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Carbon accounting and the climate politics of forestry

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ABSTRACT

Many proposals have been made for the more successful inclusion of LULUCF (Land Use, Land Use Change and Forestry) in the Kyoto framework. Though the positions of individual states or the goal of avoided deforestation guide many approaches, our model sets cost-effective strategies for climate change mitigation and the efficient and balanced use of forest resources at its center. Current approaches to forest resource-based carbon accounting consider only a fraction of its potential and fail to adequately mobilize the LULUCF sector for the successful stabilization of atmospheric greenhouse gas (GHG) concentrations. The presence of a significantly large "*incentive gap*" justifies the urgency of reforming the current LULUCF carbon accounting framework. In addition to significantly broadening the scope of carbon pools accounted under LULUCF, we recommend paying far greater attention to the troika of competing but potentially compatible interests surrounding the promotion of standing forests (in particular for the purposes of carbon sequestration, biodiversity protection and ecosystem promotion/ preservation), harvested wood products (HWP) and bioenergy use. The successful balancing of competing interests, the enhancement of efficiency and effectiveness and the balanced use of forest resources require an accounting mechanism that weighs *and rewards* each component according to its real climate mitigation potential. Further, our data suggest the benefits of such a broadly based carbon accounting strategy and the inclusion of LULUCF in national and international accounting and emission trading mechanisms far outweigh potential disadvantages. Political arguments suggesting countries could take advantage of LULUCF accounting to reduce their commitments are not supported by the evidence we present.

1. Introduction

The principal objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to "stabilize [GHG] concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Though precise atmospheric targets are disputed (IPCC, 2007; Hansen et al., 2008, 2009), widespread agreement on the need to reduce atmospheric greenhouse gas (GHG) concentrations persists. How this goal should be achieved, what is the most cost-efficient method and how existing resources can be most effectively mobilized are subjects of significant international, EU-level and national debate. Though current efforts focus primarily on the large share of emissions stemming from the energy sector (in particular power plants) and carbon-intensive industries, some have attempted to focus attention on the potential role other sectors might play in achieving emission reductions. Significant attention has been focused, for example, on

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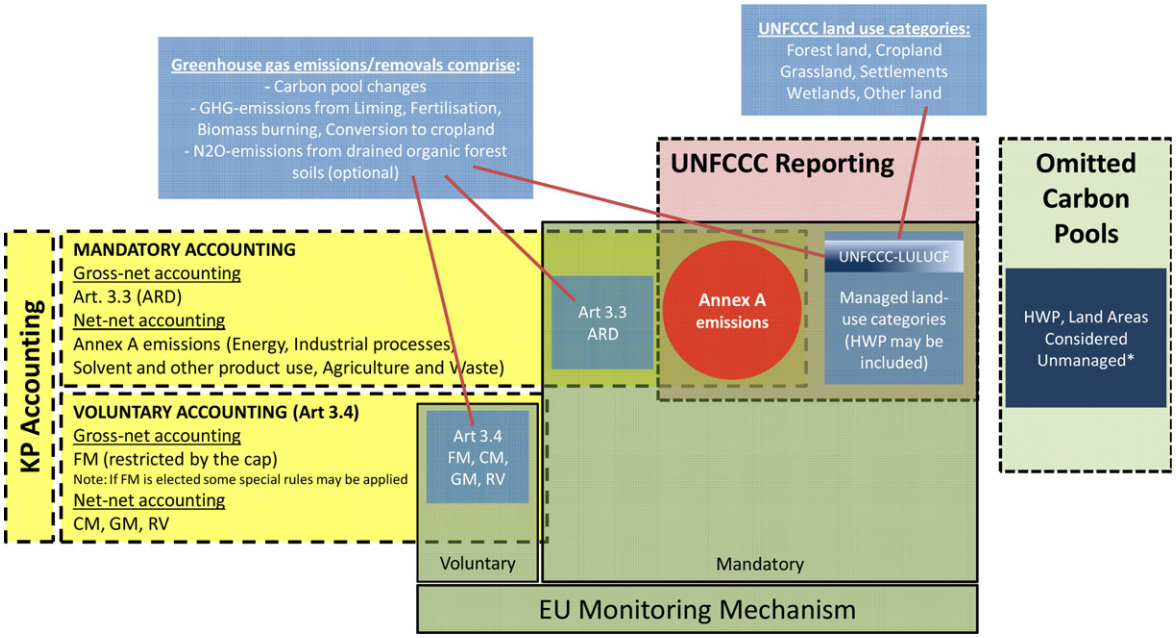

Fig. 1 – Carbon accounting and reporting frameworks.
***Source*: Based on our understanding of the KP, UNFCCC and EU regulatory mechanisms. *Note: since it is in part voluntary whether countries include some unmanaged lands under managed lands (e.g. some land use conversions may reported under FM or A/R, while some wetlands may be reported under Deforestation, IPCC, 2003).**

building-related energy use and the potential for emission reductions in the transport sector.

One of the more neglected features of climate policy is Land Use, Land-Use Change and Forestry (LULUCF) and the troika of resources and interests it represents. Forests and forest soils represent one of the principal sources of terrestrial carbon sequestration as well as natural havens for biodiversity protection and ecosystem promotion/preservation. Harvested wood products (HWP) have value both as a form of carbon sequestration and fossil fuel substitution. Biomass for heat and power generation is one of the principal sources of renewable energy generation. Standing forests, HWP and bioenergy thus define a troika crucial to the long-term survival of any agreement, to the cost-effectiveness of climate mitigation strategies and to the balanced and efficient use of forest resources.

Since significant and sometimes powerful interests underlie each of the component features of the troika, the successful revision of the existing accounting framework requires their judicious balancing. An accounting framework that favors one or more at others' expense will weaken the final LULUCF contribution to the goals of climate change mitigation and adaptation and destabilize forests and the forestry value chain. Since bioenergy substitutes for fossil fuels and emissions from bioenergy-based heat and power production are considered carbon neutral,[1] the heavy emphasis on emission reductions in other sectors means that bioenergy will be strongly favored regardless of what happens to standing forests or HWP.

Carbon accounting practices, though frequently neglected in the climate change mitigation and adaptation literature,[2] ultimately define the nuts and bolts of what counts and which resources (forest, forest-based or other) are favored and utilized. To-date, accounting practices under the UNFCCC, Kyoto Protocol (KP), European Union (EU) and other national level emission reduction schemes fail to adequately mobilize the LULUCF sector. Moreover, each of these frameworks (UNFCCC, KP, EU, etc.) employs different reporting and/or accounting conventions with significant and potentially adverse impacts on how forest resources are used (Fig. 1). Finally, each of these frameworks fails to incorporate important (though not always the same) carbon pools.

Carbon sequestration in standing forests is not fully recognized in some accounting frameworks (e.g. the EU does not allow for the inclusion of LULUCF in EU-based commitments and carbon credits cannot be traded in the EU's ETS). The implementation of LULUCF accounting is uneven across Parties to the KP. Carbon sequestered in HWP is currently not counted in any of these frameworks and bioenergy is heavily favored vis-à-vis the other elements of the troika. The successful inclusion of all major terrestrial carbon pools in a revised and updated Kyoto Protocol (KP) accounting framework in a way that fully accounts for all carbon credits from both fossil fuel substitution and carbon sequestration

[1] Depending on the role the United States plays in current negotiations, the recent decision by the US Environmental Protection Agency (EPA) to *count* such emissions may cast doubt on the long-term acceptance of "carbon neutral status" for bioenergy-based heat and power production in other countries.

[2] See however the important contributions from Pingoud et al. (2003), Schlamadinger et al. (2007a,b), Höhne et al. (2007), Cowie et al. (2007), Sathre and O'Connor (2008) and Petersson et al. (2009).

and renders these fully fungible across international (and EU) carbon trading schemes would encourage both long term carbon sequestration (in standing forests and HWP) and bioenergy resource use.

This paper has two closely intertwined goals. The first is to propose a simplified, improved and more cost-efficient strategy for stabilizing atmospheric GHG emissions. The second is to promote a more balanced and efficient use of forest-based resources that promotes the twin goals of climate change mitigation (carbon sequestration and fossil fuel substitution) and adaptation (biodiversity protection and ecosystem promotion/preservation). Including and strengthening the climate change mitigation and adaptation potential of forests and forestry in the UNFCCC framework represents one of the greatest single challenges in the current negotiation round and its relevance is only heightened by the likelihood the +2 °C target will be surpassed (see e.g. Weaver et al., 2007). Without substantial reform, LULUCF accounting cannot achieve a balanced and efficient use of forest-based resources, nor will it create the foundations for an optimal strategy of fossil fuel substitution and carbon sequestration. These twin goals can however be effectively and easily achieved with a strategy that includes both forests and forestry more generally in the climate change mitigation and adaptation framework.

Though we cannot herein address the adaptation side of this debate,[3] we focus in some detail on climate change mitigation aspects and note in passing that the promotion of carbon sequestration in standing forests simultaneously promotes both mitigation and adaptation, in particular by supporting biodiversity, future forest resilience and ecosystem promotion/preservation. At the same time, we acknowledge in advance the potential need to consider additional features, in particular where the goal of biodiversity promotion may not fully coincide with those of forestry and the goals of afforestation, HWP's and bioenergy use.

