Harvested Wood Products in the ETS
What would be the Impact?

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Abstract

The inclusion of Harvested Wood Products (HWP) in the ETS would provide a modest increase in the profitability of growing trees for carbon units as well as timber, particularly if HWP that are exported are included. The inclusion of HWP does not change optimum rotation lengths to any great extent. The greatest impact would be to reduce carbon price risk to the forest grower by (a) extending the period after harvesting over which units must be surrendered; and (b) reducing the number of units that must be surrendered, if harvesting is followed by replanting.

Inclusion of HWP in international rules would substantially reduce the carbon deficit faced by New Zealand after 2020 because of the narrow age-class structure of the Kyoto-eligible forest estate.

Introduction

The New Zealand Emissions Trading Scheme (ETS) incorporates the current Kyoto Protocol rule that harvested carbon (ie, logs extracted from the forest) is emitted at the time of harvest; in other words, the ETS excludes harvested wood products from consideration. Belton (2010) discusses some of the implications of this convention and states that "It is widely agreed that the 'instant oxidation' treatment of carbon at time of harvest under Kyoto Protocol rules is wrong and bears no relation to reality." The instant oxidation assumption is a modelling surrogate for the assumption that the global pool of HWP is currently neither increasing nor decreasing.

In the negotiations leading up to Copenhagen, New Zealand argued for harvested wood products to be included in conventions to be adopted for post-2012 international commitments. This reflects the view[1] that "Maintaining the current 'instant oxidation' approach for post-2012 would be a poor outcome in terms of encouraging longer life wood products, investment in forests and, especially, allowing sustainable timber production."

In the event, the Copenhagen Conference did not culminate in a decisive or legally binding agreement for greenhouse gas emission reductions in general, let alone for the subset of agreements relating to LULUCF (land use, land-use change and forestry). Negotiations continue, but in the meantime it would be useful to quantify the potential effect of the inclusion of carbon accounting for harvested wood products on forest profitability and risk as well as on New Zealand's longer term carbon budget.

The HWP option[2] considered at Copenhagen is summarised in Fig. 1. For HWP from those forests where emissions or sequestration have been used in accounting, a country, under the proposal, can choose whether to continue with the present default assumption (instant oxidation) or to account for emissions when they occur - provided they can provide verifiable and transparent data in support. The data will need to be verified later by the UN before accounting for HWP can be done as part of New Zealand's international obligations.

If a country chooses to account for HWP, they can do so only for domestic consumption of wood or only for exported wood or for both domestic consumption and exported wood. If for exported wood, assumptions based on the decay profile in the importing country must be used with these assumptions supported by research data.

In any case, the country must divide the wood into categories of products and provide the assumptions and evidence for each. Once wood reaches a solid waste disposal site, however, the assumption is that it instantly oxidises. Instant oxidation of waste is obviously an oversimplification, similar to instant oxidation of harvested wood, but may be somewhat more scientifically defensible. Waste is expensive and problematic to measure with precision, and waste disposal is a fast-developing technology; the long-term benefits of carbon storage in landfills must be offset against methane emissions from anaerobic decomposition, minus those emissions captured for useful (and "fossil-free") energy production.

The guideline rules apply to all wood harvested - even from harvests that occurred prior to 2008. (NZ opposes this inclusion of the existing HWP pool[3]). In the first commitment period, of course, there is the assumption of instant oxidation.

(See Figure 1 on the next page.)

