed forests	+500	+400	n/a	100	+500	+400	100
Emissions from peatland drainage	+10	+5	n/a	5	+10	+5	5

Notes:

¹ The reference value could be either the first 'net' in net-net accounting or a forward reference value.

² CP = the future commitment period.

³ 'Existing forest' refers to forest for which credits are not intended to be awarded for just expected business-as-usual performance (i.e. the 'windfall credits' issue). But actions taken to enhance the performance of such forests can earn credits. Forest management could result in net emissions if long-term carbon stocks are decreased (i.e. forest degradation).

As the table illustrates, the value of LULUCF emissions and removals are the same whether they are treated as credits/debits or included in national targets and inventories. The primary difference is that the incorporation of LULUCF in national emissions totals makes these emissions explicitly subject to the commitments taken on by Parties as expressed through their targets (i.e. their initial allocations of assigned amount).

With any form of net-net accounting it will be necessary to determine what target reductions are sought for given LULUCF emissions and how this should be expressed. For example, in the case where LULUCF emissions are included in national targets and inventories, if a historical base year (or period) is used, are the reductions sought the same as the percentage reductions being sought for non-LULUCF emissions sources (if indeed this is how targets are expressed for these sources). In the case where forward-looking references are used, the target reduction can be built into these, or these can be calculated in such a way that the target reduction being sought results from the reference less any percentage reduction applicable to non-LULUCF emission sources.

In the case where LULUCF emissions are treated (as now) as an ex-post debit to assigned amounts, similar care will be needed to ensure any form of ‘net-net’ accounting correctly builds the reductions sought into the first ‘net.’

2. Approaches to Achieve Fuller Accounting

Some parties have called for a ‘more holistic’ approach to the LULUCF sector and for greater incentives to realize the full mitigation potential of the sector.²

Three possible approaches to “fuller accounting” of emissions and removals from the LULUCF sector were presented at the workshop:

- i. Activities-based fuller accounting (ABFA)
- ii. Reporting of emissions/removals-based fuller accounting (RERBFA)
- iii. Land use-based fuller accounting (LUBFA)

Each of these can be seen as qualitatively different approaches. In general, ABFA would represent an approach that builds from the current activities-based approach to LULUCF accounting used for commitment period 1 (CP1) of the Kyoto Protocol. This approach can be seen as a ‘bottom-up plus’ approach that adds in activities to increase accounting coverage. Additional activities/pools discussed in this paper include peatland degradation and harvested wood products.

This approach is consistent with Option 3a) in the Options and issues for consideration Annex to the Conclusions from the Chair on Land Use, Land Use Change and Forestry from Bonn (FCCC/KP/AWG/2008/L.5).

RERBFA could be seen as more of a ‘top-down minus’ approach. It starts with the full reporting of emissions and removals that is required under UNFCCC reporting requirements (following IPCC 2006 Inventory Guidelines). Certain emissions and removals would then be subtracted from this full inventory as required to address sought policy outcomes, feasibility of accounting, implications for carbon markets, etc. This approach can be seen to be more like Option 3b in FCCC/KP/AWG/2008/L.5, but to be fully consistent would need some of the elements included in that document’s paragraph 4.

Although it seems plausible that the same desired outcome for post-2012 LULUCF rules could be arrived at either from a ‘bottom-up plus’ ABFA direction or a ‘top-down-minus’ RERBFA direction, in reality the two approaches would probably differ because of the legacy of rules and modalities associated with the current activities-based approach. Another practical issue will be how easy it is to negotiate and agree on a set of rules (and, in turn, implement them), as it is likely that the rules sets for these two different directions will be quite different in terms of how simple (or complex) they are.

²Summary Report by the Co-Chairs of the In-Session Thematic Workshop (Bangkok, 2008)
http://unfccc.int/files/meetings/intersessional/awg-lca_1_and_awg-kp_5/agendas/application/pdf/bkk_workshop_sumreport.pdf

LUBFA comes at the issue in a third way. It focuses on accounting when there are changes in long-term average carbon stocks due to some direct human-induced intervention within a given land-use class or a change between land-use classes. In essence, countries draw ‘maps’ of land in classes of similar long-term average carbon stocks and redraw the boundaries when some intervention changes the state of these areas. Credits and debits are then reflected in the accounting system according to the before and after conditions of long-term average carbon stocks.³

Appendix 1 provides an assessment framework for different fuller accounting approaches. A number of criteria/questions are grouped into themes important to the effectiveness of the LULUCF sector.