2. Shortcomings in the current accounting system

In order to create incentives for both cost-efficient strategies for climate change mitigation and for the balanced and efficient use of forest resources, carbon accounting measures should cover all major carbon pools and emissions and should weigh all GHG sources equally based on their global warming potentials. Climate targets should be achieved in the most cost-, land-use-efficient and balanced way possible. The unequal weighting of carbon pools or their complete neglect in carbon accounting will lead to the unbalanced and inefficient use of forest-based and other climate change mitigation resources. The overriding goal should however be to create incentives for improvements wherever possible.

Under current accounting practices, the LULUCF sector remains only weakly mobilized. Though the KP currently allows countries to voluntarily account for a share of the carbon sequestered in standing forests, important carbon pools are neglected, ignored or excluded. The omission and neglect of significant carbon pools in the carbon accounting framework creates tremendous disincentives to employ LULUCF potential in reducing GHG emissions. Restrictions on and gaps in carbon accounting procedures further significantly reduce incentives to mobilize the LULUCF sector. The likely impact on global emission-reducing potential is profound.

Ideally all lands should be equally accounted for in one unified and coherent system. Further, the accounting system should be able to handle conversions from natural net emissions to anthropogenic—such as the conversion of former unmanaged to managed land. Likewise, the conversion of other managed lands (not currently considered forest land) to forest land (e.g. abandoned cropland to forest land), could and presumably should be labeled ''afforestation''. Ceasing cultivation would thus become equivalent to human-induced change.

Carbon pool omissions are essentially of two types. The first type includes land-types not counted under the current system. Unmanaged lands and certain types of land conversions fall under the first category. Some activities are not counted because they are voluntary, while others are simply not covered. Carbon pools not accounted for under the current system include carbon pool changes under wetland restoration and peatlands. Conversions from settlements and grassland to forest are likewise not handled well.

The second type concerns either restrictions on or gaps in the accounting system and involves restrictions such as the ''cap'' or the failure to count the carbon sequestered in harvested wood products (HWP). The cap represents perhaps the greatest restriction-based disincentive to forest-based carbon sequestration, only allowing a part of the net removal/emission from forest management to be counted. The cap is a country-specific constant individually calculated and negotiated for each party[4] which limits credits/debits from forest management (FM, decision 16/CMP.1, UNFCCC, 2005). Since countries cannot be debited for fellings over the limit set by the cap, depending on how these resources are priced in the market, powerful incentives are currently in place to harvest biomass for bioenergy and/or HWP. Incentives for promoting standing forests however are undermined.

The aim of the cap is threefold: to set a limit on the potential advantage timber-rich countries might draw from forest-based carbon sequestration (in part in order not to undermine KP commitments), to ensure that only direct human-induced carbon sinks are credited (i.e. Art. 3.3 af-reforestation efforts) and to reduce the risk that large uncertainties affect accounting (in particular disturbances due to extreme events such as forest fires, wind storms or invasive species).[5] This last point involves two further issues. The first

[3] There has however been ample discussion of the potential biodiversity benefits. See for example CBD (2009).

[4] Several countries have re-negotiated their ''caps''. In particular, Russia doubled the size of its cap in 2001 (12/CP.7) and Italy dramatically raised its cap in 2006 (8/CMP.2) (Höhne et al., 2007: 357). Japan and Canada have also renegotiated their caps (Schlamadinger et al., 2007b: 297).

[5] Canada and some other countries have been driven by concerns over the potential impact of *disturbances* such as widespread forest dieback from pests like the mountain pine beetle or severe weather events. With the occurrence of more frequent severe weather events, both these concerns and the number of countries sharing them have increased in recent years.

concerns the definition of a common strategy for identifying naturally caused disturbances such that countries are not inadvertently penalized for this type of ''emission''. The second concerns the extent to which countries should be held accountable for disturbances since forest management techniques can influence their occurrence.

While strategies such as the cap have been introduced in part to diminish such incentives, they ultimately reduce the incentive and thus the likelihood that players will take advantage of forest-based carbon offsets, at least where ''forest management'' has been chosen as an over-arching national framework. This ultimately limits vast potential for forest-based carbon sequestration and thus also for combating deforestation. Again, such barriers are clearly not in the spirit of the Kyoto enterprise.

The current ''narrow'' definition of human-induced change represents a further restriction upon the forest-based crediting of carbon sequestration to Article 3.3 (af-re-forestation) activities where former managed and unmanaged land is converted to forest land by active regeneration (planting). A ''broad'' definition could encompass other carbon sequestering activities, thus promoting a more efficient and extensive use of existing forest-based resources. The current, narrow definition of human-induced activities significantly limits incentives for improvement in potentially large carbon pools. Further, the ability to voluntarily ''elect'' forest management (FM) increases the risk of ''cherry-picking'' activities that favor individual parties and potentially promotes within-country leakage across Art's. 3.3 and 3.4 (FM). Making Art. 3.4 reporting mandatory and further collapsing the division between Art. 3.3 and 3.4 would go a long way toward improving the potential for the efficient use of forest-based resources.

Although the opposite was essentially intended (Fry, 2002),[6] the split between Art. 3.3 and 3.4 activities had the impact of artificially hiving off the vast majority of human-induced change in forest cover and growth (Art. 3.4) from the category of af-re- and de-forestation (Art. 3.3). Moreover, the option to voluntarily elect and thus report ''forest management'' activities represents an almost unavoidable incentive to promote within country leakage across Art.'s 3.3 and 3.4 and may encourage forest degradation in Annex I countries and deforestation in Non-Annex I countries where sustainable forest management (SFM) practices are not well entrenched or enforced.[7]

Restricting accounting to ''human-induced'' forest growth and simultaneously limiting the potential of some countries to exploit their forest resources has ultimately had the effect of limiting the potential impact of forestry and forest-based industries—which are of course explicitly ''human (anthropogenic) practices''—on carbon sequestration (as well as emissions). The potential for disturbances and concerns that timber-rich countries could exploit forest resources in order to minimize their carbon reduction efforts by trading LULUCF against their commitments, represent further significant obstacles to the broader use of LULUCF in UNFCCC, KP and ultimately EU-level reporting and accounting practices.

The exclusion of HWP from UNFCCC and Kyoto accounting procedures represents a further significant and neglected carbon pool, reducing incentives for carbon sequestration and fossil fuel substitution. The current accounting rule used under the KP assumes that trees (and thus HWP) are oxidized at the time of harvest. Though this rule has the advantage of being simple, one disadvantage is the lack of an accounting-based incentive for storing carbon in HWP. Another disadvantage is that atmospheric removals and emissions by forest products are accounted incorrectly over time. Other potential disincentives include the likelihood that other forest resource uses become more competitive than HWP, in particular as bioenergy resources are progressively favored over fossil fuels.

Accounting for HWP would mean emissions resulting from harvesting forests are not directly accounted or are 'delayed' in various ways depending on the use (and lifetime) of wood. Four different approaches for HWP accounting (see Appendix) have been defined by the IPCC (IPCC, 2006). Harmonization is necessary in order to avoid double-counting, to align reporting practices across countries and in order to eliminate potential incentives for countries to ''cherry pick''. A particular problem in this regard arises with harmonizing the consumption and the production approaches (i.e. should producing or consuming countries have the right to credit HWP carbon sequestration?). Debiting the consumption of HWP could increase the risk of deforestation in developing countries. A further problem arises with how to handle both non-signatory countries and signatory countries without emission targets.

2.1. *Other accounting irregularities*

Further accounting inconsistencies likewise create perverse incentives. One is the ''gross-net emissions loophole'' created by the fact that FM, af-re-forestation (AR) and deforestation (D) are gross-net accounted. Only net emissions/removals occurring during the first commitment period (CP-1, 2008–2012) are accounted. All other GHG emissions are net–net accounted. While net–net accounting explicitly compares performance to a base year, gross-net accounting ignores any direct change between the base year and the beginning of the commitment period (1990–2007) and instead emphasizes year-to-year or commitment period to commitment period change.

The opportunity created by this loophole provides strong incentives for countries with advanced age-class forests to harvest all biomass and replant, thus reaping the benefits of both the harvested biomass as well as any new forest growth. This incentive was reinforced by the so-called ''compensation'' and ''fast forest fix'' rules. The compensation rule, intended to compensate Parties with slow growing forests for potentially large net af-re- and deforestation-related (ARD) emissions, permits Parties that elect FM to limit total

[6] Originally, Art. 3.3 was introduced so that LULUCF accounting would focus entirely on *human-induced* sources of climate change and natural forest growth would be excluded. Art. 3.4 was created as an afterthought, primarily at the insistence of Japan. However, this afterthought (unintentionally or not) separated forest managed lands from ''other'' lands set-aside for afforestation (carbon sequestration).

[7] The problem of ''leakage'', i.e. where deforestation-related carbon emissions are ''transferred'' to locations not subject to LULUCF reporting while ''afforestation'' is accounted represents an important dilemma (see Schlamadinger et al., 2007a: 278; Plantinga and Richards, 2008).

accounted emissions from Article 3.3 activities up to a level of 9 M ton C annually (paragraph 10, decision 16/CMP1, UNFCCC, 2005). This provides additional incentives to pursue deforestation. The fast forest fix rule (paragraph 4, annex to decision 16/CMP1, UNFCCC, 2005) allows Parties that harvest a unit of land subject to re-af-forestation between 1 January 1990 and 31 December 2007 to limit debits to the total amount of accounted credits from the same unit of land calculated from January 1st, 2008. This rule is important for those Parties with fast growing forests who have not elected FM but should not be a major problem if af-re-forestation is sustainable and continuous.

