



Use of the IPCC Inventory Software for Establishing National GHG inventories in the Agriculture, Forestry and Other Land Use (AFOLU) sector

*UNFCCC On-line Training
IPCC TFI TSU*

AFOLU anthropogenic GHG Emissions and Removals

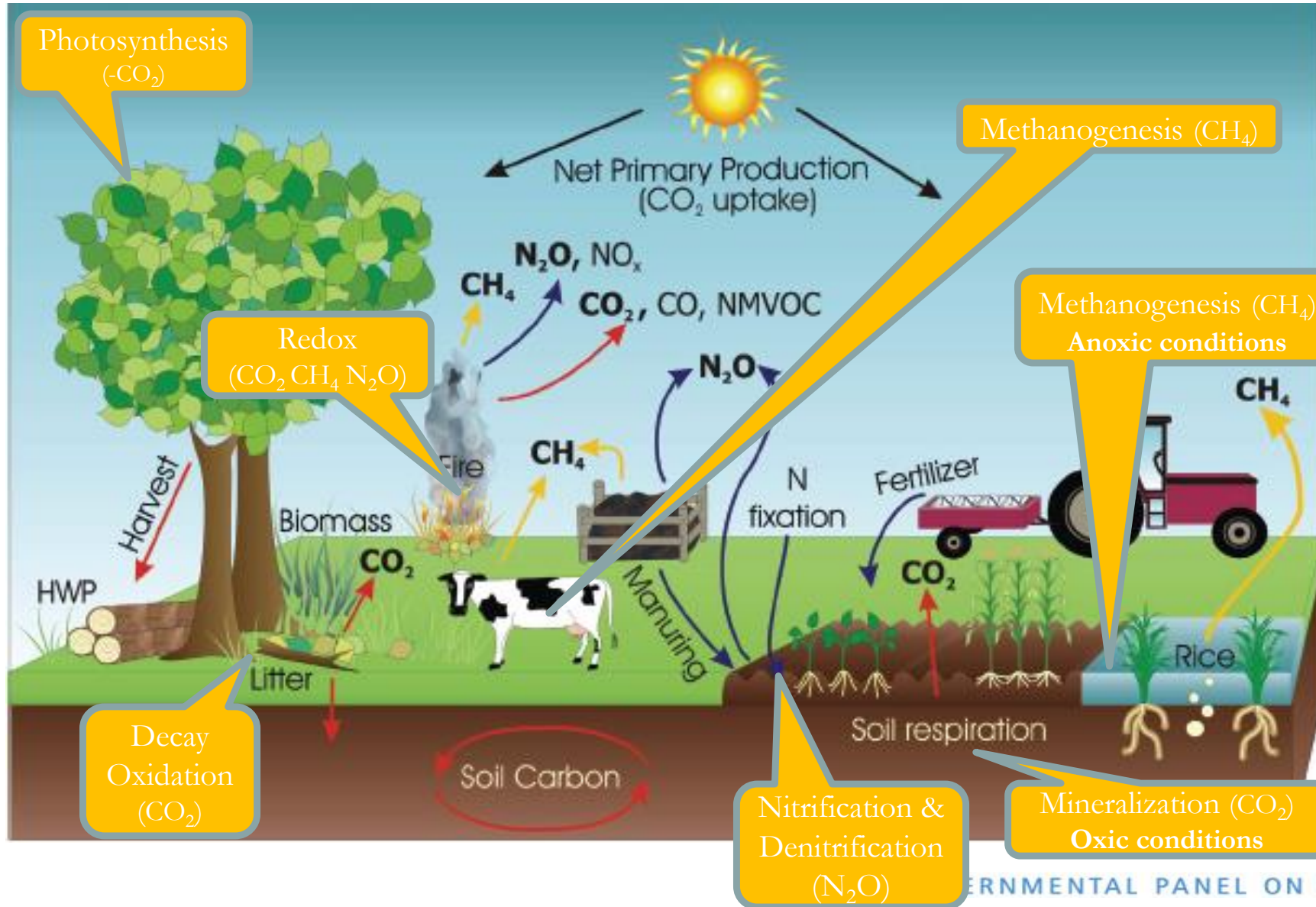
- **Emission and Removal Processes** - GHG fluxes in the AFOLU Sector can be estimated in two ways
 1. as net changes in C stocks in C pools over time, *used for most CO₂ fluxes. The use of C stock changes to estimate CO₂ emissions and removals from C pools, is based on the fact that changes in ecosystem C stocks are predominately (but not exclusively) through CO₂ exchange between the land surface and the atmosphere (i.e. other C transfer process such as leaching are assumed to be negligible)*
 2. directly as gas flux rates to and from the atmosphere *(used for estimating non-CO₂ emissions, CO₂ emissions not sourced from C pools and some CO₂ emissions and removals from C pools when C stock are not quantifiable in an operational way).*