[1] *http://www.maf.govt.nz/climatechange/international/nz-lulucf-submission-to-unfccc.pdf*

[2] *UNFCCC Ad hoc Working Group on further commitments for Annex I parties under the Kyoto Protocol. Tenth session, Copenhagen, 7-15 December 2009. http://unfccc.int/resource/docs/2009/awg10/eng/l15.pdf*

[3] *New Zealand Submission to the Ad-Hoc Working Group on Further Commitments for Annex 1 Parties under the Kyoto protocol. 15 February 2009. http://www.maf.govt.nz/climatechange/international/nz-lulucf-submission-to-unfccc.pdf*

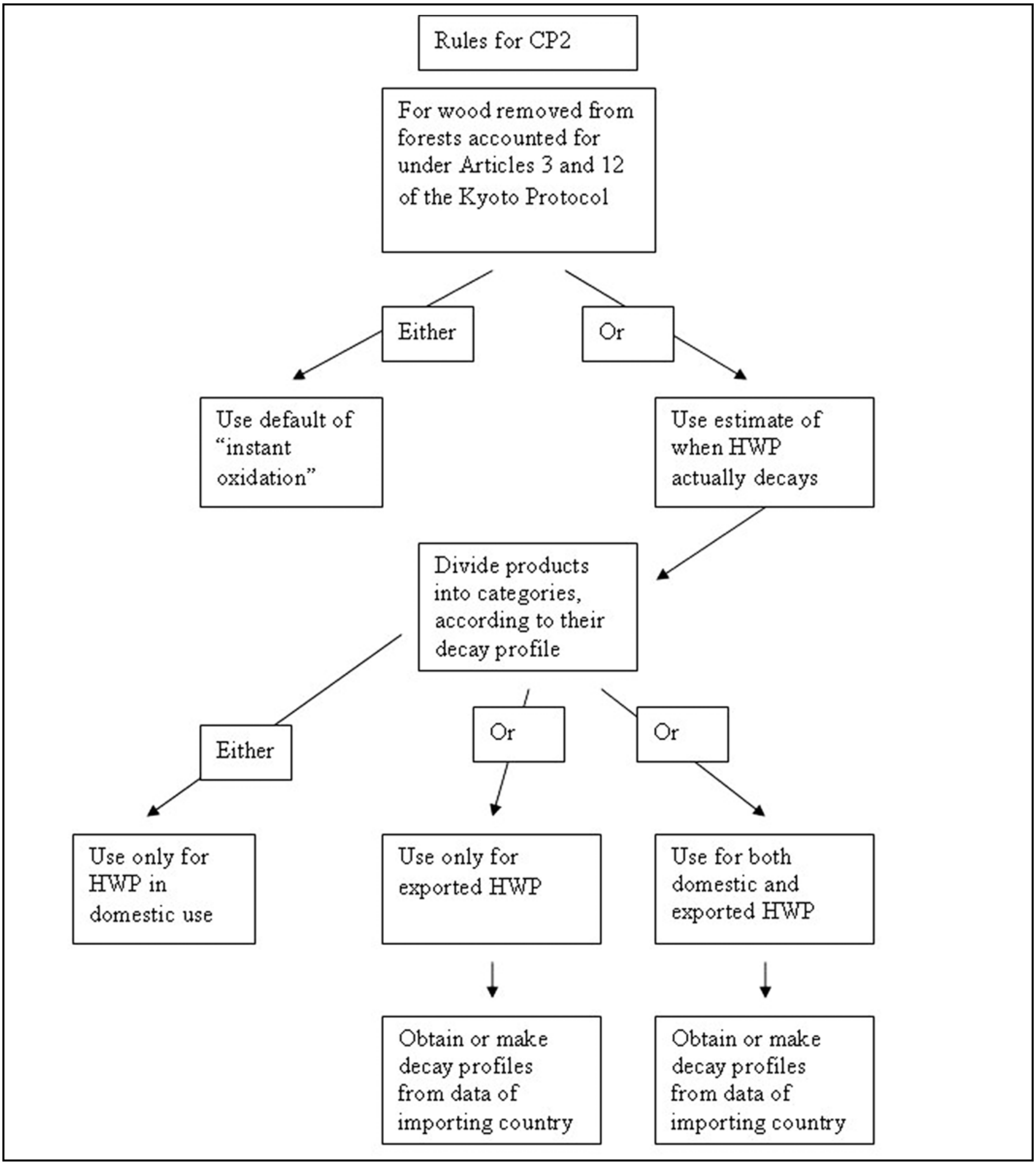


Fig. 1: Summary of proposed option for the inclusion of harvested wood products into carbon accounting for Commitment Period 2.