3. Distinct treatment for emissions and removals

LULUCF rules currently use the same accounting approach for emissions and removals, but this is not necessary. In at least one sense, emissions from LULUCF are more similar to emissions from other sectors than they are from LULUCF removals because they are immediate and short-term (“fast out”), whereas removals are slow and longer term (“slow in”). For example, deforestation results in carbon stock losses whereas afforestation results in a gradual increase in carbon stocks over time. Using the same accounting rules for emissions and removals has in fact led to problems requiring fixes, such as the ‘fast growing forest fix,’ whereby debits from harvesting forests planted since 1990 (Article 3.3 afforestation and reforestation) had to be limited to the amount of credits awarded for the same forests before they were harvested

An alternative is to treat these two different types of processes differently within a new set of accounting rules; the ‘fast out’ emissions could be separated and treated differently from the ‘slow in’ removals. Accounting of emissions from activities should be mandatory for all countries with Kyoto commitments. These activities would include deforestation, forest degradation (e.g., phasing in forest management on previously unmanaged land), devegetation, peatland degradation, grassland-to-cropland conversion, and similar activities. The choice could be made to not require mandatory accounting for activities that do not reduce long-term carbon stocks (such as forest harvest within a sustainable forest management regime) even though emissions would result in the short-term on harvested areas (see Section 4 on factoring out).

These “fast out” emissions could be included in the National emissions inventories and be subject to National emission reduction targets, or targets for LULUCF emissions could

³ Kirschbaum, M.U.F., Schlamadinger, B., Cannell, M.G.R., Hamburg, S.P., Karjalainen, T., Kurz, W.A., Pringle, S., Schulze, E.-D., Singh, T.P., 2001. A generalised approach of accounting for biospheric carbon stock changes under the Kyoto Protocol. *Environ. Sci. Policy* 4, 73–85.

Kirschbaum, M.U.F., Cowie, A.L., 2004. Giving credit where credit is due. A practical method to distinguish between human and natural factors in carbon accounting. *Climatic Change* 67, 417–436.

Cowie, A.L., Kirschbaum, M.U.F., Ward, M., 2007. Options for including all lands in a future greenhouse gas accounting framework. *Environ. Sci. Policy* 10, 306–321.

also be set separately.

Accounting of ‘slow in’ removals from activities such as afforestation, reforestation, revegetation, improved forest management, conversion of croplands to grasslands, peatland restoration, etc., could be accounted for on a voluntary basis.

4. Factoring out

We believe that scientific approaches⁴ to factoring may still be beyond our grasp, but that *policy* approaches to factoring out are feasible. Canada not electing Article 3.4 due to disturbance-related risks is taken as an indication that factoring out of emissions from natural and indirect human effects is a priority to a functioning LULUCF system.

We note that factoring out presents different challenges for emissions (“fast out”) and removals (“slow in”) and that the best approaches to factoring out one may not be the best for the other. We present two factoring out options, both of which involve distinct treatment for emissions and removals.

Factoring out emissions: Mandatory accounting of only activities leading to degradation of carbon stocks

One possible approach for factoring out direct anthropogenic effects from indirect and natural effects is *mandatory* accounting of emissions from activities that degrade long-term carbon stocks. All other effects including from natural disturbances would not be accounted for. Emissions from on-going forest management activities with their characteristic ‘saw-tooth’ emissions profile would not be accounted as emissions either if it is demonstrated that these practices are sustainable and do not result in a reduction of long-term carbon stocks.

Under this approach, factoring out only requires the separation of lands on which different activities are occurring (forest degradation, sustainable forest management, natural disturbances), and not the distinction of different parts of the carbon stock change on a unit of land. Factoring out is therefore dependent on the ability of countries to exclude emissions from those lands that are subject to indirect human induced or natural events (such as insect infestations, impacts of volcanoes or hurricanes).

Examples of emissions that would and would not be accounted:

Emissions Accounted	Emissions not Accounted
From deforestation	From natural disturbance events (as well as the subsequent removals from regrowth)
From conversion of native forests to plantations	From on-going forest management on previously managed lands, including periodic harvesting as part of sustainable forest management
From conversion of natural/unmanaged	

⁴ The word ‘approach’ is used generically here and doesn’t apply an alternative to the ‘approaches’ described in section 2.

forests to managed forests	
From over-harvesting/unsustainable logging	
From peatland conversion	
From on-going peat oxidation in managed peatlands	
From reducing carbon sequestration/storage by changing from longer to shorter rotation ages.	

The advantage of this approach is that it is a policy-based form of factoring out that is relatively simple. This approach would require an assessment framework to verify assumptions made by countries about which activities do and do not lead to long-term reductions in carbon stocks.

