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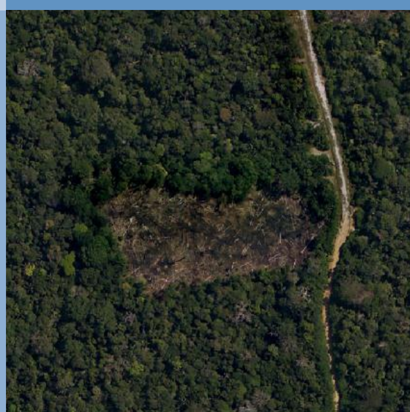

Wood product accounting and climate change mitigation projects involving tropical timber

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1 INTRODUCTION AND BACKGROUND

1.1 Scope of Review

This review and analysis plan is focused only on the accounting of harvested wood products (HWP) in forest-based climate change mitigation projects. Harvested wood product accounting is relevant to national accounting and to future REDD+ (reducing emissions from deforestation and degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries) greenhouse gas accounting schemes, however, such applications are not within the scope of this review.

The review is focused on existing methods for accounting for HWP at the project scale and possible new analyses that could be conducted to improve methods and allow equitable yet accurate accounting for forestry project and in particular forestry projects in tropical countries.

1.2 Introduction

Harvesting timber directly contributes to greenhouse gas (GHG) concentrations in the atmosphere by reducing storage of forest carbon stocks and increasing storage in wood product stocks.

The global interest in reducing GHG emissions from tropical forests is focusing renewed attention on sustainable timber management of forests as potential climate change mitigation activities. Climate change mitigation projects involving changes in forest management practices are increasing throughout the world. Greenhouse gas emissions can be reduced through several pathways that directly impact the forest carbon stocks, such as improved planning of timber harvest (e.g. decreasing the incidental damage caused during tree felling, tree skidding and construction of roads and landing decks), reducing avoidable wood waste (e.g. tops of large trees that contain up to 50% or more of the tree carbon), converting low production forests to protected forest, and extending timber rotations.

Greenhouse gas emissions can also be reduced by changes in how the extracted timber is converted into wood products. The carbon in extracted timber that is transformed into harvested wood products is not immediately oxidized but rather it is turned in wood products. Harvested wood products are an important global carbon sink that is growing. In all climate change mitigation projects in the timber harvest sector, wood products must be accounted for. For example, in the baseline case, inclusion of wood products prevents the assumption that all harvested biomass is an immediate emission whereas in the project case the inclusion of wood products increases the total amount of carbon stored and therefore increases the number of credits a project would be eligible to claim.

Because no regulatory market that involves forest-based projects exists, the methodologies for accounting for this pool have been developed for the voluntary market. Under the voluntary market one method for accounting for wood products has dominated. It can be found in six out of eight methodologies under the Verified Carbon Standard and two out of two methodologies under the American Carbon Registry. These methodologies cover improved forest management, afforestation and reforestation, and reduced emissions from deforestation and degradation.

The method used in the voluntary market methodologies is derived from the analyses of Winjum et al. (1998). In examination, the ITTO noticed high turnover or retirement rates[1] for wood products derived from projects in tropical countries. Here we examine the assumptions of Winjum et al. (1998), issues that arise from how Winjum et al. (1998) handle wood product accounting, and present alternate approaches to wood product accounting that exist in the literature.

1.3 Background

The rate at which carbon is emitted from harvested wood products is a function of the rate of retirement of products from end uses and the various processes used to dispose of products:

1. *Carbon is emitted directly to the atmosphere through the decomposition[2] of wood products;*
2. *Carbon may be emitted to the atmosphere through burning of wood products;*
3. *If wood products are burned for energy production, the carbon is emitted but the energy produced displaces fossil fuels that therefore remain in storage, resulting in emission reductions;*
4. *Retired wood products may also be recycled, extending the duration of carbon storage in end uses;*
5. *When retired products are landfilled, the rate of decomposition is extremely slow and a proportion of carbon in the product is considered to be stored indefinitely.*

[1] Wood products do not decay while in use as they are generally treated to prevent this process, instead they are retired or turned over and disposed of either by burning, recycled, or buried in landfills. The term “decay” is often mis-used instead of the term retirement. If one is referring to the biological breakdown of wood products then the correct term is decomposition, a complex process that includes microbial decay, fragmentation by invertebrates (e.g. termites), and weathering.

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Altering forest harvesting practices impacts wood product production that in turn impacts greenhouse emissions to the atmosphere. These impacts have the potential to be used for climate change mitigation and compensation for emission reductions through voluntary and compliance carbon markets.