The future of these rules is uncertain. Though some form of gross-net or net–net accounting is likely to remain the rule, the gross-net emissions loophole should disappear due to the lack of a chronological gap between the signing of an agreement and the beginning of the second commitment period (CP-2, potentially 2013–2020 or later). CP-2 should ideally follow immediately on the end of the first commitment period (CP-1, 2008–2012). Though gaps are inadvisable given the urgency of the climate change mitigation agenda, given negotiation deadlocks in Copenhagen (2009) and Cancun (2010), they have been entertained. If gaps should arise, this may complicate negotiations over gross-net and net–net. Second, any differences in the advantages arising from either gross-net or net–net accounting in LULUCF should wash out over time, thus diminishing the potential for Parties to have fundamental disagreements on the choice of model. The adoption of an all-inclusive land-based LULUCF accounting framework would eliminate the potential role of any remaining loopholes, accounting discrepancies and the potential for ''cherry-picking''.

Finally, additional confusion arises from the fact that different accounting procedures persist across ARD, FM (gross-net) and cropland management, grazing land management and revegetation (net–net). The presence of different activity-based accounting procedures makes little sense and weakens attempts to increase the potential role and importance of the LULUCF sector.

3. Defining the troika: improving and diversifying the use of forest-based resources

Powerful economic and political interests lie behind each of the major segments of the forestry industry. Achieving an agreement that can successfully balance potentially competing interests requires careful consideration of what we call the ''troika'' of interests and resources in the forestry sector. Standing forests, HWP and bioenergy are each crucial not only to the cost-effectiveness of climate mitigation strategies and to the balanced and efficient use of forest resources, but also to the long-term stability of the carbon accounting and negotiating framework.

3.1. *Standing forests*

From a climate perspective, the LULUCF sector is unique. While all other sectors create emissions, the appropriate management of LULUCF can instead lead to removals or ''carbon sequestration'' (Petersson et al., 2009). Available land can be re-af-forested, carbon stocks can be increased on existing forested and other lands and deforestation can be avoided. In essence, standing forests represent the first line of defense against climate change. Moreover, powerful interests lobby for their protection.

Estimates of the mitigation potential of standing forests vary considerably. 2007 IPCC estimates, for example, lie between 1.3 and 13.8 $GtCO_2e/yr$ (Nabuurs et al., 2007: 542).[8] Though the impact of deforestation on global emissions may have been over-estimated, total emissions from deforestation, forest degradation and peat land emissions represent at least 15% of global anthropogenic emissions (Van der Werf et al., 2009: 738). Moreover, for a large number of developing countries, deforestation and forest degradation represent the principal source of emissions (ibid.). Finally, between 2000 and 2005 global forest cover declined by approximately 1 million km^2, an area representing approximately 3.1% of global forest cover in 2000. Though rapid deforestation is typically associated with the developing world, the first four countries with the highest share of forest cover loss were Brazil, Canada, Russia and the US respectively (Hansen et al., 2010). Accounting procedures that potentially contribute to slowing deforestation and forest cover loss thus represent significant global public goods and can potentially be influential in both less developed, developing and developed countries.

3.2. *HWP and bioenergy*

In addition to the advantages of carbon sequestration in standing forests, there are other neglected uses of forest-based resources. Since mature trees accumulate smaller amounts of carbon (due to lower growth rates and higher respiration levels),[9] from a climate perspective storing carbon by harvesting mature biomass and promoting regeneration (through re-planting and the introduction of a sustainable forest management requirement) may be preferable. Harvested biomass can be turned into carbon-storing products (HWP). Storing harvested biomass in ''long-lived'' materials (e.g. buildings) is preferable to materials with a high turnover rate (e.g. paper). Carbon stored in this way is removed from the atmosphere for the duration of a product's lifespan.

Provided such products are long-lived and/or substitute for more carbon intensive materials (e.g. steel, concrete), they represent important forms of both carbon sequestration and fossil fuel substitution. Though long-lived products eventually decompose, waste material can be recycled as fuel for heat and power generation. Thus, in addition to carbon sequestration in standing forests and the combined value of carbon sequestration and fossil fuel substitution in/with HWP, the

[8] Previous estimates were considerably higher, reaching as much as 20% of global GHG emissions. Van der Werf et al. (2009) have also included new emission sources in their calculations (in particular peatlands).

[9] Luyssaert et al. (2008) establish that old growth forests continue to sequester additional carbon though at a somewhat declining rate after approximately 80 years of growth.

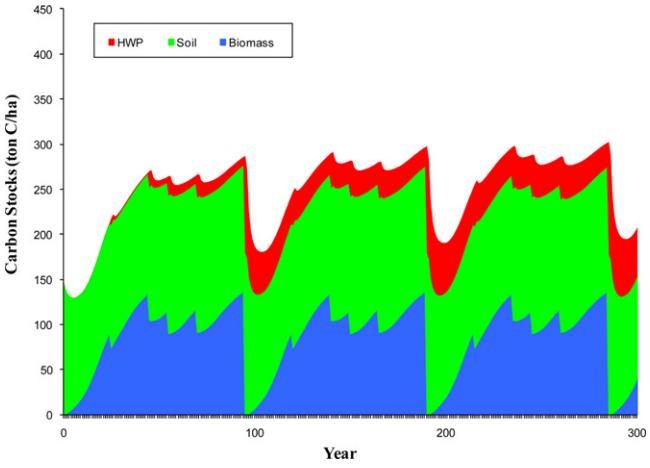

Fig. 2 – Potential carbon sequestration using forest-based soil, biomass and HWP.
***Source*: we thank Gert-Jan Nabuurs for basic data and graphics. For an overview of the CO2FIX (v2) simulation and similar output, see Masera et al. (2003) and Schelhaas et al. (2004).**

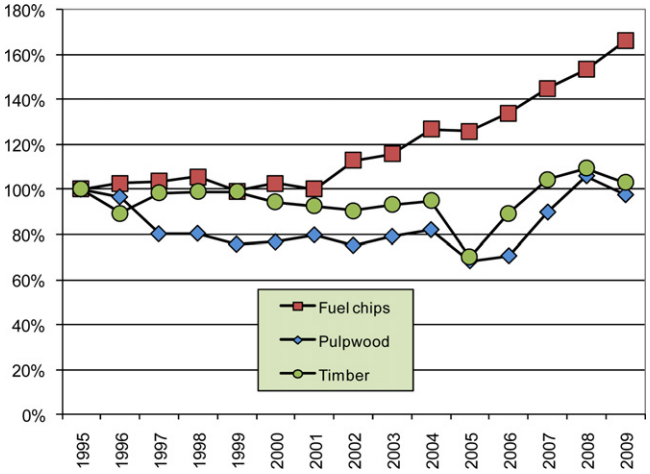

Fig. 3 – Relative prices of fuel chips, pulpwood and timber in Sweden (1995–2009).
***Source*: Swedish Forestry Agency. Note: In 1995 the average price of pulpwood was 293 SEK/m^3, for timber 422 SEK/m^3 and for fuel chips 109 SEK/MWh.**

combustion of biomass to produce heat and power represents a third valuable use of forest resources.

From a pure climate perspective, biomass from the LULUCF sector can act as a cumulative carbon pool, both sequestering carbon and substituting for more carbon-intensive materials and fuels. As illustrated in Fig. 2, the strategic management of carbon sequestration in forest biomass and biomass-based end-products can potentially represent a significant and increasingly important share of overall carbon sequestration.[10]

More importantly for our purposes, without adequate accounting practices, much of the forest-related industry could begin to disintegrate. In timber-rich countries such as Sweden and Finland, this can ultimately affect a very large share of economic activity. In 1999, for example, the sum of all forest-related industry together (including research and development) amounted to almost 1/3rd of total economic activity in Sweden (Skogsindustrierna, 1999).

While HWP currently remains economically attractive, in the longer term this may depend on a number of key factors. For one, prices of carbon intensive construction materials (concrete and steel) will rise with the increasing price of carbon emissions. In the shorter term, this will advantage wood-based construction materials over more carbon intensive materials. However, in the longer term, without a mechanism accounting for carbon sequestered in HWP, bioenergy will likely become more economically attractive.

In some instances, this is in fact already the case, as prices for bioenergy biomass have already begun to approximate those for HWP biomass. As illustrated in Fig. 3, pulpwood and timber are the biggest losers. Timber consumers—sawmills, the construction industry and or the pulp and paper industries (also furniture, wood products, the biomass and bioenergy industries)—will presumably be harder hit by the changing price structure as carbon prices continue to raise fossil fuel-based energy prices, leading to increasing competition over available wood resources.[11] Bioenergy will continue to become rapidly more competitive. The 2010 EUWood report likewise notes that demand for biomass material for energy use is likely to outstrip available supply sometime between 2015 and 2020 (Mantau et al., 2010: 23), creating the conditions for significant conflict across the different constituents of the forestry value chain. Improved forest management could however ameliorate at least some of these constraints (Verkerk et al., 2011).

Though powerful incentives for fossil fuel substitution may have important emission reducing effects, they may also have far-reaching and unintended consequences for standing forests (see in particular Wise et al., 2009), as well as for more conventional forest-based industries. Few would argue that a more diversified use of forest-based resources based on the promotion of standing forests and HWP is less efficient. Following Nabuurs et al. (2008), quite a diverse range of potential forest uses can be mobilized in order to "maintain or maximize forest carbon pools and carbon sequestration". Without entering into the details of this debate, carbon accounting strategies that provide a framework for supporting multiple forest uses represent a meaningful alternative. Thus, in order to encourage a more efficient and balanced use of

[10] See also Sathre and O'Connor (2008) and Pingoud et al. (2003).