If harvested wood products are included in international carbon accounting conventions it would be logical for them to be included within the New Zealand ETS. In this paper we evaluate the impact of including harvested wood products in the New Zealand ETS. We consider two variations:

- HWP in domestic use only.
- HWP in domestic use and exported.

For the latter, we assume that the importing countries use their products in the same proportions, and with the same decay profiles, as occurs in New Zealand.

For each variation we compare the return and risk with those for the current default assumption of instant oxidation. The analysis is done for the clearwood regime used in the analysis of Maclaren et al. (2008).

Table 1: Default values for different HWP categories. From Table3a1.3 of IPCC (2003).

HWP Category	MAF Forestry products included	Half life in use (years)	Fraction loss each year (f_{Dj}) (ln(2)/Half life in years)
Saw wood	Sawn timber, Poles	35	0.0198
Veneer, plywood and structural panels	Plywood, particleboard	30	0.0231
Non structural panels	Fibreboard	20	0.0347
Paper	Pulp	2	0.3466

We also consider the potential impact that each variation has on carbon stocks forecast for the national Kyoto estate by extending the analysis of Manley & Maclaren (2009).

Method

The same general approach is followed as Maclaren et al. (2008). For radiata pine, an average New Zealand ex-farm site of site index[4] 30.2m and 300 Index[5] of 29 m^3/ha/year is assumed. The radiata pine clearwood regime involves planting 800 stems/ha, pruning to 5.5 m in two lifts, thinning at age 8 to 250 stems/ha.

Log and carbon yields are estimated using the Radiata Pine Calculator (NZTG 2003). This calculates carbon yields based on the C_Change model (Beets et al. 1999).

The financial criterion used is Land Expectation Value (LEV) at an 8% real discount rate. Published MAF[6] 12-quarter average prices (as at January 2008) are used. Industry average costs are used. A carbon price of \$20/t CO_2 is used and a fixed cost (\$60/ha/year) is assumed for the costs of measurement, auditing, registration associated with carbon trading.

HWP

Default HWP categories and half life values from IPCC (2003) are used (Table 1). The general function used for the release of carbon from a HWP is:

$$C_t = C_0 \star \exp(-(\ln(2)/H)\star t)$$

where

C_0 is the initial carbon stored
C_t is the carbon stored after t years
H is the half life

[4] *Mean top height of 100 largest stems/ha at age 20 years.*
[5] *300 Index is an index of volume productivity. It is the stem volume mean annual increment at age 30 years for a defined silvicultural regime of 300 stems/ha (Kimberley et al. 2005).*
[6] *http://www.maf.govt.nz/forestry/statistics/logprices/*

Table 2: Products produced from New Zealand harvest volume in year to 31 March 2009 and percentage exported. (Source MAF)

Product	Production (million m^3)	% exported
Sawn timber	3.6	48
Poles	0.4	0
Plywood	0.4	23
Particleboard	0.2	58
Fibreboard	0.6	78
Pulp (log input equivalent)	4.8	75
Residues (energy or waste)	2.0	0
Export logs	6.6	100
Export chips	0.3	100
Total	18.9	

MAF statistics[7] for the year ended 31 March 2009 were used to estimate the proportion of the New Zealand plantation harvest in each HWP category. Table 2 shows the estimated breakdown of the total harvest volume of 18.9 million m^3 by product and the percentage of each product exported. Overall, some 69% of the harvest is exported as logs, chips or products.

