



Use of the IPCC Inventory Software
to Establish the National GHG inventory in the
Agriculture, Forestry and Other Land Use (AFOLU) sector
Land Carbon Stock Changes and CO₂ fluxes

IPCC TFI TSU

IPCC Guidelines

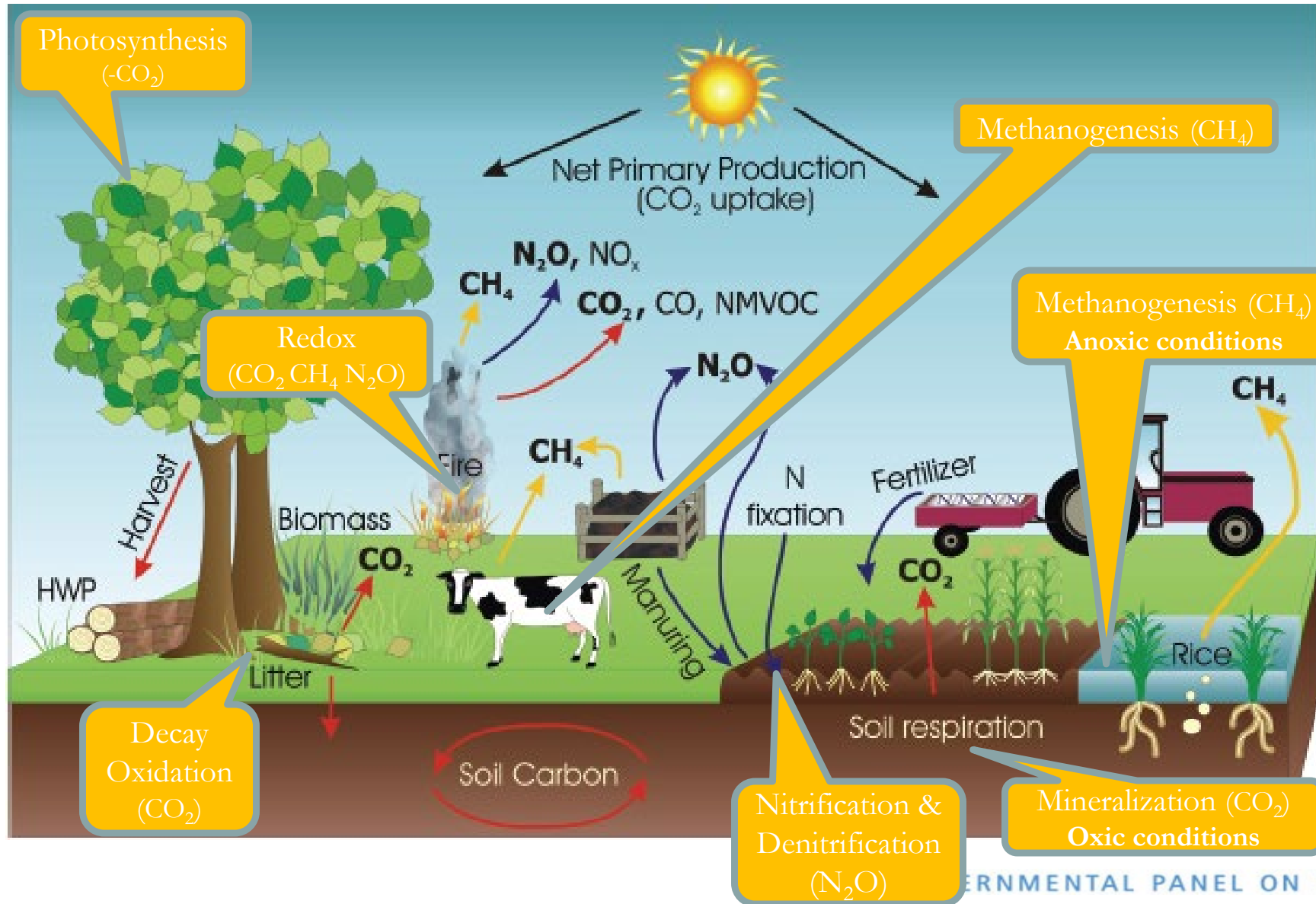
□ **Volume 4 (AFOLU)**, Chapters 2, 4, 5, 6, 7, 8, 9

✓ **2006 IPCC Guidelines**

✓ **2019 Refinement**

□ **Wetlands Supplement**, Chapters 2, 3, 4, 5

Processes covered by IPCC Guidance on AFOLU



Organic Matter

- ❑ **Organic matter is heterogeneous very complex compound. Generally, as weight, is**
 - 45–55% Carbon
 - 35–45% Oxygen
 - 3–5% Hydrogen
 - 1–4% Nitrogen
- ❑ **Organic matter is the component of**
 - Biomass, living organic matter, which can have
 - Either an annual cycle [Growth → Harvest&Consumption or Decay to dead organic matter]
 - Or a multiyear cycle [Growth in plant perennial tissues (wood)] and thus stores Carbon across years
 - Dead organic matter, dead wood, litter, soil organic matter, harvested wood products which stores Carbon across years

Organic Matter

❑ Organic matter redox/decay processes timescale

- *hours*
- *within a year*
- *years/centuries*
- *centuries/millennia*

❑ Organic matter redox/decay results in

- $\text{CO}_2, \text{CH}_4, \text{N}_2\text{O}$
- $\text{NH}_3/\text{NH}_4^+, \text{NO}_x$
- $\text{H}_2\text{O}, \text{N}_2$

Chemicals

- ❑ Nitrogen fertilizers \Rightarrow N_2O emissions
- ❑ Carbonaceous mineral amendments \Rightarrow CO_2 emissions
- ❑ Nitrogen/Carbonaceous fertilizers (Urea) \Rightarrow N_2O + CO_2 emissions

Notations

- ❑ **Nitrogen** content of **N₂O** is indicated as **N₂O-N**, and emissions of N₂O-N are **converted** to N₂O emissions multiplying **by 44/28** (proportion of the atomic weight of the two molecules)
- ❑ **Carbon** content of **CH₄** is indicated as **CH₄-C**, and emissions of **CH₄-C** are **converted** to **CH₄** emissions multiplying **by 16/12** (proportion of the atomic weight of the two molecules)
- ❑ **Carbon** content of **CO₂** is indicated as **CO₂-C**, and emissions of **CO₂-C** are **converted** to **CO₂** emissions multiplying **by 44/12** (proportion of the atomic weight of the two molecules)
- ❑ **Emissions** have a **positive sign**, while **CO₂ removals** have a **negative sign**. *This is because the "point of view" of an NGHGI is the atmosphere, so a positive sign means an addition of GHG to the atmosphere, while a negative sign means a subtraction of CO₂ from the atmosphere*
- ❑ **Carbon stock gains** have a **positive sign**, while **Carbon stock losses** have a **negative sign**. *This is because the "point of view" is the C pool to which the C stock pertains, so a positive sign means an addition of Carbon to the C pool, while a negative sign means a subtraction of C stock from the C pool*
- ❑ Thus, **converting** a net **C stock** change **to CO₂ net emission/removal** requires to multiplying the net C stock **by -44/12**, *given that the sign is to be changed*

Stratification of Activity Data

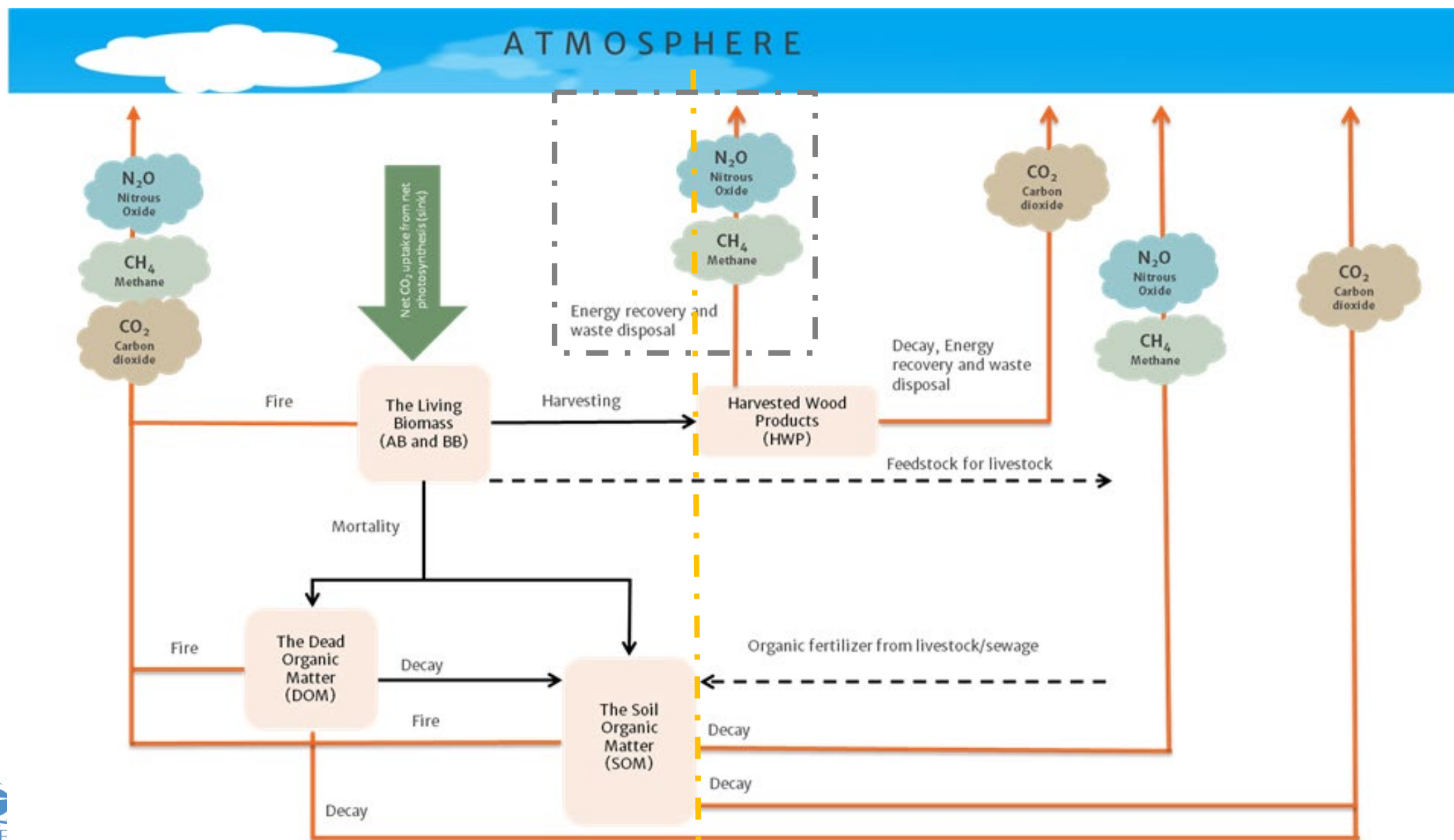
❑ Stratification of activity data promotes accuracy and precision since:

- ✓ Subdivisions are more homogenous than the whole population, *and thus associated EF are more accurate and precise*
- ✓ Propagation of random error, as it occurs summing up subdivisions' estimates, tends to cancel those out -*Systematic Errors instead DO NOT cancel out across propagation-*

Systematic Errors instead DO NOT cancel out across propagation, thus, GOOD PRACTICE is to always REMOVING any identified SYSTEMATIC ERROR -*a biased estimate is NOT acceptable in an NGHGI-*; while minimizing RANDOM ERRORS -*these indeed cannot be zeroed!-*.

Random errors do bias neither the level of emissions/removals estimated nor the estimated change across time (mitigation); while Systematic errors do.

GHG emissions and CO₂ removals from land use



AFOLU anthropogenic GHG Emissions and Removals

□ AFOLU sources/sinks

- **Plant biomass is the sink of CO₂ removal from the atmosphere.** Of the CO₂ annual net absorption (*photosynthesis minus respiration - NPP*):
 - ✓ A fraction is stored, and in managed land is reported as a **perennial biomass** accumulation
 - ✓ A fraction is transferred to other C pools (DOM, SOM, HWP) as C stocks
- DOM and SOM C stocks decays across time to CO₂, although the annual net C stock change can be positive depending on systems' phases, management practices and disturbances
- Non-CO₂ emissions are largely a product of microbiological processes (i.e., within soils, animal digestive tracts and manure) and combustion of organic matter

Annual Biomass in AFOLU

□ Within the annual time-frame of a National GHG Inventory (NGHGI)

- C stored in Annual biomass is up-taken and subsequently released (**thus, both fluxes** -CO₂ emissions and subsequent removals- **are excluded from the NGHGI**). However, C can be released as CH₄, instead of CO₂; further, annual biomass decay releases N, including as N₂O
- Various decay patterns occur:
 - ✓ **[3.B categories]** Annual biomass decays to DOM and SOM (*given that C accumulation is physically limited, the long-term annual average C stock in each C pool tends to stabilize at a level in which C inputs equal C losses so that the annual net C-stock change can be assumed equal to 0; unless the long-term annual average C stock changes*)
 - ✓ **[3.C.1 categories*]** Annual biomass is burnt to CO₂, CH₄ and N₂O
 - ✓ **[3.A categories*]** Annual biomass as feed for livestock:
 - Fermentation [*digestion*], CH₄
 - Metabolism [*respiration*], CO₂
 - Manure [Management], CH₄ & N₂O

AFOLU C pools in managed land

Resident C pools

❑ Biomass, aboveground and belowground

- ✓ **Perennial** – C sequestration and accumulation, C stock losses caused by any driver (*anthropogenic and natural*)
- ✓ **Annual** – C sequestration and subsequent C stock loss caused by any drivers (*anthropogenic and natural*) are assumed to occur in the same year, resulting in a zero net C stock change

❑ Dead Organic Matter (DOM)

- ✓ **Litter** – all non-living biomass with a size greater than the limit for SOM (*suggested 2 mm*) and less than the minimum diameter chosen for dead wood (*e.g. 10 cm*), lying dead, in various states of decomposition above or within the mineral or organic soil.
- ✓ **Dead wood** – all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil than or equal to 10 cm in diameter (*or the diameter specified by the inventory compiler*).

❑ Soil Organic Matter (SOM)

- ✓ **Mineral soils** – Includes organic carbon to a specified depth (*30 cm as IPCC default*) chosen by the country and applied consistently through the time series. Live and dead fine roots and DOM within the soil, that are less than the minimum diameter limit (*suggested 2 mm*) for roots and DOM, are included with SOM where these cannot be distinguished from it empirically.

non-Resident C pools

- ❑ **Harvested Wood Products**: wood and paper products; include i) wood products in use; ii) wood biomass used for energy purposes and iii) wood biomass in solid waste disposal sites.

Organic soils

C stocks in organic soils are not explicitly computed using IPCC methods (which estimate only annual C flux from/to organic soils).

AFOLU anthropogenic GHG Emissions and Removals

□ **Emission and Removal Processes** - GHG fluxes in the AFOLU Sector are estimated in two alternative ways

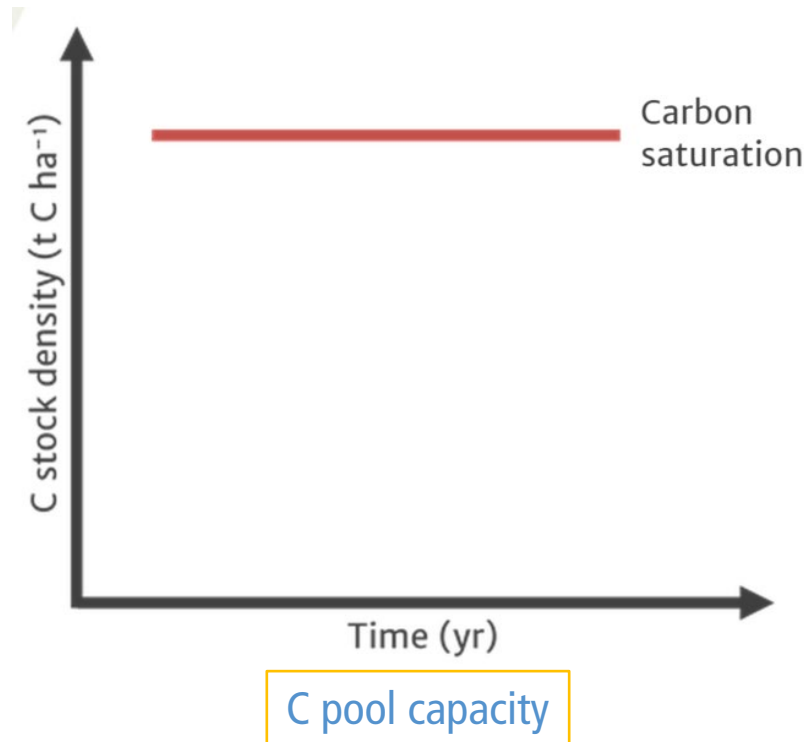
- 1. Indirectly, as net change in C stock in a C pool.** *The use of C stock changes to infer CO₂ emissions and removals from C pools, is based on the fact that changes in ecosystem C stocks are predominately (but not exclusively*) through CO₂ exchange between the land surface and the atmosphere*
- 2. Directly as flux rates to(/from) the atmosphere** *(used for estimating non-CO₂ emissions, CO₂ emissions not sourced from C pools and those CO₂ emissions and removals from SOM for which the C stock is not quantifiable in an operational way, e.g. drainage/rewetting of organic soils).*

** (i.e. processes of lateral C transfer, not to the atmosphere, such as leaching are assumed to be negligible)*

CSCs methods – C pools physical limits for C stock storage

As per the Population Ecology:

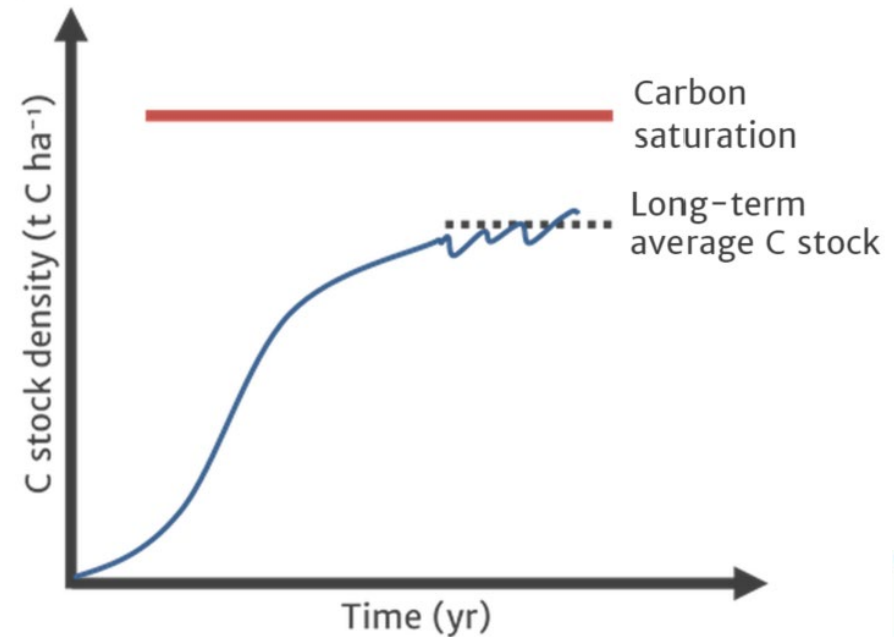
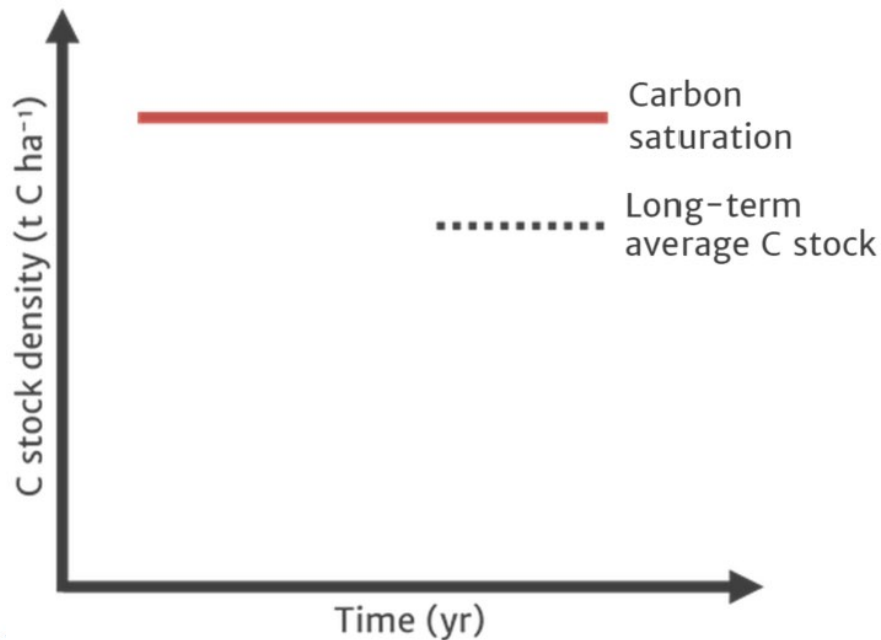
- C stocks dynamic tends to approach the physical limit of the C pool –i.e. its carrying capacity–