Under this approach, force majeure events are dealt with by temporary removal of the lands where they occur (thereby also removing regrowth). An alternative to temporary removal is to limit emissions from natural disturbance to a long-term average based on historical data (subject to international agreement). Force majeure emissions above the long-term average could be transferred to the next year to be used as part of the next year's emissions if they are below the long-term average.

Factoring out removals: Voluntary accounting of removals based on carbon response curves or using benchmarks/forward projections

Accounting for removals from forest management could remain voluntary. If a country elects to account for removals from forest management, it could provide a list of voluntary enhancement activities and use carbon response curves to estimate the removals (hence credits) that would be generated by these activities. This would achieve factoring out objectives since the carbon response curves only include effects on carbon stock changes that are predicted directly from the activity that is being accounted.

An alternative to using carbon response curves is to use benchmarks or forward projections that include estimates of natural effects. Factoring out is achieved because only removals additional to the projection (which includes natural effects) would be eligible for accounting.

Though the carbon flux of new forests established through afforestation/reforestation might also be subject to natural or indirect human effects, the ultimate decision to plant would still be the over-riding, direct-induced human activity. Therefore it may not be important to apply factoring out approaches to removals from afforestation/reforestation.

Discounting as an approach to factoring out

Another possible approach to factoring out is simply to apply a discount factor to net emissions/removals. This approach is simple, broadly applicable and a conservative discount would ensure that the environmental integrity of the Kyoto Protocol is protected from windfall credits, but could also result in significant emissions not being accounted

for. Alternatively, removals alone could be subject to a discount, and emissions could be treated using one of the approaches described above.

5. Harvested Wood Products

The default assumption proposed within the 1996 IPCC guidelines is that all carbon in biomass harvested is oxidized in the removal year. This assumption was based on the perception that carbon stocks in most countries were not increasing significantly on an annual basis.⁵ The IPCC has now developed three alternative methodologies for accounting for harvested wood products in cases where this perception is not accurate and Parties to the Convention and the Kyoto Protocol are discussing how HWPs could be included within the next climate change agreement.

In considering the inclusion of harvested wood products (HWP) in a post-2012 climate regime, we developed a number of criteria that should be met by approaches:

- Create incentives for improved management of the harvested wood products carbon pool
- Discourage unsustainable forest management (unsustainable referring to depletion of forest carbon pools)
- Avoid leakage and perverse incentives (e.g. negative impacts on biodiversity)
- Not create false credits (i.e. credits for activities when actually there are net emissions)
- Not reward countries for business-as-usual activities
- Not significantly increase countries' assigned amounts of emissions, or increase the total level of assigned amounts across Annex I countries.
- Calculation methodology is consistent with approach and realizable with current data and methodology

In order to clarify the need for alternative approaches to better address HWPs in a future climate regime, we discussed possible benefits and shortcomings of the current approaches and of the suggested calculation methodology to estimate the HWP contribution to AFOLU/LULUCF:

- Stock-change approach
- Production approach
- Atmospheric flow approach
- Simply decay approach

The use of these approaches can have substantially different effects on countries' assigned amounts for a given single circumstance, especially with exports and imports of HWPs. In some cases, there can be increases in the aggregate assigned amount, hence

⁵ Inter-governmental Panel on Climate Change. 1996. IPCC Guidelines for National Greenhouse Gas Inventories. D.J. Griggs and B.A. Callender (Eds). IPCC/OECD/IEA. UK Meteorological Office, Bracknell.

overall allowed emissions. This will need to be considered during the negotiations of targets if HWP are included.

They all reduce the penalty for harvesting by transferring a portion of the penalty to decreases in HWP. This may give a perverse incentive to increase harvesting levels, which would be a disadvantage relative to the IPCC default approach if it is assumed that maintaining forest carbon stocks results in co-benefits including biodiversity.

For the national GHG inventories it is suggested that these “should include GHG emissions and removals taking place within national territories and offshore areas over which the country has jurisdiction”.⁶ This principle is assumed to be applicable also for HWP accounting of emissions/removals under a future climate regime, where countries are going to commit themselves to achieve further quantified GHG emission limitations and reductions.

5a. Two approaches for including harvested wood products

Two options were developed to include harvested wood products based on the stated criteria and the identified strengths and short-comings of the various approaches. A restricted stock-change approach draws on the strength of this accounting approach and modifies it to address its short-comings. A non-accounting approach avoids many of the challenges and potential negative effects but may not create significant incentive for modifying behaviour.