Notes

- *Total wood use to produce pulp is estimated (using MAF production statistics and industry conversion factors) to be 4.8 million m^3 of which 3.3 million m^3 is log input. The other 1.5 million m^3 input is residue from solidwood processing.*
- *MAF estimates the total residues from solidwood processing to be 3.5 million m^3. The balance (after allocation to pulp production) of residues (2.0 million m^3) is assumed to be either waste or used as fuel (eg, cogeneration plants).*
- *The export percentage for pulp includes pulp exported in the form of pulp or paper.*

[7] *As prepared for New Zealand Forest Industry Facts & Figures 2009/2010.*

Table 3 provides the breakdown of the national harvest volume by each of the five HWP categories. The "domestic use only" values are the proportion of the national harvest volume that is processed into a HWP and consumed in New Zealand. For example, for the saw wood HWP category the total domestic use is 2.3 million m^3; ie, 0.4 million m^3 of poles and 1.9 million m^3 of sawn timber (The latter is the 52% of the 3.6 million m^3 of sawn timber produced that is consumed domestically). The 2.3 million m^3 is 11.9% of the total harvest volume of 18.9 million m^3.

Table 3: Proportion of New Zealand plantation harvest that is processed into each HWP category for variations of (i) HWP in domestic use only and (ii) HWP in domestic use and exports.

HWP Category	Domestic use only	Domestic use and exports
Saw wood	0.119	0.346
Veneer, plywood and structural panels	0.022	0.059
Non structural panels	0.007	0.038
Paper	0.063	0.342
Instant oxidation	0.789	0.216

For the "domestic use only" values, instant oxidation is assumed for all wood that is exported either in log, chip or product form as well as residues used in New Zealand for energy generation. The percentage of 78.9% is calculated by summing the harvest volume ultimately exported (13.0 million m^3) and the residue volume (2.0 million m^3) and then dividing by the total harvest volume (18.9 million m^3).

For the "domestic use and exports" variation it is assumed that log exports are processed into HWP in the same proportions that apply domestically and that log chips are processed into paper.

We apply the proportions in Table 3 to the total log production at all rotation ages of the example clearwood regime.

Results

Effect on carbon stock profile

The effect on carbon stocks of including HWP (Fig. 2) is to:

- Lessen the reduction immediately after harvesting.
- Extend the duration of carbon stocks. Under the "domestic use and exports" policy, carbon stocks of 65 t CO2 /ha still exist some 70 years after harvest because an exponential decay rate is assumed.

Carbon stocks under the "domestic use only" policy are closer those of the "no HWP" policy than those of the "domestic use and exports". This reflects the high percentage of the New Zealand plantation harvest that is exported either in log or processed form.

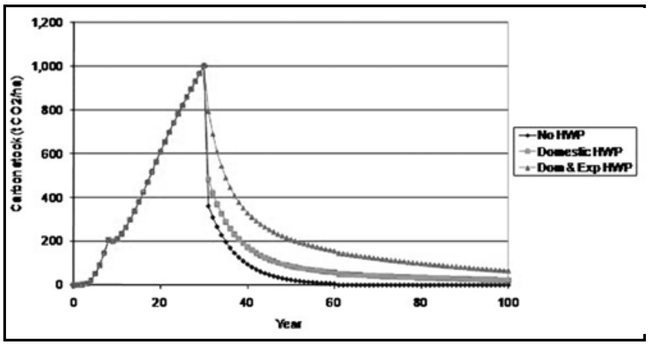


Fig. 2: Carbon stock at different ages under different HWP policies for a single rotation of the clearwood regime grown on a 30 year rotation.

Effect on forest profitability

Including HWP in the ETS would improve the profitability of afforestation (Fig. 3). The impact of including HWP is much less than the impact of including carbon trading under the ETS (ie, the LEV of forestry only compared to the LEV of forestry and carbon under the No HWP policy). Nevertheless the LEV at age 30 under the "domestic use and exports" policy is $464/ha higher than with no HWP (Table 4).