CSCs methods – long-term average C stock

As per the Population Ecology:

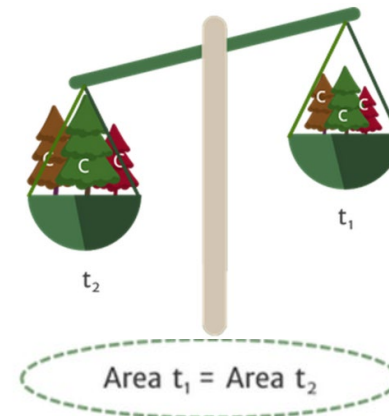
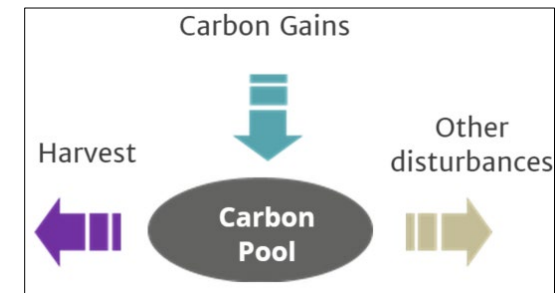
- ❑ C stocks contained in C pools at any given time is a function of the type and duration of the use of lands, as well as of the disturbances occurred
- ❑ With a constant rate of activities and disturbances C stocks in a C pool tend to approach a so-called long-term average C stock



IPCC Methodological approaches to estimate C stock changes

IPCC provides 2 different fully equivalent methodologies to estimate the annual net C stock change in any C pool

- ❑ The **Gain and Loss** methodology, which estimates the annual net C stock change in a C pool by summing up **ALL**
 - ✓ Annual C stock gains (inflow in the C pool)
 - ✓ Annual C stock losses (outflow from the C pool)in a managed land, regardless of drivers of such C stock changes
- ❑ The **Stock Difference** methodology, which estimates the annual net C stock change in a C pool in a managed land as the difference in the resident C stock between two points in time



IPCC Methodological approaches to estimate C stock changes

- ❑ C stock changes in resident C pools are estimated and reported in an NGHGI according to 6 IPCC land categories:
 - ✓ Forest land
 - ✓ Cropland
 - ✓ Grassland
 - ✓ Wetlands
 - ✓ Settlements
 - ✓ Other land
- ❑ National-specific categorization shall be reconciled to the 6 IPCC default categories while ensuring that:
 - no national-specific category* overlaps 2 or more IPCC categories –i.e. every national-specific category fully corresponds to 1 IPCC category, although it may be just a subset of it–
 - The entire territory is classified –i.e. no land is left uncategorised–

* Lowest layer of stratification i.e. land subdivision

3.B – Land

Category	Activity		GHGs
3.B.1	Forest land	3.B.1a Forest land Remaining Forest land	CO ₂ -C
		3.B.1b Land converted to Forest land	
3.B.2	Cropland	3.B.2a Cropland Remaining Cropland	
		3.B.2b Land Converted to Cropland	
3.B.3	Grassland	3.B.3a Grassland Remaining Grassland	
		3.B.3b Land Converted to Grassland	
3.B.4	Wetlands	3.B.4a Wetlands Remaining Wetlands	
		3.B.4b Land Converted to Wetlands	
3.B.5	Settlements	3.B.5a Settlements Remaining Settlements	
		3.B.5b Land Converted to Settlements	
3.B.6	Other land	3.B.5b Land Converted to Other land	

The IPCC Inventory Software

- ❑ **All methods in the 2006 IPCC Guidelines and its Wetlands Supplement are implemented in the IPCC Inventory Software**

Thus, needed flexibility to deal with any national circumstances, as per IPCC tiered approach, is ensured

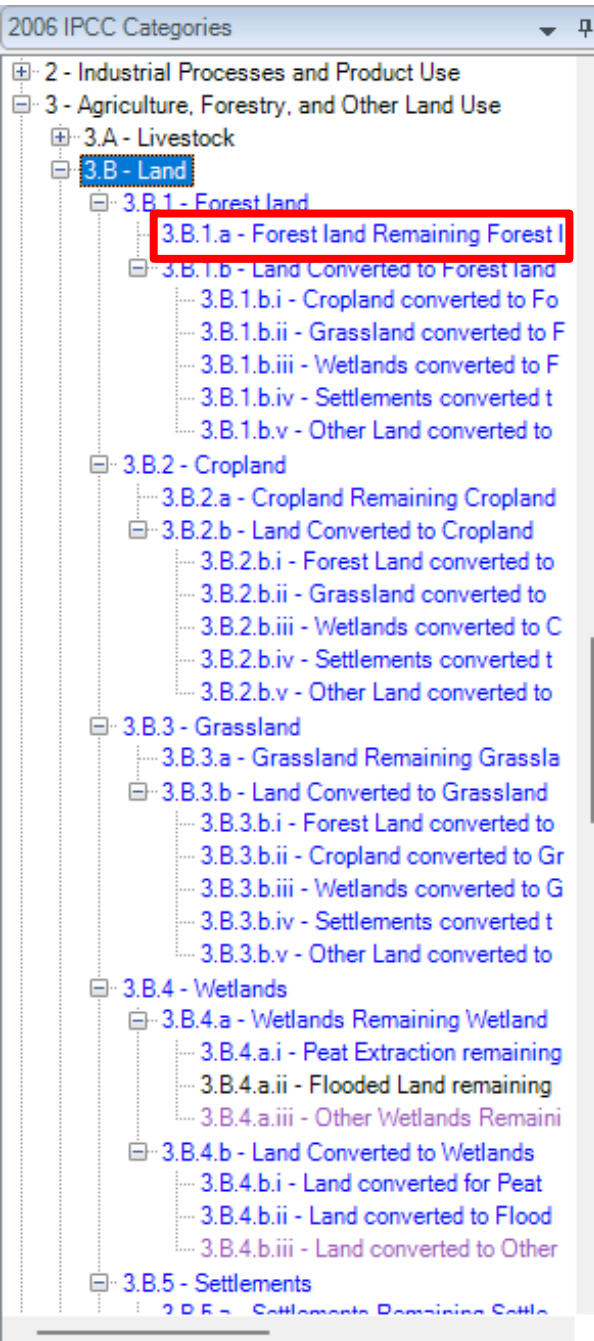
- ❑ **Subnational disaggregation (Geographical Zone)**

Thus, tracking of specific activities/projects, and associated emission level & trend, within a national GHG inventory is allowed

- ❑ **Interoperability with UNFCCC ETF reporting tool** allows to export a complete set of CRTs and upload it in the UNFCCC ETF reporting tool

User-specific Tier 3 estimates to be accommodated in Tier 1 methodological approach worksheets

- ❑ **AFOLU sector Guidebook – version 1 under development**



Open the Calculation Worksheets

- ❑ Clicking on **blue categories** opens the relevant calculation worksheets where to enter parameters and Carbon-Stock-Change Factors.
- ❑ Each category is populated with the worksheets needed according to the units of land entered in the land representation as well as with the selection of the methodology to apply in each of the C pools.

Calculation Worksheets

- ☐ For each C pool, depending on methodology to calculate C stock changes or CO₂ fluxes selected in the Land Representation Manager, the *Software* maps each unit of land to the relevant TAB
- ☐ Although land categories are shown in blue ink -e.g. 3.B.1 Forest land-, calculation worksheets are limited to subcategories -e.g. 3.B.1.a Forest land remaining Forest land-.
- ☐ Although land conversion categories are shown in blue ink -e.g. 3.B.1.b Land converted to Forest land-, calculation worksheets are limited to subcategories -e.g. 3.B.1.b.i Cropland converted to Forest land-.

Case Study for Land – Land dynamic

❑ Region 1:

- Forest land is first expanded on Grassland, and then deforested likely for Settlements
- Settlements is expanded likely on Grassland, and then likely on Forest land
- Grassland is subject to prescribed burning

❑ Region 2:

- Primary forest converted to Forest plantation; area converted is affected by a wildfire event in 2020
- Mangrove forest is deforested to urban park, and a fraction subsequently abandoned to Tidal marsh
- Oil Palm plantation is converted to Lotus cultivation; thus, land is rewetted
- Tidal marshes excavated and converted to Harbor

❑ Region 3:

- Rotation Rice (1y) – Maize (1y) – Poplar (5y) established (1996-2005) on land cultivated at rice for long-term; then replaced (2006 onward) with a rotation Rice (2y) – Maize (2y) – Poplar (10y)

Case Study for Land – 3.B: CSCs and CO₂ fluxes

☐ Estimate annual net C stock changes in:

- Aboveground Biomass
- Belowground Biomass
- Dead Wood
- Litter
- Soil Organic Matter (mineral soils, coastal wetlands*)

☐ Estimate annual net CO₂ fluxes in

- Organic Soils [Drained and Rewetted]
- Coastal Wetlands [Drained and Rewetted]

* Limited to Extraction

Case Study for Land – 3.C.1: GHG Emissions

☐ Estimate CH₄ and N₂O emissions:

- Aboveground Biomass
- Dead Organic Matter - DOM (Dead Wood + Litter)
- Soil Organic Matter [Organic soils only], limited to CH₄

☐ Estimate CO₂ emissions from peat fires

- Organic Soils [Drained]

Case Study – Data

Region	Category	Subcategory	Subdivision	Aboveground biomass stock	Aboveground biomass net growth	R	CF	D	Growing stock level	Net Annual Increment	AGP	N classes	Harvest cycle	BCEF _I	BCEF _S	BCEF _R	SOC _{REF}	F _{LU}
1	Forest land	Managed	Secondary forest			0.220	0.470		unspecified						0.670		63.000	1.000
2	Forest land	Managed	Forest plantation			0.200	0.470	0.555	166	16.6				0.850	0.990	1.050		
	Forest land	Unmanaged	Primary forest			0.200	0.470		232						0.950			
	Forest land	Unmanaged	Mangroves forest	192		0.490	0.451		unspecified									
3	Cropland	Annual	Maize	5.8		0.220											80	0.690
	Cropland	Annual	Rice	3.8		0.160											80	0.690
	Cropland	Perennial	Poplar (5)	35	7	0.310							5				80	1.000
	Cropland	Perennial	Poplar (10)	130	13	0.190							10				80	1.000
2	Cropland	Annual	Lotus (long-term)	3.57*		0.000											68	1.000
	Cropland	Annual	Lotus (converted)	3.57*		0.000											68	0.800
	Cropland	Perennial	Oil palm	60	2.4	0.190	0.445						25				68	1.010
1	Grassland	Managed	Grazed	13.5**		4.000	0.500										63	1.000
2	Wetlands	Managed	Tidal marshes	8.6*		0.500												
	Wetlands	Unmanaged	Tidal marshes	33.4*		0.500												
2	Settlements	Treed	Urban park	67		0.330	0.470				30	4						
	Settlements	Other	Harbor															
1	Settlements	Other	Buildings	13.5		0.340	0.470										63	0.800
* annual average including belowground																		
** Herbaceous biomass																		

3.B categories: C stock changes and CO₂ emissions/removals

Tool:

Land Representation

3.B Calculation Worksheets

IPCC Inventory Software - Worksheets

3.B categories have 2 series of worksheets for each C pool

☐ TABs where to enter data for the **IPCC default method**

- ✓ **Biomass C pool**, 5 tabs: *Biomass G&L 1/4, 2/4, 3/4, 4/4*; + in the year of conversion only *Biomass G&L-Abrupt*
- ✓ **DOM C pool**, 1 tab: *DOM G&L*
- ✓ **SOM Mineral C pool**, 2 tabs: *Formulation A, Formulation B*
- ✓ **SOM organic soils**, 2 tabs: *Drained, Rewetted (including Coastal Wetlands soils)*

☐ TABs where to enter data for the **Stock Difference method**, for which 2 set of worksheets are provided depending on the Land representation approach applied to the unit of land:

I. Approach 1:

- ✓ **Biomass C pool**, 1 tab: *Biomass SD-Approach 1*
- ✓ **DOM C pool**, 1 tab: *DOM SD-Approach 1*
- ✓ **SOM**, 1 tab: *SOM SD-Approach 1*

I. Approaches 2 & 3:

- ✓ **Biomass C pool**, 1 tab: *Biomass SD-Approaches 2&3*
- ✓ **DOM C pool**, 1 tab: *DOM SD-Approaches 2&3*
- ✓ **SOM**, 1 tab: *SOM SD-Approaches 2&3*

Calculation Worksheets

For each C pool, depending on methodology to calculate C stock changes or CO₂ fluxes selected in the Land Representation Manager, the *Software* maps each unit of land to the relevant TAB

relevant TAB

Region	Region 1	Region area (ha)	3,000,000	Discrepancy (ha)	2020: OK, 2000: OK	Approach 1
Land use category		Area (2020) (ha)	Area (2000) (ha)			
Forest Land		960	1000			
Land use subcategory		Area (2020) (ha)	Area (2000) (ha)			
Managed Forest Land		960	1000			
Current Land use subdivision			Remark			
Secondary forest						
Land unit code (Automatic)		Land unit code (User defined)	Area (2020) (ha)	Area (2000) (ha)		
MFL-SF-NF-OB-1		MFL_1	960 ↔	1000		
*			↔			

Land Unit Parameters

C pools / Methods

Biomass change

Stock difference

DOM - Deadwood

Stock difference

DOM - Litter

Stock difference

SOM - Mineral

Default

From Land representation

Land Unit Parameters	
C pools / Methods	
Biomass change	Stock difference
DOM - Deadwood	Stock difference
DOM - Litter	Stock difference
SOM - Mineral	Default

From Land representation, unit MFL_1 is mapped to

TAB SOM mineral – Eq. 2.25 Formulation A

Sheet: SOM Mineral – Eq. 2.25 Formulation A				
Data				
Region	Region 1	- Approach 1		
Land use category		Equation 2.25 Formulation A		
Land unit code	Land use during reporting year	Soil organic carbon stock in mineral soils in year 2020 (tonnes C)	Soil organic carbon stock in mineral soils in year 2000 (tonnes C)	Annual change in carbon stocks in mineral soils (tonnes C / yr)
▼	▼	▼	SOC(2020)	SOC(2000)
▼	▼	▼	$\Delta C_{\text{mineral}} = ((\text{SOC}(2020) - \text{SOC}(2000)) / 20)$	
► MFL_1	Managed Forest Land	Secondary forest	60480	63000
				-126

Region 1

Calculation Worksheets

I. Forest land remaining Forest land:

- ✓ Biomass (SD – Approach 1) – *Forest Inventory Data*
- ✓ DOM (SD – Approach 1) – *Forest Inventory Data*
- ✓ SOM Mineral – Eq. 2.25 Formulation A – *IPCC default data (auto-compiled by the Software)*

II. Grassland remaining Grassland

- ✓ Biomass (SD – Approach 1) – *long-term biomass stock from literature*
- ✓ DOM (SD – Approach 1) – *long-term biomass stock from literature*
- ✓ SOM Mineral – Eq. 2.25 Formulation A – *IPCC default data (auto-compiled by the Software)*

III. Settlements remaining Settlements

- ✓ Biomass (SD – Approach 1) – *City Inventory Data*
- ✓ DOM (SD – Approach 1) – *City Inventory Data*
- ✓ SOM Mineral – Eq. 2.25 Formulation A – *IPCC default data (auto-compiled by the Software)*

Forest land

Forest land Data

C pool	Forest Inventory							CF t C / t d.m.
	1990	1995	2000	2005 m ³	2010	2015	2020	
Biomass (woody)	134,640	140,310	162,200	165,330	168,462	172,175	174,240	0.47
t d.m.								
Dead Wood	60,480	63,090	72,900	74,349	75,754	77,406	78,336	0.49
Litter	12,780	13,320	15,400	15,741	16,072	16,393	16,608	0.37

Forest land remaining Forest land - Biomass

SOM Mineral - Eq. 2.25 Formulation B | SOM (SD - Approach 1) | SOM (SD - Approaches 2&3) | SOM Organic Drained | **SOM Organic Revegetated** | Total Net CO₂ Emission / Removal

Biomass gains (G&L 1/4) | Biomass loss (G&L 2/4) | Biomass loss (G&L 3/4) | Biomass loss (G&L 4/4) | Biomass (G&L - Abrupt) | **Biomass (SD - Approach 1)** | Biomass (SD - Approaches 2&3) | DOM (G&L) | DOM (SD - Approach 1) | DOM (SD - Approaches 2&3) | SOM Mineral - Eq. 2.25 Formulation A

Worksheet

Sector: Agriculture, Forestry and Other Land Use 2020

Category: Forest Land

Subcategory: 3.B.1.a - Forest land Remaining Forest land

Sheet: Annual net C stock change in biomass - Stock difference method - Approach 1

Data

Region Region 1 - Approach 1

Land use category			Equation 2.8 - Approach 1														
			Biomass conversion and expansion factor from merchantable growing stock volume to above-ground biomass (t d.m. / m3 volum)	Biomass expansion factor from growing stock volume (including bark) to above-ground biomass volume	Basic wood density (t d.m. / m3 fresh volume)	Total merchantable growing stock volume at the end of the inventory period (m3)	Total final above-ground biomass (t d.m.)	Total merchantable growing stock volume at the beginning of the inventory period (m3)	Total initial above-ground biomass (t d.m.)	Ratio of below-ground biomass to above-ground biomass (t bg d.m. / t ag d.m.)	Carbon fraction of dry matter (tonnes C / tonne d.m.)	Total final biomass C stock (tonne C)	Total initial biomass C stock (tonne C)	Time period between two inventories (Year)	Annual change in carbon stocks in biomass (tonnes C / yr)		
Land unit code	Land use during reporting year		BCEFs = BEF2 * D or specified	Table 3A.1.10 - Annex 3A.10 of the Good Practice Guidance for Land Use, Land-use Change, and Fore	Tables 4.13 / 4.14 / 4.6 WS	National statistics or international data sources	AB(final) = V(t2) * BCEFs	National statistics or international data sources	AB(initial) = V(t1) * BCEFs	Table 4.4 / 4.5 WS	Table 4.3	CB(final) = AB (final) * (1+R) * CF	CB(initial) = AB (initial) * (1+R) * CF	T = t2 - t1	ΔCB = (CB(final) - CB(initial)) / T		
▼	Δ ▼	Δ ▼	BCEFs	BEF2	D	V(t2)	AB(final)	V(t1)	AB(initial)	R	CF	CB(final)	CB(initial)	T	ΔCB		
► MFL_1	Manage...	Second...	0.67			181.500	121.605	177.500	118.925	0.22	0.470	69.728	68.192	5.000	0.307		
Total												69.728	68.192		0.307		