Accounting approach for including harvested wood products: Restricted stock-change approach

Basing the estimation of emissions and removals within a country on stock changes (i.e. pool changes of products being consumed) appears to be the best starting point for any accounting approach for including HWPs.

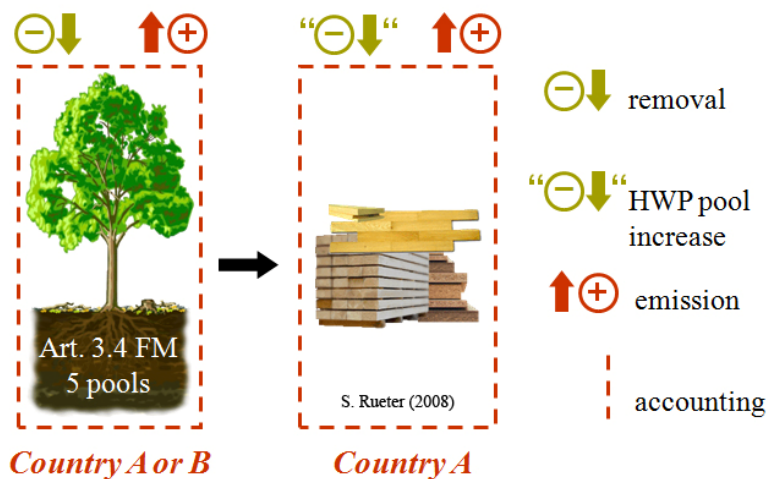
However, any accounting for wood products should only be permitted if carbon fluxes in the forest are also being accounted. Otherwise, accounting for harvested wood products could result in the creation of credits when actually there is a net emission to the atmosphere due to emissions from forest carbon pools.

In the context of the Kyoto-Protocol this results in a **restricted stock-change approach**, restricting the availability of HWP accounting to only those countries that are accounting for the effects of forest management (i.e. electing Article 3.4 FM) and only for products that are produced by countries that are accounting for activities under Article 3.3 and 3.4. The estimation of HWP contribution thus is based on the calculation of carbon pool changes including domestically produced products and products imported from other Parties that are also accounting for the effects of forest management.

⁶ UNFCCC (2003). Estimation, Reporting and Accounting of Harvested Wood Products. *Technical Paper FCCC/TP/2007/Para 51*. Bonn.

As data might not be feasible to identify the country of origin of HWP imports due to limitations in the global tracking of trade in timber (i.e. import data only show last port of transshipment), this accounting approach could be further restricted to only HWPs produced domestically.

Figure 4-1: Stock-change approach restricted to Article 3.4



Non-accounting approach for including harvested wood products: Sectoral approach

An alternative to accounting for carbon in harvested wood products would be for Parties to work in partnership with stakeholders and international institutions such as the World Business Council on Sustainable Development, FAO or UNFF, to develop sectoral agreements containing voluntary or mandatory quantitative actions or harmonized policies aimed at improved management of the HWP carbon pool.

In order to decrease emissions from HWPs and increase the contribution of HWPs to GHG mitigation respectively, such agreements could include:

- a shift towards longer-lived uses of HWPs
- increased recycling of HWPs, for both short- and long-lived products (this includes an improved capture of the wood waste stream)
- increased efficiency if HWPs are used for energy production

Sectoral agreements could involve the following sectors:

- Building sector
- Energy sector
- Waste sector

The primary short-coming of this approach is that it would create weaker incentives for improvements in management of this carbon pool.

Table 4-1: Comparison of the accounting and non-accounting approach to including HWPs

Criteria	Does the Restricted Stock Change Approach meet the criterion?	Does the Sectoral Approach meet the criterion?
Create incentives for improved management of the harvested wood products carbon pool	Yes, insofar as credits would be generated from reduced emissions from this pool.	Limited, because no credits would be created.
Discourage unsustainable forest management (unsustainable referring to depletion of forest carbon pools)	Yes, insofar as this approach requires Parties to also account for the effects of forest management, thus setting the incentive to maintain forest carbon stocks No, insofar as any HWP accounting approach somewhat weakens the incentive to maintain and enhance forest carbon stocks.	Yes, insofar as this approach does not weaken the incentive to maintain and enhance forest carbon stocks. No, insofar as this approach creates no incentive to account for the effects of forest management.
Minimize unintended negative impacts on biodiversity	Yes, insofar as this approach does not create an incentive to create credits through import of wood from deforestation or forest degradation No, insofar as any HWP accounting approach somewhat weakens the incentive to maintain and enhance forest carbon stocks.	Yes, insofar as this approach does not weaken the incentive to maintain and enhance forest carbon stocks.
Not create false credits (i.e. credits for activities when actually there are net emissions)	Yes because HWP carbon stores must be balanced against changes in forest carbon.	Yes because no credits are created.
Not reward countries for business-as-usual activities	No unless targets are increased to accommodate the increase in assigned amounts from HWP accounting.	Yes because no credits are created.
Not significantly increase	Yes because scale of credits	Yes because no credits