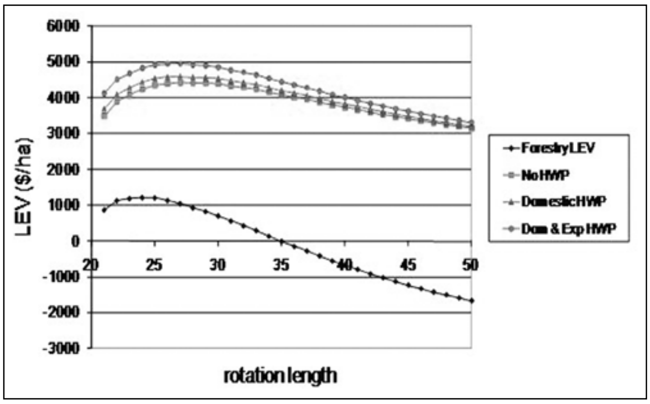


Fig. 3: LEV ($/ha) at different rotation ages under different HWP policies for the clearwood regime. The forestry LEV includes revenues only from logs while the other three curves also include revenues from carbon.

Table 4: LEV (forestry and carbon combined) under different HWP policies for the clearwood regime on a 30 year rotation.

Policy	LEV ($/ha)
No HWP	4391
Domestic use only HWP	4538
Domestic use and exports HWP	4855

The optimum rotation age under the three scenarios that include carbon is 27 years but LEV is very flat around this age (Fig. 3). Further stand-level analysis assumes a 30 year rotation under all policies.[8]

Effect on risk

The cashflow risk associated with the need to purchase carbon units for surrender when carbon stocks decrease has been identified as a deterrent for afforestation. As a measure of risk we consider the number and percentage of carbon units that need to be surrendered after harvest of a stand, assuming that replanting occurs.

Fig. 4 shows the carbon stock profile over time under different HWP policies for multiple 30 year rotations. Key points are:

- HWP policy affects the minimum carbon stock after harvest (See Table 5).
- Carbon stocks increase from one rotation to the next under the policies that include HWP. In other words, "carbon in wood products" is a continuously expanding carbon pool because of the assumption of an exponential decay curve with a long half-life for some products. For example, consider the pattern for the "domestic use and exports" policy. At year 80 (3rd rotation stand is age 20) the carbon stock is 917 t CO_2 /ha compared to 818 t CO_2 /ha at year 50 (2nd rotation stand is age 20) and 610 t CO_2 /ha at year 20 (1st rotation stand is age 20). This 917 t CO_2 /ha consists of 610 t CO_2 /ha standing in the 3rd rotation crop plus 209 t CO_2 /ha from the 2nd crop (24 t CO_2 /ha of on-site residues and 185 t CO_2 /ha of HWP) plus 98 t CO_2 /ha of HWP from the 1st rotation crop.

Including HWP within the ETS would have a major impact on the carbon units that would need to be surrendered after harvest. Total carbon stock is 1002 t CO_2 /ha at age 30. Whereas 752 t CO_2 /ha would need to be surrendered under the No HWP policy, only 465 t CO2 /ha would need to be surrendered under the "domestic use and exports" policy. Table 5 shows that the percentage of carbon units received that need to be surrendered on harvest drops from 75% (No HWP) to 66% (Domestic use only) and 46% (Domestic use and exports).

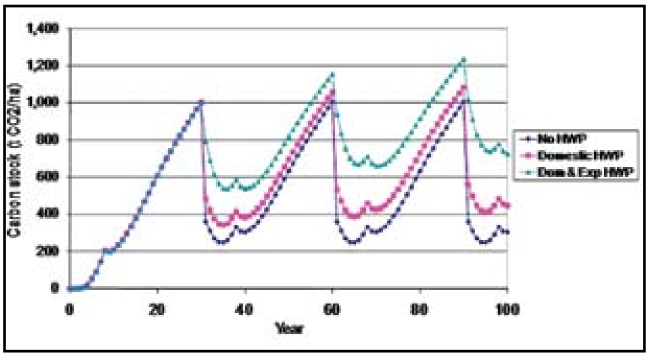


Fig. 4: Carbon stock profile over time under different HWP policies for multiple rotations of the clearwood regime grown on a 30 year rotation.