Forest land remaining Forest land - DOM

SOM Mineral - Eq. 2.25 Formulation B		SOM (SD - Approach 1)		SOM (SD - Approaches 2&3)		SOM Organic Drained		SOM Organic Rewetted		Total Net CO2 Emission / Removal	
Biomass gains (G&L 1/4)		Biomass loss (G&L 2/4)		Biomass loss (G&L 3/4)		Biomass loss (G&L 4/4)		Biomass (G&L - Abrupt)		Biomass (SD - Approach 1)	
										DOM (G&L)	
										DOM (SD - Approach 1)	
										DOM (SD - Approaches 2&3)	
										SOM Mineral - Eq. 2.25 Formulation A	

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Forest Land

Subcategory: 3.B.1.a - Forest land Remaining Forest land

Sheet: Annual net C stock change in dead organic matter (Stock difference method) - Approach 1

Data

Region: Region 1 - Approach 1

Land use category			Equation 2.19 - Approach 1										
			DOM C pool	Total Dead Wood/Litter stock at the end of the inventory period (t d.m.)	Total Dead Wood/Litter stock at the beginning of the inventory period (t d.m.)	Carbon fraction of dry matter (tonnes C / tonne d.m.)	Total final Dead Wood/Litter C stock (tonnes C)	Total initial Dead Wood/Litter C stock (tonnes C)	Time period between two inventories (Year)	Annual change in carbon stocks in dead wood/litter (tonnes C / yr)			
Land unit code	Land use during reporting year			National statistics or international data sources	National statistics or international data sources	for litter IPCC default is 0.37	$CDOM(final) = DOM(t2) * CF$	$CDOM(initial) = DOM(t1) * CF$	$T = t2 - t1$	$\Delta C(DOM) = (CDOM(final) - CDOM(initial)) / T$			
				DOM(t2)	DOM(t1)	CF	CDOM(final)	CDOM(initial)	T	ΔC(DOM)			
► MFL_1	Managed For...	Secondary for...	Dead wood	81.600	79.800	0.490	39.984	39.102	5.000	0.176			
			Litter	17.300	16.900	0.37	6.401	6.253	5.000	0.030			
Total										0.206			

Mineral soil SOC change – Equation 2.25

BOX 2.1 (UPDATED)

ALTERNATIVE FORMULATIONS OF EQUATION 2.25 FOR APPROACH 1 ACTIVITY DATA VERSUS APPROACH 2 OR 3 ACTIVITY DATA WITH TRANSITION MATRICES

Two alternative formulations are possible for Equation 2.25 depending on the Approach used to collect activity data, including

Formulation A (Approach 1 for Activity Data Collection)

$$\Delta C_{Mineral} = \frac{\left[\sum_{c,s,i} \left(SOC_{REF_{c,s,i}} \cdot F_{LU_{c,s,i}} \cdot F_{MG_{c,s,i}} \cdot F_{I_{c,s,i}} \cdot A_{c,s,i} \right) \right]_0 - \left[\sum_{c,s,i} \left(SOC_{REF_{c,s,i}} \cdot F_{LU_{c,s,i}} \cdot F_{MG_{c,s,i}} \cdot F_{I_{c,s,i}} \cdot A_{c,s,i} \right) \right]_{(0-T)}}{D}$$

Formulation B (Approaches 2 and 3 for Activity Data Collection)

$$\Delta C_{Mineral} = \frac{\sum_{c,s,p} \left[\left\{ \left(SOC_{REF_{c,s,p}} \cdot F_{LU_{c,s,p}} \cdot F_{MG_{c,s,p}} \cdot F_{I_{c,s,p}} \right)_0 - \left(SOC_{REF_{c,s,p}} \cdot F_{LU_{c,s,p}} \cdot F_{MG_{c,s,p}} \cdot F_{I_{c,s,p}} \right)_{(0-T)} \right\} \cdot A_{c,s,p} \right]}{D}$$

Where:

p = a parcel of land representing an individual unit of area over which the inventory calculations are performed.

The *Software* applies to each unit of land the formulation associated with the approach for land representation selected for the *Region* to which the unit of land belongs

Equation 2.25 – Formulation A

$$\Delta C_{\text{Mineral}} = \frac{(SOC_{0_GHGI} - SOC_{(0-T)_GHGI})}{D}$$

$$= \frac{[\sum_{c,s,i} (SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i})]_0 - [\sum_{c,s,i} (SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i})]_{(0-D)}}{D}$$

Where, **D** is the **transition period** (*IPCC default is 20 years*), and **c** (*climate*), **s** (*soil*), **i** (*management system*) correspond to **variables** according to which the **unit of land** is **stratified**

According to such variables, **SOC at equilibrium**, in any inventory year, for each unit of land **c,s,i**, is calculated according to the subdivision in Year:

✓ $SOC_0 = (SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i})_0$ *in the current inventory year, Y = 0; t C*

✓ $SOC_{0-D} = (SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i})_{0-D}$ *in D years (20-year) before the current inventory year, Y = 0 – D; t C*

Consequently, the net annual SOC change is calculated as: $\Delta C_{\text{Mineral}} = \frac{SOC_0 - SOC_{0-D}}{D}$

Equation 2.25 – Formulation B – Approach 2

$$\Delta C_{Mineral} = \frac{(SOC_{0_GHGI} - SOC_{(0-T)_GHGI})}{T}$$

$$= \frac{\sum_{c,s,i,p} \left\{ \left[(SOC_{REF_{c,s,p}} \cdot F_{LU_{c,i,p}} \cdot F_{MG_{c,i,p}} \cdot F_{I_{c,i,p}})_0 - (SOC_{REF_{c,s,p}} \cdot F_{LU_{c,i,p}} \cdot F_{MG_{c,i,p}} \cdot F_{I_{c,i,p}})_{0-T} \right] \cdot A_{c,s,i,p} \right\}}{D}$$

Where, **D** is the **transition period** (*IPCC default is 20 years*), and **c** (*climate*), **s** (*soil*), **i** (*management system*) correspond to **variables** according to which the **unit of land** is **stratified**

According to such variables, **SOC at equilibrium**, in any inventory year, for each unit of land **c,s,i**, is calculated according to the subdivision in Year:

✓ $SOC_0 = (SOC_{REF_{c,s,p}} \cdot F_{LU_{c,i,p}} \cdot F_{MG_{c,i,p}} \cdot F_{I_{c,i,p}})_0$ *in the current inventory year, Y = 0; t C ha⁻¹*

✓ $SOC_{0-T} = (SOC_{REF_{c,s,p}} \cdot F_{LU_{c,i,p}} \cdot F_{MG_{c,i,p}} \cdot F_{I_{c,i,p}})_{0-T}$ *in the the year before the conversion occurred, Y = 0-T; t C ha⁻¹*

Consequently, the net annual SOC change is calculated as: $\Delta C_{Mineral} = \frac{SOC_0 - SOC_{0-T}}{D} * A$

Equation 2.25 – Formulation B – Approach 3

$$\Delta C_{Mineral} = \frac{(SOC_{0_GHGI} - SOC_{(0-T)_GHGI})}{T}$$

$$= \frac{\sum_{c,s,i,p} \left\{ \left[(SOC_{REF_{c,s,p}} \cdot F_{LU_{c,i,p}} \cdot F_{MG_{c,i,p}} \cdot F_{I_{c,i,p}})_0 - SOC_{@conversion_{c,s,i,p}(0-T)} \right] \cdot A_{c,s,i,p} \right\}}{D}$$

Where, **D** is the **transition period** (*IPCC default is 20 years*), and **c** (*climate*), **s** (*soil*), **i** (*management system*) correspond to **variables** according to which the **unit of land** is **stratified**

According to such variables, **SOC at equilibrium**, in the **current inventory year**, for each unit of land **c,s,i**, is calculated according to the **current subdivision**:

✓ $SOC_0 = (SOC_{REF_{c,s,p}} \cdot F_{LU_{c,i,p}} \cdot F_{MG_{c,i,p}} \cdot F_{I_{c,i,p}})_0$ in the current inventory year $Y = 0$; t C ha⁻¹

While the **SOC just before the conversion** ($SOC_{@conversion_{0-T}}$) is **NOT** calculated as **SOC at equilibrium** of the subdivision in the latest year before the conversion $Y = 0-T$, it is calculated with Eq 2.25 Formulation B and according to the number of years passed from any previous conversion

✓ $SOC_{@conversion_{(0-T)}}$ is instead the actual SOC of the unit of land in the latest year $0-T$ before the conversion; t C ha⁻¹

Consequently, the net annual SOC change is calculated as: $\Delta C_{Mineral} = \frac{SOC_0 - SOC_{@conversion_{(0-T)}}}{D} * A$

Forest land remaining Forest land - SOM

SOM Mineral - Eq. 2.25 Formulation B										
SOM (SD - Approach 1)										
SOM (SD - Approaches 2&3)										
SOM Organic Drained										
SOM Organic Rewetted										
Total Net CO2 Emission / Removal										
Biomass gains (G&L 1/4)										
Biomass loss (G&L 2/4)										
Biomass loss (G&L 3/4)										
Biomass loss (G&L 4/4)										
Biomass (G&L - Abrupt)										
Biomass (SD - Approach 1)										
Biomass (SD - Approaches 2&3)										
DOM (G&L)										
DOM (SD - Approach 1)										
DOM (SD - Approaches 2&3)										
SOM Mineral - Eq. 2.25 Formulation A										
Worksheet										
Sector: Agriculture, Forestry and Other Land Use										
Category: Forest Land										
Subcategory: 3.B.1.a - Forest land Remaining Forest land										
Sheet: SOM Mineral - Eq. 2.25 Formulation A										
Data										
Region: Region 1 - Approach 1										
Land use category										
Equation 2.25 Formulation A										
Land unit code	Land use during reporting year		Soil organic carbon stock in mineral soils in year 2020 (tonnes C)	Soil organic carbon stock in mineral soils in year 2000 (tonnes C)	Annual change in carbon stocks in mineral soils (tonnes C / yr)					
			SOC(2020)	SOC(2000)	$\Delta C_{\text{mineral}} = ((\text{SOC}(2020) - \text{SOC}(2000)) / 20)$					
MFL_1	Managed Forest Land	Secondary forest	60,480.000	63,000.000	-126.000					
Total			60,480.000	63,000.000	-126.000					

Forest land remaining Forest land - Summary

Biomass gains (G&L 1/4) | Biomass loss (G&L 2/4) | Biomass loss (G&L 3/4) | Biomass loss (G&L 4/4) | Biomass (G&L - Abrupt) | Biomass (SD - Approaches 1 & 2) | Biomass (SD - Approaches 2&3) | DOM (G&L) | DOM (SD - Approach 1) | DOM (SD - Approaches 2&3) | SOM Mineral - Eq. 2.25 Formulation A | SOM Mineral - Eq. 2.25 Formulation B | SOM (SD - Approach 1) | SOM (SD - Approaches 2&3) | SOM Organic Drained | SOM Organic Rewetted | **Total Net CO2 Emission / Removal**

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Land

Subcategory: 3.B.1.a - Forest land Remaining Forest land

Sheet: Total Net CO2 Emission / Removal

Data

Region (All) - All Approaches

2020

Equation 2.2, 2.3

Land unit					Net carbon stock change (tonnes C / yr)												
Land use category					Area (ha)		Biomass gain		Biomass loss		Biomass total		Dead organic matter		Soil organic matter		
Land unit code	Initial land use		Land use during reporting year		Mineral soil	Organic soil	Above-ground	Below-ground	Above-ground	Below-ground	Above-ground	Below-ground	Dead wood	Litter	Mineral soil	Organic soil	Total Net CO2 Emission / Removal (Gg CO2)
▽	Δ▽	Δ▽	Δ▽	Δ▽			A	B	C	D	E = A + C	F = B + D	G	H	I	J	$K = ((E + F + G + H + I + J) * - (44/12)) / 1000$
MFL_1	NA	NA	Manag...	Secon...	960.000		0.252	0.055	0.000	0.000	0.252	0.055	0.176	0.030	-126.000		0.460
MFL-M...	Manag...	Forest...		Forest...		2,000.000	17,578.000	0.000	0.000		17,578.000	0.000					-64.453
UFL-M...		Forest...		Forest...		85.000	747.065	0.000	0.000		747.065	0.000					-2.739
UFL-M...	Unman...	Primar...		Forest...		600.000	5,273.400	0.000	0.000		5,273.400	0.000					-19.336
UFL-M...		Primar...		Forest...		350.000	3,076.150	0.000	0.000		3,076.150	0.000					-11.279
UFL-M...		Primar...		Forest...		175.000	1,538.075	0.000	0.000		1,538.075	0.000					-5.640
Total					960.000	3,210.000	28,212.942	0.055	0.000	0.000	28,212.942	0.055	0.176	0.030	-126.000	0.000	-102.986

Grassland

Grassland Data

C pool	Stock _{longterm} t d.m. ha ⁻¹	R(a)	CF	T	Grassland						
					1990	1995	2000	2005	2010	2015	2020
					t d.m.						
Biomass (herbaceous)	13.5	4	0.5	5	27,000	27,000	25,515	25,380	25,245	25,110	25,110
Biomass (woody)			0.47	5							
dead wood			0.49	5							
litter	0.78		0.37	5	1,560	1,560	1,474	1,466	1,459	1,451	1,451

Grassland remaining Grassland - Biomass

SOM (SD - Approaches 2&3)		SOM Organic D...		SOM Mineral - Eq. 2.25 Formulation A		SOM Mineral - Eq. 2.25 Formulation B		Total Net CO2 Emission / Removal											
Biomass change (G&L)		Biomass (G&L - Abrup)		Biomass (SD - Approach 1)		Biomass (SD - Approaches 2&3)		DOM (SD - Approach 1)		DOM (G&L)		DOM (SD - Approaches 2&3)		SOM (SD - Approach 1)		SOM Mineral - Eq. 2.25 Formulation A		SOM Mineral - Eq. 2.25 Formulation B	
Worksheet																			
Sector: Agriculture, Forestry and Other Land Use Category: Grassland Subcategory: 3.B.3.a - Grassland Remaining Grassland Sheet: Annual net C stock change in biomass - Stock difference method - Approach 1																			
Data																			
Region Region 1 - Approach 1																			
Land use category		Equation 2.8 - Approach 1																	
		C pool	Unit	Total above-ground biomass at the end of the inventory period (tonnes U)	Total above-ground biomass at the beginning of the inventory period (tonnes U)	Ratio of below-ground biomass to above-ground biomass (t bg U / t ag U)	Biomass carbon fraction (tonnes C / tonne U)	Total final biomass C stock (tonne C)	Total initial biomass C stock (tonne C)	Time period between two inventories (Year)	Annual change in carbon stocks in biomass (tonnes C / yr)								
Land unit code	Land use during reporting year		d.m. or C	National statistics or international data sources	National statistics or international data sources	Table 4.4 / 4.5 WS	Tables 4.3	$CB(final) = AB(final) * (1+R) * CF$	$CB(initial) = AB(initial) * (1+R) * CF$	$T = t2 - t1$	$\Delta CB = (CB(final) - CB(initial)) / T$								
			U	AB(final)	AB(initial)	R	CF	CB(final)	CB(initial)	T	ΔCB								
► MGL_1	Managed...	Grazed	Herbaceous	d.m.	25,110.000	25,110.000	4	0.500	62,775.000	62,775.000	5.000	0.000							
■ MGL_1		Grazed	Woody	d.m.	⚠	⚠	⚠	0.470			⚠								
Total									62,775.000	62,775.000		0.000							

Grassland remaining Grassland - DOM

SOM (SD - Approaches 2&3) | SOM Organic Drained | **SOM Organic Rewetted** | Total Net CO2 Emission / Removal

Biomass change (G&L) | Biomass (G&L - Abrupt) | Biomass (SD - Approach 1) | Biomass (SD - Approaches 2&3) | **DOM (SD - Approach 1)** | DOM (G&L) | DOM (SD - Approaches 2&3) | SOM (SD - Approach 1) | SOM Mineral - Eq. 2.25 Formulation A | SOM Mineral - Eq. 2.25 Formulation B

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Grassland

Subcategory: 3.B.3.a - Grassland Remaining Grassland

Sheet: Annual net C stock change in dead organic matter (Stock difference method) - Approach 1

Data

Region: Region 1 - Approach 1

Land use category			Equation 2.19 - Approach 1											
			DOM C pool	Total Dead Wood/Litter stock at the end of the inventory period (t d.m.)	Total Dead Wood/Litter stock at the beginning of the inventory period (t d.m.)	Carbon fraction of dry matter (tonnes C / tonne d.m.)	Total final Dead Wood/Litter C stock (tonnes C)	Total initial Dead Wood/Litter C stock (tonnes C)	Time period between two inventories (Year)	Annual change in carbon stocks in dead wood/litter (tonnes C / yr)				
Land unit code	Land use during reporting year			National statistics or international data sources	National statistics or international data sources	for litter IPCC default is 0.37	$CDOM(final) = DOM(t2) * CF$	$CDOM(initial) = DOM(t1) * CF$	$T = t2 - t1$	$\Delta C(DOM) = (CDOM(final) - CDOM(initial)) / T$				
	Δ	Δ		DOM(t2)	DOM(t1)	CF	CDOM(final)	CDOM(initial)	T	ΔC(DOM)				
MGL_1	Managed Gra...	Grazed	Dead wood	1,451.000	1,451.000	0.37	536.870	536.870	5.000	0.000				
			Litter											
Total											0.000			

Grassland remaining Grassland - SOM

SOM (SD - Approaches 2&3)

SOM Organic Drained

SOM Organic Rewetted

Total Net CO2 Emission / Removal

Biomass change (G&L)

Biomass (G&L - Abrupt)

Biomass (SD - Approach 1)

Biomass (SD - Approaches 2&3)

DOM (SD - Approach 1)

DOM (G&L)

DOM (SD - Approaches 2&3)

SOM (SD - Approach 1)

SOM Mineral - Eq. 2.25 Formulation A

SOM Mineral - Eq. 2.25 Formulation B

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Grassland

Subcategory: 3.B.3.a - Grassland Remaining Grassland

Sheet: SOM Mineral - Eq. 2.25 Formulation A

Data

Region

Region 1

- Approach 1

Land use category			Equation 2.25 Formulation A		
Land unit code	Land use during reporting year		Soil organic carbon stock in mineral soils in year 2020 (tonnes C)	Soil organic carbon stock in mineral soils in year 2000 (tonnes C)	Annual change in carbon stocks in mineral soils (tonnes C / yr)
			SOC(2020)	SOC(2000)	$\Delta C_{\text{mineral}} = ((\text{SOC}(2020) - \text{SOC}(2000)) / 20)$
MGL_1	Managed Grassland	Grazed	130,069.800	132,167.700	-104.895
Total			130,069.800	132,167.700	-104.895