AFOLU anthropogenic GHG Emissions and Removals

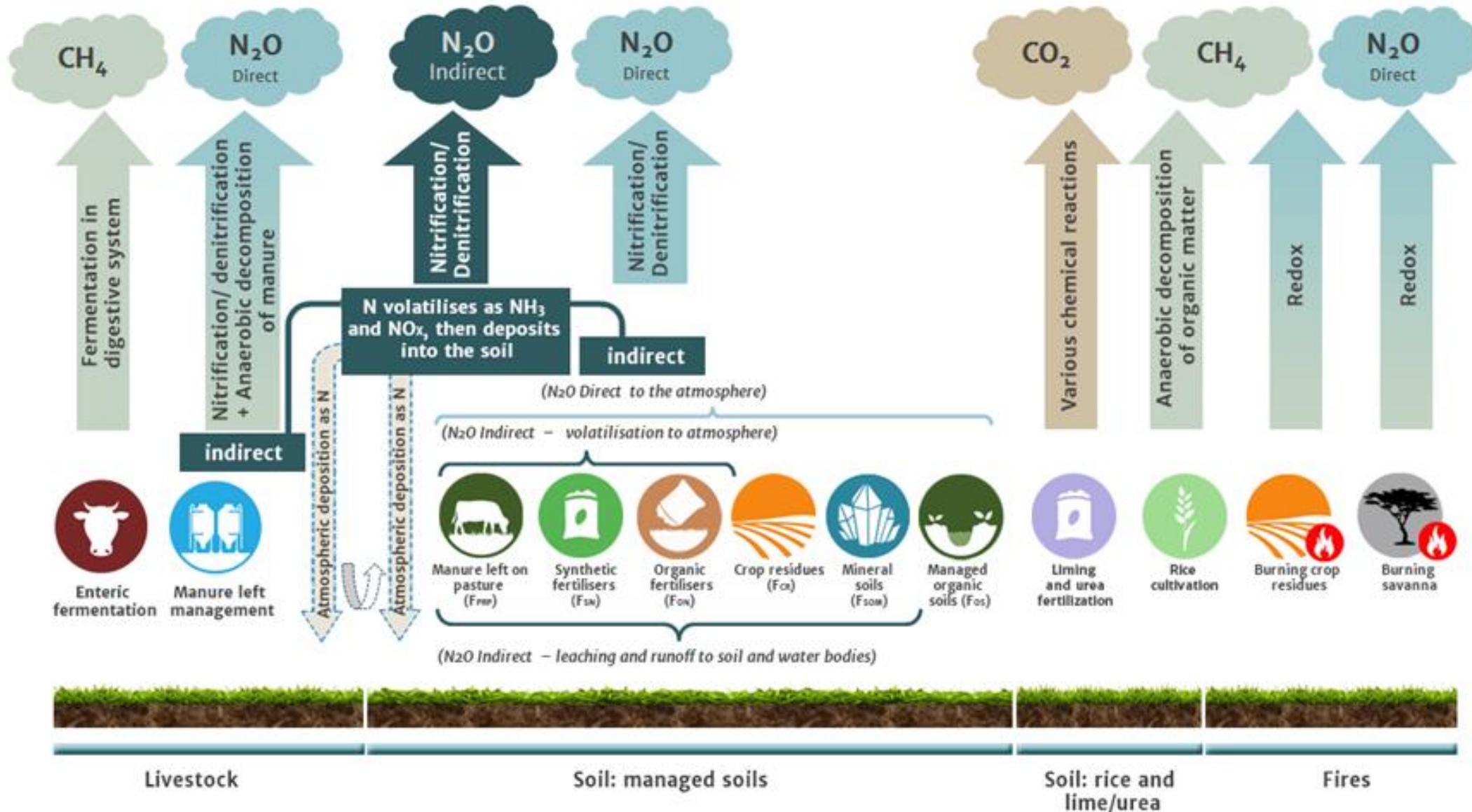
□ AFOLU sources/sinks

- 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 incrementally accumulating as perennial biomass
 - ✓ 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