Table 5: Minimum carbon stock and the percentage of carbon units received that need to be surrendered after harvest under different HWP policies for the clearwood regime on a 30 year rotation.

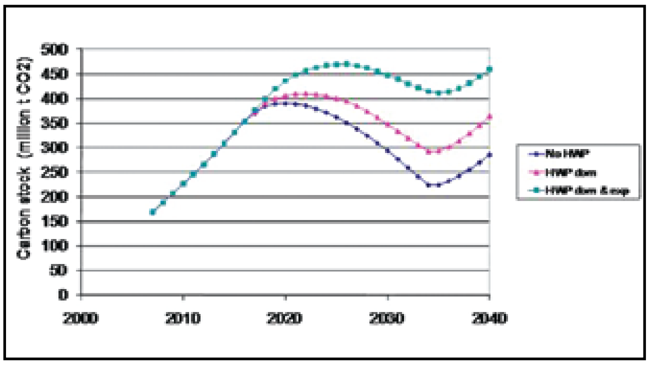
Policy	Minimum carbon stock (t CO2 /ha)	% Units surrendered
No HWP	250	75
Domestic use only HWP	342	66
Domestic use and exports HWP	537	46

National implications

Based on same assumptions used in Manley and Maclaren (2009), we constructed a carbon profile for the national Kyoto plantation estate until 2040. The current situation is problematic: the benefits of carbon sequestration are the result of a major planting boom in the 1990s, but the rate of new-land planting has not been maintained in recent years. The large age-cohort of plantings from the 1990s is due for harvest commencing about 2020, resulting in a marked decline in carbon stocks for several decades.

The effect of inclusion of HWP in the ETS would be to substantially ameliorate the anticipated decline, in other words to partially fill in the expected trough (Fig. 5)

Fig. 5. The effect of inclusion of HWP in the ETS on the forestry carbon budget of New Zealand's Kyoto plantations.

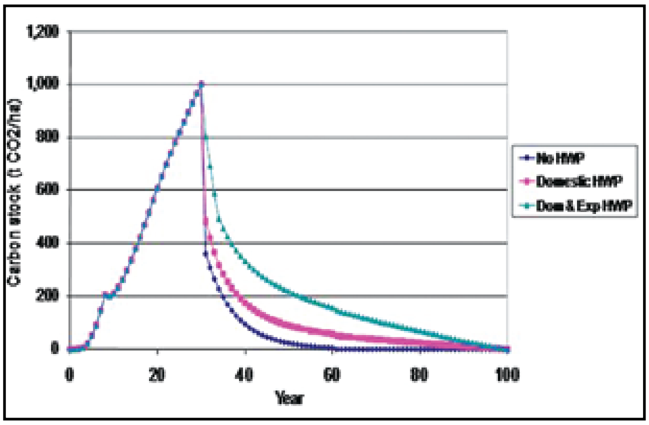


[8] *To explore the impact of HWP policy on rotation age further we evaluated an extreme (and impossible) variation of the domestic use and exports policy in which 100% of HWP are in the saw wood category. Optimum rotation age decreased to 26 years.*

Use of a linear decay function

New Zealand has proposed that a linear decay function should be used for HWP rather than the exponential decay function specified by IPCC (2003) as defaults. We evaluated this alternative approach. Decay was calculated as a constant percentage of the initial value by dividing 100 by twice the wood product half life. The carbon stock profile (Fig. 6) is initially similar to that for exponential decay (Fig. 2) but terminates after 70 years. The linear decay function results in the same LEV as using an exponential decay curve.

Fig. 6: Carbon stock at different ages under different HWP policies for a single rotation of the clearwood regime grown on a 30 year rotation. Decay is calculated using a linear function.



