VCS MODULE VMD0026

ESTIMATION OF CARBON STOCKS IN THE LONG LIVED WOOD PRODUCTS POOL

Version 1.0

16 November 2012

Sectoral Scope 14

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1 SOURCES

VCS module *VMD0005 Estimation of carbon stocks in the long-term wood products pool (CP-W), v1.0*

2 SUMMARY DESCRIPTION OF THE MODULE

This module provides a method for estimating carbon stocks and changes in carbon stocks in the harvested wood products pool, based on the end use of the wood removed or projected to be removed from the project area. Estimates of harvest volumes are determined using the module *VMD0025 Estimation of Woody Biomass Harvesting and Utilization*.

3 DEFINITIONS

Project Area: The area or areas of land on which the project proponent will undertake the project activities.

Wood Density: The mass per unit volume of the dry wood of a given species.

4 APPLICABILITY CONDITIONS

None

5 PROCEDURES

This module estimates annual sequestration of carbon stock in wood products (C_{G_WPt}) following the conceptual framework detailed in Winjum et al 1998. Where the estimates of harvested wood volumes are determined for the project area as a whole, the calculation of carbon sequestration in wood products will also be undertaken for the project area as a whole and no stratification is used. However, if estimates of harvested wood volumes are undertaken separately for strata within the project area and wood from each stratum produces a different mix of wood products, the equations given below must be used separately for each stratum, and the results summed to provide the amount sequestered for the area as a whole.

Note that the oxidization factors are subject to ongoing updating as further research is undertaken, and the most recent factors applicable to the types of wood and products produced must be used.

Step 1: Calculate the biomass carbon of the volume extracted by wood product type *ty* over a given period *p* from within the project area:

$$C_{XB,ty,p} = \sum_{j}^{S} (V_{ex,ty,j,p} * D_j * CF_j) \qquad (10.1)$$

Where:

$C_{XB,ty,p}$	=	Total carbon stock of extracted biomass from within the project area by class of wood product *ty* over a given time period *p*; t C
$V_{ex,ty,j,p}$	=	Volume of timber extracted from within the project area (does not include slash left onsite) by species *j* and wood product class *ty* over a given time period *p*; m^3
D_j	=	Wood density (specific gravity) of species *j*; t d.m.m^{-3}
CFj	=	Carbon fraction of biomass for tree species *j*; t C t^{-1} d.m.
j	=	*1, 2, 3 … S* tree species

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ty = Wood product class – defined here as sawnwood, wood-based panels, other industrial round wood, paper and paper board, and other

Step 2: Calculate the proportion of biomass carbon extracted during the time period *p* that remains sequestered in long-term wood products after a number of years *y* since the wood products were initially created. All factors are derived from Winjum et al.1998.

$$Cwp_y = \sum_{ty}^{z}\left(\left(\left(C_{XB,ty,p} - WW_{ty}\right) - SLF_{ty}\right) - OF_{ty,y}\right) \qquad (10.2)$$

Where:

Cwp_y = Carbon stock sequestered in wood products created over a given period *p*, that remain sequestered after a number of years *y* since the wood products were created; t C

$C_{XB,ty,p}$ = Total carbon stock of extracted biomass from within the project area by class of wood product *ty* over a given period *p*, t C

WW_{ty}(*) = Wood waste fraction of wood products *ty* immediately emitted through mill inefficiency; t C*

SLF_{ty}(**) = Short-lived fraction of wood products of type *ty* that will be emitted to the atmosphere within 3 years of timber harvest; t C **

$OF_{ty,y}$(***) = Oxidized fraction of wood products of type *ty* whose carbon will be emitted between 3 and 100 years after creation of the harvested wood product, remaining at year *y* after the wood products were created; t C

ty = Wood product class (defined here as sawnwood, wood-based panels, other industrial round wood, paper and paper board, and other)

z = number of wood products classes *ty*

y = 1,2,3… y years elapsed since the wood products were created.

Values for WW, SLF and OF must be derived based on the following guidance:

Wood waste fraction (WW)*:

Winjum et al 1998 indicate that the proportion of extracted biomass that is oxidized (burning or decaying) from the production of commodities to be equal to 19% for developed countries, 24% for developing countries. *WW* is therefore equal to $C_{XB,ty,p}$ multiplied by 0.19 for developed countries and 0.24 for developing countries.