[11] The Swedish Forestry Association reports that demand for energy wood is affecting harvesting practices. See "Forest Owners Make Profits on Energy Wood" (*Nordic Forest Owners' Association*, July 28th, 2009). Industry experts note there is even competition over what share of harvested treetops should be used for bioenergy vs. what share should be used for sawn timber. Finally, according to a FERN report, Finland's decision to promote bioenergy triggered objections from forest-based industries about the impact rising demand for biomass material might have on prices and increasing competition with other forest products (FERN, 2008a: 13; FERN, 2008b: 7).

forest resources, a more flexible and dynamic carbon accounting framework is presumably a requirement.

4. At the bargaining table: current options for future reporting

Thus the two principal goals to be achieved in order to promote a more balanced and efficient use of forest resources are the full inclusion of LULUCF accounting (in particular the merging of Art. 3.3 af-re-deforestation (ARD) and 3.4 forest management (FM) activities into one all-encompassing and all-inclusive carbon-accounting framework) and the inclusion of HWP in UNFCCC and Kyoto accounting procedures. Although the rules for LULUCF-sector accounting under a revised Kyoto Protocol are currently under consideration, none of the options currently on the negotiating table propose merging Art's 3.3 and 3.4.

Options for future reporting and accounting in the LULUCF-sector have been discussed since 2008 under the so called Ad Hoc Working Group on Further Commitments (AWG-KP) for Annex I Parties under the Kyoto Protocol (UNFCCC, 2009a). Among the options currently under negotiation, the most important involve discussions of (1) gross-net vs. net–net (vis-à-vis some kind of reference level) accounting, (2) how to deal with the problem of ''disturbances'' and (3) HWP. A number of additional issues—such as the inclusion of new activities or carbon pools (in particular rewetting and drainage) and production vs. equivalent forest—are likewise under discussion.

According to the latest information posted on the UNFCCC website concerning AWG-KP negotiations (June 2010), it remains unclear whether new carbon pools and activities will be included and which accounting approach will be used for forest management. In the latest revised proposal by the Chair (FCCC/AWG/CRP.41) used at the 16th AWG-KP meeting, a preference was expressed for moving in the direction of ''complete coverage of managed lands''. In the same draft, a request was proposed to the Subsidiary Body for scientific and Technological Advice (SBSTA) to further study this matter, essentially indicating that land-based accounting and the possible introduction of mandatory reporting have been postponed.

In what follows, we discuss and analyze the predicted outcomes associated with adopting various proposals on the negotiating table. Since strategies for incorporating all major carbon pools in a unified LULUCF framework merging Art.'s 3.3 and 3.4 are not currently on the negotiating table, they are not addressed in this section. We return however to these issues in our broader discussion below.

4.1. *Net–net vs. gross-net and reference level accounting under FM and handling uncertainty*

Three main concepts (and some variants) have for a long time been the target of negotiation: activity-based net–net and gross-net accounting. As a compromise between net–net and gross-net accounting the concept of a reference level (also called the bar) was introduced in 2009 (UNFCCC, 2009b). The idea was to define a level acceptable both for the group of countries preferring either pure net–net or gross-net accounting. Suggestions on how to set the reference level cover a wide range of alternatives, from the 1990-level based on historical mean values to projection-based strategies.[12] Although the accounting options have now been grouped into four approaches called ''reference levels'', ''baselines'', ''net–net relative the first CP'' and ''cap'' (according to the current negotiation draft) the main differences between options presented here remain.

While net–net (using either 1990 as a base year or a flexible reference level) or gross-net accounting themselves yield very different credit/debit outcomes, alternative methods for accounting in forest management have also been discussed. The first two (the cap and a discount factor) have mainly been discussed in combination with gross-net accounting and the third (the band) in combination with a flexible reference level.

The objective with a discount factor is the same as with the cap, but a discount factor is set as a percentage of the actual removal/emission and is not absolute (as in the case of a cap). Thus if a discount factor is used instead of a cap, it is more difficult to predict the actual contribution of the LULUCF-sector to overall commitments. In contrast to the cap, a discount factor set proportionally to actual removals may raise incentives to pursue removals and limit large emissions. However, we suggest below that even this model fails to adequately consider all potential incentives for carbon sequestration.

A third way to restrict accounting, mainly when using the flexible reference level concept, was introduced during 2009 (UNFCCC, 2009c) and called the ''band''. The idea is to only credit or debit emissions/removals outside the band that can be set symmetrically around the reference level as a percentage of the reference level or asymmetrically from the reference level to a predefined level (i.e. zero).

One principal justification behind restrictions such as the cap, discount factor and the reference band is the potential effect of disturbances. Though in principle restrictions are not desirable—in particular due to their impact on incentives for carbon sequestration—other ways of handling this problem are also under discussion. Force majeure is a mechanism meant to handle extraordinary events or circumstances whose occurrence or severity is beyond the control of and not materially influenced by an individual Party (UNFCCC, 2009a). Though the details are still under consideration, some kind of threshold for the magnitude of the event related to the total emission of the Party could be applied. Emissions from land where such events have occurred during a commitment period could either be excluded from accounting until subsequent removals have balanced out the loss at the time of the event, or could be carried over to the subsequent commitment period. Such procedures would only be acceptable under the provision that no land-use change has occurred on those lands and thus that the harvesting of salvage wood be considered incompatible with their use.

[12] See the summary of Party submissions (11/2009): http://unfccc.int/files/kyoto_protocol/application/pdf/summarytable.pdf.

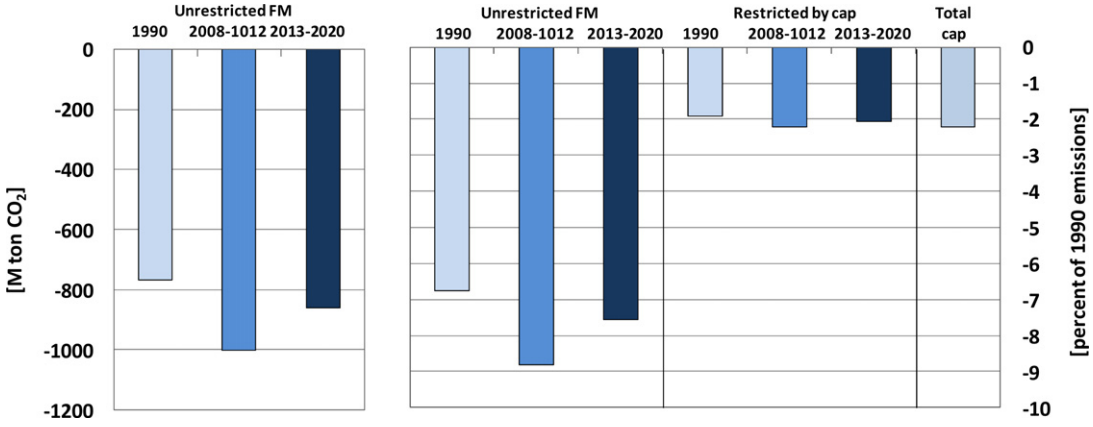

Fig. 4 – Total predicted removals from forest management (in M ton CO_2 and Relative to 1990 Emissions).

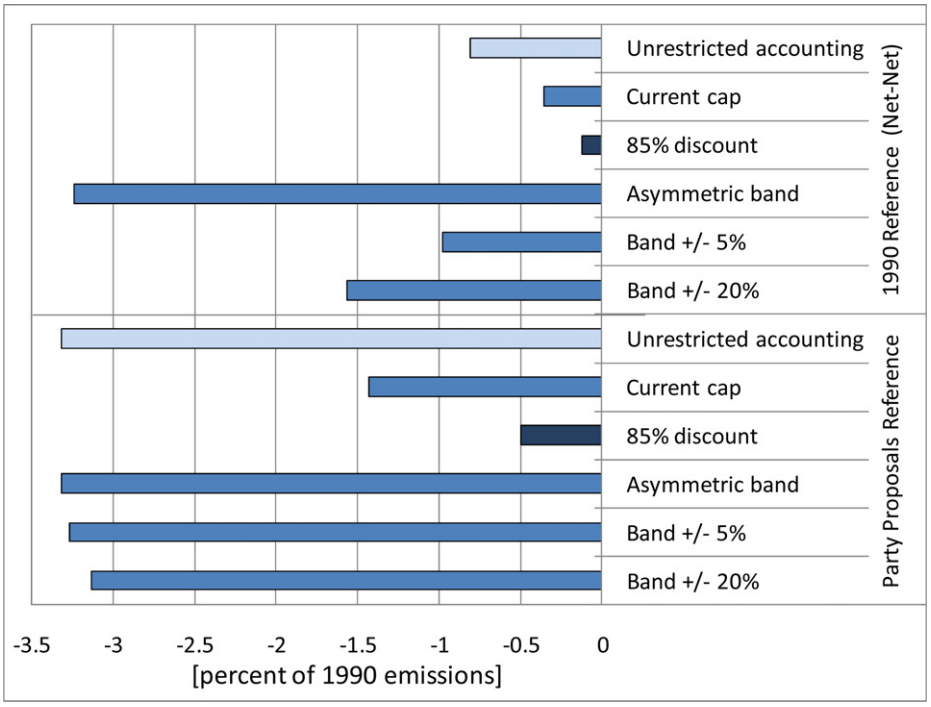

Fig. 5 – Predicted outcomes by FM accounting approach relative to 1990 emissions (excl. LULUCF).
***Source*: Annex-I country submissions to AWG-KP 13 (August 2010). Totals represent data for all Annex I countries with a cap inscribed in decision 16/CMP.1 (UNFCCC, 2005) and that have also submitted a reference level to the AWG-KP.**

5. The potential impact of alternative accounting mechanisms on FM removals[13]

In the context of different accounting approaches, large variations in net removals from FM have major implications. To what extent the projections used to calculate CP-2 predictions are based on similar country-level assumptions (e.g. regarding harvest rates and projected demand) remains unclear. Though some EU member states employ the same underlying assumptions when projecting the demand for bioenergy (EU-submission, August), a review of individual Party submissions under AWG-KP during 2009–2010 illustrates that "small changes" in the assumptions and models used for projections may result in large changes in net removals. This is important to bear in mind when assessing the different accounting options.