Grassland remaining Grassland - Summary

Biomass change (G&L) Biomass (G&L - Abrupt) Biomass (SD - Approach 1) Biomass (SD - Approaches 2&3) DOM (SD - Approach 1) DOM (G&L) DOM (SD - Approaches 2&3) SOM (SD - Approach 1) SOM Mineral - Eq. 2.25 Formulation A SOM Mineral - Eq. 2.25 Formulation B															
SOM (SD - Approaches 2&3) SOM Organic Drained SOM Organic Rewetted Total Net CO2 Emission / Removal															
Worksheet															
Sector: Agriculture, Forestry and Other Land Use Category: Land Subcategory: 3.B.3.a - Grassland Remaining Grassland Sheet: Total Net CO2 Emission / Removal															2020
Data															
Region: (All) - All Approaches															
Equation 2.2, 2.3															
Land unit						Net carbon stock change (tonnes C / yr)									
Land use category					Area (ha)	Biomass gain		Biomass loss		Biomass total		Dead organic matter		Soil organic matter	
Land unit code	Initial land use	Land use during reporting year			Mineral soil	Organic soil	Above-ground	Below-ground	Above-ground	Below-ground	Above-ground	Below-ground	Dead wood	Litter	Total Net CO2 Emission / Removal (Gg CO2)
▼	△▼	△▼	△▼	△▼			A	B	C	D	E = A + C	F = B + D	G	H	$K = ((E + F + G + H + I + J) \cdot - (44/12)) / 1000$
► MGL_1	NA	NA	Manag...	Grazed	1,860.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.385
Total					1,860.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.385

Settlements

Settlements Data

C pool	City Tree Inventory						
	1990	1995	2000	2005 t d.m.	2010	2015	2020
Biomass (woody)	1,390	1,510	1,793	2,275	2,855	3,496	3,978
Dead Wood	0	0	0	0	0	0	0
Litter	0	0	0	0	0	0	0

Settlements remaining Settlements - Biomass

SOM (SD - Approaches 2&3) SOM Organic Drained SOM Organic Revegetated Total Net CO2 Emission / Removal

Biomass change (G&L) Biomass (G&L - Abrupt) **Biomass (SD - Approach 1)** Biomass (SD - Approaches 2&3) DOM (G&L) DOM (SD - Approach 1) DOM (SD - Approaches 2&3) SOM Mineral - Eq. 2.25 Formulation A SOM Mineral - Eq. 2.25 Formulation B SOM (SD - Approach 1)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Settlements

Subcategory: 3.B.5.a - Settlements Remaining Settlements

Sheet: Annual net C stock change in biomass - Stock difference method - Approach 1

Data

Region Region 1 - **Approach 1**

Land use category			Equation 2.8 - Approach 1									
			Unit	Total above-ground biomass at the end of the inventory period (tonnes U)	Total above-ground biomass at the beginning of the inventory period (tonnes U)	Ratio of below-ground biomass to above-ground biomass (t bg U / t ag U)	Biomass carbon fraction (tonnes C / tonne U)	Total final biomass C stock (tonne C)	Total initial biomass C stock (tonne C)	Time period between two inventories (Year)	Annual change in carbon stocks in biomass (tonnes C / yr)	
Land unit code	Land use during reporting year		d.m. or C	National statistics or international data sources	National statistics or international data sources	Table 4.4 / 4.5 WS	Tables 4.3	$CB(final) = AB(final) * (1+R) * CF$	$CB(initial) = AB(initial) * (1+R) * CF$	$T = t2 - t1$	$\Delta CB = (CB(final) - CB(initial)) / T$	
▼	Δ ▼	Δ ▼	U	AB(final)	AB(initial)	R	CF	CB(final)	CB(initial)	T	ΔCB	
OSL_1	Settlements...	Buildings	d.m.	3,978.000	3,496.000	0.34	0.470	2,505.344	2,201.781	5.000	60.713	
Total								2,505.344	2,201.781		60.713	

Settlements remaining Settlements - DOM

SOM (SD - Approaches 2&3) SOM Organic Drained SOM Organic Rewetted Total Net CO2 Emission / Removal

Biomass change (G&L) Biomass (G&L - Abrupt) Biomass (SD - Approach 1) Biomass (SD - Approaches 2&3) DOM (G&L) **DOM (SD - Approach 1)** DOM (SD - Approaches 2&3) SOM Mineral - Eq. 2.25 Formulation A SOM Mineral - Eq. 2.25 Formulation B SOM (SD - Approach 1)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Settlements

Subcategory: 3.B.5.a - Settlements Remaining Settlements

Sheet: Annual net C stock change in dead organic matter (Stock difference method) - Approach 1

Data

Region: Region 1 - Approach 1

Land use category			Equation 2.19 - Approach 1										
			DOM C pool	Total Dead Wood/Litter stock at the end of the inventory period (t d.m.)	Total Dead Wood/Litter stock at the beginning of the inventory period (t d.m.)	Carbon fraction of dry matter (tonnes C / tonne d.m.)	Total final Dead Wood/Litter C stock (tonnes C)	Total initial Dead Wood/Litter C stock (tonnes C)	Time period between two inventories (Year)	Annual change in carbon stocks in dead wood/litter (tonnes C / yr)			
Land unit code	Land use during reporting year			National statistics or international data sources	National statistics or international data sources	for litter IPCC default is 0.37	$CDOM(final) = DOM(t2) * CF$	$CDOM(initial) = DOM(t1) * CF$	$T = t2 - t1$	$\Delta C(DOM) = (CDOM(final) - CDOM(initial)) / T$			
	Δ	Δ		DOM(t2)	DOM(t1)	CF	CDOM(final)	CDOM(initial)	T	ΔC(DOM)			
OSL_1	Settlements (...)	Buildings	Dead wood	❗	❗	❗			❗				
			Litter	❗	❗	❗			❗				
Total											0.000		

Settlements remaining Settlements - SOM

SOM (SD - Approaches 2&3)		SOM Organic Drained		SOM Organic Rewetted		Total Net CO2 Emission / Removal			
Biomass change (G&L)		Biomass (G&L - Abrupt)		Biomass (SD - Approach 1)		Biomass (SD - Approaches 2&3)		DOM (G&L)	
								DOM (SD - Approach 1)	
								DOM (SD - Approaches 2&3)	
								SOM Mineral - Eq. 2.25 Formulation A	
								SOM Mineral - Eq. 2.25 Formulation B	
								SOM (SD - Approach 1)	

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Settlements

Subcategory: 3.B.5.a - Settlements Remaining Settlements

Sheet: SOM Mineral - Eq. 2.25 Formulation A

Data

Region Region 1 - Approach 1

Land use category			Equation 2.25 Formulation A		
Land unit code	Land use during reporting year		Soil organic carbon stock in mineral soils in year 2020 (tonnes C)	Soil organic carbon stock in mineral soils in year 2000 (tonnes C)	Annual change in carbon stocks in mineral soils (tonnes C / yr)
			SOC(2020)	SOC(2000)	$\Delta C_{\text{mineral}} = ((\text{SOC}(2020) - \text{SOC}(2000)) / 20)$
OSL_1	Settlements (Other)	Buildings	11,340.000	6,930.000	220.500
Total			11,340.000	6,930.000	220.500

2020

Settlements remaining Settlements - Summary

<div> <div>Biomass change (G&L)</div> <div>Biomass (G&L - Abrupt)</div> <div>Biomass (SD - Approach 1)</div> <div>Biomass (SD - Approaches 2&3)</div> <div>DOM (G&L)</div> <div>DOM (SD - Approach 1)</div> <div>DOM (SD - Approaches 2&3)</div> <div>SOM Mineral - Eq. 2.25 Formulation A</div> <div>SOM Mineral - Eq. 2.25 Formulation B</div> <div>SOM (SD - Approach 1)</div> </div>																
<div> <div>SOM (SD - Approaches 2&3)</div> <div>SOM Organic Drained</div> <div>SOM Organic Rewetted</div> <div>Total Net CO2 Emission / Removal</div> </div>																
Worksheet																
<div> <div>Sector:</div> <div>Agriculture, Forestry and Other Land Use</div> </div>																2020
<div> <div>Category:</div> <div>Land</div> </div>																
<div> <div>Subcategory:</div> <div>3.B.5.a - Settlements Remaining Settlements</div> </div>																
<div> <div>Sheet:</div> <div>Total Net CO2 Emission / Removal</div> </div>																
Data																
<div> <div>Region</div> <div>(All)</div> <div>- All Approaches</div> </div>																
Equation 2.2, 2.3																
Land unit					Net carbon stock change (tonnes C / yr)											
Land use category					Area (ha)		Biomass gain		Biomass loss		Biomass total		Dead organic matter		Soil organic matter	
Land unit code	Initial land use		Land use during reporting year		Mineral soil	Organic soil	Above-ground	Below-ground	Above-ground	Below-ground	Above-ground	Below-ground	Dead wood	Litter	Mineral soil	Organic soil
	Δ	Δ	Δ	Δ			A	B	C	D	E = A + C	F = B + D	G	H	I	J
OSL_1	NA	NA	Settlem...	Buildin...	180.000		45.308	15.405	0.000	0.000	45.308	15.405			220.500	
TSL-T...	Settlem...	Urban...	Settlem...	Urban...		100.000			0.000		0.000	0.000				
Total					180.000	100.000	45.308	15.405	0.000	0.000	45.308	15.405	0.000	0.000	220.500	0.000
																-1.031

Region 2

Calculation Worksheets

I. Forest land remaining Forest land

- ✓ Biomass, DOM: – IPCC Default (G&L), SOM Drained

II. Cropland remaining Cropland

- ✓ Biomass, DOM: – IPCC Default (G&L), SOM Rewetted

III.A Wetlands remaining Wetlands

- ✓ Biomass, DOM: – IPCC Default (G&L), SOM Rewetted

III.B Settlements converted to Wetlands

- ✓ Biomass, DOM: – IPCC Default (G&L), SOM Rewetted

IV.A Settlements remaining Settlements

- ✓ Biomass, DOM: – IPCC Default (G&L), SOM Drained

IV.B Forest land converted to Settlements

- ✓ Biomass, DOM: – IPCC Default (G&L), SOM Drained

IV.C Wetlands converted to Settlements

- ✓ Biomass, DOM: – IPCC Default (G&L), SOM Extracted

Forest land

Forest land remaining Forest land – Biomass (Losses)

Region	Category	Subcategory	Subdivision	R	CF	D	Growing stock level	Net Annual Increment	BCEF _I	BCEF _S	BCEF _R
2	Forest land	Managed	Forest plantation	0.200	0.470	0.555	166	16.6	0.850	0.990	1.050
2	Forest land	Unmanaged	Primary forest	0.200	0.470		232			0.950	

Forest land remaining Forest land – Biomass (Gains)

SOM Mineral - Eq. 2.25 Formulation B														
SOM (SD - Approach 1)														
SOM (SD - Approaches 2&3)														
SOM Organic Drained														
SOM Organic Rewetted														
Total Net CO2 Emission / Removal														
Biomass gains (G&L 1/4)														
Biomass loss (G&L 2/4)														
Biomass loss (G&L 3/4)														
Biomass loss (G&L 4/4)														
Biomass (G&L - Abrupt)														
Biomass (SD - Approach 1)														
Biomass (SD - Approaches 2&3)														
DOM (G&L)														
DOM (SD - Approach 1)														
DOM (SD - Approaches 2&3)														
SOM Mineral - Eq. 2.25 Formulation A														
Worksheet														
Sector: Agriculture, Forestry and Other Land Use														
Category: Forest Land														
Subcategory: 3.B.1.a - Forest land Remaining Forest land														
Sheet: 1 of 4 Annual increase in carbon stocks in biomass (includes above-ground and below-ground biomass)														
Data														
Region: Region 2 - Approach 2														
Land use category				Equation 2.9		Equation 2.10						Equation 2.9		
				Area (ha)	Mean annual increment of growing stock (m3 / ha / yr)	Biomass expansion factor for conversion of annual net increment to above-ground biomass increment	Basic wood density (t d.m. / m3 fresh volume)	Biomass conversion and expansion factor for increment (t d.m. / m3 wood volume)	Average annual above-ground biomass growth (tonnes d.m. / (ha * yr))	Ratio of below-ground biomass to above-ground biomass (t bg d.m. / t ag d.m.)	Average annual biomass growth above- and below-ground (tonnes d.m. / (ha * yr))	Carbon fraction of dry matter (tonnes C / tonne d.m.)	Annual increase in biomass carbon stocks due to biomass growth (tonnes C / yr)	
Land unit code	Initial land use	Land use during reporting year		National statistics or international data sources	National statistics or international data sources	Table 3.A.1.10 / National statistics or international data sources	Tables 4.13 / 4.14 / 4.6 WS / National statistics or international data sources	BCEFI = BEF1 * D / Specified	Gw = Iv * BCEFI / Specified	Zero (0) or Table 4.4 / 4.5 WS / National statistics or international data sources	Gtotal = Gw * (1+R)	0.47 / Table 4.3 / 0.451 WS mangroves	ΔCG = A * Gtotal * CF	
	Δ	Δ	Δ	A	Iv	BEF1	D	BCEFI	Gw	R	Gtotal	CF	ΔCG	
► MFL-MFL...	Managed...	Forest pla...	Managed...	Forest pla...	2,000.000	16.600		0.850	14.110	0.000	14.110	0.470	13,263.400	
UFL-MFL...	Unmanag...	Primary F...		Forest pla...	600.000	16.600		0.850	14.110	0.2	16.932	0.470	4,774.824	
UFL-MFL...		Primary F...		Forest pla...	350.000	16.600		0.850	14.110	0.2	16.932	0.470	2,785.314	
UFL-MFL...		Primary F...		Forest pla...	175.000	16.600		0.850	14.110	0.2	16.932	0.470	1,392.657	
UFL-MFL...		Primary F...		Forest pla...	85.000	16.600		0.850	14.110	0.2	16.932	0.470	676.433	
Total					3,210.000						81.838		22,892.628	

Belowground biomass is estimated only in units of land under conversions from unmanaged forest

Forest land remaining Forest land – Biomass (Losses)

Harvesting

ID	Harvest (m ³) - Industrial Roundwood						Harvest (m ³) - Fuelwood					
	1995	2000	2005	2010	2015	2020	1995	2000	2005	2010	2015	2020
MFL-MFL_1	13,280	13,280	13,280	13,280	13,280	13,280	3,320	3,353	3,420	3,486	3,552	335,552
UFL-MFL_2000-1		IE						IE	IE	IE	IE	
UFL-MFL_2005-1			IE						IE	IE	IE	IE
UFL-MFL_2010-1				IE						IE	IE	IE
UFL-MFL_2015-1					IE						IE	IE
UFL-MFL_2020-1						IE						IE
	13,280	13,280	13,280	13,280	13,280	13,280	3,320	3,353	3,420	3,486	3,552	335,552

Forest land remaining Forest land – Biomass (Losses)

Harvesting: Industrial Roundwood

SOM Mineral - Eq. 2.25 Formulation B - SOM (SD - Approach 1) SOM (SD - Approaches 2&3) SOM Organic Drained SOM Organic Rewetted Total Net CO2 Emission / Removal											
Biomass gains (G&L 1/4) Biomass loss (G&L 2/4) Biomass loss (G&L 3/4) Biomass loss (G&L 4/4) Biomass (G&L - Abrupt) Biomass (SD - Approach 1) Biomass (SD - Approaches 2&3) DOM (G&L) DOM (SD - Approach 1) DOM (SD - Approaches 2&3) SOM Mineral - Eq. 2.25 Formulation A											
Worksheet											
Sector: Agriculture, Forestry and Other Land Use											
Category: Forest Land											
Subcategory: 3.B.1.a - Forest land Remaining Forest land											
Sheet: 2 of 4 Loss of carbon from wood removals											
Data											
Region: Region 2 - Approach 2											
Land use category					Equation 2.12						
					Annual wood removal (m3/yr)	Biomass expansion factor for conversion of merchantable volume to above-ground biomass	Basic wood density (t d.m. / m3 fresh volume)	Biomass conversion and expansion factor for wood and fuelwood removal (BCEFr) (t d.m. / m3 wood volume)	Ratio of below-ground biomass to above-ground biomass (t bg d.m. / t ag d.m.)	Carbon fraction of dry matter (tonnes C / tonne d.m.)	Annual carbon loss due to biomass removals (tonnes C / yr)
Land unit code	Initial land use	Land use during reporting year			National statistics or international data sources	Table 3.A.1.10 / National statistics or international data sources	Tables 4.13 / 4.14 / 4.6 WS / National statistics or international data sources	BCEFr = BEF2 * D / Specified	Zero (0) or Table 4.4 / 4.5 WS / National statistics or international data sources	0.47 / Table 4.3 / 0.451 WS mangroves	Lwr = H * BCEFr * (1+R) * CF
	Δ ▽	Δ ▽	Δ ▽	Δ ▽	H	BEF2	D	BCEFr	R	CF	Lwr
► MFL-MFL_1	Managed For...	Forest plantat...	Managed For...	Forest plantat...	13,280,000			1.05	0.000	0.470	6,553,680
UFL-MFL_20...	Unmanaged...	Primary Forest		Forest plantat...						0.470	
UFL-MFL_20...		Primary Forest		Forest plantat...						0.470	
UFL-MFL_20...		Primary Forest		Forest plantat...						0.470	
UFL-MFL_20...		Primary Forest		Forest plantat...						0.470	
Total					13,280,000						6,553,680

Belowground biomass is estimated only in conversions between different forest subdivisions

Forest land remaining Forest land – Biomass (Losses)

Harvesting: Fuelwood

SOM Mineral - Eq. 2.25 Formulation B													
SOM (SD - Approach 1)													
SOM (SD - Approaches 2&3)													
SOM Organic Drained													
SOM Organic Rewetted													
Total Net CO2 Emission / Removal													
Biomass gains (G&L 1/4)													
Biomass loss (G&L 2/4)													
Biomass loss (G&L 3/4)													
Biomass loss (G&L 4/4)													
Biomass (G&L - Abrupt)													
Biomass (SD - Approach 1)													
Biomass (SD - Approaches 2&3)													
DOM (G&L)													
DOM (SD - Approach 1)													
DOM (SD - Approaches 2&3)													
SOM Mineral - Eq. 2.25 Formulation A													
Worksheet													
Sector: Agriculture, Forestry and Other Land Use													
Category: Forest Land													
Subcategory: 3.B.1.a - Forest land Remaining Forest land													
Sheet: 3 of 4 Loss of carbon from fuelwood removals													
Data													
Region: Region 2 - Approach 2													
Land use category													
Equation 2.13													
Annual volume of fuelwood removal of whole trees (m3/yr)													
Biomass expansion factor for conversion of merchantable volume to above-ground biomass													
Basic wood density (t d.m. / m3 fresh volume)													
Biomass conversion and expansion factor for wood and fuelwood removal (BCEFr) (t d.m. / m3 wood volume)													
Ratio of below-ground biomass to above-ground biomass (t bg d.m. / t ag d.m.)													
Annual volume of fuelwood removal as tree parts (m3/yr)													
Basic wood density (t d.m. / m3 fresh volume)													
Carbon fraction of dry matter (tonnes C / tonne d.m.)													
Annual carbon loss due to fuelwood removal (tonnes C / yr)													
Land unit code													
Initial land use													
Land use during reporting year													
FAO Statistics													
Table 3.A.1.10 / National statistics or international data sources													
Tables 4.13 / 4.14 / 4.6 WS / National statistics or international data sources													
BCEFr = BEF2 * D / Specified													
Zero (0) or Table 4.4 / 4.5 WS / National statistics or international data sources													
FAO Statistics													
Tables 4.13 / 4.14 / 4.6 WS / National statistics or international data sources													
0.47 / Table 4.3 / 0.451 WS mangroves													
Lfw = [FGtrees * BCEFr * (1+R) + FGpart * D] * CF													
FGtrees													
BEF2													
D													
BCEFr													
R													
FGpart													
D													
CF													
Lfw													
Total													
0.000													
335,552,000													
87,528,739													

Fuelwood collected from part of trees only

Salvage logging in unit of land MFL-MFL

Forest land remaining Forest land – DOM

Disturbances: Wildfire

ID	Disturbances					
	1995	2000	2005	2010	2015	2020
MFL-MFL_1						wildfire over 1,000 ha, Fd=0.6
UFL-MFL_2000-1						
UFL-MFL_2005-1						
UFL-MFL_2010-1						
UFL-MFL_2015-1						
UFL-MFL_2020-1						