Improving the accuracy of methods for accounting will reduce uncertainty in estimations of emission reductions, enhancing compensation for activities that reduce emissions from forest harvests and wood product use and promoting sustainable forest management and activities that increase storage in harvested wood products.

2 AVAILABLE PROJECT ACCOUNTING APPROACHES METHODS

2.1 Winjum et al (1998) – *the dominant approach in the voluntary market methodologies*

The goal of the Winjum et al. paper was to develop approaches for estimating the national greenhouse gas emissions and removals from forest harvesting and wood product use. As part of the paper they proposed methods for accounting for the use and disposition of the harvested wood products. The methods proposed in the paper have been the dominant accounting method in voluntary market . The literature on which the analysis is based essentially consists of six papers that inform both the proportion of products assumed to be emitted immediately (<5 years life) and the annual subsequent emitted proportion (through burning and decomposition).

Winjum et al. (1998) used data from the FAO (1995) global forest products database to estimate emissions from harvested wood product (HWP) use at the global scale, and reported by developing and developed countries and for selected developing and developed countries. Annual harvest volumes and wood commodities reported for each country in the FAO database were converted to equivalent carbon content to estimate emissions.

Emissions were estimated as the sum of emissions from:

- decomposition of harvest slash, decomposition and oxidation of short-term wood products (uses < 5 years);
- oxidation of waste produced in the conversion of industrial roundwood to commodities;
- retirement and oxidation of the long-term wood products pool (uses ≥ 5 years); and

- burning of fuelwood and charcoal[3].

Annual wood products production was represented by four commodity categories (from FAO):

1. sawnwood (dimension lumber, etc.);
2. woodbase panels (plywood, decorative panels, etc.);
3. other industrial roundwood (i.e., poles, pilings, fence posts, etc.); and
4. paper and paperboard.

The estimated proportion of wood products going into long-term uses in each commodity category was the same for developing and developed countries. The remainder in each commodity category was considered to go into short-term use and assumed to be oxidized in the base year. Emissions from wood waste generated during production of primary wood products was calculated for each country as the difference between industrial roundwood consumed and wood commodities produced. Emissions from long-term wood products were estimated assuming a constant annual retirement rate of wood in long-term use based on commodity groups and major latitudinal regions.

An implicit simplifying assumption in Winjum et al. (1998) is that the carbon in wood products in long-term uses is completely oxidized over time as products are retired at a constant rate, and there is no distinction between disposal methods.

As applied in the methodologies developed for the voluntary market, the volume extracted from the forest is multiplied by three separate factors.

The first factor is wood waste which gives the proportion emitted immediately due to mill inefficiency this is 0.19 in developed countries, 0.24 in developing countries.

The second is the short-lived fraction, this is the proportion of the produced product that has a life of less than 5 years this is given as 0.2 for sawnwood.

The final factor is the oxidation factor or the emissions occurring after the initial five years. The simplification taken in the Winjum et al. derived approach is to state that all oxidation emissions that will occur between years 5 and 100 are immediate and any products still sequestered at 100 years should be considered permanent. Oxidation fractions vary from 0.005/year for sawnwood in boreal zones to 0.10/year for paper and paperboard in tropical zones giving 99% oxidation for paper and paperboard in the tropics but only 36% for sawnwood in boreal zones. Sawnwood oxidation in temperate zones is 60% and 84% in tropical zones.

The VCS has changed its requirements recently (http://www.v-c-s.org/sites/v-c-s.org/files/VCS%20Program%20Update%20Catalogue%2C%201%20FEB%202012_3.pdf) so that

[3] Accounting assumed that a fraction of fuelwood or charcoal is obtained from postharvest slash in both developing and developed countries.

in the baseline it is no longer acceptable for wood product emissions occurring over the 100 year period to be considered to occur immediately. Instead they must be projected over at least a 20 year period. All methodologies will have to be updated to conform.

2.2 The IPCC Guidance for National Greenhouse Gas Inventories (2006)

The IPCC 2006 Guidance for National Greenhouse Gas Inventories (Volume 4 - Chapter 12) provides alternative methods of accounting for emissions from HWP. The guidance explains how key variables for tracking changes to carbon stock in HWP and solid wood disposal sites can be estimated from default data or more detailed data specific to a particular country to estimate emissions. The IPCC (2006) guidance assumes that the amount of wood product in use is reduced according to first-order decay, that is, the annual loss is a constant proportion of the amount of product in use. The technique used to estimate first-order decay is detailed in Pingoud and Wagner (2006). Default half-lives are provided for the two pools considered – solidwood products and paper products. Changes in HWP stocks in solid wood disposal sites are estimated using IPCC 2006 Waste Sector methods. The IPCC (2006) provides spreadsheet tools for default methods of estimating both changes in HWP stocks in use and HWP in solid wood disposal sites.