countries' assigned amounts of emissions, or increase the overall Kyoto level of assigned amount.	generated from the stock-change approach is limited and does not include credits for HWP from developing countries.	would be generated through this approach.
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It is worth noting that the greatest mitigation potential for harvested wood products stems from the benefits of energy and product substitution, rather than from the actual storage in wood products and that the emissions reductions benefits of these activities are already captured under current accounting approaches (e.g. emissions from building, waste and energy sectors). Accounting for carbon stored in wood products could potentially be a complementary incentive to these substitution effects.

6. Forest degradation

The IPCC Fourth Assessment Report identifies reduced deforestation and degradation as the forest mitigation option with the largest and most immediate carbon stock impact.⁷ For the purpose of our discussions, we defined forest degradation simply as “direct human-induced activity that leads to a long-term reduction in forest carbon stocks.”⁸ Examples of forest degradation include conversion of natural/unmanaged forests to managed forests or plantations, unsustainable harvesting that reduces long-term carbon stocks, a shift from longer to shorter rotation periods.

Although a comprehensive review of the literature on forest degradation has not been done for this paper, some example studies from Canada, Finland and the United States show that managed forests store less carbon than unmanaged forests and that converting natural/unmanaged forests to managed forests results in the loss of carbon stores.⁹

Issue 1: Failure to account for emissions from forest degradation

⁷ Nabuurs, G.J., O. Masera, K. Andrasko, P. Benitez-Ponce, R. Boer, M. Dutschke, E. Elsidig, J. Ford-Robertson, P. Frumhoff, T. Karjalainen, O. Krankina, W.A. Kurz, M. Matsumoto, W. Oyhantcabal, N.H. Ravindranath, M.J. Sanz Sanchez, X. Zhang, 2007: Forestry. In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

⁸ IPCC Report on Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types

⁹ Kurz, W.A., S.J. Beukema and M.J. Apps. 1998. Carbon budget implications of the transition from natural to managed disturbance regimes in forest landscapes. *Mitigation and Adaptation Strategies for Global Change* 2: 405-241.

Karjalainen, T. 1996. Dynamics and potentials of carbon sequestration in managed stands and wood products in Finland under changing climatic conditions. *Forest Ecology and Management* 80: 113-132.

Harmon, M.E., W.K. Ferrell and J.F. Franklin. 1990. Effects on Carbon Storage of Conversion of Old-Growth Forests to Young Forests. *Science, New Series*: 247 No. 4943.

Cooper, C. 1982. Carbon storage in managed forests. *Canadian Journal of Forest research*. 13: 155-166.

Under current Kyoto accounting approaches, emissions from forest degradation could be accounted under Article 3.4. However, almost half of Annex-1 countries have elected not to account for emissions and removals under Article 3.4, meaning that emissions from forest degradation in these countries are not accounted (see Table 6.2).

In the situation where a future LULUCF framework maintains an Article 3.3/3.4 activities-based approach, we propose three possible approaches to remedy this problem:

- Mandatory accounting of emissions from forest degradation under Article 3.3.
- Mandatory accounting of emissions from forest degradation as a new activity under Article 3.4 (thus requiring the current Article 3.4 activity “forest management” to become voluntary “carbon stock enhancing forest management activities,” to avoid double counting.
- Mandatory accounting of emissions and removals from forest management under Article 3.4.

Mandatory accounting of emissions would retain some flexibility for Parties while still ensuring that all significant emissions are accounted for, a more conservative outcome for the atmosphere.

If accounting of forest degradation becomes mandatory, the definition of degradation will be very important. Defining the actual activity (transformation of primary forests, replacement of native forests with plantations, switch to shorter rotation ages, etc.) could lead to the inadvertent exclusion of some degrading activities. It may therefore be more appropriate to simply define forest degradation as any “direct human-induced activity that leads to a long-term reduction in forest carbon stocks.”¹⁰

Issue 2: Under-estimating natural forest carbon

Accurate estimates of forest degradation will often require accurate estimates of old, natural, unmanaged forests, but estimates of forest carbon stocks may often be based on inventories and measurements in younger managed forests. Mackey et al.¹¹ have demonstrated this problem in Australia, revealing that the national forest inventory and the default IPCC values for temperate forests significantly underestimate carbon stores in natural forests because measurements are not taken in older, more carbon-rich forests. Using default carbon values for natural forests will probably also underestimate soil carbon stores for forested peatlands.