Short-lived fraction (SLF)**:

Fraction of wood products that are oxidized within 3 years after creation, assumed to be 3/5 of the wood products that would have been oxidized within 5 years of creation, as per the estimates of the short lived proportion (slp) given in Winjum et al 1998 (applicable internationally):

Estimate the short-lived fraction using the following short lived proportion (slp) factors by wood product class:

Sawnwood	= 0.12
Woodbase panels	= 0.06
Other industrial round wood	= 0.18
Paper and Paperboard	= 0.24

Note that these factors for short-lived wood products are subject to ongoing updating as further research is undertaken, and the most recent factors applicable to the types of wood and products produced must be used, considering that only wood products that decay within 3 years may be considered in the short-lived fraction.

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Therefore SLF will be equal to:

$$SLF_{ty} = (C_{XB,ty,p} - WW_{ty}) \cdot slp \qquad (10.3)$$

Where:

SLF_{ty}	=	Short-lived fraction of wood products that will be emitted to the atmosphere within 3 years of timber harvest from wood product *ty*; t C
$C_{XB,ty,p}$	=	Total carbon stock of extracted biomass from within the project area by class of wood product *ty* over a given period p; t C
WW_{ty}	=	Wood waste - fraction of extracted biomass carbon immediately emitted through mill inefficiency from wood product *ty*; t C
slp	=	Short-lived proportion: Using the factors for the product classes given above.
ty	=	Wood product class (defined here as sawnwood, wood-based panels, other industrial round wood and paper and paperboard)

Additional oxidized fraction (OF)***:

Winjum et al 1998 gives annual oxidation fractions for each class of wood products split by forest region (boreal, temperate and tropical). This methodology projects these fractions over 97 years to give the additional proportion that is oxidized between 3 and 100 years after initial harvest (Table 1):

Table 1: The fraction oxidized (fo) factors for wood products oxidized between 3 and 100 years after initial harvest by wood product class and forest region

Wood Product Class	Boreal	Temperate	Tropical
Sawnwood	0.39	0.62	0.86
Woodbase panels	0.62	0.86	0.98
Other industrial round wood	0.86	0.98	0.99
Paper and paperboard	0.39	0.62	0.99

Note that these oxidization factors are subject to ongoing updating as further research is undertaken, and the most recent factors applicable to the types of wood and products produced must be used, considering that the oxidized fraction of wood products must include those which oxidize between 3 and 100 years.

As per VCS guidance this oxidization is presumed to occur following a linear decay function over a 20 year period.

OF is therefore equal to:

$$OF_{ty,y} = ((C_{XB,ty} - WW_{ty}) - SLF_{ty}) \cdot (fo \cdot (m / 20)) \qquad (10.4)$$

Where

$OF_{ty,y}$	=	Oxidized fraction of wood products of type *ty* created during period *p* whose carbon will be emitted between 3 and 100 years after creation of the harvested wood product, remaining at year *y* after the wood products were created; t C
$C_{XB,ty.p}$	=	Total carbon stock of extracted biomass from within the project area by class of wood product *ty* over a given period p; t C

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WW_{ty}	=	Wood waste fraction of wood products *ty* immediately emitted through mill inefficiency; t C
SLF_{ty}	=	Fraction of wood products of type *ty* that will be emitted to the atmosphere within 3 years of timber harvest; t C
fo	=	Fraction oxidized – see Table 1 for defaults; t C t C^{-1}
ty	=	Wood product class (defined here as sawnwood, wood-based panels, other industrial round wood, paper and paper board, and other)
y	=	the number of years since the wood products were created.
m	=	the number of years since the wood products were created, *y*, where for all *y* >20, *m*=20

Step 3: Calculate the total HWP remaining *t* years after the project start date, consisting of the HWP remaining out of the products created during each period *p* since project commencement (*t*=0), using the following equation.

$$Cwp_t = \sum_p Cwp_y \qquad 10.5$$

Where

Cwp_t	=	The total carbon contained in harvested wood products at time *t*, tC
Cwp_y	=	Carbon stock sequestered in wood products created over a given period *p*, that remain sequestered after a number of years *y* ; t C
y	=	The number of years since the wood products in the given period *p* were created

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6 PARAMETERS

Data Unit / Parameter:	$C_{XB,ty,p}$
Data unit:	tonnes C
Description:	Extracted biomass carbon during period p
Source of data:	Estimated from census
Justification of choice of data or description of measurement methods and procedures applied:	Total carbon stock of extracted biomass from within the project area by class of wood product ty over a given time period p
Any comment:	