Fig. 4 shows the total predicted unrestricted removals (total forest growth, minus harvesting) from FM for three periods in time (1990, 2008–2012 and 2013–2020). The comparison comprises all Parties with a cap inscribed in decision 16/CMP.1 (UNFCCC, 2005) and with submitted reference levels under the AWG-KP. The total impact of unrestricted removals was estimated at approximately 800, 1000 and 900 M ton CO_2 for 1990, 2008–2012 and 2013–2020, respectively. Unrestricted removals from FM thus represent approximately 7–9% of 1990 emissions relative to other sectors. Fig. 5 also illustrates the significant restriction of the cap limit on potential accountable

[13] Forest management data for 1990, 2008–2012 and 2013–2020 and the proposed *reference level* for individual countries are provided in Table A-I (Appendix).

credits. For the countries considered, the cap represents only 25% of total potential carbon sequestration.

Different accounting approaches lead to significantly different outcomes (Fig. 5). Moreover, the results are highly sensitive to changes in the parameters (e.g. reference levels) chosen by individual countries. Thus the predicted results for some individual countries can strongly influence the total outcome. Uncertainty in various forms thus significantly affects these results.

Assuming the business-as-usual (BAU) prediction is correct, all options result in more credits than the current system. However, all currently proposed models impose restrictions on actual removals. Switching from unrestricted gross-net to net–net accounting or vice versa does not influence incentives for improvements but does have a large influence on national commitments. A country specific projected baseline is a way of focusing on incentives rather than national commitments. However, uncertainty in projections may end up in crediting/debiting incorrect trends. All models that impose restrictions decrease incentives, but in different ways. The cap creates fair incentives up to the cap but not above, while discount factors create partly restricted incentives along a range. Underlying assumptions for predictions/projections are country specific.

For individual countries, different accounting models likewise lead to very different results depending on the size of the net removals and the trend from 1990 onwards. Moreover, Parties do not always use the same reference level approach. To understand country positions regarding accounting approaches, projections for three example countries—Sweden, Russia and the UK are provided (Table 1). These results are broadly representative of the range of possible outcomes across countries and illustrate potential country-level sensitivity to changes in the accounting options.

For Sweden, where FM represents a large share of total emissions, a shift from the current system to one of the

Table 1 – Forest management under alternative accounting options, relative to 1990 emissions (select countries by commitment period).

	FM credits relative 1990 emissions (excl. LULUCF) [%]						
	Outcome based on:	Unrestricted accounting	Cap	85% discount	Asym. band	Sym. 5%	band 20%
Sweden accounting approach							
Total *unrestricted* removals based on subm. to AWG-KP	1990	−49.4	–	–	–	–	–
	2008–2012	−28.9		–			–
	2013–2020	−30.4		–			–
Current system (*gross-net*)	2013–2020	−30.4	−3.0				
Reference level set to 1990 removals (*net-net*)	2008–2012	20.6	3.0	3.1	0.0	18.1	10.7
	2013–2020	19.1	3.0	2.9	0.0	16.6	9.2
Party proposal ref. level (*reference level approach*)	1990	−19.1	−3.0	−2.9	−19.1	−17.6	−13.0
	2008–2012	1.5	1.5	0.2	0.0	0.0	0.0
	2013–2020	0.0	0.0	0.0	0.0	0.0	0.0
Party proposal ref. level (*reference level approach*)	2013–2020 (+40%)	−12.1	−3.0	−1.8	−12.1	−10.6	−6.1
	2013–2020 (−40%)	12.1	3.0	1.8	0.0	10.6	6.1
Russia Accounting approach							
Total *unrestricted* removals based on subm. to AWG-KP	1990	−2.7					
	2008–2012	−14.7					
	2013–2020	−12.7					
Current system (*gross-net*)	2013–2020	−12.7	−3.6				
Reference level set to	2008–2012	−12.1	−3.6	−1.8	−12.1	−11.9	−11.5
1990 removals (*net-net*)	2013–2020	−10.0	−3.6	−1.5	−10.0	−9.8	−9.4
Party proposal ref. level (*reference level approach*)	1990	0.0	0.0	0.0	0.0	0.0	0.0
	2008–2012	−12.1	−3.6	−1.8	−12.1	−11.9	−11.5
	2013–2020	−10.0	−3.6	−1.5	−10.0	−9.8	−9.4
Party proposal ref. level (*reference level approach*)	2013–2020 (+40%)	−15.0	−3.6	−2.3	−15.0	−14.9	−14.5
	2013–2020 (−40%)	−4.9	−3.6	−0.7	−4.9	−4.8	−4.4
UK Accounting approach							
Total *unrestricted* removals based on subm. to AWG-KP	1990	−1.6					
	2008–2012	−1.1					
	2013–2020	−0.4					
Current system (*gross-net*)	2013–2020	−0.4	−0.2				
Reference level set to 1990 removals (*net-net*)	2008–2012	−2.9	−2.9	−0.4	−2.9	−2.6	−1.8
	2013–2020	−2.1	−2.1	−0.3	−2.1	−1.8	−1.0
Party proposal ref. level (*reference level approach*)	1990	0.0	0.0	0.0	0.0	0.0	0.0
	2008–2012	−2.9	−2.9	−0.4	−2.9	−2.6	−1.8
	2013–2020	−2.1	−2.1	−0.3	−2.1	−1.8	−1.0
Party proposal ref. level (*reference level approach*)	2013–2020 (+40%)	−5.0	−3.6	−0.8	−5.0	−4.8	−4.0
	2013–2020 (−40%)	0.9	0.90	0.1	0.00	0.6	0.0

Source: based on historical and projected data submitted to AWG-KP.

LULUCF accounting options currently under consideration could significantly change the contribution from FM. Changing to a net–net system with 1990 as the baseline, for example, means that FM would become a source (+20.6% relative to 1990 emissions) instead of a sink (−3% of 1990 emissions due to the cap) using the current system for CP-1. Flexible reference levels would mean zero credits based on the BAU prediction (like most countries, Sweden proposes to use a BAU-projection for 2013–2020 as the reference level). However, a relatively small increase or decrease in fellings during the commitment period could significantly alter these results.

Two sensitivity analyses were conducted by increasing or decreasing annual net removals ±40%. Depending on the deviation from the BAU-prediction, the potential importance of a restriction mechanism increases (see the last rows in each country table). For example, the predicted outcome in Sweden changes from a significant debit to a credit compared to BAU. Sensitivity beyond the control of individual Parties is often used as an argument for restricting accounting using a cap, a discount factor or a band. Similar results emerge for Canada and Russia. However, for countries where the relative size of FM is small, sensitivity to change in net removals is less important. Other potential deviations may arise due to uncertainties in the projection, natural disturbances or unexpected (not climate-induced) changes in the forest sector.

For our purposes, both currently proposed restrictions and the cap represent significant disincentives to the effective and efficient promotion of carbon sequestration. While we sympathize with concerns regarding disturbances, we likewise point to the negative impact restrictions have on incentives for carbon sequestration. As illustrated in Fig. 6, many countries have very large potentials for carbon sequestration that are not encouraged under the current accounting mechanism. Thus countries currently account only for a very small share of the potential carbon sequestration that occurs under FM (Fig. 7, right panel).

We highlight this disincentive for carbon sequestration by referring to what we call the ''incentive gap''; essentially that amount of potential carbon sequestration not incentivized in the current carbon accounting framework. Though there are several possible ways of measuring the incentive gap, we describe only two possibilities in what follows. In Fig. 6 (right panel) we measure the incentive gap as the total amount of new forest growth (after harvesting) under forest management not accounted for under the current cap system. As suggested in this graphic, the amount is quite large. Total potential non-incentivized carbon removals/sequestration represents an additional 75% of total carbon sequestration. Thus the cap significantly limits the potential incentivizing of forest-based resources for the purposes of carbon sequestration by failing to encourage this type of strategic behavior.