Non-CO₂ emissions are estimated in category 3.C.1

Forest land remaining Forest land – Biomass (Losses)

Disturbances: Wildfire

SOM Mineral - Eq. 2.25 Formulation B															
SOM (SD - Approach 1)															
SOM (SD - Approaches 2&3)															
SOM Organic Drained															
SOM Organic Rewetted															
Total Net CO2 Emission / Removal															
Biomass gains (G&L 1/4)															
Biomass loss (G&L 2/4)															
Biomass loss (G&L 3/4)															
Biomass loss (G&L 4/4)															
Biomass (G&L - Abrupt)															
Biomass (SD - Approach 1)															
Biomass (SD - Approaches 2&3)															
DOM (G&L)															
DOM (SD - Approach 1)															
DOM (SD - Approaches 2&3)															
SOM Mineral - Eq. 2.25 Formulation A															
Worksheet															
Sector: Agriculture, Forestry and Other Land Use															
Category: Forest Land															
Subcategory: 3.B.1.a - Forest land Remaining Forest land															
Sheet: 4 of 4 Loss of carbon from disturbance															
Data															
Region: Region 2 - Approach 2															
Land use category				Equation 2.14											Equation 2.11
				Area (ha)	Area affected by disturbances (ha / yr)	Biomass expansion factor for conversion of merchantable volume to above-ground biomass	Basic wood density (t d.m. / m3 fresh volume)	Biomass conversion and expansion factor for standing stock (t d.m. / m3 wood volume)	Growing stock level (m3 / ha)	Above-ground biomass stock (t d.m. / ha)	Ratio of below-ground biomass to above-ground biomass (t bg d.m. / t ag d.m.)	Carbon fraction of dry matter (tonnes C / tonne d.m.)	Fraction of biomass lost in disturbance	Annual other losses of carbon (tonnes C / yr)	Annual decrease in carbon stocks due to biomass loss (tonnes C / yr)
Land unit code	Initial land use	Land use during reporting year		National statistics or international data sources	National statistics or international data sources	Table 3.A.1.10 / National statistics or international data sources	Tables 4.13 / 4.14 / 4.6 WS / National statistics or international data sources	BCEFs = BEF2 * D / Specified	National statistics or international data sources	Bw = BCEFs * V / Specified	Zero (0) or Table 4.4 / 4.5 WS / National statistics or international data sources	0.47 / Table 4.3 / 0.451 WS mangroves	National statistics or international data sources	Ldisturb = Adisturb * Bw * (1+R) * CF * fd	ΔCL = Lwr + Lfw + Ldisturb
				A	Adisturb	BEF2	D	BCEFs	V	Bw	R	CF	fd	Ldisturb	ΔCL
► MFL-M...	Manage...	Forest p...	Manage...	Forest p...	2,000,000	1,000,000		0.990	166,000	164,340	0.000	0.470	0.600	46,343.880	141,676.518
UFL-MF...	Unmana...	Primary...		Forest p...	600,000			0.990	166,000	164,340	0.000	0.470		0.000	0.000
UFL-MF...		Primary...		Forest p...	350,000			0.990	166,000	164,340	0.000	0.470		0.000	0.000
UFL-MF...		Primary...		Forest p...	175,000			0.990	166,000	164,340	0.000	0.470		0.000	0.000
UFL-MF...		Primary...		Forest p...	85,000			0.990	166,000	164,340	0.000	0.470		0.000	0.000
Total					3,210,000	1,000,000								46,343.880	141,676.518

Non-CO₂ emissions are estimated in category 3.C.1

Forest land remaining Forest land – DOM

C stock losses in red, C stock gains in green

ID	DOM C stocks in & out d.m. (Dead Wood) - CF 0.49										DOM C stocks in & out d.m. (litter) - CF 0.37									
	1995	2000	2005	2010	2015	2020	1995	2000	2005	2010	2015	2020	1995	2000	2005	2010	2015	2020	1995	2020
MFL-MFL_1																				
UFL-MFL_2000-1		1,107	73,333	1,107	1,107	1,107		553	36,667	553	553	553								
UFL-MFL_2005-1			664	44,000	664	664			332	22,000	332	332						332		
UFL-MFL_2010-1				387	25,667	387					194	12,833						194		
UFL-MFL_2015-1					194	12,833					97	6,417						97		
UFL-MFL_2020-1						94						6,233						47		3,117

Non-CO₂ emissions are estimated in category 3.C.1

Forest land remaining Forest land – DOM

SOM Mineral - Eq. 2.25 Formulation B

SOM (SD - Approach 1)

SOM (SD - Approaches 2&3)

SOM Organic Drained

SOM Organic Rewetted

Total Net CO2 Emission / Removal

DOM (G&L)

DOM (SD - Approach 1)

DOM (SD - Approaches 2&3)

SOM Mineral - Eq. 2.25 Formulation A

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Forest Land

Subcategory: 3.B.1.a - Forest land Remaining Forest land

Sheet: Annual net C stock change in dead organic matter (Gain & Loss method)

Data

Region

Region 2

- Approach 2

Land use category					Equation 2.18										
					DOM C pool	Area (ha)	Average annual transfer of biomass into the dead wood or litter pool due to annual processes and disturbances (t d.m. or C / ha / yr)	Average annual decay and disturbance carbon loss out of dead wood or litter pool (t d.m. or C / ha / yr)	DOM Unit	Carbon fraction of dry matter (tonnes C / tonne d.m.)	Annual change in carbon stocks in dead wood/litter (tonnes C / yr)				
Land unit code	Initial land use	Land use during reporting year				National statistics or international data sources	See Chapter 2. Section 2.3.2.1	See Chapter 2. Section 2.3.2.1		for litter IPCC default is 0.37	$\Delta C(DOM) = A * (DOMin - DOMout) * CF$				
						A	DOMin	DOMout		CF	$\Delta C(DOM)$				
MFL-MFL_1	Managed Fo...	Forest planta...	Managed Fo...	Forest planta...	Dead wood	2,000.000			(t d.m./ha/yr)						
		Forest planta...			Litter				(t d.m./ha/yr)						
UFL-MFL_2005_1	Unmanaged...	Primary Forest			Dead wood	600.000	664.000		(t d.m./ha/yr)	0.490					
		Primary Forest			Litter		332.000		(t d.m./ha/yr)	0.37					
UFL-MFL_2010_1		Primary Forest			Dead wood	350.000	387.000		(t d.m./ha/yr)	0.490					
		Primary Forest			Litter		194.000		(t d.m./ha/yr)	0.37					
UFL-MFL_2015-1		Primary Forest			Dead wood	175.000	194.000		(t d.m./ha/yr)	0.490					
		Primary Forest			Litter		97.000		(t d.m./ha/yr)	0.37					
UFL-MFL_2020-1		Primary Forest			Dead wood	85.000	94.000	6,233.000	(t d.m./ha/yr)	0.490	-255,689.350				
		Primary Forest			Litter		47.000	3,117.000	(t d.m./ha/yr)	0.37	-96,551.500				
Total												-352,240.850			

Non-CO₂ emissions are estimated in category 3.C.1

Forest land remaining Forest land – SOM Drained

ID	SOM Drained
MFL-MFL_1	$EF_{(OS)} - DOC_{(flux)} - \Delta DOC - Frac(DOC)$ IPCC Default values for Temperate climate region
UFL-MFL_2000-1	
UFL-MFL_2005-1	
UFL-MFL_2010-1	
UFL-MFL_2015-1	
UFL-MFL_2020-1	

Non-CO₂ emissions are estimated in categories 3.C.4, .8, .9

Forest land remaining Forest land – SOM Drained

Biomass gains (G&L 1/4) Biomass loss (G&L 2/4) Biomass loss (G&L 3/4) Biomass loss (G&L 4/4) Biomass (G&L 5/4) Abrupt Biomass (SD - Approach 1) Biomass (SD - Approaches 2&3) DOM (G&L) DOM (SD - Approach 1) DOM (SD - Approaches 2&3) SOM Mineral - Eq. 2.25 Formulation A												
SOM Mineral - Eq. 2.25 Formulation B SOM (SD - Approach 1) SOM (SD - Approaches 2&3) SOM Organic Drained SOM Organic Rewetted Total Net CO2 Emission / Removal												
Worksheet												
Sector: Agriculture, Forestry and Other Land Use												
Category: Forest Land												
Subcategory: 3.B.1.a - Forest land Remaining Forest land												
Sheet: Annual net C stock change in soil organic matter of drained organic soils												
Data												
Region: Region 2 - Approach 2												
Land use category					Equation 2.2, 2.3, 2.4, 4.8 WS							
					Area (ha)	CO2 on-site emission factor for climate type and nutrient status of peat and drainage class in drained soils (tonnes CO2-C / ha / yr)	Flux of DOC from natural (undrained) organic soil (tonnes C / ha / yr)	Proportional increase in DOC flux from drained sites relative to undrained sites	Conversion factor for proportion of DOC converted to CO2 following export from site	CO2 off-site emission factor for climate type and nutrient status of peat and drainage class in drained soils (tonnes CO2-C / ha / yr)	CO2 emissions from peat fire in drained land (tonnes CO2-C / yr)	Annual carbon loss from drained organic soils (tonnes C / yr)
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources	Table 4.6 / 2.1 WS / 4.13 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS / Eq. 2.5 or national statistics	From 3.C.1	CO2-C(d) = A(d) * (EF (os) + EF(DOC)) + L (fd)	
	Δ	Δ	Δ	Δ	A(d)	EF(os)	DOC(flux)	ΔDOC	Frac(DOC)	EF(DOC)	L(fd)	CO2-C(d)
► MFL-MFL...	Managed...	Forest plan...	Managed...	Forest plan...	2,000.000	2.6	0.210	0.600	0.900	Calculated	0.302	5,804.800
UFL-MFL...	Unmanage...	Primary Fo...		Forest plan...	600.000	2.6	0.210	0.600	0.900	Calculated	0.302	1,741.440
UFL-MFL...		Primary Fo...		Forest plan...	350.000	2.6	0.210	0.600	0.900	Calculated	0.302	1,015.840
UFL-MFL...		Primary Fo...		Forest plan...	175.000	2.6	0.210	0.600	0.900	Calculated	0.302	507.920
UFL-MFL...		Primary Fo...		Forest plan...	85.000	2.6	0.210	0.600	0.900	Calculated	0.302	246.704
Total					3,210.000							9,316.704

Cropland

Cropland Remaining Cropland – Biomass (Gain&Losses)

variables	unit of land PCL-PCL_1					
	1995	2000	2005	2010	2015	2020
Ai (harvested) ha	120	120	115	104	114	114
fd	1	1	1	1	1	1
R	0	0	0	0	0	0

Cropland Remaining Cropland – Biomass (Gain&Losses)

SOM (SD - Approaches 2&3)

SOM Organic Drained

SOM Organic Rewetted

Total Net CO2 Emission / Removal

Biomass change (G&L)

Biomass (G&L - Abrupt)

Biomass (SD - Approach 1)

Biomass (SD - Approaches 2&3)

DOM (G&L)

DOM (SD - Approach 1)

DOM (SD - Approaches 2&3)

SOM Mineral - Eq. 2.25 Formulation A

SOM Mineral - Eq. 2.25 Formulation B

SOM (SD - Approach 1)

Sector:

Agriculture, Forestry and Other Land Use

Category:

Cropland

Subcategory:

3.B.2.a - Cropland Remaining Cropland

Sheet:

Annual net C stock change in biomass - Gain & Loss method

Data

Region

Region 2

- Approach 2

Land use category					Equation 2.7												
					Area (ha)	Average area-specific annual accumulation rate of above-ground biomass (perennial) (tonnes C / ha / yr) or (tonnes d.m. / ha / yr)	Average annual growth of perennial above-ground biomass (tonnes C / yr)	Area with perennial biomass that is disturbed/cleared in the year (ha)	Above-ground biomass in the area disturbed/cleared (tonnes C / yr) or (tonnes d.m. / yr)	Fraction of biomass lost	Perennial biomass loss (tonnes C / yr)	Ratio of below-ground biomass to above-ground biomass (t bg d.m. / t ag d.m.) or (t bg C / t ag C)	Carbon fraction of perennial biomass dry matter (tonnes C / tonne d.m.)	Annual change in carbon stocks in biomass (tonnes C / yr)			
Land unit code	Initial land use		Land use during reporting year		National statistics or international data sources	National statistics or international data sources	$\Delta C_g = A * G * (1 + R) * CF$	National statistics or international data sources	IPCC default or national/international data	National data	$\Delta C_l = A_l * B * f_d * (1 + R) * CF$	IPCC default or national/international data	IPCC default or national/international data	$\Delta C_b = \Delta C_g - \Delta C_l$			
	Δ	Δ	Δ	Δ	A	G	ΔC_g	A _l	B	f _d	ΔC_l	R	CF	ΔC_b			
PCL-ACL...	Cropland...	Oil Palm	Cropland...	Lotus (co...	5.000				3.570			0	1.000	0.000			
PCL-PCL...		Oil Palm	Cropland...	Oil Palm	2.970.000	2.400	7.128.000	114.000	0.000	1.000	0.000	0.000	1.000	7.128.000			
Total					2.975.000		7.128.000	114.000			0.000			7.128.000			

2020

Although regrowth is to be estimated here, it was estimated TAB Biomass (G&L – Abrupt)

Cropland Remaining Cropland – Biomass (Abrupt)

unit of land PCL-PCL_1						
variables	1995	2000	2005	2010	2015	2020
Ai (harvested) ha	120	120	115	104	114	114
fd	1	1	1	1	1	1
R	0	0	0	0	0	0
units of land in conversion to <i>Lotus</i>						
variables	1995	2000	2005	2010	2015	2020
AB(a), t C			3.57	3.57	3.57	3.57
R(a)*	0	0	0	0	0	0
CF(a)**	1	1	1	1	1	1
* included in AB(a)						
* AB(a) is in t C						

Cropland Remaining Cropland – Biomass (Abrupt)

SOM (SD - Approaches 2&3) Biomass (G&L - Abrupt) SOM Organic Rewetted Total Net CO2 Emission / Removal															
Biomass change (G&L) Biomass (SD - Approach 1) Biomass (SD - Approaches 2&3) DOM (G&L) DOM (SD - Approach 1) DOM (SD - Approaches 2&3) SOM Mineral - Eq. 2.25 Formulation A SOM Mineral - Eq. 2.25 Formulation B SOM (SD - Approach 1)															
Worksheet															
Sector: Agriculture, Forestry and Other Land Use															
Category: Cropland															
Subcategory: 3.B.2.a - Cropland Remaining Cropland															
Sheet: Initial change in biomass carbon stocks on land converted to another land category (abrupt change)															
Data															
Region: Region 2 - Approach 2															
Land use category				Equation 2.16											
				Area (ha)	Unit	Above-ground biomass before the conversion (t U / ha)	Above-ground biomass after the conversion (t U / ha)	Ratio of below-ground biomass to above-ground biomass before the conversion (t bg U / t ag U)	Biomass carbon fraction before the conversion (tonnes C / tonne U)	Biomass C stocks before the conversion (tonne C / ha)	Ratio of below-ground biomass to above-ground biomass after the conversion (t bg U / t ag U)	Biomass carbon fraction after the conversion (tonnes C / tonne U)	Biomass C stocks after the conversion (tonne C / ha)	Annual change in carbon stocks in biomass (tonnes C / yr)	
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources	d.m. or C				National data	IPCC default or national/international data	$CB(b) = AB(b) * (1+R(b)) * CF(b)$		IPCC default or national/international data	$CB(a) = AB(a) * (1+R(a)) * CF(a)$	$\Delta CB = (CB(a) - CB(b)) * \Delta A$	
	Δ	Δ	Δ	Δ	Δ	AB(b)	AB(a)	R(b)	CF(b)	CB(b)	R(a)	CF(a)	CB(a)	ΔCB	
PCL-AC...	Cropland...	Oil Palm	Cropland...	Lotus (c...	5.000	C	60.000	3.570	0.190	1.000	71.400	0.000	1.000	3.570	-339.150
Total										71.400			3.570	-339.150	

Although regrowth is to be estimated in TAB Biomass change (G&S), it was estimated here

Cropland Remaining Cropland – DOM

DOM is only estimated as a net loss in conversion to *Lotus*

DOM(out), estimated in conversion to <i>Lotus</i> , in the first year only						
variables	1995	2000	2005	2010	2015	2020
A (ha) [converted to <i>Lotus</i> in the year]			5	15	5	5
Dead wood (t d.m)			6.122	6.122	6.122	6.122
Litter (t.d.m.)			4.054	4.054	4.054	4.054
CF dead wood	0.49					
CF litter	0.37					
DOM(in), estimated in conversion to <i>Lotus</i> , in the first year only						
variables	1995	2000	2005	2010	2015	2020
Dead wood (t d.m)			0.000	0.000	0.000	0.000
Litter (t.d.m.)			0.000	0.000	0.000	0.000

DOM in *Lotus* is included in the Biomass C pool estimates

DOM in *Oil palm* is assumed to have zero net annual C stock changes (*inputs and outputs average out across the time series*)

Cropland Remaining Cropland – DOM

SOM (SD - Approaches 2&3) SOM Organic Drained SOM Organic Rewetted Total Net CO2 Emission / Removal

Biomass change (G&L) Biomass (G&L - Abrupt) Biomass (SD - Approach 1) Biomass (SD - Approaches 2&3) **DOM (G&L)** DOM (SD - Approach 1) DOM (SD - Approaches 2&3) SOM Mineral - Eq. 2.25 Formulation A SOM Mineral - Eq. 2.25 Formulation B SOM (SD - Approach 1)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Cropland

Subcategory: 3.B.2.a - Cropland Remaining Cropland

Sheet: Annual net C stock change in dead organic matter (Gain & Loss method)

Data

Region: Region 2 - Approach 2

2020

Land use category					Equation 2.18									
					DOM C pool	Area (ha)	Average annual transfer of biomass into the dead wood or litter pool due to annual processes and disturbances (t d.m. or C / ha / yr)	Average annual decay and disturbance carbon loss out of dead wood or litter pool (t d.m. or C / ha / yr)	DOM Unit	Carbon fraction of dry matter (tonnes C / tonne d.m.)	Annual change in carbon stocks in dead wood/litter (tonnes C / yr)			
Land unit code	Initial land use	Land use during reporting year			National statistics or international data sources		See Chapter 2, Section 2.3.2.1	See Chapter 2, Section 2.3.2.1		for litter IPCC default is 0.37	$\Delta C(DOM) = A * (DOMin - DOMout) * CF$			
						A	DOMin	DOMout		CF	$\Delta C(DOM)$			
ACL-ACL_1	Cropland An...	Lotus (long-t...	Cropland An...	Lotus (long-...	Dead wood	10.000			(t d.m./ha/yr)					
		Lotus (long-t...			Litter				(t d.m./ha/yr)					
PCL-ACL_2005-1	Cropland Per...	Oil Palm		Lotus (conv...	Dead wood	5.000			(t d.m./ha/yr)					
		Oil Palm			Litter				(t d.m./ha/yr)					
PCL-ACL_2010-1		Oil Palm			Dead wood	15.000			(t d.m./ha/yr)					
		Oil Palm			Litter				(t d.m./ha/yr)					
PCL-ACL_2015-1		Oil Palm			Dead wood	5.000			(t d.m./ha/yr)					
		Oil Palm			Litter				(t d.m./ha/yr)					
PCL-ACL_2020-1		Oil Palm			Dead wood		0.000	6.122	(t d.m./ha/yr)	0.490	-14.999			
		Oil Palm			Litter		0.000	4.054	(t d.m./ha/yr)	0.37	-7.500			
PCL-PCL_1		Oil Palm	Cropland Per...	Oil Palm	Dead wood	2,970.000			(t d.m./ha/yr)					
		Oil Palm			Litter				(t d.m./ha/yr)					
Total											-22.499			