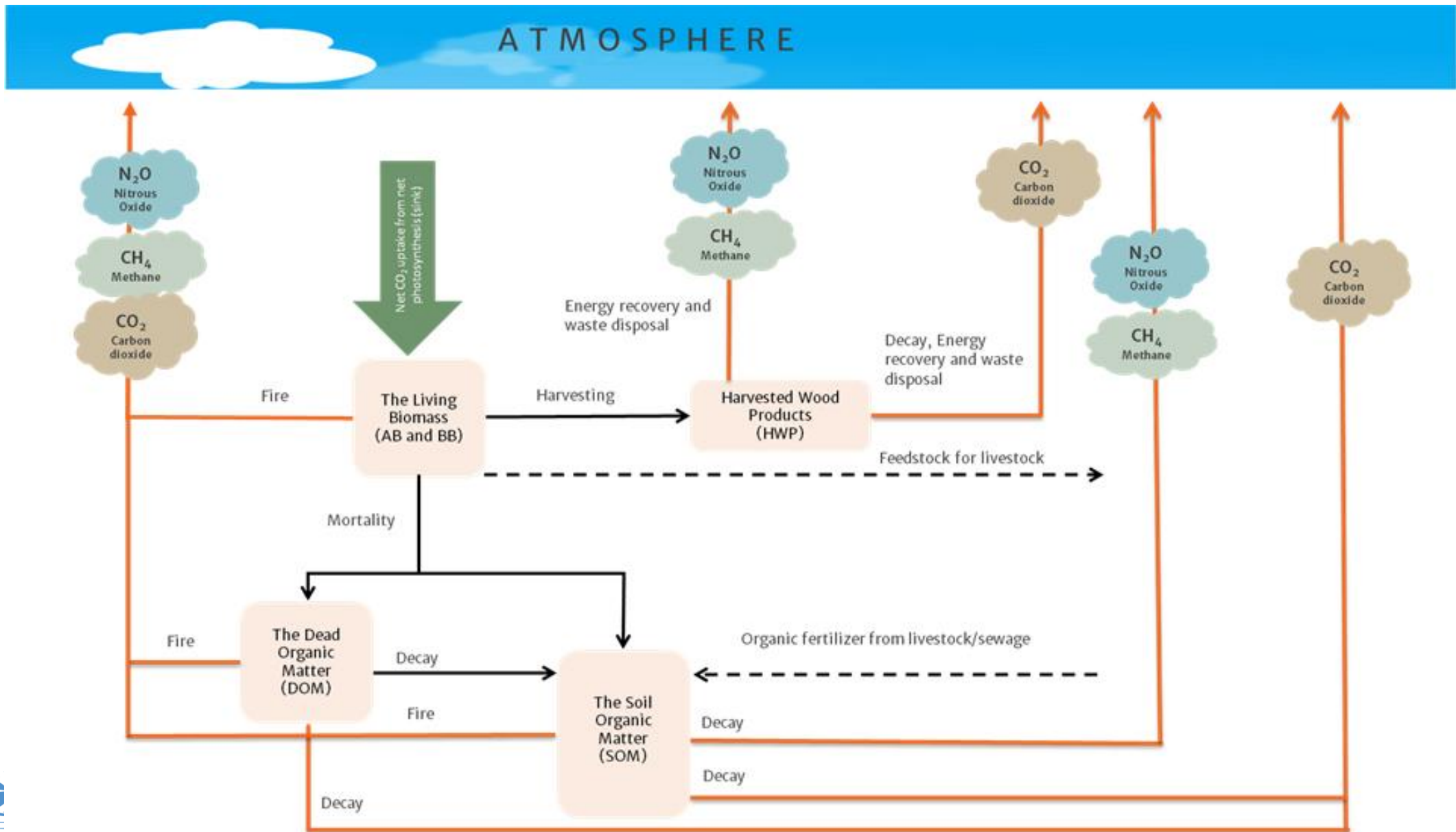
Processes covered by IPCC Guidance on AFOLU



GHG emissions in Agriculture



GHG emissions and CO₂ removals from land use (C pools)



Outline

Use of dedicated data managers

- ✓ Livestock Manager
- ✓ Land Type Manager
- ✓ Land Representation Manager

AFOLU specific worksheets

- ✓ 3.A Livestock
- ✓ 3.B Land (*SOC mineral*)
- ✓ 3.C Aggregate Sources and non-CO₂ Emissions Sources on Land (*SOC mineral related*)

Input activity data, emission factors and other parameters (*practical exercises*)

Worksheets map

IPCC Category	Number of Worksheets			
	Total	IPCC Tier (Equations)		
		Tier 1	Tier 2	Tier 3
3.A.1 – Enteric fermentation	44			
3.A.1.a – Cattle	10			
3.B.1.a.i – Dairy Cow	5		2	
			3	
3.A.1.a.ii – Other Cattle	5		2	
			3	
3.A.1.b – Buffalo	5		2	
			3	
3.A.1.c – Sheep	5		2	
			3	
3.A.1.d – Goats	4		2	
			2	
3.A.1.e – Camels	4		2	
			2	
3.A.1.f – Horses	4		2	
			2	
3.A.1.g – Mules and Assess	4		2	
			2	
3.A.1.h – Swine	4		2	
			2	
3.A.1.j – Other	4		2	
			2	