Default methods for estimating the outflow from HWP in use in the IPCC 2006 Guidelines is based on estimated half-life and assumption of first-order decay, though alternative decay profiles (Ford and Robertson 2003) are mentioned.

2.3 Smith et al. (2006) – US Forest Service

The United States Forest Service has developed methods and data for accounting for the portion of harvested carbon sequestered in long-lasting wood products in the United States (Smith et al. 2006). This method uses the system of Birdsey (1996) who created tables of forest carbon stocks and carbon in harvested wood for estimation of average carbon change as a result of forest harvest activities. The tables are commonly called “look-up tables” because users can select the appropriate table for their forest and look up the average regional carbon values for that type of forest, including disposition of carbon in HWP over time to estimate carbon stock changes. The approach to estimation of carbon in HWP focuses on carbon stored in two components: carbon in products in use and carbon in landfills. Carbon emitted to the atmosphere by products in use is classified according to whether or not it occurred by combustion for energy production.

Smith et al. (2006) propose three methods for calculating the disposition of carbon in harvested wood based on the type of data initially available: i) the volume of wood in a forest available for harvest and subsequent processing, ii) industrial roundwood harvest from a forest in the form of saw logs and pulpwood, and iii) primary wood products. The model used to estimate carbon storage over time in wood products following harvest and emissions to the atmosphere is the same for all three starting points. The model is based on carbon disposition in primary wood products. Fractions of wood product carbon in-use, landfilled, and emitted with or without energy production are based on allocation patterns in Row and Phelps (1996).

For the starting points for primary wood product, the total carbon emissions to the atmosphere from long-term wood products for a given year are the difference between the initial quantity of carbon in primary wood products and the sum of carbon in-use or in landfills. Recycling of paper products is an assumption included in the average estimates of carbon disposition in primary wood products and landfills over time.

For the starting points for industrial roundwood, average disposition of carbon is determined by regional patterns in conversion of industrial roundwood to primary wood products developed by Adams et al. (2006). Fractions of carbon in industrial roundwood in-use and disposal patterns are based on patterns in Row and Phelps (1996) as for primary wood products.

For the forest growing-stock starting point, the linkage between growing-stock and roundwood and thus disposition of carbon in primary wood products is based on compiled harvest statistics (Johnson 2001) and tree biomass (Jenkins et al. 2004). Factors for converting growing stock volume to carbon in industrial roundwood are found in the look-up tables.

The method has been applied in at least one VCS methodology (VM0003) with the assumption that the amount of carbon stored in wood products at year 100 after harvest (according to the look up tables) is permanent and all emissions occurring up to year 100 are immediate.

The method models product retirement, emissions, energy generation and landfill storage and is not significantly questioned scientifically. However, the resulting numbers are only for forests in the US and so cannot be applied elsewhere in the world without replication of the analyses which would be likely very difficult due to the differences in data availability in the US versus in many other countries.

3 THE SCIENCE OF WOOD PRODUCT ACCOUNTING

3.1 Wood product retirement

For any analysis of wood products, the input data – the volumes of wood harvested from the forest - typically will be good to fair depending on the scale (good at project scale but fair to poor at subnational to national scale). There can also be some degree of confidence about the range of products produced (both products directly produced and products such as fibreboard produced from industrial wood residues). However, the emissions in the production process, disposal rates, and retirement rates are not well known with uncertain theoretical oxidation factors that are not well tested (Pingoud et al 2001).

The approach in Winjum et al (1998) is to separate out products with a short lifespan (<5 years) and then apply a linear rate of retirement for the remaining proportion. There is no separation by landfill versus direct emission, no recycled proportion, and no energy generation proportion.

The scientific consensus is that wood product retirement occurs following a typical exponential decay-type curve that can be predicted from the estimated half-life (half-life is the time after which half the carbon in no longer in use) of a given product (e.g. Skog and Nicholson, 2000; IPCC, 2006). This will lead to a high level of retirement in early years followed by a long tail (cf Figure 1).