Data Unit / Parameter:	$V_{ex,ty,j,p}$
Data unit:	m3
Description:	Volume
Source of data:	Estimated from census
Justification of choice of data or description of measurement methods and procedures applied:	Volume of timber extracted from within the project area (does not include slash left onsite) by species j and wood product class ty over a given time period p
Any comment:	

Data Unit / Parameter:	D_j
Data unit:	t d.m.m-3
Description:	Basic wood density
Source of data:	Known or measured
Justification of choice of data or description of measurement methods and procedures applied:	Basic wood density of species j
Any comment:	

Data Unit / Parameter:	CF_j
Data unit:	t C t-1 d.m
Description:	Carbon fraction of biomass
Source of data:	Known
Justification of choice of data or description of measurement methods and procedures applied:	Carbon fraction of biomass for tree species j
Any comment:	

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Data Unit / Parameter:	*p*
Data unit:	none
Description:	a period over which biomass was extracted
Source of data:	Known
Justification of choice of data or description of measurement methods and procedures applied:	A period over which biomass was extracted, not exceeding one year in duration.
Any comment:	

Data Unit / Parameter:	*t*
Data unit:	Years
Description:	1,2,3… t years elapsed since the start of the project activity.
Source of data:	Project records
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	

Data Unit / Parameter:	*j*
Data unit:	Species
Description:	Tree Species
Source of data:	Census
Justification of choice of data or description of measurement methods and procedures applied:	1, 2, 3 … S tree species
Any comment:	

Data Unit / Parameter:	*ty*
Data unit:	
Description:	Wood product class
Source of data:	Known
Justification of choice of data or description of measurement methods and procedures applied:	Wood product class – defined here as z = 5 categories: sawnwood, wood-based panels, other industrial round wood, paper and paper board, and other
Any comment:	

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Data Unit / Parameter:	Cwp_y
Data unit:	tC
Description:	Total carbon stock in wood products pool from period p
Source of data:	Calculated
Justification of choice of data or description of measurement methods and procedures applied:	Total carbon stock in wood products pool created during a given period p, that remain sequestered after a number of years y since the wood products were created.
Any comment:	

Data Unit / Parameter:	WW_{ty}
Data unit:	tC
Description:	Wood waste
Source of data:	Winjum et. al., or superseding research
Justification of choice of data or description of measurement methods and procedures applied:	The wood waste fraction immediately emitted through mill inefficiency
Any comment:	

Data Unit / Parameter:	SLF_{ty}
Data unit:	tC
Description:	Fraction of wood products that will be emitted to the atmosphere within 3 years of timber harvest
Source of data:	Winjum et. al., or superseding research
Justification of choice of data or description of measurement methods and procedures applied:	Fraction of wood products that will be emitted to the atmosphere within 3 years of timber harvest
Any comment:	

Data Unit / Parameter:	$OF_{ty,y}$
Data unit:	tC
Description:	Fraction of wood products that will be emitted to the atmosphere between 3 and 50 years of timber harvest
Source of data:	Winjum et. al., or superseding research
Justification of choice of data or description of measurement methods and procedures applied:	Fraction of wood products of type ty whose carbon will be emitted between 3 and 100 years after creation of the harvested wood product, remaining at year y after the wood products were created; t C
Any comment:	

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Data Unit / Parameter:	*slp*
Data unit:	dimensionless
Description:	Short-lived proportion factor
Source of data:	Winjum et. al., or superseding research
Justification of choice of data or description of measurement methods and procedures applied:	Short-lived proportion
Any comment:	

Data Unit / Parameter:	*fo*
Data unit:	dimensionless
Description:	Fraction oxidized
Source of data:	Winjum et. al., or superseding research
Justification of choice of data or description of measurement methods and procedures applied:	Fraction oxidized
Any comment:	

Data Unit / Parameter:	*m*
Data unit:	dimensionless
Description:	number of years since HWP were created
Source of data:	Known
Justification of choice of data or description of measurement methods and procedures applied:	the number of years since the wood products were created, y, where for all y >20, m=20
Any comment:	

Data Unit / Parameter:	Cwp_t
Data unit:	tC
Description:	Total HWP carbon
Source of data:	Calculated
Justification of choice of data or description of measurement methods and procedures applied:	the total carbon contained in harvested wood products at time t
Any comment:	

7 REFERENCES AND OTHER INFORMATION

Winjum, J.K., Brown, S. and Schlamadinger, B. 1998. Forest harvests and wood products: sources and sinks of atmospheric carbon dioxide. *Forest Science* 44: 272-284

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DOCUMENT HISTORY

Version	Date	Comment
v1.0	16 Nov 2012	Initial version released

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