One additional way of thinking about the incentive gap is to consider the total amount of annual forest growth (before harvesting). With appropriate incentives in place for carbon

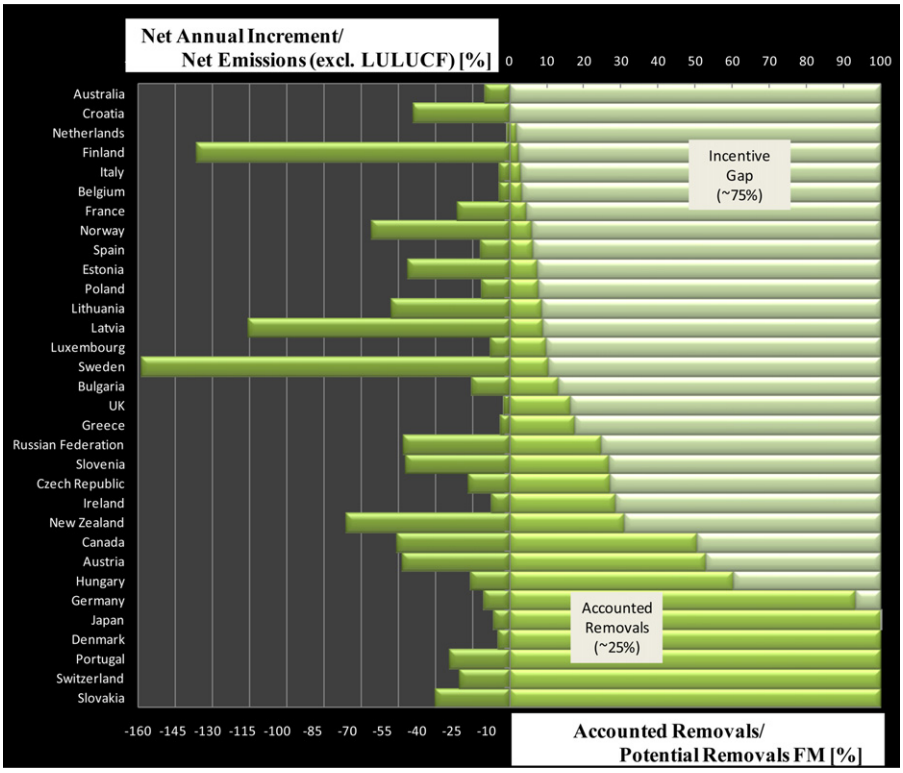

Fig. 6 – Left: Net annual increment in forests available for wood supply/Net emissions (excl. LULUCF) in mid-1990s. Right: Accounted/potential removals for forest management (first commitment period, excluding Art. 3.3 ARD).
***Source*: UN (2000) and Annex-I country submissions to AWG-K. *Note*: in the right panel, values of 100% result from the fact that total removals are equal to the level of the cap. However, even these countries may still have significant potential to raise their FM contribution to carbon sequestration by increasing forest cover and/or raising the total amount of forest growth. Further, carbon removals from afforestation (Art. 3.3 ARD) are not included or depicted here.**

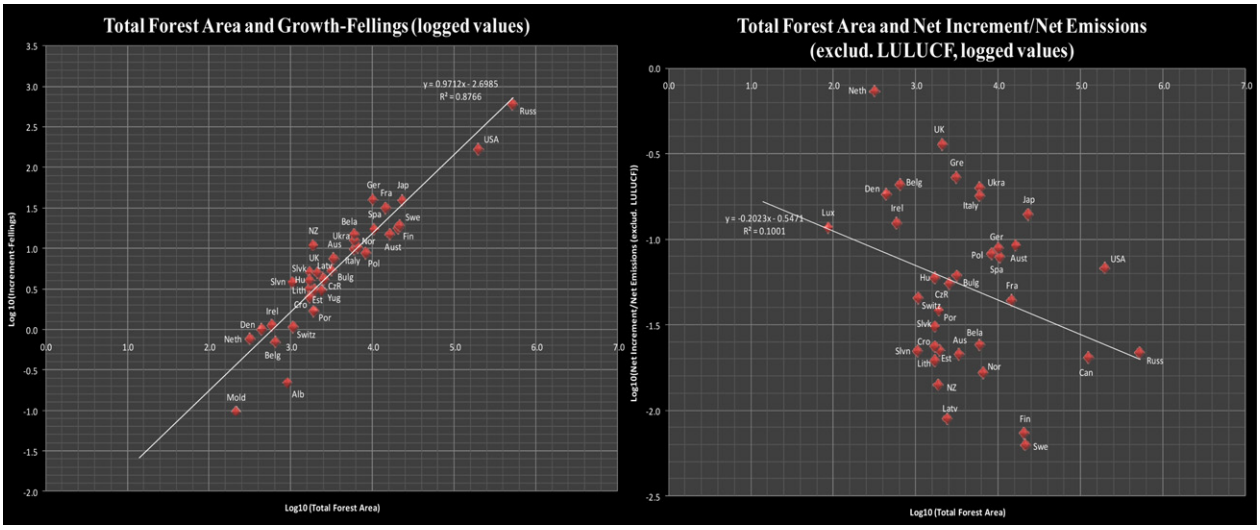

Fig. 7 – Total forest area, growth and emissions.

sequestration in standing forests, it is possible that a large share of the annual forest increment (growth) be used for carbon sequestration (and not harvested). Thus total annual forest increment represents one additional conceptualization of the incentive gap.

Fig. 6 (left panel) illustrates total annual forest growth relative to net carbon emissions in other sectors (excluding LULUCF). For many or most countries, total annual forest growth represents a relatively small share of emissions. On the other hand, several countries exhibit carbon sequestration potential that well exceeds net emissions (in particular Sweden, Finland and Latvia). However, it is difficult to determine how countries would behave if firm incentives were in place to encourage and account for carbon sequestration in standing forests. Our emphasis throughout has been to encourage the efficient and balanced use of forest resources. Assuming adequate incentives for bioenergy, standing forests and HWP, it is unlikely that timber-rich countries would decide to leave all new forest standing and cease harvesting.

Concerns that countries with extensive forest cover would disproportionately benefit from including the LULUCF sector should be considered in more detail.[14] Even in countries where currently accounted removals represent 100% of potential FM removals, there is still likely to be significant potential for increasing the overall contribution from FM by raising the share of forest cover and/or by increasing forest growth. Thus, for example, in Fig. 7 (right panel) countries like Denmark, Switzerland and Portugal presumably have significant remaining forest growth potential. Japan, on the other hand, has already set its cap high enough to cover all current forest growth, thereby incentivizing carbon sequestration in standing forests.

On the other hand, as suggested in Fig. 7 (panel a), there is a powerful and highly significant relationship between the total forest area and the amount of available carbon sequestration potential (or total growth/fellings). It is above all this relationship that generates concern that some countries might use their generous forest endowments to reduce commitments. As illustrated in Fig. 8 (panel b), however, there is virtually no measurable relationship between total forest area and the potential for net forest increment (annual forest growth) to cover net GHG emissions (excluding LULUCF). This point suggests in particular that the relative size of the forested area in individual countries matters far less in terms of the total potential carbon sequestration impact of forests on minimizing commitments than do other factors. Thus, for example, forest management traditions in countries like Sweden, Finland, Latvia and New Zealand matter far more than the total forested area. The US, for example, would only be able to cover about 14% of its total emissions through forest growth, while Russia and Canada would be able to cover approximately 46 and 48% respectively.

6. HWP

The predicted impact of the proposed HWP accounting rules varies dramatically from country to country and rule to rule (Fig. 8). Of the approaches suggested (the stock change approach SCA, the atmospheric flow approach AFA, the stock change approach domestic use SCAD and the production approach PA) the biggest potential change in carbon accounting practices would result from the atmospheric flow approach (AFA), which attempts to consider trade-related HWP flows in national-level accounting. This model in particular has a significant impact on the carbon balance of individual countries. For instance, in 2007, HWP removals in Sweden (under AFA) represent about −41% of net emissions (excluding LULUCF). Under the production approach (PA), removals represent only −7.5% of net emissions (SLU, 2009). Thus selecting which model should be used is a delicate task.

Arriving at a viable inclusion of HWP accounting procedures is no simple matter. As illustrated in particular by the

[14] One recent example of this concern is represented by a contribution from Ecofys and Climate Analytics: ''Climate Action Tracker: Developed Countries Set to Widen the Emissions Gap'', (December 8th, 2010).