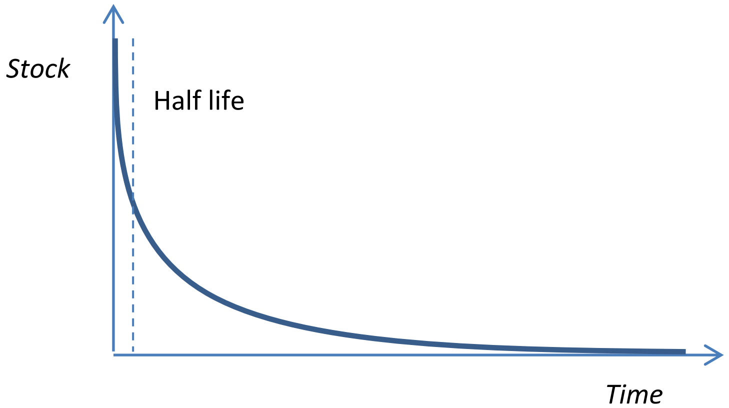

Figure 1 Example of exponential decay-type pattern of product retirement.

The equation describing this model is:

$$M_1/M_0 = e^{-kt} \quad \text{(Eq. 1)}$$

Where

M_1 = mass at time 1

M_0 = initial mass

K = decay coefficient, yr^{-1}

t = time, yr

The K coefficient can be calculated as:

$$K= -(0.69/t) \quad \text{(Eq. 2)}$$

Where 0.69 is the natural log of 0.5 (where $M_1/M_0 = 0.5$)

So for example, the K coefficient for railroad ties is -0.02/yr or 2% per year.

The literature contains estimates of product half-lives as given in the following table (from Skog and Nicholson, 2000):

PRODUCT	Half Life (years)
Single Family Homes	100
Multi Family Homes	70
Mobile Homes	20
Non Residential Construction	67
Pallets	6
Manufacturing	12
Furniture	30
Railroad Ties	30
Paper (free sheet – i.e. long lived publications)	6
Paper (all other)	1

The IPCC (2006) just gives two half-life values:

Solidwood products	30 years
Paper products	2 years

3.2 Landfill emissions

In developed countries (the destination for much exported tropical timber products), the retirement of wood products will generally lead to disposal in a landfill. Modern landfill practices involve rapid coverage with a soil layer and thus exclusion of oxygen (anaerobic conditions).

Anaerobic conditions exclude fungi and fungal decay (Blanchette et al 1990), in the anaerobic conditions of landfills decay therefore occurs through anaerobic bacteria (Blanchette et al 1990, Micales and Skog, 1997, Ximenes et al. 2008, Skog and Nicholson 2000).

Anaerobic bacteria cannot, however, break down lignin precluding products derived from wood from being fully broken down. For example, even newsprint has a lignin content of 20-27% making it very resistant to decay (Skog and Nicholson 2000) as can be witnessed from readable newspaper decades after initial landfill disposal. The anaerobic bacteria break down cellulose and hemicellulose releasing methane (CH_4) and carbon dioxide (CO_2). Where cellulose or hemicellulose is enclosed in lignin it is protected.

In general, much less than half of the carbon in products retired to landfills can ever be released (Micales and Skog 1997). However, the fact that methane has a global warming potential 25 times greater than carbon dioxide can have significant atmospheric consequences. Emissions are approximately 40% CO_2 and 60% CH_4 (Micales and Skog 1997), with 10% of CH_4 converted to CO_2 by microorganisms before reaching the atmosphere and in the US 15% of methane burned (with the expectation that this will rise to almost 60% by 2040)(Skog and Nicholson 2000).

Micales and Skog (1997) estimated that half of the CO_2 is emitted within 3 years and half of the CH_4 within 20 years. Skog and Nicholson (2000) give the following maximum conversion percentages for carbon in landfills:

Solid Wood	3%
Newsprint	16%
Coated Paper	18%
Box Board	32%
Office Paper	38%

4 KEY ISSUES WITH WINJUM-BASED PROJECT ACCOUNTING METHODS

4.1 Linear decay

For the proportion in long term (>5 year) storage, the assumption is made in the accounting methods that a constant rate of retirement occurs. Given patterns of use this is unlikely to be true. Instead there is common agreement that retirement will follow an exponential decay-function with different products having different half-lives (e.g. Skog and Nicholson, 2000; Pingoud et al., 2001; Pingoud and Wagner 2006; IPCC 2006). The implication of this is that more emissions will occur in earlier years and less in later years. This will have significant implications for projects with a reduction in harvesting relative to the baseline and particularly projects that go from logged to protected forest.