Discussion

The IPCC Good Practice Guidance 2003 provided the default half-lives used in Table 1 but until the international process is finalised, the IPCC numbers remain indicative only. There is variation in the half life of HWP calculated from different studies reported by IPCC (2003). For example the half life for saw wood varies between 18 and 50 years - the IPCC default is 35 years. It may transpire, for example, that countries that adopt the inclusion of HWP may be forced to develop their own half lives for the various timber products rather than relying on international defaults. The research and tracking of timber could be very expensive, and might take the gloss off the advantages of HWP.

The division into the various IPCC categories of products is somewhat arbitrary. "Saw wood" is obvious, but what proportion of this finds its way into, for example, a building where it may typically last 35 years? A substantial proportion must end up as offcuts, or be used for ephemeral purposes such as boxing for concrete. Plywood may endure as long as the framing of a house to which it is attached, or again it may just be used for boxing. Particleboard - less offcuts - is generally used for flooring and may endure as long as structural timber, but fibreboard is considered "non-structural" and assumed to have a shorter lifetime, despite the fact than many floors are now made of MDF. Paper may be used for throw-away junk mail or it could be an essential liner to a house internally clad in gib-board.

The use of assumptions and anecdotal information in determining the half lives of different products may be very misleading - there is no substitute for hard data, which is currently unavailable in the New Zealand context. We should not assume that New Zealand houses have an identical construction to timber houses elsewhere.

Inclusion of only domestic HWP has a limited impact. This is not surprising given that only 31% of total wood production is consumed within New Zealand - we are in the situation of exporting far more of our plantation-grown wood than we use ourselves. The potential impacts of the inclusion of exported HWPs must be tempered because it has been assumed that log exports are processed into HWP in the same proportions that apply domestically.

The challenges increase if exported wood products are to be included because of the intention that "estimates shall be reported separately for each country for which the harvested wood products are exported, using nationally specific data on the fate of the wood in the importing country". The requirement to provide verifiable and transparent data in support of decay profiles for New Zealand wood products consumed offshore will pose difficulties. However a positive by-product would be a better understanding of the end-use of logs exports and other wood products.

Our analysis has applied a constant national level HWP mix to all rotation ages. In practice, the HWP mix should vary with the log grade mix produced and hence vary with rotation age. Older rotation ages would be expected to produce a greater proportion of longer lived products. Similarly the silvicultural regime implemented would affect the HWP mix. HWP accounting could provide an incentive to produce log product mixes that generated longer lived wood products. However the impacts of this may be limited. For example, increasing the saw wood proportion by 0.2 and reducing the paper and instant oxidation proportions by 0.1 (under the "domestic use and exports" HWP policy) would only increase LEV at age 30 by $81/ha.

This paper does not provide the definitive answer on the benefits of inclusion of HWP in the ETS. It merely indicates the order of magnitude of the changes that might occur:

- forest growing increases in profitability, but not by a large amount compared with the profitability under the current ETS rules;
- optimum rotation age remains the same. The patterns of the LEV curves (Fig. 3) indicate a slight trend for rotation age to reduce with HWP included. Although

[9] *New Zealand input to the AWG-KP Session 6 (Ghana, August 2008) on Land Use Change and Forestry Rules for Post-2012. http://www.maf.govt.nz/climatechange/international/Accra-LULUCF-submission.pdf*

this trend may appear counter-intuitive, inclusion of HWP means that recognised carbon storage extends well beyond harvesting. The economic incentive to extend the rotation to increase carbon stocks is reduced.

- risk associated with surrender of units at harvest is reduced both by (a) extending the period after harvesting over which units have to be surrendered; and (b) if replanting occurs, reducing the number of units that have to be surrendered.

If the proposal to include HWP in international protocols is adopted, New Zealand carbon liabilities after 2020 are dramatically reduced.

Acknowledgement

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