This could be a systemic problem suggesting that emissions resulting from the conversion of natural/unmanaged forests to managed forests from native forests to plantations could be significantly under-estimated.

¹⁰ IPCC Report on Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types

¹¹ Mackey, B., H. Keith, S. Berry and D. Lindenmayer. In press. Green Carbon: The role of natural forests in carbon storage. The Fenner School of Environment and Society, The Australian National University.

We recommend that inventories should be improved and that estimates of carbon stocks in natural forests must be based on inventories including the full range of forest ages and carbon stored in peat soils. If a country converts natural forests to plantations or managed forests, it should be able to provide an accurate estimate C stock lost in tree biomass, soil, and dead wood. Inventory review teams should also be directed to pay particular attention to this aspect of inventories.

7. Peatland Degradation

For the purpose of our discussions, we defined peatland degradation similarly to forest degradation as “direct human-induced activity that leads to a long-term reduction in peat carbon stocks.”¹² Although carbon stock losses will also result from biomass, most of the carbon stock loss is from the soil organic matter. Gains and losses from this pool would have to be taken into account to determine the overall effect of both degrading and restoration activities on peatlands.

Despite the high uncertainties connected to the estimate of the carbon stored in peatlands, the scientific community agrees that this carbon stock has a significant role in the global carbon balance. Previous studies estimated that boreal and subarctic peatlands store 270-370 10^{15} gC¹³. In addition the peatlands in Indonesia, currently threatened by intensive degradation, store 25-50 10^9 gC.¹⁴ Therefore, the degradation activities occurring in peat ecosystems are a major source of greenhouse gas emissions worldwide. Drainage of peatlands results in the oxidation of partially decomposed organic soils leading to a large increase of GHG emissions. Although most emissions are concentrated in Southeast Asia, most of the World’s peatlands are actually located in Annex I countries and activities in these countries can decrease the long-term carbon stocks of peatlands resulting in emissions to the atmosphere. Intensive degrading activities are peat extraction for fuel use and horticultural use, conversion to other land uses (forest land, cropland, grazing land), and fires for clearing purposes.

Issue 1: Failure to account for emissions from peatland degradation

Only the emissions/removals from Article 3.3 activities and elected activities under Article 3.4 must be reported and accounted under the Kyoto Protocol. In Annex I countries, the degradation activities in peatlands are in most of the cases accountable under the additional activities of the Protocol (Table 6.1). Since most of the countries elected only forest management or didn’t elect any activities from Article 3.4, the degradation activities on peatlands will not be accounted in the first commitment period (Table 6.2)

¹² IPCC Report on Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types

¹³ Turunen, J., Tomppo, E., Tolonen, K., and Reinikainen, A.: Estimating carbon accumulation rates of undrained mires in Finland – application to boreal and subarctic regions, *Holocene*, 12, 69–80, 2002

¹⁴ Page, S. E., Siegert, F., Rieley, J. S. O., Boehm, H. D. V., Jaya, A., and Limin, S.: The amount of carbon released from peat and forest fires in Indonesia during 1997, *Nature*, 420, 61–65, 2002

Table 6.1 Main degradation activities under different land use categories in peatlands and possibilities to account for them under the Kyoto Protocol.

Land category	C loss due to:	KP activities
Wetlands remaining Wetlands	Drainage, peat extraction	Not accounted
Grassland remaining Grassland	Drainage, peat extraction	GM
Wetlands to Forest land	Drainage	A/R when planted after 1990 FM when planted before 1990
Wetlands to Cropland	Drainage	CM
Wetlands to Grassland	Drainage	GM

* FM = Forest management; GM = grazing land management; CM = cropland management; RV = revegetation; A/R = afforestation/reforestation

Table 6.2 Annex I countries containing a significant extent of peatlands and elected activities under Article 3.4 of the Kyoto Protocol.