Cropland Remaining Cropland – SOM

SOM (SD - Approaches 2&3) SOM Organic Drained **SOM Organic Rewetted** Total Net CO2 Emission / Removal

Biomass change (G&L) Biomass (G&L - Abrupt) Biomass (SD - Approach 1) Biomass (SD - Approaches 2&3) DOM (G&L) DOM (SD - Approach 1) DOM (SD - Approaches 2&3) SOM Mineral - Eq. 2.25 Formulation A **SOM Mineral - Eq. 2.25 Formulation B** SOM (SD - Approach 1)

Worksheet

Sector: Agriculture, Forestry and Other Land Use 2020

Category: Cropland

Subcategory: 3.B.2.a - Cropland Remaining Cropland

Sheet: Annual net C stock change in soil organic matter of mineral soils - Approach 2 and Approach 3 (Default method)

Data

Region Region 2 - **Approach 2**

Land use category					Equation 2.25 - B														
					Area (ha)	Reference carbon stock for the climate and soil combination (tonnes C / ha)	Time dependence of stock change factors (D) or number of years over a single inventory time	Stock change factor for land-use system for the subdivision in the current inventory year (-)	Stock change factor for management regime for the subdivision in the current inventory year (-)	Stock change factor for C input for the subdivision in the current inventory year (-)	Soil organic carbon stock in mineral soils at equilibrium for the current subdivision (tonnes C / ha)	Stock change factor for land-use system at conversion (-)	Stock change factor for management regime at conversion (-)	Stock change factor for C input at conversion (-)	Soil organic carbon stock in mineral soils for the subdivision at conversion (tonnes C / ha)	Annual change in carbon stocks in mineral soils (tonnes C / yr)			
Land unit code	Initial land use		Land use during reporting year		National statistics or international data sources	Tables 2.3 / 5.2 WS	Default value is 20	National statistics or international data sources	National statistics or international data sources	National statistics or international data sources	$SOC(0) = SOC_{ref} * Flu(0) * Fmg(0) * Fi(0)$	IPCC defaults or country-specific	IPCC defaults or country-specific	IPCC defaults or country-specific	$SOC(c) = SOC_{ref} * Flu(c) * Fmg(c) * Fi(c)$	$\Delta C_{mineral} = ((SOC(0) - SOC(c)) * A) / D$			
	Δ	Δ	Δ	Δ	A	SOC _{ref}	D	Flu(0)	Fmg(0)	Fi(0)	SOC(0)	Flu(c)	Fmg(c)	Fi(c)	SOC(c)	ΔC _{mineral}			
► PCL-ACL_2005-1	Cropland	Oil Palm	Cropland	Lotus (c...	5.000	68.000	20.000	0.800	1.220	1.110	73.668	1.010	1.000	1.000	68.680	1.247			
PCL-ACL_2010-1		Oil Palm		Lotus (c...	15.000	68.000	20.000	0.800	1.220	1.110	73.668	1.010	1.000	1.000	68.680	3.741			
PCL-ACL_2015-1		Oil Palm		Lotus (c...	5.000	68.000	20.000	0.800	1.220	1.110	73.668	1.010	1.000	1.000	68.680	1.247			
PCL-ACL_2020-1		Oil Palm		Lotus (c...	5.000	68.000	20.000	0.800	1.220	1.110	73.668	1.010	1.000	1.000	68.680	1.247			
Total					30.000											7.483			

CH₄ emissions are estimated in category 3.C.14

Wetlands

Wetlands remaining Wetlands

No area in the NGHGI time series

Settlements Converted to Wetlands – Biomass (Abrupt)

Biomass change (G&L)

Biomass (G&L - Abrupt)

Biomass (SD - Approaches 2&3)

DOM (G&L)

DOM (SD - Approaches 2&3)

SOM Mineral - Eq. 2.25 Formulation B

SOM (SD - Approaches 2&3)

SOM Organic Rewetted

Total Net CO2 Emission / Removal

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Wetlands

Subcategory: 3.B.4.b.iii - Land converted to Other Wetlands

Sheet: Initial change in biomass carbon stocks on land converted to another land category (abrupt change)

Data

Region

Region 2

- Approach 2

Land use category					Equation 2.16												
Land unit code	Initial land use	Land use during reporting year			C pool	Area (ha)	Unit	Above-ground biomass before the conversion (t U / ha)	Above-ground biomass after the conversion (t U / ha)	Ratio of below-ground biomass to above-ground biomass (R) (t bg U / t ag U)	Biomass carbon fraction (tonnes C / tonne d.m.)	Biomass C stocks before the conversion (tonne C / ha)	Biomass C stocks after the conversion (tonne C / ha)	Annual change in carbon stocks in biomass (tonnes C / yr)			
						National statistics or international data sources	d.m. or C	National statistics or international data sources	National statistics or international data sources	Zero (0) or Table 4.4 / 4.5 WS / National statistics or international data sources	0.47 / Table 4.3 / 0.451 WS mangroves	CB(b) = AB(b) * (1+R) * CF	CB(a) = 0	ΔCB = (CB(a) - CB(b)) * ΔA			
▼	Δ▼	Δ▼	Δ▼	Δ▼	▼	ΔA	U	AB(b)	AB(a)	R	CF	CB(b)	CB(a)	ΔCB			
► OSL-MW...	Settleme...	Urban pa...	Managed...	Tidal mar...	Class 1	100.000	d.m.	67.000	0.000	0.330	0.470	41.882	0.000	-4,188.170			
Total												41.882	0.000	-4,188.170			

Biomass after conversion constrained to zero. [To be removed!]

Settlements

Settlements Remaining Settlements – Biomass

Settlements Remaining Settlements – Biomass

variables	unit of land TSL-TSL_1 (Biomass)											
	1995		2000		2005		2010		2015		2020	
	N(i)	C(i)	N(i)	C(i)	N(i)	C(i)	N(i)	C(i)	N(i)	C(i)	N(i)	C(i)
Class 1 (1-20 y)	2,000	0.007	2,500	0.007	2,875	0.007	3,114	0.007	3,239	0.007	3,278	0.007
Class 2 (21-40 y)	2,000	0.010	2,000	0.010	2,125	0.010	2,313	0.010	2,513	0.010	2,694	0.010
Class 2 (41-50 y)	2,000	0.005	1,500	0.005	1,250	0.005	1,156	0.005	1,156	0.005	1,206	0.005
Class 4* (51-80 y)	6,000	0	6,000	0	5,750	0	5,417	0	5,092	0	4,822	0
	12,000		12,000		12,000		12,000		12,000		12,000	
*Class 4 includes all trees with age > AGP												
All Classes apply equation 8.3												
All Classes disaggregate aboveground and belowground biomass estimates												

Settlements Remaining Settlements – Biomass

SOM (Eq. 2.25 Formulation A)		SOM (Eq. 2.25 Formulation B)		SOM Organic Drained		SOM Organic Rewetted		Total Net CO2 Emission / Removal	
Biomass change (G&L)		Biomass (G&L - Abrupt)		Biomass (SD - Approach 1)		Biomass (SD - Approaches 2&3)		DOM (G&L)	
		DOM (SD - Approach 1)		DOM (SD - Approaches 2&3)		SOM Mineral - Eq. 2.25 Formulation A		SOM Mineral - Eq. 2.25 Formulation B	
		SOM (SD - Approach 1)							

Worksheet: Agriculture, Forestry and Other Land Use
 Category: Settlements
 Subcategory: 3.B.5.a - Settlements Remaining Settlements
 Sheet: Annual net C stock change in biomass - Gain & Loss method

Data

Region: Region 2 - Approach 2

Land use category										Equation 8.2 (Tier 2a)				Equation 8.3 (Tier 2b)					
Land unit code	Initial land use	Land use during reporting year	Area (ha)	Class	Age older than active growing period (AGP)	Method	Disaggr egate in above-ground and below-ground biomass	Total crown cover area of class i (ha)	Crown cover area-based growth rate of class i (tonnes C / ha / yr)	Ratio of below-ground biomass to above-ground biomass (t bg C / t ag C)	Annual net accumulation in biomass carbon stocks based on total crown cover area (tonnes C / yr)	Number of individuals of class i	Annual average carbon accumulation per class i (tonnes C / yr)	Ratio of below-ground biomass to above-ground biomass (t bg C / t ag C)	Annual net accumulation in biomass carbon stocks based on individual plants (tonnes C / yr)	Annual change in carbon stocks in biomass (tonnes C / yr)			
			National statistics or international data sources					National statistics or international data sources	Table 8.1 or National data		$\Delta CB(T2a) = A(i) * CRW(i) * (1+R)$	National statistics or international data sources	Table 8.2 or National data		$\Delta CB(T2b) = N(i) * C(i) * (1+R)$	$\Delta CB = \Delta CB(T2a) \text{ or } \Delta CB(T2b)$			
			A	i				A(i)	CRW(i)	R	$\Delta CB(T2a)$	N(i)	C(i)	R	$\Delta CB(T2b)$	ΔCB			
TSL-T...	Settle...	Urban...	Settle...	Urban...	100.000	Class 1	<input type="checkbox"/>	Eq. 8.3	<input checked="" type="checkbox"/>			2,000.000	0.007	0.330	18.620	18.620			
TSL-T...		Urban...				Class 2	<input type="checkbox"/>	Eq. 8.3	<input checked="" type="checkbox"/>			2,000.000	0.01	0.330	26.600	26.600			
TSL-T...		Urban...				Class 3	<input type="checkbox"/>	Eq. 8.3	<input checked="" type="checkbox"/>			12,000.000	0.005	0.330	79.800	79.800			
TSL-T...		Urban...				Class 4	<input checked="" type="checkbox"/>												
Total											0.000			125.020	125.020				

2020

Settlements Remaining Settlements – DOM

Negligible

Settlements remaining Settlements – SOM Drained

ID	SOM Drained
TSL-TSL_2000-1	$EF_{(os)} - DOC_{(flux)} - \Delta DOC - Frac(DOC)$ IPCC Default values for Temperate climate region

Non-CO₂ emissions are estimated in categories 3.C.4, .8, .9

Forest land converted to Settlements – SOM Drained

Forest land converted to Settlements – SOM Drained

Biomass change (G&L)

Biomass (SD - Approach 1)

Biomass (SD - Approaches 2&3)

DOM (G&L)

DOM (SD - Approach 1)

DOM (SD - Approaches 2&3)

SOM Mineral - Eq. 2.25 Formulation A

SOM Mineral - Eq. 2.25 Formulation B

SOM (SD - Approach 1)

SOM (SD - Approaches 2&3)

SOM Organic Drained

SOM Organic Rewetted

Total Net CO2 Emission / Removal

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Settlements

Subcategory: 3.B.5.a - Settlements Remaining Settlements

Sheet: Annual net C stock change in soil organic matter of drained organic soils

Data

Region

Region 2

- Approach 2

Land use category

Equation 2.2, 2.3, 2.4, 4.8 WS

					Area (ha)	CO2 on-site emission factor for climate type and nutrient status of peat and drainage class in drained soils (tonnes CO2-C / ha / yr)	Flux of DOC from natural (undrained) organic soil (tonnes C / ha / yr)	Proportional increase in DOC flux from drained sites relative to undrained sites	Conversion factor for proportion of DOC converted to CO2 following export from site	CO2 off-site emission factor for climate type and nutrient status of peat and drainage class in drained soils (tonnes CO2-C / ha / yr)	CO2 emissions from peat fire in drained land (tonnes CO2-C / yr)	Annual carbon loss from drained organic soils (tonnes C / yr)	
Land unit code	Initial land use	Land use during reporting year			National statistics or international data sources	Table 5.6 / 2.1 WS / 4.13 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS / Eq. 2.5 or national statistics	From 3.C.1	CO2-C(d) = A(d) * (EF (os) + EF(DOC)) + L (fd)	
▼	Δ▼	Δ▼	Δ▼	Δ▼	A(d)	EF(os)	DOC(flux)	ΔDOC	Frac(DOC)		EF(DOC)	L(fd)	CO2-C(d)
► TSL-TSL_1	Settlement...	Urban park	Settlement...	Urban park	100.000	7.9	0.210	0.600	0.900	Calculated	0.302		820.240
Total					100.000								820.240

2020

Forest land converted to Settlements – Biomass & DOM

variables	unit of land UFL-TSL_2000-1 (Biomass)											
	1995		2000		2005		2010		2015		2020	
	N(i)	C(i)	N(i)	C(i)	N(i)	C(i)	N(i)	C(i)	N(i)	C(i)	N(i)	C(i)
Class 1 (1-20 y)	0	0.007	10,000	0.007	10,000	0.007	10,000	0.007	10,000	0.007	0	0.007
Class 2 (21-40 y)	0	0.010	0	0.010	0	0.010	0	0.010	0	0.010	0	0.010
Class 2 (41-50 y)	0	0.005	0	0.005	0	0.005	0	0.005	0	0.005	0	0.005
Class 4* (51-80 y)	0	0	0	0	0	0	0	0	0	0	0	0
	0		10,000		10,000		10,000		10,000		0	
*Class 4 includes all trees with age > AGP												
All Classes apply equation 8.3												
All Classes disaggregate aboveground and belowground biomass estimates												
Aboveground biomass at the end of the first year of conversion is = $0.007 * 100 / 0.47 = 1.489$												

Forest land converted to Settlements – Biomass (Abrupt)

Biomass change (G&L)		Biomass (G&L - Abrupt)		Biomass (SD - Approaches 2&3)		DOM (G&L)		DOM (SD - Approaches 2&3)		SOM Mineral - Eq. 2.25 Formulation B		SOM (SD - Approaches 2&3)		SOM Organic Drained		SOM Organic Rewetted		Total Net CO2 Emission / Removal	
Worksheet																		2000	
Sector:		Agriculture, Forestry and Other Land Use																	
Category:		Settlements																	
Subcategory:		3.B.5.b.i - Forest Land converted to Settlements																	
Sheet:		Initial change in biomass carbon stocks on land converted to another land category (abrupt change)																	
Data																			
Region		Region 2 - Approach 2																	
Land use category					Equation 2.16														
			Area (ha)	Unit	Above-ground biomass before the conversion (t U / ha)	Above-ground biomass after the conversion (t U / ha)	Ratio of below-ground biomass to above-ground biomass before the conversion (t bg U / t ag U)	Biomass carbon fraction before the conversion (tonnes C / tonne U)	Biomass C stocks before the conversion (tonne C / ha)	Ratio of below-ground biomass to above-ground biomass after the conversion (t bg U / t ag U)	Biomass carbon fraction after the conversion (tonnes C / tonne U)	Biomass C stocks after the conversion (tonne C / ha)	Annual change in carbon stocks in biomass (tonnes C / yr)						
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources	d.m. or C	National statistics or international data sources	National statistics or international data sources	Zero (0) or Table 4.4 / 4.5 WS / National statistics or international data sources	0.47 / Table 4.3 / 0.451 WS mangroves	CB(b) = AB(b) * (1+R(b)) * CF(b)	Zero (0) or Table 4.4 / 4.5 WS / National statistics or international data sources	0.47 / Table 4.3 / 0.451 WS mangroves	CB(a) = AB(a) * (1+R(a)) * CF(a)	ΔCB = (CB(a) - CB(b)) * ΔA						
▽	Δ ▽	Δ ▽	ΔA	U	AB(b)	AB(a)	R(b)	CF(b)	CB(b)	R(a)	CF(a)	CB(a)	ΔCB						
► UFL-TF	Unmana...	Mangrov...	Settleme...	Urban p...	100,000	d.m.	192,000	1,489	0.490	0.451	129,022	0.330	0.470	0.931	-12,809.131				
Total														129,022	0.931	-12,809.131			

Forest land converted to Settlements – Biomass (G&L)

Biomass change (G&L) | Biomass (G&L - Abrupt) | Biomass (SD - Approaches 2&3) | DOM (G&L) | DOM (SD - Approaches 2&3) | SOM Mineral - Eq. 2.25 Formulation B | SOM (SD - Approaches 2&3) | SOM Organic Drained | **SOM Organic Rewetted** | Total Net CO2 Emission / Removal

Worksheet: **2015**

Sector: Agriculture, Forestry and Other Land Use

Category: Settlements

Subcategory: 3.B.5.b.i - Forest Land converted to Settlements

Sheet: Annual net C stock change in biomass - Gain & Loss method

Data

Region: Region 2 - **Approach 2**

Land use category								Equation 8.2 (Tier 2a)				Equation 8.3 (Tier 2b)									
			Area (ha)	Class	Age older than active growing period (AGP)	Method	Disaggregate in above-ground and below-ground biomass	Total crown cover area of class i (ha)	Crown cover area-based growth rate of class i (tonnes C / ha / yr)	Ratio of below-ground biomass to above-ground biomass (t bg C / t ag C)	Annual net accumulation in biomass carbon stocks based on total crown cover area (tonnes C / yr)	Number of individuals of class i	Annual average carbon accumulation per class i (tonnes C / yr)	Ratio of below-ground biomass to above-ground biomass (t bg C / t ag C)	Annual net accumulation in biomass carbon stocks based on individual plants (tonnes C / yr)	Annual change in carbon stocks in biomass (tonnes C / yr)					
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources					National statistics or international data sources	Table 8.1 or National data		$\Delta CB(T2a) = A(i) * CRW(i) * (1+R)$	National statistics or international data sources	Table 8.2 or National data		$\Delta CB(T2b) = N(i) * C(i) * (1+R)$	$\Delta CB = \Delta CB(T2a) \text{ or } \Delta CB(T2b)$					
	▼	▲▼	▲▼	▲▼	▲▼	A	i	▼	▼	▼	▼	A(i)	CRW(i)	R	$\Delta CB(T2a)$	N(i)	C(i)	R	$\Delta CB(T2b)$	ΔCB	
UFL-T...	Unman...	Mangr...	Settle...	Urban...	100.000	Class 1	<input type="checkbox"/>	Eq. 8.3	<input checked="" type="checkbox"/>			10,000.000	0.007	0.330	93.100	93.100					
UFL-T...		Mangr...				Class 2	<input type="checkbox"/>	Eq. 8.2	<input type="checkbox"/>	⚠											
UFL-T...		Mangr...				Class 3	<input type="checkbox"/>	Eq. 8.2	<input type="checkbox"/>	⚠											
UFL-T...		Mangr...				Class 4	<input type="checkbox"/>	Eq. 8.2	<input type="checkbox"/>	⚠											
Total																					
											0.000					93.100	93.100				

Forest land converted to Settlements – Biomass & DOM

unit of land UFL-TSL_2000-1 (DOM)

Dead wood & Litter C stocks in Mangroves before conversions were 10.7 and 0.7 t C ha⁻¹ respectively

DOM in Urban Park is Negligeable

Forest land converted to Settlements – DOM

Biomass change (G&L) | Biomass (G&L - Abrupt) | Biomass (SD - Approaches 2&3) | DOM (G&L) | DOM (SD - Approaches 2&3) | SOM Mineral - Eq. 2.25 Formulation B | SOM (SD - Approaches 2&3) | SOM Organic Drained | SOM Organic Rewetted | Total Net CO2 Emission / Removal

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Settlements

Subcategory: 3.B.5.b.i - Forest Land converted to Settlements

Sheet: Annual net C stock change in dead organic matter (Gain & Loss method)