Tier 2 requires an energy balance -i.e. feed intake vs energy uses + manure- to estimate the fraction of energy used by enteric flora and requires stratification of livestock populations by age, diet, productivity and husbandry system. The energy balance can be calculated through a detailed calculation or simply derived from the dry matter intake and its quality (energy content and digestibility)

Worksheets map

IPCC Category	Number of Worksheets			
	Total	IPCC Tier (Equations)		
		Tier 1	Tier 2	Tier 3
3.A.2 – Manure management	104			
3.A.2.a – Cattle	22			
3.B.2.a.i – Dairy Cow	11	5		
		1	5	
3.A.2.a.ii – Other Cattle	11	5		
		1	5	
3.A.2.b – Buffalo	11	5		
		1	5	
3.A.2.c – Sheep	11	5		
		1	5	
3.A.2.d – Goats	10	5		
		1	4	
3.A.2.e – Camels	10	5		
		1	4	
3.A.2.f – Horses	10	5		
		1	4	
3.A.2.g – Mules and Assess	10	5		
		1	4	
3.A.2.h – Swine	10	5		
		1	4	
3.A.2.j – Other	10	5		
		1	4	

Tier 2 requires an energy balance -i.e. feed intake vs energy uses + manure- to estimate the fraction of energy used by enteric flora and requires stratification of livestock populations by age, diet, productivity and husbandry system. The energy balance can be calculated through a detailed calculation or simply derived from the dry matter intake and its quality (energy content and digestibility).

Further Tier 2 requires daily estimates of:

- Volatile solid excretion rate, based on additional info on the urinary energy and ash content of manure
- N excretion rate, based on daily N intake and N retention rate

Worksheets map

IPCC Category	Number of Worksheets			
	Total	IPCC Tier (Equations)		
		Tier 1	Tier 2	Tier 3
3.B.1 – Forest land	73			
3.B.1.a – Forest land remaining Forest land	13	4 B + (1 ^{**})		
		1* SOM 2.25A +1 +1		
			1 ^{**} SOM 2.25B	3 SD
		1 DOM G&L		
3.B.1.b – Land converted to Forest land	60			
3.B.1.b.i – Cropland converted to Forest land	12	4 B + (1)		
		1 SOM 2.25B +1 +1		3 SD
			1 DOM G&L	
3.B.1.b.ii – Grassland converted to Forest land	12	4 B + (1)		
		1 SOM 2.25B +1 +1		3 SD
			1 DOM G&L	
3.B.1.b.iii – Wetlands converted to Forest land	12	4 B + (1)		
		1 SOM 2.25B +1 +1		3 SD
			1 DOM G&L	
3.B.1.b.iv – Settlements converted to Forest land	12	4 B + (1)		
		1 SOM 2.25B +1 +1		3 SD
			1 DOM G&L	
3.B.1.b.v – Other land converted to Forest land	12	4 B + (1)		
		1 SOM 2.25B +1 +1		3 SD
			1 DOM G&L	

The IPCC Default –i.e. the Gain & Loss– method applies to all Tiers (where default values are provided by IPCC), while the Stock-Difference method applies to Tier 3 only

A worksheet for “abrupt biomass loss” is provided (eq 2.16), although it does not apply to harvesting losses

Worksheets map

IPCC Category	Number of Worksheets			
	Total	IPCC Tier (Equations)		
		Tier 1	Tier 2	Tier 3
3.B.2 – Cropland	55			
3.B.2.a – Cropland remaining Cropland	10	1 B + (1)		
		1 SOM 2.25B & 1* SOM 2.25A +1 +1		3 SD
			1 DOM G&L	
3.B.2.b – Land converted to Cropland	45			
3.B.2.b.i – Forest land converted to Cropland	9	1 B + (1)		
			1 DOM G&L	
		1 SOM 2.25B +1 +1		3 SD
3.B.2.b.ii – Grassland converted to Cropland	9	1 B + (1)		
			1 DOM G&L	
		1 SOM 2.25B +1 +1		3 SD
3.B.2.b.iii – Wetlands converted to Cropland	9	1 B + (1)		
			1 DOM G&L	
		1 SOM 2.25B +1 +1		3 SD
3.B.2.b.iv – Settlements converted to Cropland	9	1 B + (1)		
			1 DOM G&L	
		1 SOM 2.25B +1 +1		3 SD
3.B.2.b.v – Other land converted to Cropland	9	1 B + (1)		
			1 DOM G&L	
		1 SOM 2.25B +1 +1		3 SD