4.2 100-year permanence assumption

The voluntary market accounting methodology makes the assumption that any products that can be calculated as having a lifetime (either in use or in landfill storage) of >100 years are considered permanently stored, and all products with a lifetime of less than 100 years are considered immediately emitted. It is overly conservative on the project side to give credit only for products with a life of > 100 years – products are sequestered and not in the atmosphere for each of the years between harvest and 100 years. Equally, on the baseline side it inflates credits to claim all but the 100 year sequestration is immediately emitted – as a result a project could claim an emission reduction from an emission that will not actually occur for another 99 years. For this reason the VCS amended its standard in February 2012 and now requires emissions occurring between years 3 and 100 at a minimum to occur in a linear fashion over 20 years.

4.3 Landfill emissions

The Winjum et al. accounting approach recognized that a significant portion of HWP are retired and disposed of in landfills, but at the time of their study they did not make this distinction because no global data base was available with which to make this separation. Today more data are available and the proportion of the carbon stored effectively permanently in landfills (see above) can be accounted for in methodologies. However, it could be overly generous to claim no emissions from products stored in landfills because decay does occur and is accompanied by methane release.

4.4 Emissions from burning

The proportion of HWP disposed in a landfill versus added to debris piles or burned is not well known. However, these different modes of retirement have significant emission consequences. This is particularly true where burning is paired with energy production. Fires lead to the emission of non-CO_2 gases, which have higher global warming impacts than CO_2, while burning for energy production will offset emissions that might instead come from burning of fossil fuels. The Winjum et al. accounting approach recognized that HWP are burned, but at the time of their study they did not make this distinction because no global data base was available with which to make this separation.

4.5 Export of products

The high emission from tropically derived wood products in the Winjum et al. derived accounting approach is largely a result of the assumption that products are retired and disposed of in the country in which they are produced, a simplifying assumption when global data on the details on the import-export trade were unavailable. In reality a significant proportion of tropically derived wood is likely exported to temperate and boreal regions where rates of retirement and decay in landfills will occur at a significantly slower rate. This is likely both longer in-use half-lives in non-tropical regions and the introduction of landfill storage with accompanying permanent sequestration.

To demonstrate the impact of the export assumption we can apply the accounting method based on Winjum et al. In this case study we assume timber is extracted and processed as sawnwood in the tropics and then either remains in the tropics or is exported to a developed country. The HWP remaining stored after 100 years would be just 9.7% in the tropics but 24.3% where exported to a temperate country.

5 RECOMMENDATIONS FOR DEVELOPING AN ENHANCED WOOD PRODUCTS ACCOUNTING METHODOLOGY

5.1 Improvements in carbon accounting for wood products

5.1.1 Linear decay

We propose the half-life approach along with the exponential function be used to estimate emissions from HWP through time.

5.1.2 Wood product permanence

We propose two potential approaches to estimating the quantity of wood products that are effectively sequestered permanently.

Radiative forcing

The first approach lies in examination of an atmospheric or radiative forcing approach. The IPCC defines radiative forcing as:

> *Radiative forcing is a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system and is an index of the importance of the factor as a potential climate change mechanism.*
>
> *IPCC 4th Assessment Report*

The proposed approach would calculate the amount of stored carbon in HWP for each year of the product's life and therefore calculate the actual atmospheric impact of the specific units of carbon dioxide equivalent kept out of the atmosphere. This would be akin to the calculation of the global warming potential of the post-harvest emissions from timber.

To provide a hypothetical example: Subsequent to harvest, timber is extracted from the forest for processing to timber products. The following proportional emissions occur in the year of processing and in subsequent years:

Year 0	50%	Year 11	2%
Year 1	2%	Year 12	2%
Year 2	3%	Year 13	2%
Year 3	5%	Year 14	2%

Year 4	8%	Year 15	1%
Year 5	5%	Year 16	1%
Year 6	4%	Year 17	1%
Year 7	3%	Year 18	1%
Year 8	3%	Year 19	1%
Year 9	2%	Year 20	1%
Year 10	2%	Year 21	1%

In comparison to no wood product storage 2% of potential emissions are avoided for one year, 3% for two years, 5% for three years through to 1% for 22 years. The analysis asks what is the impact on the atmosphere over a 100-year time period in terms of radiative forcing (affecting the balance of incoming and outgoing energy) of these periods of storage relative to a full immediate emission in the year of harvest.

Without considering radiative forcing the calculations would represent just a delay in emissions but ultimately no long term impact on the atmosphere. The reality is different. An emission avoided today avoids an ongoing atmospheric impact and delaying by 5 or 20 or 40 years has a permanent effect that the radiative forcing calculations capture

Long term average

The second approach is a long term average based solution. This approach only works for projects that have a harvest cycle. The solution is derived from the VCS approach for the carbon pool in trees in afforestation and forest management projects. For these pools the available offsets cannot exceed the calculated long term average stock that is stored over the harvest cycle.