Country	FM	CM	GM	RV
Belarus	Not elected	Not elected	Not elected	Not elected
Canada	Not elected	Elected	Not elected	Not elected
Denmark	Elected	Elected	Elected	Not elected
Estonia	Not elected	Not elected	Not elected	Not elected
Finland	Elected	Not elected	Not elected	Not elected
France	Elected	Not elected	Not elected	Not elected
Germany	Elected	Not elected	Not elected	Not elected
Iceland	Not elected	Not elected	Not elected	Elected
Ireland	Not elected	Not elected	Not elected	Not elected
Latvia	Not elected	Not elected	Not elected	Not elected
Lithuania	Elected	Not elected	Not elected	Not elected
Netherlands	Not elected	Not elected	Not elected	Not elected
Norway	Elected	Not elected	Not elected	Not elected
Poland	Elected	Not elected	Not elected	Not elected
Romania	Elected	Not elected	Not elected	Elected
Russian Fed.	Elected	Not elected	Not elected	Not elected
Sweden	Elected	Not elected	Not elected	Not elected
UK	Elected	Not elected	Not elected	Not elected
Ukraine	Elected	Not elected	Not elected	Not elected

This problem of poor accounting coverage is exacerbated by the fact that emissions from activities that do not cause lands to be moved from wetlands into one of these four categories would also not be accounted. For example, peat extraction is usually reported under “Wetlands” and therefore not accounted under the Kyoto Protocol, but only reported in the UNFCCC GHG reports. Peat extraction would be accounted only when occurring on other land use categories like in Great Britain where emission from peat extraction are reported under “Grassland remaining Grassland”.

Due to the large amount of carbon stored in peat, we propose mandatory accounting for all activities that decrease long-term carbon stocks in peatlands.

Issue 2: UNFCCC reporting

Of Annex I countries containing a significant extent of peatlands, most of them are attempting to report emissions from peatlands under the Convention. The level of

accuracy and the type of land use activities reported vary significantly from country to country. However, Estonia, France, Germany, Latvia, Poland and Romania are not reporting emissions from peatlands or for organic soils in general.

Although the 2006 IPCC guidelines have made significant advancement in identifying sources of emissions from peatlands, methodologies need to be developed for several emissions sources:

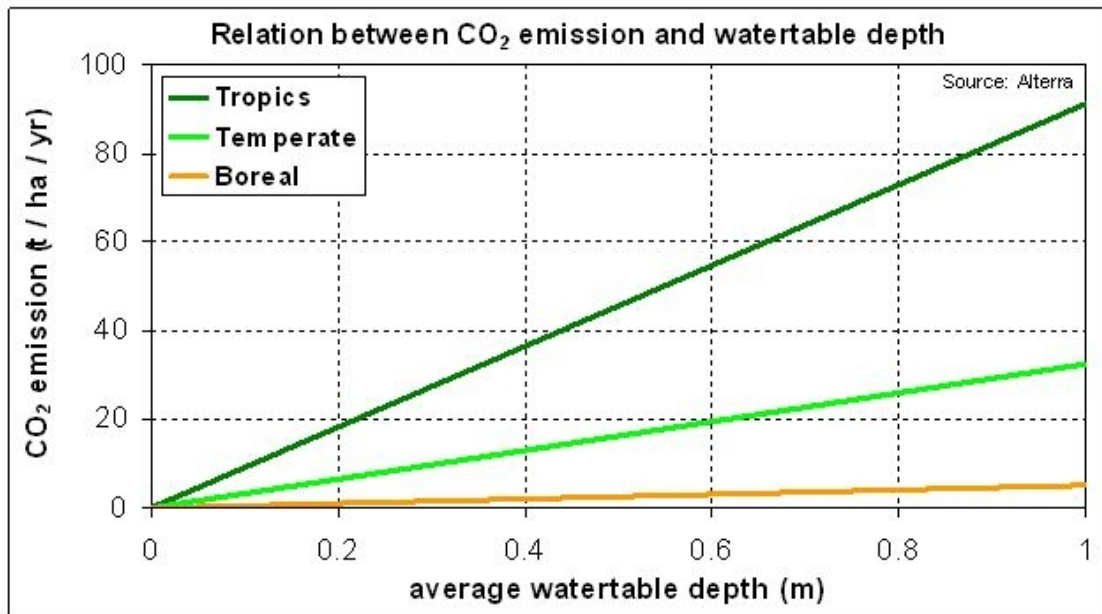
- Emissions from fires resulting from drainage
- Emissions and removals from wetland restoration
- Emissions from peat extracted for non-energy purposes
- Emissions from non-drainage impacts such as the hydrological impacts resulting from forest management.

We propose that countries develop national approaches to estimate emissions from these activities in order to support mandatory accounting of emissions from the degradation of peatlands.

Also, the 2006 IPCC guidelines only provide default values for drained soils, concluding that the use of default data "is unlikely to be considered credible for any country which has significant emissions or activities in this area" (IPCC, 1997, Vol. 3, p. 5.15). In other words, the use of national data is likely to increase the accuracy of estimates in GHGs, changes in carbon stocks, and their associated activities. This increased accuracy could be important for compliance under the Protocol."