Data

Region

Region 2

 - Approach 2

Land use category					Equation 2.18									
					DOM C pool	Area (ha)	Average annual transfer of biomass into the dead wood or litter pool due to annual processes and disturbances (t d.m. or C / ha / yr)	Average annual decay and disturbance carbon loss out of dead wood or litter pool (t d.m. or C / ha / yr)	DOM Unit	Carbon fraction of dry matter (tonnes C / tonne d.m.)	Annual change in carbon stocks in dead wood/litter (tonnes C / yr)			
Land unit code	Initial land use	Land use during reporting year				National statistics or international data sources	See Chapter 2, Section 2.3.2.1	See Chapter 2, Section 2.3.2.1		for litter IPCC default is 0.37	$\Delta C(DOM) = A * (DOMin - DOMout) * CF$			
						A	DOMin	DOMout		CF	$\Delta C(DOM)$			
UFL-TFL_20...	Unmanaged...	Mangroves f...	Settlements (...)	Urban park	Dead wood	100.000	0.000	10.700	(t C/ha/yr)	1.000	-1,070.000			
		Litter			0.000		0.700	(t C/ha/yr)	1.000	-70.000				
Total											-1,140.000			

Forest land converted to Settlements – SOM Drained

ID	SOM Drained
UFL-TSL_2000-1	$EF_{(os)} - DOC_{(flux)} - \Delta DOC - Frac(DOC)$ IPCC Default values for Temperate climate region

Non-CO₂ emissions are estimated in categories 3.C.4, .8, .9

Forest land converted to Settlements – SOM Drained

Biomass change (G&L)		Biomass (G&L - Abrupt)		Biomass (SD - Approaches 2&3)		DOM (G&L)		DOM (SD - Approaches 2&3)		SOM Mineral - Eq. 2.25 Formulation B		SOM (SD - Approaches 2&3)		SOM Organic Drained		SOM Organic Rewetted		Total Net CO2 Emission / Removal	
Worksheet																		2015	
Sector:		Agriculture, Forestry and Other Land Use																	
Category:		Settlements																	
Subcategory:		3.B.5.b.i - Forest Land converted to Settlements																	
Sheet:		Annual net C stock change in soil organic matter of drained organic soils																	
Data																			
Region		Region 2 - Approach 2																	
Land use category					Equation 2.2, 2.3, 2.4, 4.8 WS														
					Area (ha)	CO2 on-site emission factor for climate type and nutrient status of peat and drainage class in drained soils (tonnes CO2-C / ha / yr)	Flux of DOC from natural (undrained) organic soil (tonnes C / ha / yr)	Proportional increase in DOC flux from drained sites relative to undrained sites	Conversion factor for proportion of DOC converted to CO2 following export from site	CO2 off-site emission factor for climate type and nutrient status of peat and drainage class in drained soils (tonnes CO2-C / ha / yr)	CO2 emissions from peat fire in drained land (tonnes CO2-C / yr)	Annual carbon loss from drained organic soils (tonnes C / yr)							
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources	Table 5.6 / 2.1 WS / 4.13 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS / Eq. 2.5 or national statistics	From 3.C.1	CO2-C(d) = A(d) * (EF (os) + EF(DOC)) + L (fd)								
▼	△▼	△▼	△▼	△▼	A(d)	EF(os)	DOC(flux)	ΔDOC	Frac(DOC)		EF(DOC)	L(fd)	CO2-C(d)						
► UFL-TFL...	Unmanage...	Mangroves...	Settlement...	Urban park	100.000	7.9	0.210	0.600	0.900	Calculated	0.302		820.240						
Total					100.000								820.240						

Wetlands converted to Settlements

Wetlands converted to Settlements – Biomass (Abrupt)

Software currently constrained to Tier 1. To be enhanced to higher Tiers!

Wetlands converted to Settlements – DOM

Software currently constrained to Tier 1. To be enhanced to higher Tiers!

Wetlands converted to Settlements – SOM Extracted

unit of land UWL-OSL_2020-1 (SOM)
SOC at unmanged Tidal marshes is 255 t C ha ⁻¹
All SOC is extracted to convert to Harbor

Wetlands converted to Settlements – SOM Extracted

Biomass change (G&L) Biomass (G&L - Abrupt) Biomass (SD - Approaches 2&3) DOM (G&L) DOM (SD - Approaches 2&3) SOM Mineral - Eq. 2.25 Formulation B SOM (SD - Approaches 2&3) SOM Organic Drained SOM Organic Rewetted Total Net CO2 Emission / Removal									
Worksheet									
Sector: Agriculture, Forestry and Other Land Use									2020
Category: Settlements									
Subcategory: 3.B.5.b.iv - Wetlands converted to Settlements									
Sheet: Annual net stock change in soil organic matter (Stock-Difference) - Approaches 2&3									
Data									
Region: Region 2 - Approach 2									
Land use category					Equation 2.5 - Approach 2 or 3				
					Area (ha)	SOC at the end of the time period (tonnes C / ha)	SOC at the beginning of the time period (tonnes C / ha)	Number of years over a single inventory time period (Year)	Annual SOC change (tonnes C / yr)
Land unit code	Initial land use	Land use during reporting year			National statistics or international data sources	National statistics or international data sources	National statistics or international data sources		$\Delta SOC = [(SOC(t2) - SOC(t1)) / T] * A$
					A	SOC(t2)	SOC(t1)	T	ΔSOC
UWL-OSL_2020_1	Unmanaged Wet...	Tidal marshes (un...	Settlements (Other)	Harbor	50.000	0.000	255.000	1.000	-12,750.000
Total					50.000				-12,750.000

Region 3

Cropland

Calculation Worksheets

□ Cropland remaining Cropland

- ✓ Biomass (G&L), for perennial cropland only
- ✓ Biomass (G&L – Abrupt)
- ✓ DOM (G&L)
- ✓ SOM Mineral – Eq. 2.25 Formulation B – *(auto-compiled by the Software)*

Cropland Data

Region	Category	Subcategory	Subdivision	Aboveground biomass stock	Aboveground biomass net growth	R	CF	D	Growing stock level	Net Annual Increment	AGP	N classes	Harvest cycle	BCEF _I	BCEF _S	BCEF _R	SOC _{REF}	F _{LU}
1	Forest land	Managed	Secondary forest			0.220	0.470		unspecified						0.670		63.000	1.000
2	Forest land	Managed	Forest plantation			0.200	0.470	0.555	166	16.6				0.850	0.990	1.050		
	Forest land	Unmanaged	Primary forest			0.200	0.470		232						0.950			
	Forest land	Unmanaged	Mangroves forest	192		0.490	0.451		unspecified									
3	Cropland	Annual	Maize	5.8		0.220											80	0.690
	Cropland	Annual	Rice	3.8		0.160											80	0.690
	Cropland	Perennial	Poplar (5)	35	7	0.310							5				80	1.000
	Cropland	Perennial	Poplar (10)	130	13	0.190							10				80	1.000
2	Cropland	Annual	Lotus (long-term)	3.57*		0.000											68	1.000
	Cropland	Annual	Lotus (converted)	3.57*		0.000											68	0.800
	Cropland	Perennial	Oil palm	60	2.4	0.190							25				68	1.010
1	Grassland	Managed	Grazed	13.5**		4.000	0.5										63	1.000
2	Wetlands	Managed	Tidal marshes	8.6*		0.500												
	Wetlands	Unmanaged	Tidal marshes	33.4*		0.500												
2	Settlements	Treed	Urban park	67		0.330	0.47				30	4						
	Settlements	Other	Harbor															
1	Settlements	Other	Buildings	13.5		0.340	0.47										63	0.800
* annual average including belowground																		
** Herbaceous biomass																		

Cropland remaining Cropland – Biomass (G&L)

<div> <div>SOM (SD - Approach 1)</div> <div>SOM (SD - Approaches 2&3)</div> <div>SOM Organic Drained</div> <div>SOM Organic Rewetted</div> <div>Biomass change (G&L)</div> <div>Biomass (G&L - Abrupt)</div> <div>Biomass (SD - Approach 1)</div> <div>Biomass (SD - Approaches 2&3)</div> <div>DOM (G&L)</div> <div>DOM (SD - Approach 1)</div> <div>DOM (SD - Approaches 2&3)</div> <div>Total Net CO2 Emission/ Removal</div> <div>SOM Mineral - Eq. 2.25 Formulation A</div> <div>SOM Mineral - Eq. 2.25 Formulation B</div> </div>														
<div> <div>Sector: Agriculture, Forestry and Other Land Use</div> <div>Category: Cropland</div> <div>Subcategory: 3.B.2.a - Cropland Remaining Cropland</div> <div>Sheet: Annual net C stock change in biomass - Gain & Loss method</div> <div>Data</div> <div>Region: Region 3 - Approach 3</div> </div>														2020
Land use category					Equation 2.7									
					Area (ha)	Average area-specific annual accumulation rate of above-ground biomass (perennial) (tonnes C / ha / yr) or (tonnes d.m. / ha / yr)	Average annual growth of perennial above-ground biomass (tonnes C / yr)	Area with perennial biomass that is disturbed/cleared in the year (ha)	Above-ground biomass in the area disturbed/cleared (tonnes C / yr) or (tonnes d.m. / yr)	Fraction of biomass lost	Perennial biomass loss (tonnes C / yr)	Ratio of below-ground biomass to above-ground biomass (t bg d.m. / t ag d.m.) or (t bg C / t ag C)	Carbon fraction of perennial biomass dry matter (tonnes C / tonne d.m.)	Annual change in carbon stocks in biomass (tonnes C / yr)
Land unit code	Initial land use	Land use during reporting year			National statistics or international data sources	National statistics or international data sources	$\Delta C_g = A * G * (1 + R) * CF$	National statistics or international data sources	IPCC default or national/international data	National data	$\Delta C_l = A_l * B_l * f_d * (1 + R) * CF$	IPCC default or national/international data	IPCC default or national/international data	$\Delta C_b = \Delta C_g - \Delta C_l$
	$\Delta \nabla$	$\Delta \nabla$	$\Delta \nabla$	$\Delta \nabla$	A	G	ΔC_g	A _l	B	f _d	ΔC_l	R	CF	ΔC_b
CL-CL_41	Cropland...	Maize	Cropland...	Poplar (1...	50.000	13.000	650.000		130.000			0.000	1.000	650.000
CL-CL_71		Maize		Poplar (1...	50.000	13.000	650.000		130.000			0.000	1.000	650.000
CL-CL_21		Maize		Poplar (1...	50.000	13.000	650.000		130.000			0.000	1.000	650.000
CL-CL_11		Rice		Poplar (1...	50.000	13.000	650.000		130.000			0.000	1.000	650.000
CL-CL_31		Rice		Poplar (1...	50.000	13.000	650.000		130.000			0.000	1.000	650.000
CL-CL_51		Rice		Poplar (1...	50.000	13.000	650.000		130.000			0.000	1.000	650.000
CL-CL_50	Cropland...	Poplar (1...	Cropland...	Maize	50.000				5.800			0.000	1.000	0.000
CL-CL_61		Poplar (1...		Maize	50.000				5.800			0.000	1.000	0.000
CL-CL_40		Poplar (1...		Rice	50.000				3.800			0.000	1.000	0.000
CL-CL_60		Poplar (1...		Rice	50.000				3.800			0.000	1.000	0.000
Total					500.000		3.900.000	0.000			0.000			3.900.000

Although regrowth is to be estimated here, it was estimated TAB Biomass (G&L – Abrupt)

Cropland remaining Cropland – Biomass (Abrupt)

SOM (SD - Approach 1) SOM (SD - Approaches 2&3) SOM Organic Drained SOM Organic Rewetted															
Biomass change (G&S) Biomass (G&L - Abrupt) Biomass (SD - Approach 1) Biomass (SD - Approaches 2&3) DOM (G&L) DOM (SD - Approach 1) DOM (SD - Approaches 2&3) Total Net CO2 Emission / Removal SOM Mineral - Eq. 2.25 Formulation A SOM Mineral - Eq. 2.25 Formulation B															
Worksheet															
Sector: Agriculture, Forestry and Other Land Use															
Category: Cropland															
Subcategory: 3.B.2.a - Cropland Remaining Cropland															
Sheet: Initial change in biomass carbon stocks on land converted to another land category (abrupt change)															
Data															
Region Region 3 - Approach 3															
Land use category				Equation 2.16											
				Area (ha)	Unit	Above-ground biomass before the conversion (t U / ha)	Above-ground biomass after the conversion (t U / ha)	Ratio of below-ground biomass to above-ground biomass before the conversion (t bg U / t ag U)	Biomass carbon fraction before the conversion (tonnes C / tonne U)	Biomass C stocks before the conversion (tonne C / ha)	Ratio of below-ground biomass to above-ground biomass after the conversion (t bg U / t ag U)	Biomass carbon fraction after the conversion (tonnes C / tonne U)	Biomass C stocks after the conversion (tonne C / ha)	Annual change in carbon stocks in biomass (tonnes C / yr)	
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources	d.m. or C				National data	IPCC default or national/international data	CB(b) = AB(b) * (1+R(b)) * CF(b)	National data	IPCC default or national/international data	CB(a) = AB(a) * (1+R(a)) * CF(a)	ΔCB = (CB(a) - CB(b)) * ΔA	
▽	Δ ▽	Δ ▽	Δ ▽	Δ ▽	ΔA	U	AB(b)	AB(a)	R(b)	CF(b)	CB(b)	R(a)	CF(a)	CB(a)	ΔCB
CL-CL_...	Cropland...	Maize	Cropland...	Poplar (1...	50.000	C	5.800	13.000	0.220	1.000	7.076	0.310	1.000	17.030	497.700
CL-CL_...	Cropland...	Maize	Cropland...	Poplar (1...	50.000	C	5.800	13.000	0.220	1.000	7.076	0.310	1.000	17.030	497.700
CL-CL_...	Cropland...	Rice	Cropland...	Poplar (1...	50.000	C	3.800	13.000	0.160	1.000	4.408	0.310	1.000	17.030	631.100
CL-CL_...	Cropland...	Rice	Cropland...	Poplar (1...	50.000	C	3.800	13.000	0.160	1.000	4.408	0.310	1.000	17.030	631.100
CL-CL_...	Cropland...	Poplar (1...	Cropland...	Maize	50.000	C	130.000	5.800	0.310	1.000	170.300	0.220	1.000	7.076	-8,161.200
CL-CL_...	Cropland...	Poplar (1...	Cropland...	Maize	50.000	C	130.000	5.800	0.310	1.000	170.300	0.220	1.000	7.076	-8,161.200
CL-CL_...	Cropland...	Poplar (1...	Cropland...	Rice	50.000	C	130.000	3.800	0.310	1.000	170.300	0.160	1.000	4.408	-8,294.600
CL-CL_...	Cropland...	Poplar (1...	Cropland...	Rice	50.000	C	130.000	3.800	0.310	1.000	170.300	0.160	1.000	4.408	-8,294.600
Total										704.168			91.088	-30,654.000	

Although regrowth is to be estimated in TAB Biomass change (G&S), it was estimated here

Cropland remaining Cropland - DOM

Assumed negligible

Cropland remaining Cropland - SOM

SOM Organic Drained **SOM Organic Rewetted** Total Net CO2 Emission/ Removal

Biomass change (G&L) Biomass (G&L - Abrupt) Biomass (SD - Approach 1) Biomass (SD - Approaches 2&3) DOM (G&L) DOM (SD - Approach 1) DOM (SD - Approaches 2&3) **SOM Mineral - Eq. 2.25 Formulation B** SOM (SD - Approach 1) SOM (SD - Approaches 2&3)

Worksheet

Sector: Agriculture, Forestry and Other Land Use 2020

Category: Cropland

Subcategory: 3.B.2.a - Cropland Remaining Cropland

Sheet: Annual net C stock change in soil organic matter of mineral soils - Approach 2 and Approach 3 (Default method)

Data

Region Region 3 **- Approach 3**

Land use category					Equation 2.25 - B											
					Area (ha)	Reference carbon stock for the climate and soil combination (tonnes C / ha)	Time dependence of stock change factors (D) or number of years over a single inventory time period (T) (yr)	Stock change factor for land-use system for the subdivision in the current inventory year (-)	Stock change factor for management regime for the subdivision in the current inventory year (-)	Stock change factor for C input for the subdivision in the current inventory year (-)	Soil organic carbon stock in mineral soils at equilibrium for the current subdivision (tonnes C / ha)	Soil organic carbon stock in mineral soils for the subdivision at conversion (tonnes C / ha)	Annual change in carbon stocks in mineral soils (tonnes C / yr)			
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources	Tables 2.3 / 5.2 WS	Default value is 20	National statistics or international data sources	National statistics or international data sources	National statistics or international data sources	National statistics or international data sources	SOC(0) = SOCref * Flu(0) + Fmg(0) + Fi(0)			$\Delta C_{\text{mineral}} = ((SOC(0) - SOC(c)) * A) / D$			
	Δ ▾	Δ ▾	Δ ▾	Δ ▾	A	SOCref	D	Flu(0)	Fmg(0)	Fi(0)	SOC(0)	SOC(c)	ΔCmineral			
CL-CL_10	Cropland A...	Maize	Cropland P...	Poplar (10-...	50.000	80.000	20.000	1.000	1.000	1.000	80.000	78.657	3.357			
CL-CL_30		Maize		Poplar (10-...	50.000	80.000	20.000	1.000	1.000	1.000	80.000	78.657	3.357			
CL-CL_41		Maize		Poplar (10-...	50.000	80.000	20.000	1.000	1.000	1.000	80.000	78.529	3.677			
CL-CL_71		Maize		Poplar (10-...	50.000	80.000	20.000	1.000	1.000	1.000	80.000	78.529	3.677			
CL-CL_21		Maize		Poplar (10-...	50.000	80.000	20.000	1.000	1.000	1.000	80.000	78.785	3.038			
CL-CL_11		Rice		Poplar (10-...	50.000	80.000	20.000	1.000	1.000	1.000	80.000	87.948	-19.870			
CL-CL_20		Rice		Poplar (10-...	50.000	80.000	20.000	1.000	1.000	1.000	80.000	80.948	-2.370			
CL-CL_31		Rice		Poplar (10-...	50.000	80.000	20.000	1.000	1.000	1.000	80.000	87.948	-19.870			
CL-CL_51		Rice		Poplar (10-...	50.000	80.000	20.000	1.000	1.000	1.000	80.000	87.692	-19.231			
CL-CL_70		Rice		Poplar (10-...	50.000	80.000	20.000	1.000	1.000	1.000	80.000	80.756	-1.890			
CL-CL_50	Cropland P...	Poplar (10-...	Cropland A...	Maize	50.000	80.000	20.000	0.690	1.000	0.920	50.784	83.846	-82.656			
CL-CL_61		Poplar (10-...		Maize	50.000	80.000	20.000	0.690	1.000	0.920	50.784	80.453	-74.172			
CL-CL_40		Poplar (10-...		Rice	50.000	80.000	20.000	1.100	1.080	0.920	87.437	79.265	20.431			
CL-CL_60		Poplar (10-...		Rice	50.000	80.000	20.000	1.100	1.080	0.920	87.437	80.453	17.461			
Total					700.000								-165.060			

3.C.1 - Burning

Tool:

Land Representation

3.C.1 Calculation Worksheets

Forest land

3.C.1.a Burning in Forest Land – Data

CO₂ emissions are expected to be estimated as C stock losses in 3.B.1 – Forest land

ID	Disturbances					
	1995	2000	2005	2010	2015	2020
MFL-MFL_1						wildfire over 1,000 ha, Fd=0.6
UFL-MFL_2000-1						
UFL-MFL_2005-1						
UFL-MFL_2010-1						
UFL-MFL_2015-1						
UFL-MFL_2020-1						
Wildfire affects both Biomass & DOM C pool						
Biomass stock (d.m.) = 164.34						
Combustion factor = 0.59						
DOM stock (d.m.) = 11.07 + 5.53 = 16.60						
Combustion factor = 0.61						
SOM stock (d.m.) = 353						
EF = IPCC default values for Tropical Climate						