The IPCC Default –i.e. the Gain & Loss– method applies to all Tiers (where default values are provided by IPCC), while the Stock-Difference method applies to Tier 3 only

Worksheets map

IPCC Category	Number of Worksheets			
	Total	IPCC Tier (Equations)		
		Tier 1	Tier 2	Tier 3
3.B.3 – Grassland	55			
3.B.3.a – Grassland remaining Grassland	10	1 B + (1)		
		1 SOM 2.25B & 1* SOM 2.25A +1 +1		3 SD
			1 DOM G&L	
3.B.3.b – Land converted to Grassland	45			
3.B.3.b.i – Forest land converted to Grassland	9	1 B + (1)		
			1 DOM G&L	
		1 SOM 2.25B +1 +1		3 SD
3.B.3.b.ii – Cropland converted to Grassland	9	1 B + (1)		
			1 DOM G&L	
		1 SOM 2.25B +1 +1		3 SD
3.B.3.b.iii – Wetlands converted to Grassland	9	1 B + (1)		
			1 DOM G&L	
		1 SOM 2.25B +1 +1		3 SD
3.B.3.b.iv – Settlements converted to Grassland	9	1 B + (1)		
			1 DOM G&L	
		1 SOM 2.25B +1 +1		3 SD
3.B.3.b.v – Other land converted to Grassland	9	1 B + (1)		
			1 DOM G&L	
		1 SOM 2.25B +1 +1		3 SD

The IPCC Default –i.e. the Gain & Loss– method applies to all Tiers (where default values are provided by IPCC), while the Stock-Difference method applies to Tier 3 only

Worksheets map

IPCC Category	Number of Worksheets			
	Total	IPCC Tier (Equations)		
		Tier 1	Tier 2	Tier 3
3.B.4 – Wetlands	28			
3.B.4.a – Wetlands remaining Wetlands	12			
3.B.4.a.i – Peat Extraction remaining Peat Extraction	3	+1 +2		
3.B.4.a.ii – Flooded land remaining Flooded land				
3.B.4.a.iii – Other Wetlands remaining Other Wetlands	9	+2		3 SD
		1* SOM2.25A		
			2 B&DOM G&L	
			1 SOM2.25B	
3.B.4.b – Land converted to Wetlands	16			
3.B.4.b.i – Land converted for Peat Extraction	6	2 B&DOM +1 +2		1 SD
3.B.4.b.ii – Land converted to Flooded land	1	1		
3.B.4.b.iii – Land converted to Other Wetlands	9	1 SOM2.25B +2		3 SD
			2 B	
			1 DOM G&L	

The IPCC Default –i.e. the Gain & Loss– method applies to all Tiers (where default values are provided by IPCC), while the Stock-Difference method applies to Tier 3 only

Worksheets map

IPCC Category	Number of Worksheets			
	Total	IPCC Tier (Equations)		
		Tier 1	Tier 2	Tier 3
3.B.5 – Settlements	61			
3.B.5.a – Settlements remaining Settlements	11	+1 +2		
		1* SOM 2.25A		
		2 B&DOM G&L + (1**)		
		1** SOM 2.25B	3 SD	
3.B.5.b – Land converted to Settlements	50			
3.B.5.b.i – Forest land converted to Settlements	10	1 B + (1)		
		1 DOM G&L		
		1 SOM 2.25B +1 +2	3 SD	
3.B.5.b.ii – Cropland converted to Settlements	10	1 B + (1)		
		1 DOM G&L		
		1 SOM 2.25B +1 +2	3 SD	
3.B.5.b.iii – Grassland converted to Settlements	10	1 B + (1)		
		1 DOM G&L		
		1 SOM 2.25B +1 +2	3 SD	
3.B.5.b.iv – Wetlands converted to Settlements	10	1 B + (1)		
		1 DOM G&L		
		1 SOM 2.25B +1 +2	3 SD	
3.B.5.b.v – Other land converted to Settlements	10	1 B + (1)		
		1 DOM G&L		
		1 SOM 2.25B +1 +1	3 SD	

The IPCC Default –i.e. the Gain & Loss– method applies to all Tiers (where default values are provided by IPCC), while the Stock-Difference method applies to Tier 3 only