Presuming a system where harvest happens on a sustainable cycle with regrowth restoring harvested biomass then it would be possible to model out the retirement and emissions from wood products over many cycles ultimately calculating the stable resulting quantity that is effectively stored in the wood products pool.

5.1.3 Landfill emissions and emissions from burning

A key topic we will address is the identification of the practices used in tropical countries to dispose of wood products—burning, landfills, debris piles, and the like. For the US, Smith et al. (2006) give proportions of disposal to landfills and energy production and we would investigate broad application of these data to developing countries.

The IPCC has tools for calculating the emissions (including differentiated methane emissions) from harvested wood products disposed at landfills. These should be used as part of total wood product sequestration calculations.

5.1.4 Export of products

The additional information required to account for imports or exports is essentially the long-term disposition of the specific quantities of carbon imported or exported. To improve accounting, the proportion of exports from tropical countries going to temperate of boreal regions should be estimated and appropriate rates of retirement and disposal methods should be applied to calculate emissions from the exported proportion of HWP. Statistical databases exist (e.g. FAO databases) that record export proportions could be used to develop default factors for timber originating in tropical countries and being exported to make products in temperate or boreal regions of countries

5.2 Detailed plan

5.2.1 Wood product permanence

The most complex part of the new analysis will be with respect to permanence. The current methodology considers between 0.5% and 9.7% of timber biomass extracted to be permanently stored for tropical timber and 1.7% to 25.9% for temperate timber. The remainder is considered immediately emitted.

This approach is neither conservative for projects that decrease timber harvest, and thus wood product storage, nor does it give realistic credit for projects that increase timber harvest and wood product storage. Even products that have a lifetime of just one year still keep a quantity of greenhouse gases out of the atmosphere for a year which has an impact on the ultimate global warming that occurs.

Two approaches are proposed. Both will be prepared and relative strengths and weaknesses considered including situations in which one or other is significantly favored.

Radiative forcing

The first proposed approach is to look at the radiative forcing avoided by having units of greenhouse gases sequestered in harvested wood products. This means that over a 100 year period, the atmospheric impact of a unit of carbon stored in product x can be directly compared to a unit emitted to the atmosphere in year zero.

A methodology would either have a set of defaults for products by category, origination country and destination country (with calculation of landfilled proportion and burned proportion on retirement), or would provide a tool that users would be able to use by entering in values and details to gain a final atmospheric impact.

Similar analyses have already been conducted in estimating biogenic CO_2 fluxes in life cycle assessments (e.g. Cherubini et al 2012) that can be viewed as a partial proof of concept.

This radiative forcing approach is more complex but can be applied in every situation. In contrast, the long term average approach is limited to stable harvesting cycles (perhaps uncommon in tropical situations). The relative benefits of each option in terms of carbon credit accounting is still to be determined.

The calculations of radiative forcing require specific expertise and knowledge. Therefore to prepare a truly user-friendly method and outputs the plan incorporates a consultancy with an expert in radiative forcing calculations.

Long term average

The long term average approach works only in the situation where there is a sustainable repeated harvest cycle with recovery of aboveground biomass and constant harvest volumes at the end of each cycle. In this case it is possible to model the sequestration and emissions from the harvested wood products pool over several cycles within single compartments/management units to the point where the emissions resulting from existing stocks is balanced by the sequestration after each harvest cycle. An example is given in Figure 2 of a 36 year cycle with products produced with a 20 year half-life. In this case, after three cycles a constant is reached for which an average wood product stock can be calculated (red line). The example plots exponential decay of in-use products. A more complex analysis could plot emissions considering disposal methods as well.