3.C.1.a Burning in Forest land – C pools selection

Select **Region** in the toggle, **All** is suggested

Fire types and areas burnt | Emissions from burning (1 of 2) | Emissions from burning (2 of 2)

Worksheet: 2020

Sector: Agriculture, Forestry and Other Land Use

Category: Burning

Subcategory: 3.C.1.a - Burning in Forest Land

Sheet: Fire types and areas burnt

Data

Region: (All)

Land unit	Initial land use	Land use during reporting year	Prescribed burning of savannas	Fire type	Fire type subdivision	Area burnt (ha)	Available C pools					CO2 Emissions Reporting	
				FT	FTS	A	Biomass+DOM	Biomass perennial	Biomass annual	DOM	SOM (peat)	Biomass perennial	DOM
MFL-MFL_1	Managed Forest Land	Forest plantation	Managed Forest Land	Forest plantation									

- ✓ **CO₂ emissions** from Biomass and DOM are expected to be **estimated as C stock losses**
- Thus, **CO₂ emissions reporting** for Biomass as well as for DOM is **left unchecked**

3.C.1.a Burning in Forest land – CO₂

Select the *GHG* in the toggle, and enter the relevant EFs

Fire types and areas burnt Emissions from burning (1 of 2) Emissions from burning (2 of 2)

Worksheet

Sector: Agriculture, Forestry and Other Land Use 2020

Category: Burning

Subcategory: 3.C.1.a - Burning in Forest Land

Sheet: Sheet 1 of 2 - Emissions from burning in Forest Land (Forest land remaining Forest land)

Data

Region (All) Gas CARBON DIOXIDE (CO2)

Land use category					Equation 2.27 of the 2006 IPCC Guidelines and Equation 2.8 of the Wetlands Supplement												
Land unit		Initial land use		Land use during reporting year		Fire type	Fire type subdivision	Area burnt (ha)	Mass of fuel available for combustion (tonnes d.m. / ha)		Combustion factor	Mass of fuel consumed (tonnes d.m. / ha)		CO2 Emission Factor (g/kg d.m. burnt)	CO2 Emissions from fire (tonnes)		
						FT	FTS	A	Mb		Cf		FC = Mb*Cf or specified	Gef	Lfire		
									C pool	Stock	Table 2.6		Table 2.4 WS Table 2.6	Table 2.5 WS Table 2.7	A* FC * Gef / 1000		
► MFL-MFL_1	Manage...	Forest p...	Manage...	Forest p...	Wildfires	Wildfire		1,000.000	Biomass perennial	164.340	0.59	Calculated	96.961	1,580	153,197.748		
MFL-MFL_1									DOM	16.600	0.61	Calculated	10.126	1,580	15,999.080		
MFL-MFL_1									Peat (SOM)	353.000	1.000	Calculated	353.000	464	163,792.000		
Total													460.087		332,988.828		

CO₂ emissions from Biomass and DOM are expected to be **estimated as C stock losses**

Thus, **CO₂ emissions reporting** for Biomass as well as for DOM is **left unchecked**

Select the *GHG* in the toggle, and enter the relevant EFs

3.C.1.a Burning in Forest land – N₂O

Select the *GHG* in the toggle, and enter the relevant EFs

Fire types and areas burnt

Emissions from burning (1 of 2)

Emissions from burning (2 of 2)

Worksheet

Sector:

Agriculture, Forestry and Other Land Use

2020

Category:

Burning

Subcategory:

3.C.1.a - Burning in Forest Land

Sheet:

Sheet 1 of 2 - Emissions from burning in Forest Land (Forest land remaining Forest land)

Data

Region

(All)

Gas

NITROUS OXIDE (N2O)

Land use category					Equation 2.27 of the 2006 IPCC Guidelines and Equation 2.8 of the Wetlands Supplement										
					Fire type	Fire type subdivision	Area burnt (ha)	Mass of fuel available for combustion (tonnes d.m. / ha)		Combustion factor	Mass of fuel consumed (tonnes d.m. / ha)		N2O Emission Factor (g/kg dm burnt)	N2O Emissions from fire (tonnes)	
Land unit	Initial land use	Land use during reporting year			FT	FTS	A	Mb		Cf		FC = Mb*Cf or specified	Gef	Lfire	
								C pool	Stock	Table 2.6		Table 2.4 WS Table 2.6	Table 2.5 WS Table 2.7	A * FC * Gef / 1000	
MFL-MFL_1	Manage...	Forest p...	Manage...	Forest p...	Wildfires	Wildfire	1,000.000	Biomass perennial	164.340	0.59	Calculated	96.961	0.2	19.392	
MFL-MFL_1								DOM	16.600	0.61	Calculated	10.126	0.2	2.025	
MFL-MFL_1								Peat (SOM)	353.000	1.000	Calculated	353.000	0.000	0.000	
Total												460.087		21.417	

3.C.1.a Burning in Forest land – SOM

Biomass gains (G&L 1/4) | Biomass loss (G&L 2/4) | Biomass loss (G&L 3/4) | Biomass loss (G&L 4/4) | Biomass (G&L 4/4) | Biomass (SD - Approach 1) | Biomass (SD - Approaches 2&3) | DOM (G&L) | DOM (SD - Approach 1) | DOM (SD - Approaches 2&3) | SOM Mineral - Eq. 2.25 Formulation A

SOM Mineral - Eq. 2.25 Formulation B | SOM (SD - Approach 1) | SOM (SD - Approaches 2&3) | **SOM Organic Drained** | SOM Organic Rewetted | Total Net CO2 Emission / Removal

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Forest Land

Subcategory: 3.B.1.a - Forest land Remaining Forest land

Sheet: Annual net C stock change in soil organic matter of drained organic soils

Data

Region

Region 2

 - Approach 2

Land use category					Equation 2.2, 2.3, 2.4, 4.8 WS												
					Area (ha)	CO2 on-site emission factor for climate type and nutrient status of peat and drainage class in drained soils (tonnes CO2-C / ha / yr)	Flux of DOC from natural (undrained) organic soil (tonnes C / ha / yr)	Proportional increase in DOC flux from drained sites relative to undrained sites	Conversion factor for proportion of DOC converted to CO2 following export from site	CO2 off-site emission factor for climate type and nutrient status of peat and drainage class in drained soils (tonnes CO2-C / ha / yr)	CO2 emissions from peat fire in drained land (tonnes CO2-C / yr)	Annual carbon loss from drained organic soils (tonnes C / yr)					
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources	Table 4.6 / 2.1 WS / 4.13 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS or national statistics	Table 2.2 WS / Eq. 2.5 or national statistics	From 3.C.1	CO2-C(d) = A(d) * (EF (os) + EF(DOC)) + L (fd)						
	Δ	Δ	Δ	Δ	A(d)	EF(os)	DOC(flux)	ΔDOC	Frac(DOC)	EF(DOC)	L(fd)	CO2-C(d)					
► MFL-MFL_1	Managed...	Forest plan...	Managed...	Forest pla...	2,000,000	2.6	0.210	0.600	0.900	Calculated	0.302	44,670.545	50,475.345				
UFL-MFL_20...	Unmanag...	Primary Fo...		Forest pla...	600,000	2.6	0.210	0.600	0.900	Calculated	0.302		1,741.440				
UFL-MFL_20...		Primary Fo...		Forest pla...	350,000	2.6	0.210	0.600	0.900	Calculated	0.302		1,015.840				
UFL-MFL_20...		Primary Fo...		Forest pla...	175,000	2.6	0.210	0.600	0.900	Calculated	0.302		507.920				
UFL-MFL_20...		Primary Fo...		Forest pla...	85,000	2.6	0.210	0.600	0.900	Calculated	0.302		246.704				
Total					3,210,000								53,987.249				

✓ *CO₂ emissions from fire in SOM organic soils are automatically mapped to worksheet SOM Organic Drained in the relevant 3.B land category*

Cropland

3.C.1.b Burning in Cropland – Data

Region 2

- I. Prescribed burning of Oil palm residues for clearing land to subsequent planting
- II. Prescribed burning of residues for clearing land converted to *Lotus*

✓ Fuel (Biomass + DOM) t d.m. = 54

✓ $C_f = 0.85$

✓ CH_4 EF = 3.1

✓ N_2O EF = 0.22

Region 3

- I. Prescribed burning of residues for clearing land converted from poplar

✓ Poplar (5-y) Fuel (Biomass + DOM) t d.m. = 30

✓ Poplar (10-y) Fuel (Biomass + DOM) t d.m. = 55

✓ $C_f = 0.85$

✓ CH_4 EF = 3.7

✓ N_2O EF = 0.25

3.C.1.b Burning in Cropland

Fire types and areas burnt

Emissions from burning (1 of 2)

Emissions from burning (2 of 2)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Burning

Subcategory: 3.C.1.b - Burning in Cropland

Sheet: Sheet 1 of 2 - Emissions from burning in Cropland (Cropland remaining Cropland)

2020

Data

Region (All)

Gas METHANE (CH4)

Land use category					Equation 2.27 of the 2006 IPCC Guidelines and Equation 2.8 of the Wetlands Supplement														
					Crop category	Crop subcategory	Fire type	Fire type subdivision	Area burnt (ha)	Mass of fuel available for combustion (tonnes d.m. / ha)		Combustion factor	Mass of fuel consumed (tonnes d.m. / ha)		CH4 Emission Factor (g/kg dm burnt)	CH4 Emissions from fire (tonnes)			
Land unit	Initial land use	Land use during reporting year			Cc	Cs	FT	FTS	A	Mb		Cf		FC = Mb*Cf or specified	Gef	Lfire			
	Δ ▾	Δ ▾	Δ ▾	Δ ▾	▾	▾	▾	▾		C pool ▾	Stock	Table 2.6		Table 2.4 WS Table 2.6	Table 2.5 WS Table 2.7	A * FC * Gef / 1000			
► PCL-ACL_2020-1	Cropla...	Oil Pal...	Cropla...	Lotus ...	oil palm	oil palm	Controlled B...	Land clearing fire	5.000	Biomass+DOM	54.000	0.850	Calculated	45.900	3.100	0.711			
Cropla...			Oil Pal...		114.000	Biomass+DOM			54.000	0.850	Calculated	45.900	3.100	16.221					
Poplar...		Cropla...	Maize	poplar	poplar	50.000			Biomass+DOM	55.000	0.850	Calculated	46.750	3.700	8.649				
									Biomass+DOM	55.000	0.850	Calculated	46.750	3.700	8.649				
									Biomass+DOM	55.000	0.850	Calculated	46.750	3.700	8.649				
									Biomass+DOM	55.000	0.850	Calculated	46.750	3.700	8.649				
Total													278.800		51.528				

Fire types and areas burnt

Emissions from burning (1 of 2)

Emissions from burning (2 of 2)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Burning

Subcategory: 3.C.1.b - Burning in Cropland

Sheet: Sheet 1 of 2 - Emissions from burning in Cropland (Cropland remaining Cropland)

Data

Region

(All)

Gas

NITROUS OXIDE (N2O)

2020

Land use category					Equation 2.27 of the 2006 IPCC Guidelines and Equation 2.8 of the Wetlands Supplement														
					Crop category	Crop subcategory	Fire type	Fire type subdivision	Area burnt (ha)	Mass of fuel available for combustion (tonnes d.m. / ha)		Combustion factor	Mass of fuel consumed (tonnes d.m. / ha)		N2O Emission Factor (g/kg dm burnt)	N2O Emissions from fire (tonnes)			
Land unit	Initial land use		Land use during reporting year		Cc	Cs	FT	FTS	A	Mb		Cf		FC = Mb*Cf or specified	Gef	Lfire			
	Δ	Δ	Δ	Δ						C pool	Stock	Table 2.6		Table 2.4 WS Table 2.6	Table 2.5 WS Table 2.7	A * FC * Gef / 1000			
► PCL-ACL_2020-1	Cropla...	Oil Pal...	Cropla...	Lotus...	oil palm	oil palm	Controlled B...	Land clearing fire	5.000	Biomass+DOM	54.000	0.850	Calculated	45.900	0.250	0.057			
PCL-PCL_1			Cropla...	Oil Pal...		114.000			Biomass+DOM	54.000	0.850	Calculated	45.900	0.250	1.308				
CL-CL_50		Poplar...	Cropla...	Maize	poplar	poplar			50.000	Biomass+DOM	55.000	0.850	Calculated	46.750	0.220	0.514			
CL-CL_61									Biomass+DOM	55.000	0.850	Calculated	46.750	0.220	0.514				
CL-CL_40									Biomass+DOM	55.000	0.850	Calculated	46.750	0.220	0.514				
CL-CL_60				Rice					Biomass+DOM	55.000	0.850	Calculated	46.750	0.220	0.514				
Total														278.800		3.423			

Grassland

3.C.1.c Burning in Grassland – Data

CO₂ emissions are expected to be estimated as C stock losses in 3.B.3 – Grassland

ID	Disturbances - Prescribed burning of savannas (ha)					
	1995	2000	2005	2010	2015	2020
MGL-1	200	189	188	187	186	186
Every year 1/10 th of grazed land is burnt for regeneration (bad practice!)						
Prescribed burning affects both Biomass & DOM C pool						
Biomass stock (d.m.) = 13.5						
Combustion factor = 0.67						
DOM stock (d.m.) = 0 + 0.78 = 0.78						
Combustion factor = 0.95						
EF = IPCC default values for Temperate Climate						

3.C.1.c Burning in Grassland – C pools selection

Select **Region** in the toggle, **All** is suggested

Fire types and areas burnt | Emissions from burning (1 of 2) | Emissions from burning (2 of 2)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Burning

Subcategory: 3.C.1.c - Burning in Grassland

Sheet: Fire types and areas burnt

Data

Region: (All)

Land unit	Initial land use		Land use during reporting year		Burning of agricultural residue	Crop category	Crop subcategory	Prescribed burning of savannas	Fire type	Fire type subdivision	Area burnt (ha)	Available C pools					CO2 Emissions Reporting	
												Biomass +DOM	Biomass perennial	Biomass annual	DOM	SOM (peat)	Biomass perennial	DOM
* MGL_1	Managed Grassland	Grazed	Managed Grassland	Grazed	<input type="checkbox"/>			<input checked="" type="checkbox"/>	Control...	Prescribed fire (surf...	186,000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>	
*					<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

✓ Given **Grazed** land contains **annual biomass** only, **no CO₂ emissions** from biomass are **reported**

✓ **CO₂ emissions** from DOM are expected to be **estimated as C stock losses**

Thus, **CO₂ emissions reporting** for DOM is **left unchecked**

3.C.1.a Burning in Grassland – CO₂

Select the *GHG* in the toggle, and enter the relevant EFs

Fire types and areas burnt: Emissions from burning (1 of 2) Emissions from burning (2 of 2)

Worksheet: 2020

Sector: Agriculture, Forestry and Other Land Use

Category: Burning

Subcategory: 3.C.1.c - Burning in Grassland

Sheet: Sheet 1 of 2 - Emissions from burning in Grassland (Grassland remaining Grassland)

Data Region: (All) Gas CARBON DIOXIDE (CO2)

Land use category					Equation 2.27 of the 2006 IPCC Guidelines and Equation 2.8 of the Wetlands Supplement											
					Crop category	Crop subcategory	Fire type	Fire type subdivision	Area burnt (ha)	Mass of fuel available for combustion (tonnes d.m. / ha)	Combustion factor	Mass of fuel consumed (tonnes d.m. / ha)	CO2 Emission Factor (g/kg dm burnt)	CO2 Emissions from fire (tonnes)		
Land unit	Initial land use	Land use during reporting year	Cc	Cs	FT	FTS	A	Mb	Cf	FC = Mb*Cf or specified	Gef	Lfire				
	Δ	Δ	Δ	Δ				C pool	Stock	Table 2.6	Table 2.4 WS Table 2.6	Table 2.5 WS Table 2.7	A * FC * Gef / 1000			
MGL_1	Manag...	Grazed	Manag...	Grazed			Controlled Bur...	Prescribed fire (sur...	186.000	DOM	0.780	0.67	Calculated	0.523	1,613	156.789
MGL_1										Biomass annual	13.500	0.95	Calculated	12.825	1,613	3,847.731
Total													13.348		4,004.520	

✓ **CO₂ emissions** from Biomass, if any, and DOM are expected to be **estimated as C stock losses**

Thus, **CO₂ emissions reporting** for Biomass as well as for DOM is **left unchecked**

3.C.1.a Burning in Grassland – CH₄

Select the *GHG* in the toggle, and enter the relevant EFs

Fire types and areas burnt: Emissions from burning (1 of 2) Emissions from burning (2 of 2)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Burning

Subcategory: 3.C.1.c - Burning in Grassland

Sheet: Sheet 1 of 2 - Emissions from burning in Grassland (Grassland remaining Grassland)

Data

Region: (All) Gas METHANE (CH₄)

Land use category					Equation 2.27 of the 2006 IPCC Guidelines and Equation 2.8 of the Wetlands Supplement											
					Crop category	Crop subcategory	Fire type	Fire type subdivision	Area burnt (ha)	Mass of fuel available for combustion (tonnes d.m. / ha)	Combustion factor	Mass of fuel consumed (tonnes d.m. / ha)	CH ₄ Emission Factor (g/kg dm burnt)	CH ₄ Emissions from fire (tonnes)		
Land unit	Initial land use	Land use during reporting year			Cc	Cs	FT	FTS	A	Mb	Cf		FC = Mb*Cf or specified	Gef	Lfire	
	Δ▽	Δ▽	Δ▽	Δ▽	▽	▽	▽	▽		C pool	Stock	Table 2.6	Table 2.4 WS Table 2.6	Table 2.5 WS Table 2.7	A * FC * Gef / 1000	
MGL_1	Mana...	Grazed	Manag...	Grazed			Controlled B...	Prescribed fire (s...	186.000	DOM	0.780	0.67	Calculated	0.523	2.3	0.224
MGL_1										Biomass annual	13.500	0.95	Calculated	12.825	2.3	5.487
Total													13.348		5.710	

3.C.1.a Burning in Forest land – N₂O

Select the *GHG* in the toggle, and enter the relevant EFs

Fire types and areas burnt: Emissions from burning (1 of 2) Emissions from burning (2 of 2)

Worksheet: 2020

Sector: Agriculture, Forestry and Other Land Use

Category: Burning

Subcategory: 3.C.1.c - Burning in Grassland

Sheet: Sheet 1 of 2 - Emissions from burning in Grassland (Grassland remaining Grassland)

Data

Region: (All) Gas NITROUS OXIDE (N₂O)

Land use category					Equation 2.27 of the 2006 IPCC Guidelines and Equation 2.8 of the Wetlands Supplement											
					Crop category	Crop subcategory	Fire type	Fire type subdivision	Area burnt (ha)	Mass of fuel available for combustion (tonnes d.m. / ha)	Combustion factor	Mass of fuel consumed (tonnes d.m. / ha)	N ₂ O Emission Factor (g/kg dm burnt)	N ₂ O Emissions from fire (tonnes)		
Land unit	Initial land use	Land use during reporting year			Cc	Cs	FT	FTS	A	Mb	Cf	FC = Mb*Cf or specified	Gef	Lfire		
	Δ▽	Δ▽	Δ▽	Δ▽	▽	▽	▽	▽		C pool ▽	Stock	Table 2.6	Table 2.4 WS Table 2.6	Table 2.5 WS Table 2.7	A * FC * Gef / 1000	
MGL_1	Mana...	Grazed	Manag...	Grazed			Controlled B...	Prescribed fire (s...	186.000	DOM	0.780	0.67	Calculated	0.523	0.21	0.020
MGL_1										Biomass annual	13.500	0.95	Calculated	12.825	0.21	0.501
Total													13.348		0.521	



Thank you

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INTERGOVERNMENTAL PANEL ON climate change