Worksheets map

IPCC Category	Number of Worksheets			
	Total	IPCC Tier (Equations)		
		Tier 1	Tier 2	Tier 3
3.B.6 – Other land	20			
3.B.6.a – Other land remaining Other land				
3.B.6.b – Land converted to Other land	20			
3.B.6.b.i – Forest land converted to Other land	4	(1)		
			1 DOM SD	
		1 SOM 2.25B +1		
3.B.6.b.ii – Cropland converted to Other land	4	(1)		
			1 DOM SD	
		1 SOM 2.25B +1		
3.B.6.b.iii – Grassland converted to Other land	4	(1)		
			1 DOM SD	
		1 SOM 2.25B +1		
3.B.6.b.iv – Wetlands converted to Other land	4	(1)		
			1 DOM SD	
		1 SOM 2.25B +1		
3.B.6.b.v – Settlements converted to Other land	4	(1)		
			1 DOM SD	
		1 SOM 2.25B +1		

The IPCC Default –i.e. the Gain & Loss– method applies to all Tiers (where f/default values are provided by IPCC)

Worksheets map

IPCC Category	Number of Worksheets			
	Total	IPCC Tier (Equations)		
		Tier 1	Tier 2	Tier 3
3.C.1 – Biomass burning	12			
3.C.1.a – Biomass burning in Forest land	3		3	
3.C.1.b – Biomass burning in Cropland	3		3	
3.C.1.c – Biomass burning in Grassland	3		3	
3.C.1.d – Biomass burning in all other lands	3		3	
3.C.2 – Liming	1		1	
3.C.3 – Urea application	1		1	
3.C.4 – Direct N₂O emissions	10		9 +1	
3.C.5 – Indirect N₂O emissions from managed soils	2		2	
3.C.6 – Indirect N₂O emissions from manure management	4		4	
3.C.7 – Rice cultivation	1		1	
3.C.8 – CH₄ emissions from drained inland organic soils	1		1	
3.C.9 – CH₄ from drainage ditches on organic soils	1		1	
3.C.10 – CH₄ from rewetting of inland organic soils	1		1	
3.C.11 – CH₄ from rewetting of mangroves and tidal marshes	1		1	
3.C.12 – N₂O emissions from aquaculture	1		1	
3.C.13 – CH₄ from rewetted and created Wetlands in inland wetland mineral soils	1		1	
3.C.14 – Other	1		1***	
3.D.1 – Harvested Wood Products	13		13	
3.D.2 – Other	1		1***	

The methodological tier of CO₂ emissions estimated as C stock losses in 3.B categories could be higher than that of non-CO₂ emissions

IPCC Category	Worksheets Number
	Total
3.A. – Livestock	148
3.A.1 – Enteric fermentation	44
3.A.2 – Manure management	104
3.B. – Land	292
3.B.1 – Forest land	73
3.B.2 – Cropland	55
3.B.3 – Grassland	55
3.B.4 – Wetlands	28
3.B.5 – Settlements	61
3.B.6 – Other land	20
3.C. – Aggregated Sources and non-CO₂ emissions sources on land	38
3.C.1 – Biomass burning	12
3.C.2 – Liming	1
3.C.3 – Urea application	1
3.C.4 – Direct N ₂ O emissions	10
3.C.5 – Indirect N ₂ O emissions from managed soils	2
3.C.6 – Indirect N ₂ O emissions from manure management	4
3.C.7 – Rice cultivation	1
3.C.8 – CH ₄ emissions from drained inland organic soils	1
3.C.9 – CH ₄ from drainage ditches on organic soils	1
3.C.10 – CH ₄ from rewetting of inland organic soils	1
3.C.11 – CH ₄ from rewetting of mangroves and tidal marshes	1
3.C.12 – N ₂ O emissions from aquaculture	1
3.C.13 – CH ₄ from rewetted and created Wetlands in inland wetland mineral soils	1
3.C.14 – Other	1
3.D. - Other	14
3.D.1 – Harvested Wood Products	13
3.D.2. – Other	1
TOTAL AFOLU SECTOR	492

Worksheets map *[notes]*

- ()** for biomass and in the year of change only
- +1** for drained organic soils only
- +2** on-site and off-site emissions associated with extracted peat decay
- +1** for rewetted organic soils only
- +2** for rewetted organic soil or for SOM excavation in Wetlands
- *** for regions where Approach 1 of land representation is applied only
- **** for management changes only
- ***** IPCC generic methodology [ADxEF] applies, but no IPCC default values are provided for EF

Summary

- ❑ **All methods in the 2006 IPCC Guidelines 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**