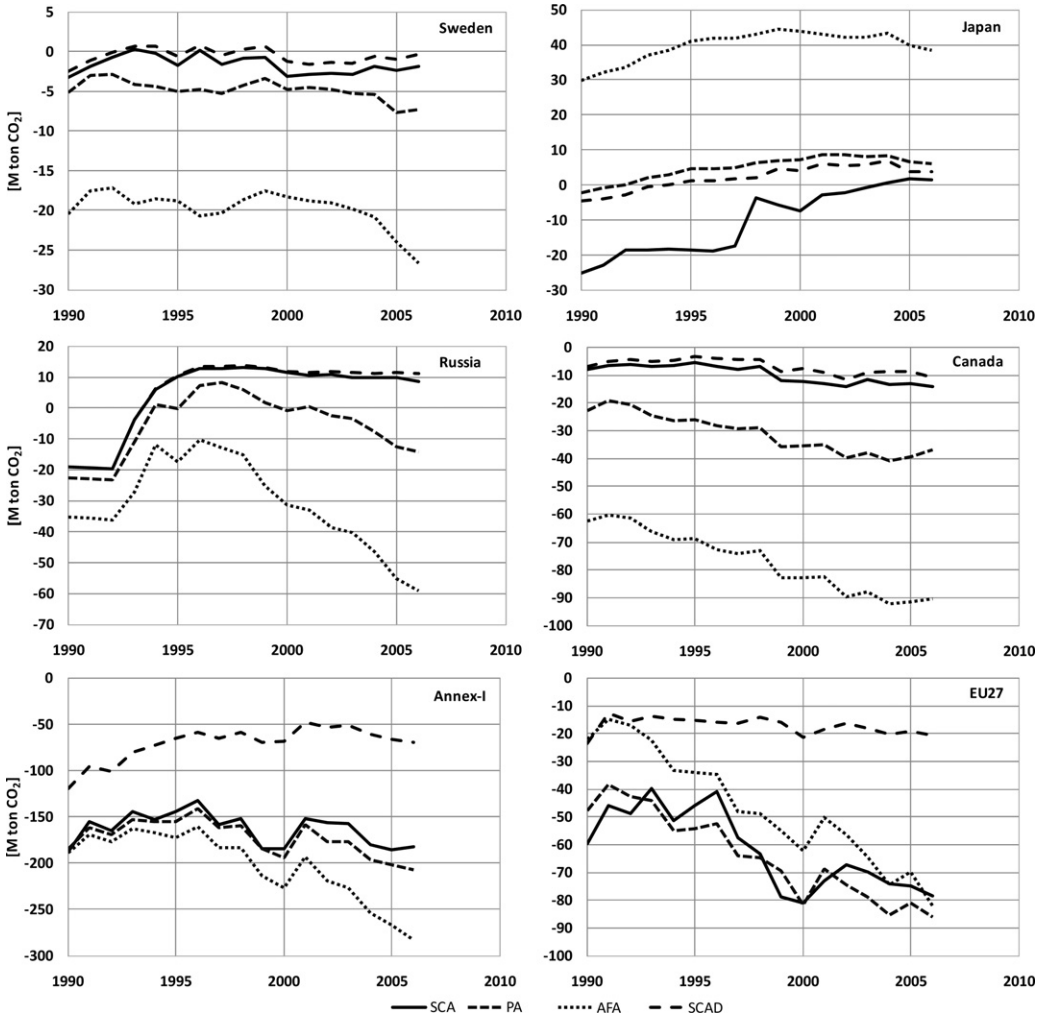

Fig. 8 – HWP contribution to climate mitigation by method and country (or group of countries). *Source*: based on HWP-modeling by Kim Pingoud.

differentiated impact of the AFA and PA accounting models, very significant differences could potentially emerge depending on whether the producers or consumers of wood products bear the consequence of their future decay and/or gain the benefit of including the sequestered carbon in their national inventories.

At least one powerful argument in favor of PA over AFA has to do with the many disadvantages that arise from the timber trade. For one, most wood exports are relatively carbon-intensive due to the role of long-range transport (see e.g. Magelli et al., 2009). Moreover, the AFA approach may ultimately provide quite powerful encouragement to the illegal timber trade. In many ways the PA approach appears to represent a more balanced strategy and is the main alternative in the current negotiating text.

7. Discussion

Proposed changes to the current accounting rules would not significantly change total FM credits. If the ''cap'' is retained, incentives for promoting carbon sequestration in standing forests will not be enhanced. If the cap is replaced with a discount factor or a band (combined with a flexible reference level), uncertainty over the total credits or debits from forest management will increase. Though this uncertainty might enhance incentives to manage the forest to keep the net uptake above the reference level, the removal of all restrictions on accounting the carbon sequestered in standing forests would create potentially far more significant incentives. In this sense, developing alternatives such as force majeure for handling disturbances may be preferable to any of the other models currently under discussion. Though an alternative might be to remove areas with potentially large impacts from natural disturbances from accounting requirements, the incentive to manage natural disturbances would thereby decrease and incentives to promote increased forest growth diminished. Similar problems arise with discussions over whether FM should be voluntary or mandatory.

In order to use the world's forests more efficiently, accounting strategies must be found to (1) promote sequestration in standing forests and (2) encourage an efficient and balanced use of forest products (including both HWP and bioenergy). The original and artificial decision to separate

accounting into ARD (Art 3.3) and FM (Art 3.4) has, and will ultimately have, a negative impact on both strategic goals. The reasons for this are straightforward. Confining afforestation to ARD lands has the result of unnecessarily restricting incentives and efforts to promote standing forests, while the ability to voluntarily designate forest lands as ''managed forests'' subject to a ''cap'' discourages both their sustainable use and large scale investments to promote increased forest growth.

Though the technical challenges confronting both an adequate accounting of forest resources and the inclusion of currently omitted carbon pools are significant, the techniques used are constantly improving and today's monitoring systems are already far more advanced than those of only a decade ago. Moreover, incorporating and accounting for more carbon resources will only propel these developments forward. Thus, although technical challenges represent important obstacles that need to be taken into account, the advantages that can be achieved argue in favor of forward rather than backward motion.

Two principal arguments support movement in the direction of an all-inclusive national inventory model for LULUCF accounting that collapses the division between ARD and FM, includes additional activities and incorporates HWP accounting principles. The first is the incentive to promote standing forests. This incentive is important not only in order to encourage more countries in the developing world to become formal members of the KP strategy by allowing them to sell carbon credits from forestry in return for formal emission commitments, sustainable forest management (SFM) principles as well as the development of verifiable national forest inventories, but also in order to slow and eventually put a stop to deforestation and declining forest cover both in the developed and developing world. In particular for the more forested countries, the ability to sell carbon credits from standing forests in the Kyoto framework should provide powerful incentives for more countries to become formal, contributing members and should add significantly re-invigorated incentives to current REDD+ and forest-related CDM efforts.

The second is the incentive to use HWP and continue increasing the size of the HWP carbon pool. The alternative to promoting the increasing use of HWP and a cumulatively increasing HWP carbon pool is the further promotion of bioenergy use—in particular at the expense of HWP. The consequence of failing to provide competing incentives in the Kyoto accounting framework either for standing forests or HWP—in particular under the current regimen where managed forests are only voluntarily accounted for (i.e. not at all in many cases)—is the potential devastation of many of the earth's remaining forests and a shift from extensive use of harvested wood products (HWP) to extensive bioenergy use.

As illustrated in Fig. 3 above, the likely consequence of failing to include HWP accounting mechanisms in the Kyoto framework is the gradual elimination of traditional forest-based industries in favor of bioenergy. Moreover, in the EU context, under the current EU Emission Trading Scheme and the newly revised Renewables Directive (2009/28/EC), biomass-based heat and power production is strongly favored over wood-based end products. The European Commission's Renewable Energy Roadmap, for example, envisions a large and significant role for biomass material in heating and power production (European Commission, 2005, 2007). And bioenergy use has roared ahead at an impressive pace, having grown by as much as 174% in the New Member states, 68% across the EU15 and 88% across the EU as whole between 1990 and 2009.[15]

Depletion of the world's forests and the decline of forest-based industries is surely not the desired goal of the Kyoto framework. Yet the potential (if unintended) consequence of failure to resolve these inadequacies is likely to have far-reaching impacts on the global use of forest-based resources. These points ultimately require KP contracting Parties to find a way to both incorporate HWP accounting into the formal accounting mechanism and to approve a strategy for collapsing ARD and FM (as well as the remaining categories) into one national LULUCF inventory model.

The division between ARD and FM ultimately neglects the greatest human-induced impact on forest cover: the role and importance of forestry and forest-based industries. In order to correct this error, these activities should be re-united under a single mantle and sustainable forest management (SFM) principles as well as the development of verifiable national forest inventories pursued instead. Though this might seem an impossible task, the principles of SFM are ultimately reinforced through an emphasis on accounting procedures and the requirement of verifiable national forest inventories. Since any deforestation is counted as an ''emission'', countries (and governments) hoping to benefit from LULUCF under the Kyoto system are ultimately encouraged to promote and enforce SFM. Further, involving governments in the Kyoto mechanism by allowing them the right to buy and sell forest-based carbon credits ultimately places governments on the side of protecting forests and against illegal logging. Failing this, any within country ''leakage''—for example between afforestation and forestry—automatically cancels out potential benefits arising from the right to sell carbon credits in the international accounting framework.

Many NGO's and even some developing countries have objected to the inclusion of forests and forestry in national accounting procedures. Though there are many reasons for these objections—fears of a collapse in carbon prices, fears that industry and the power sector would experience reduced pressures to reduce emissions and/or fears that timber-rich countries might leverage advantages in forest cover and growth potential against their emission reduction commitments—these fears are not well founded. If we agree that the principal goal of Kyoto or its replacement is emission reductions, then we should immediately agree that slowing deforestation represents one of the greatest potentials of a successor to the Kyoto framework. Achieving this goal alone could significantly help reduce emissions. Reversing deforestation would surpass this goal.

NGO and developing world fears are unfounded for the following reasons. First, a collapse in carbon prices ultimately means cheaper alternatives for reducing emissions have become available. Whether caused by the potential to account for emissions/removals from forestry or some other factor, cheaper alternatives mean emission reductions will occur

[15] Based on online Eurostat data for ''wood and wood waste'' use in gross inland consumption.

more cost-efficiently and rapidly. In this sense, if carbon prices fall, this represents a positive (not a negative) development and should be encouraged (by whatever means—except of course by ''grandfathering'' or giving away carbon credits). Second, the ultimate goal of any carbon accounting framework should be to reduce emissions where this can be done most cost-efficiently. Forcing industry to reduce emissions when other more cost-efficient strategies are available—such as by reducing building-related energy use or raising the carbon sequestration/fossil fuel substitution potential of forests and forestry—ultimately reduces the overall effectiveness of emission-reducing strategies.