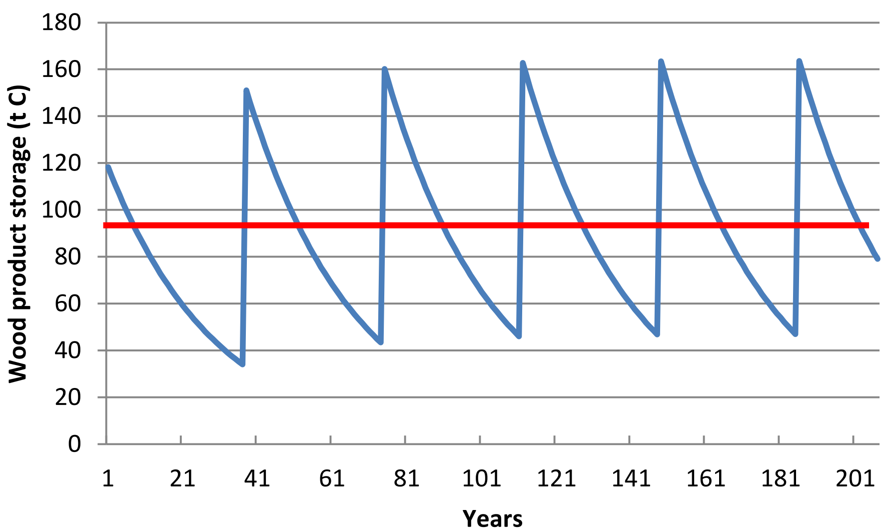

Figure 2. Example of long term average storage in harvested wood products

5.2.2 Export of products

Determination of ultimate emissions from landfill, debris piles or burning will be governed by the country in which the product is retired and not by the country that produced the timber. It is incorrect to assume products are not exported from the country where the timber was harvested.

We would examine ForesSTAT which is part of FAOSTAT maintained by the Food and Agriculture Organization of the United Nations (http://faostat.fao.org/site/626/default.aspx#ancor). For each country it is possible to pull up for a given year a volume and / or biomass of harvested products exported (e.g. Table 1 for Congo in 2009).

The assumption would be made that all exports of wood products would be to temperate or boreal countries. Through comparisons of outputs from ForesSTAT, Winrock would compute the proportion that is exported for each producing country by exported product.

Significant analysis has already been conducted by scientists at UC Davis (http://steps.ucdavis.edu/research/Thread_6/lcfs/forestry) that would be built on as part of this work.

Table 1 Results from ForesSTAT for wood product exports from Congo for 2009

Export Quantity (m3)

	item	2009		
Congo	Chips and Particles	173906.00	m3	*
Congo	Ind Rwd Wir (C)	1162.00	m3	
Congo	Ind Rwd Wir (NC) Other	5565.00	m3	*
Congo	Ind Rwd Wir (NC) Tropica	546005.00	m3	
Congo	MDF	2.00	m3	F
Congo	Plywood	113.00	m3	
Congo	Sawnwood (C)	0.00	m3	*
Congo	Sawnwood (NC)	93015.00	m3	
Congo	Veneer Sheets	19153.00	m3	
Congo	Wood Residues	14.00	m3	*
Congo	Fibreboard + (Total)	2.00	m3	A
Congo	Industrial Roundwood + (Total)	552732.00	m3	A
Congo	Industrial Roundwood(C) + (Total)	1162.00	m3	A
Congo	Industrial Roundwood(NC) + (Total)	551570.00	m3	A
Congo	Roundwood + (Total)	552732.00	m3	A
Congo	Sawnwood + (Total)	93015.00	m3	A
Congo	Wood-Based Panels + (Total)	19268.00	m3	A

Export Quantity (tonnes)

	item	2009		
Congo	Chemical Wood Pulp	0.00	tonnes	
Congo	Newsprint	1.00	tonnes	*
Congo	Other Paper+Paperboard	3.00	tonnes	
Congo	Printing+Writing Paper	0.00	tonnes	F
Congo	Recovered Paper	28.00	tonnes	F
Congo	Unbleached Sulphate Pulp	0.00	tonnes	F
Congo	Wood Charcoal	12.00	tonnes	F
Congo	Wrapg+Packg Paper+Board	3.00	tonnes	
Congo	Wrapping Papers	3.00	tonnes	F
Congo	Paper and Paperboard + (Total)	4.00	tonnes	A
Congo	Paper+-Board Ex Newsprnt + (Total)	3.00	tonnes	A

Congo	Pulp for Paper + (Total)	0.00	tonnes	A
Congo	Total Fibre Furnish + (Total)	28.00	tonnes	A
Congo	Wood Pulp + (Total)	0.00	tonnes	A
Congo	Wood Pulp Exc Mechanical + (Total)	0.00	tonnes	A

* = Unofficial figure | [ ] = Official data | A = May include official, semi-official or estimated data | F = FAO estimate

5.2.3 Linear decay

The first step in determining emissions from wood products is to accurately estimate how long products remain in use. We will adopt the commonly used approach given in the IPCC of an exponential decay curve centered on a published half-life value for a given product.

Winrock will investigate product half-lives and will plot exponential decay curves that will fit into the wood-product-atmospheric-impact calculations. Analysis will be needed to establish defaults for which products are typically produced by which country. Proportional recycling and reuse of products will also be considered.