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

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

Case Study for Livestock

□ 2 Regions with

➤ 2 different Livestock Characterizations

- A. Basic (*Tier 1*) – Dairy cows, Other cattle,
- B. Enhanced (*Tier 2*) – Mature dairy (High vs Low productivity), Other Cattle (Mature vs Growing [dairy high, dairy low, other])

➤ 2 different climate zones

- A. Annual Average Temperature 22°C
- B. Annual Average Temperature 12°C

➤ 2 different sets of Manure Management Systems

- A. Solid storage (*3 months*) + Spread; Pasture/Range/Paddock
- B. Liquid Slurry (*6 months*) + Spread; Anaerobic Digester

□ For both Regions estimate

- CH₄ emissions from Enteric Fermentation
- CH₄ and N₂O emissions from Manure Management

GHG emissions from Livestock

I. Livestock Manager

- ✓ Stratification of livestock population
- ✓ Stratification of manure

II. Livestock population

- ✓ Annual Average Population
- ✓ Typical Animal Mass

III. Average Feed Intake (*Tier 2*)

- ✓ Gross Energy Intake vs Dry Matter Intake

IV. Volatile Solid Excretion Rate (*Tier 2*)

V. N Excretion Rate

CH₄ emissions from Enteric Fermentation

CH₄ emissions from Manure Management

N₂O emissions from Manure Management

Livestock Manager

- ❑ Geographical zones
- ✓ Characterized by the “Average Annual Temperature”
- ✓ A single Geographical zone or several Geographical zones

Livestock Manager

Geographical zones Livestock Manure Management System

Save Undo Close

Geographical zone	Average annual temperature [°C]	Remark	
▶ Zone A	22		✘
Zone B	12		
*			

Geographical zones are user-defined. Entire country may be reported under a single Geographical zone.

Livestock Manager

□ Livestock Characterization

➤ A single characterization for the entire inventory

Basic or Enhanced or Country-specific or Any combination

The screenshot shows the 'Livestock Manager' application window. It has three tabs: 'Geographical zones', 'Livestock', and 'Manure Management System'. The 'Livestock' tab is active. At the top right of the window are buttons for 'Save', 'Undo', and 'Close'. The main area displays a hierarchical tree structure for livestock categories and subcategories. The tree is organized as follows:

- Category: Dairy Cows
 - Livestock Subcategory: Dairy Cows
 - Livestock Subcategory: Mature Dairy Cow
 - Livestock Subdivision: High-producing cows that have calved at least once and are used principally for milk production
 - Livestock Subdivision: Low-producing cows that have calved at least once and are used principally for milk production
 - Livestock Subcategory: *
 - Livestock Subcategory: *
 - Livestock Subcategory: *
- Category: Other Cattle
 - Livestock Subcategory: Other cattle (marked with a red X)
 - Livestock Subcategory: Mature Cattle
 - Livestock Subcategory: Growing Cattle
 - Livestock Subdivision: Growing for high productivity dairy
 - Livestock Subdivision: Growing for low productivity dairy
 - Livestock Subdivision: Growing other
 - Livestock Subcategory: *
 - Livestock Subcategory: *

User-defined Livestock categories will show under 3.A.1j and 3.A.2j respectively (Other - please specify)