The last major objection—that countries could leverage forest growth potential against their Kyoto commitments—deserves more discussion. Many countries (both developed and developing) may well under-estimate their potential for utilizing the Kyoto framework (assuming the inclusion of LULUCF and HWP) to promote domestic forest growth. At least one measure of the potential for promoting domestic forest growth is provided by EU member states that have taken advantage of incentives in the EU's Common Agricultural Policy for promoting re-af-forestation. Several have both significantly increased their share of land devoted to forests as well as total annual growth, in particular Spain, Ireland, Italy and Greece (Fig. 9, panel a). While Hungary also significantly increased forest cover and annual growth, it became an EU member only in 2004. A number of other EU member states have increased total annual forest growth without increasing the share of land devoted to forests (Fig. 9, panel b). Thus, even countries without significant land use conversion potential may be able to take advantage of unexplored LULUCF potential.

Such barriers need not stifle progress toward the goal of stabilizing and reducing global emissions, nor should they stand in the way of arresting deforestation. Though potential carbon sequestration amounts may seem like a lot in some countries, a few important points should not be forgotten. For one, we should expect countries like Sweden, Finland and others to continue using a significantly large share of their forest-based resources for other uses (such as HWP, bioenergy and other forestry-based value chains). For another, one way of skirting this dilemma is to set the rules of the game (how and what is accounted for) before setting commitments (''rules before commitments''). Though this is no longer possible, whether it matters in the longer term is questionable. If the rules are in place when states re-set commitments at the following round, this makes it possible to set commitments after setting rules. Any advantages states may obtain from setting rules after commitments cannot easily be repeated at the following round. For another, caps or bands do not have to be continued. If set for one round (to diminish attempts to exploit domestic advantages), they can be removed for later rounds.

The greatest benefits from the sequestration potential of forests and HWP, however, can ultimately only be attained if the rules are set (during current negotiations over Kyoto-II) to allow for maximum potential emission reductions and removals in the shortest timeframe possible. The inclusion of forest-based and HWP carbon removals in Kyoto accounting procedures is the best and quickest way to achieve this goal. Moreover, given deforestation pressures, significant benefits can be obtained by a strategy requiring participant countries to become formal members (with commitments) in the Kyoto process and requiring the development and elaboration of SFM and national inventory procedures, in order to be able to take advantage of the right to sell carbon credits resulting from forest-based carbon offsets and/or additional forest-based carbon sequestration.

The introduction of a ''conditionality principle'' is ultimately in the interest of all Parties. Such a principle, along with the requirement of formal Kyoto commitments, could be used to encourage more developing countries with significant forest resources to become a part of the Kyoto process in order to take advantage of selling carbon credits—a significant incentive in countries frequently strapped for financial resources. Moreover, since developing countries generally do not face the requirement of setting emission reduction commitments, being able to benefit financially from Kyoto inclusion represents a win–win strategy. While such a strategy places significant pressure on developing world governments

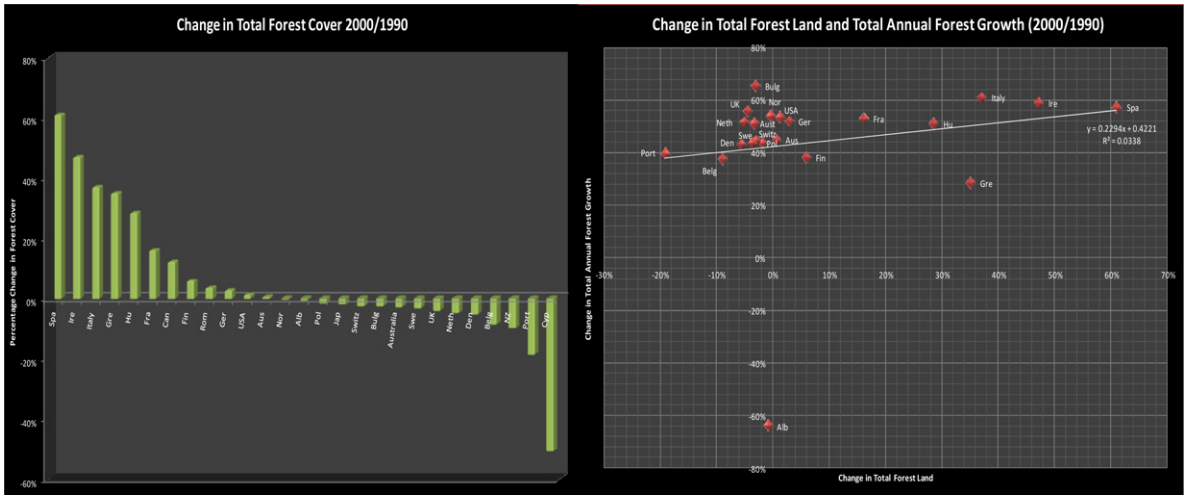

Fig. 9 – Change in total forest cover and land conversions.
***Source*: based on data published in UN (2000).**

to police (adequately monitor) domestic forest resources, the potential financial gains represent a significant incentive. For the developed world, the involvement of developing timber-rich countries also represents a potential advantage by making cheaper carbon credits readily available.

Though we essentially assume throughout, for the sake of simplicity, that afforestation is equivalent to biodiversity protection and promotion, this may not always be true. Where the model proposed herein succeeds in promoting standing forests, in particular over other forest resource uses, the interests of biodiversity may be adequately protected. However, where forestry itself is accelerated at the expense of biodiversity, this could be counter to the goals of promoting future forest resilience and ecosystem preservation and promotion. In this regard, it may be necessary to tweak the model in order to provide a context for favoring biodiversity protection over other forest resource uses. One possibility, for example, might be to value and thus count the carbon sequestration value of natural, untouched forests at a moderately higher level than that of managed forests. However, by granting more weight to standing forests and diminishing the emphasis on bioenergy, the above model already represents a significant improvement with respect to biodiversity promotion.

Finally, this last point suggests it is incumbent upon international and national decision-making bodies to create and maintain frameworks for the constant monitoring of agreements such as the Kyoto Protocol and its eventual successors in order to ensure that the outcomes match the intended goals.

8. Conclusions

Current carbon accounting frameworks do not adequately reward or even recognize the climate change mitigation and adaptation potential of forests and forest-related industries. In order to successfully balance competing interests, to enhance the efficiency and effectiveness of the climate change mitigation framework and to promote the balanced use of forest resources, an improved carbon accounting framework is necessary. While we recognize the political difficulties of improving international frameworks like the Kyoto Protocol, we think the advantages far outweigh potential costs.

Current international bargaining, however, focuses primarily on strategies designed to prevent rapid deforestation, in particular through REDD+ and avoided deforestation. We do not wish to diminish such efforts. Further, attempts to promote an all-encompassing, land-based, carbon-accounting framework utilizing national LULUCF inventories and to expand accounting practices to include all major carbon pools point in the right direction (Cowie et al., 2007; Plantinga and Richards, 2008; Andersson et al., 2009). However, further incentivizing forests and forest-based resources in fully accounting for all LULUCF activities could significantly contribute to a framework that either lacks adequate resources (REDD+) or is under-utilized by international investors (the forest component of the clean development mechanism or CDM).

The inclusion of HWP in carbon-accounting, however, represents the other foot in the grand scheme of LULUCF accounting practices. Without this second important piece in the bargaining framework, resistance to LULUCF inclusion from some quarters is likely to continue. Together, and along with the current advantage enjoyed by bioenergy, these two additional options should help to achieve a more balanced use of forest resources and to achieve broader support at the bargaining table. Without the inclusion of HWP accounting, other uses of forest-based resources (in particular bioenergy) will be favored.

The two greatest obstacles to an improved Kyoto-style agreement including both LULUCF and HWP accounting are: (1) fears that some of the developed countries will take advantage of extensive forest resources in order to diminish emission reduction efforts and (2) the interests of the timber-rich countries with extensive forest-based industries which presumably fear excessive competition over forest-based resources and the potential decline of forest-based industries. The timber-rich countries in the developed world in particular are likely to resist attempts to include LULUCF in Kyoto accounting mechanisms without parallel concessions on the inclusion of HWP accounting procedures. Without this, the potentially negative impact on local forest-based industries is likely to be substantial and potentially prohibitive. On the other hand, including HWP is likely to encourage far more widespread support for LULUCF inclusion in the Kyoto accounting process. Further, fears that developed countries could take advantage of their forest resources to diminish emission reduction efforts are not supported by the evidence.

Current discussions of the revised and updated Kyoto framework do not include all of the options discussed above. In particular there is currently no real discussion—at least at the negotiating table—about the possibility of collapsing Art's 3.3 and 3.4 into a single category or of merging all fluxes into one larger, all-encompassing model. On the other hand, there is currently discussion about the possibility of including HWP in the accounting framework and there has even been some discussion of shifting from voluntary to mandatory reporting under Art 3.4 (forest management).

Focusing on the bargaining framework, both LULUCF and HWP accounting are essential to ensuring a successful outcome. Developing countries are likely to support the inclusion of LULUCF accounting if their respective governments can attain the benefits of selling forestry-based carbon credits in the Kyoto framework. Moreover, such a strategy may help encourage governments to side with supporting standing forests over the illegal timber trade, since any within-country leakage would effectively become an economic cost. This ''carrot'' can ultimately be used as a strategy to encourage developing countries to join the Kyoto framework by implementing a conditionality principle: countries should only be permitted to buy and sell carbon credits (including forest-based carbon offset credits) in the UNFCCC and Kyoto frameworks if they are formal members of the agreement and submit annual national inventory reports. Timber-rich countries with important forest-based industries should favor the inclusion of HWP in the accounting framework since this would ultimately help protect the interests of forest-based industries and ensure bioenergy concerns do not completely disrupt more traditional forest-resource uses and value chains.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.envsci.2011.07.001.

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