Estimates of emissions resulting from peatland drainage have been developed by Wosten et al.¹⁵ and can be used by to establish default emissions values for tropical, temperate and boreal systems for drainage depths of 0.2 – 1.0 m.

¹⁵ Wösten, J.H.M., A.B. Ismail and A.L.M. van Wijk. 1997. Peat subsidence and its practical implications: a case study in Malaysia. *Geoderma* 78:25-36.



Finally, emission factors used in the 2006 IPCC guidelines are probably too low for the tropics. Whereas the guidelines provide an emission factor of 2 tonnes C/ha/yr for peat extraction in the tropics, we are aware of estimates 8 times this default value for 60cm drainage in Kalimantan, Indonesia.

Knowing the limitations of present knowledge, a conservative approach should be used when reporting and accounting for emissions from peatlands.

Appendix I: *An assessment framework for different fuller accounting approaches*

Policymakers will need to come to agreement as to which approaches to fuller accounting they wish to explore in more detail. The following framework, which includes a series of assessment 'criteria questions' (CQs) grouped under some general themes, is put forward as potentially being helpful in this exercise.

Smooth Transition

CQ1. Does/How does the approach work from the basis of current collected data – i.e. for UNFCCC inventory reporting requirements and for KP CPI accounting requirements?

Consistency/not reintroducing old problems

CQ2. Does/How does the approach address the CPI rules problem that necessitated the 'slow growing fix'?

This problem is that the sum of A/R and D under Article 3.3 could be net emissions even though overall the country was a net 'remover' (sink) for LULUCF. The 'slow growing fix' allowed up to 9 MtC x 5 (165 MtCO₂) of net emissions to be 'forgiven'. This became a deduction from Article 3.4 FM net removals prior to the application of the FM removals cap. Or, put another way, countries could get up to 165 MtCO₂ removals from FM, beyond the capped amount, to offset any net emissions under Article 3.3.

CQ3. Does/How does the approach address the CPI rules problem that necessitated the 'fast growing fix'?

This problem is that new A/R forests begun prior to Jan 1 2008 (when accounting starts) will not receive carbon sequestration credits during the pre-2008 period, potentially, for up to 18 years. When these forests are harvested this would produce a net emission in the accounting system. The 'fast growing fix' is that "debits shall not be greater than credits for this unit of land"

Environmental integrity

CQ4. Does/How does the approach deal with issues such as permanence and factoring out of indirect natural effects such as CO₂ and nitrogen fertilisation?

CQ5. Does/How does the approach contribute to the conservation of biological diversity and the sustainable use of resources?

Fuller accounting / Addressing problems still existing with CP1 rules

CQ6. Does/How does the approach help to reduce major sources of emissions from LULUCF (i.e. reduce deforestation, forest degradation, peatland degradation unsustainable logging etc)?

CQ7. Does/How does the approach help to enhance and expand major reservoirs?

CQ8. Does/How does the approach either require or voluntarily encourage the fuller inclusion of forests and other lands than has been the case for countries in CPI?

CQ9. Does/How does the approach allow for dynamic land-use, i.e. the 'shifting' of planted production forests to different more suitable land between one rotation and the next without this being 'captured' as deforestation and incurring deforestation liabilities?

Note, there are conceptual similarities of this problem to the problem that necessitated the 'slow growing fix' (CQ2).

Feasibility

CQ10. How feasible is the approach to negotiate? What are the likely key issues and challenges, and how will these need to be addressed? How simple will the rules be, e.g. for senior level decision-makers to understand?

CQ11. How feasible is the approach to implement? What are the likely key issues and challenges, and how will these need to be addressed? How simple will the rules be, e.g. for domestic forest policymakers and forestry sector practitioners to understand?

CQ12. Is the approach scientifically feasible? Do we have enough scientific confidence in inventories to rigorously employ this approach?

CQ13. What are the implications of this approach for country emission reduction commitments, carbon markets and mitigation potential?

CQ14. How is the approach likely to interface with the carbon market?

A subset of this question is what level of 'credits' may be introduced into the market.

Other

CQ15. Does/How does the approach help to promote the sustainable use of biomass in materials and for energy generation?

CQ16. Does/How does the approach help to link emission reduction and sink enhancement activities with adaptation strategies?

Note that the 'shifting forest' issue in CQ9 is partially an adaptation issue.

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CQ17. What precedents (and are these helpful or possibly problematic) are set by these rules approaches with respect to treatment of LULUCF in developing countries – now and as they transition to having the same or similar rules as will apply now for developed countries?