5.2.4 Landfill and burning of products

Once retired, wood products will either decompose in debris piles, be stored and a proportion decomposed in landfills, or will be burned. The three different pathways will have significant implications for the ultimate estimate of emissions.

Winrock will examine the literature and consult with experts to determine the proportion following each of the three pathways for the region in which the wood product will be retired.

IPCC methods will be used to estimate emissions through time. For example for landfills, the IPCC has a spreadsheet tool that allows calculation of emissions for landfilled wood and paper each year after deposition. The emissions estimates will feed into the wood product atmospheric impact calculations.

5.2.5 Summed calculation model

The study will ultimately derive a model that will, for a given timber producing country, estimate the products produced, the export of products, the in-use lifetime of the products, and the post-retirement emissions from products. The plan is for the model to calculate all these factors for the year of production and then calculate an effective lifetime atmospheric impact of the units of carbon dioxide effectively sequestered in the products.

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ANNEX 1 – BROAD IPCC WOOD PRODUCT ACCOUNTING APPROACHES

Accounting of harvested wood products has been included in forest carbon budgets since the 1990s and is part of IPCC guidelines for UNFCCC national GHG inventories. There are multiple approaches for national accounting of emissions from forest harvest and wood product use that may use the methods reviewed here. The approaches differ in their system boundaries for tracking carbon fluxes. The main approaches described in the literature are:

1. the atmospheric-flow approach
   focuses on flows to and from the atmosphere from forest harvest and wood product use;
2. the stock-change approach
   focuses on the impacts of these activities on carbon stocks in forests and harvested wood products within national boundaries; and
3. the production approach
   similar to the stock-change approach in its focus on forest and harvested wood product stocks, however, the production approach accounts emissions from exported wood products in the country of origin, while the stock-change approach accounts emissions from wood products in the country where they occur.

(Winjum et al. 1998, Lim et al. 1999)

For projects, the context is slightly different. In this case we are not concerned where emissions occur but must track emissions that result from the wood products derived from the forest-based project both in the baseline and with project implementation.

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ANNEX 2 – FURTHER DETAILS ON WINJUM ASSUMPTIONS AND SOURCE LITERATURE

Winjum et al. (1998) assumed that a certain proportion of wood products in each commodity group goes into long-term uses and the remaining fraction is oxidized in the first five years of use. The proportion of wood products going into long-term uses is based on Kurz et al. (1992), Nabuurs and Mohren (1993), and Row and Phelps (1996). Then, emissions from long-term wood products are estimated using simple straight-line relationships represented by annual oxidation fractions or the amount of in-use wood commodities that decay or burn each year. The annual oxidation fractions of in-use wood commodities that decay or burn each year within the three major forest regions of the world were adapted from Dewar (1990), Karjalainen et al. (1995), Kurz et al. (1992), Nabuurs and Mohren (1995), and Row and Phelps (1996).

Row and Phelps (1996) do not distinguish between products going into short- and long-term uses; the rate of retirement is variable and based on the median useful life of primary products in 12 end uses. An econometric block model - HARVCARB - was used to simulate flows of carbon from forests to harvested wood to final disposition over timeframes as long as 100 years. The HARVCARB model accounts for different flows of wood carbon for different species and diverse wood products as well as irregular flows of carbon from phase to phase as a result of waste. The final output is the fraction of wood product carbon in use, emitted to the atmosphere through decay, and burned with or without energy production over time.

The model assumes that the retirement rate for products in each end use rises slowly initially, accelerates around the median useful life, and slows thereafter. Different equations are used to simulate retirement of wood products when the time in use exceeds the median life, when the time in use is between half the median and the median, and when the time in use is shorter than half the median. Half-lives of products in housing industry end-uses are complemented by a logistic-curve as estimates of building lives based on US census data indicate lives for recently built houses exceeding 200 years (Row and Phelps 1996).

Kurz et al. (1992) developed carbon retention curves to characterize the annual fraction of carbon leaving four forest product pools over time, with the initial rate of retirement higher compared to later time periods. Any carbon leaving a forest product pool is assumed to meet one of five fates: both decomposition and burning (for energy or waste) result in immediate release into the atmosphere, product recycling is assumed to return the carbon to the first age class of the forest product pool, and transfers to a landfill lead to carbon release through gradual decomposition. Carbon retention curves in Dewar (1990) are based on model Weibull curves in Thompson and Mathews (1989) derived from estimates of time to maximum rate of carbon loss and time to 95% carbon loss in multiple wood product categories recognized by the market.

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