Livestock Manager

❑ Manure Management Systems

✓ A single set for the entire Inventory

Livestock Manager
✕

Geographical zones | Livestock | Manure Management System

Save Undo Close

	System	Definition	
<input checked="" type="checkbox"/>	Pasture/Range/Paddock	The manure from pasture and range grazing animals is allowed to lie as deposited, and is not managed.	
<input type="checkbox"/>	Daily spread	Manure is routinely removed from a confinement facility and is applied to cropland or pasture within 24 hours of excretion.	
<input type="checkbox"/>	Solid storage	The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure is able to be stacked due to the presence of a sufficient amount of bedding material or loss of moisture by evaporation.	
<input type="checkbox"/>	Dry lot	A paved or unpaved open confinement area without any significant vegetative cover where accumulating manure may be removed periodically.	
<input type="checkbox"/>	Liquid/Slurry	Manure is stored as excreted or with some minimal addition of water in either tanks or earthen ponds outside the animal housing, usually for periods less than one year.	
<input type="checkbox"/>	Uncovered anaerobic lagoon	A type of liquid storage system designed and operated to combine waste stabilization and storage. Lagoon supernatant is usually used to remove manure from the associated confinement facilities to the lagoon. Anaerobic lagoons are designed with varying lengths of storage (up to a year or greater), depending on the climate region, the volatile solids loading rate, and other operational factors. The water from the lagoon may be recycled as flush water or used to irrigate and fertilise fields.	
<input type="checkbox"/>	Pit storage below animal confinements	Collection and storage of manure usually with little or no added water typically below a slatted floor in an enclosed animal confinement facility, usually for periods less than one year.	
<input checked="" type="checkbox"/>	Anaerobic digester	Animal excreta with or without straw are collected and anaerobically digested in a large containment vessel or covered lagoon. Digesters are designed and operated for waste stabilization by the microbial reduction of complex organic compounds to CO ₂ and CH ₄ , which is captured and flared or used as a fuel.	
<input type="checkbox"/>	Burned for fuel	The dung and urine are excreted on fields. The sun dried dung cakes are burned for fuel.	
<input type="checkbox"/>	Cattle and Swine deep bedding	As manure accumulates, bedding is continually added to absorb moisture over a production cycle and possibly for as long as 6 to 12 months. This manure management system also is known as a bedded pack manure management system and may be combined with a dry lot or pasture.	
<input type="checkbox"/>	Composting - invessel	Composting, typically in an enclosed channel, with forced aeration and continuous mixing.	
<input type="checkbox"/>	Composting - Static pile	Composting in piles with forced aeration but no mixing.	
<input type="checkbox"/>	Composting - Intensive windrow	Composting in windrows with regular (at least daily) turning for mixing and aeration.	
<input type="checkbox"/>	Composting - Passive windrow	Composting in windrows with infrequent turning for mixing and aeration.	
<input type="checkbox"/>	Poultry manure with litter	Similar to cattle and swine deep bedding except usually not combined with a dry lot or pasture. Typically used for all poultry breeder flocks and for the production of meat type chickens (broilers) and other fowl.	
<input type="checkbox"/>	Poultry manure without litter	May be similar to open pits in enclosed animal confinement facilities or may be designed and operated to dry the manure as it accumulates. The latter is known as a high-rise manure management system and is a form of passive windrow composting when designed and operated properly.	
<input type="checkbox"/>	Aerobic treatment	The biological oxidation of manure collected as a liquid with either forced or natural aeration. Natural aeration is limited to aerobic and facultative ponds and wetland systems and is due primarily to photosynthesis. Hence, these systems typically become anoxic during periods without sunlight.	
<input checked="" type="checkbox"/>	Solid storage (3 months) + Spread		
<input checked="" type="checkbox"/>	Liquid slurry (6 months) + Spread		
<input type="checkbox"/>			✕

Only those Manure Management Systems that are selected here will appear in the worksheets

Case Study for Livestock Livestock Population

Region	Characterisation	species/category/subcategory	Population heads		Method
			1990	2000	
A	Basic	Dairy cows	2,000	3,333	Tier 1
		Other cattle	8,000	13,333	Tier 1
B	Enhanced	Mature dairy, High productivity	3,700	6,167	Detailed Tier 2
		Other Cattle, Mature	2,500	4,167	Detailed Tier 2
		Mature dairy, Low productivity	1,500	2,500	Simplified Tier 2
		growing Dairy, High productivity	1,000	1,667	Simplified Tier 2
		growing Dairy, Low productivity	300	500	Simplified Tier 2
		growing Other	1,000	1,667	Simplified Tier 2

Light Blue indicates Tier 2
Light Green indicates Tier 1

Case Study for Livestock Manure Management Systems

species/category/subcategory	Method	Manure Management System (manure apportion and MCF)															
		Solid storage (3 months) + Spread				Pasture/Range/Paddock				Liquid Slurry (6 months) + Spread				Anaerobic Digester			
		1990	2000	N2O EF	MCF%	1990	2000	N2O EF	MCF%	1990	2000	N2O EF	MCF%	1990	2000	N2O EF	MCF%
Dairy cows	Tier 1	1.000	1.000	0.010													
Other cattle	Tier 1					1.000	1.000	NA									
Mature dairy, High productivity	Detailed Tier 2													1.000	1.000	0.001	0.000
Other Cattle, Mature	Detailed Tier 2									1.000	1.000	0.005	21.000				
Mature dairy, Low productivity	Simplified Tier 2									1.000	1.000	0.005	21.000				
growing Dairy, High productivity	Simplified Tier 2													1.000	1.000	0.001	0.000
growing Dairy, Low productivity	Simplified Tier 2									1.000	1.000	0.005	21.000				
growing Other	Simplified Tier 2									1.000	1.000	0.005	21.000				

Light Blue indicates Tier 2
Light Green indicates Tier 1

Case Study for Livestock Parameters I

species/category/subcategory	Method	Population heads	TAM kg	WG kg/day	C	MW kg	Work hours	Ca	Tw	Cfi	Cfi (in_cold	Milk kg/day	Milk's Fat %	Females giving birth %	C_Pregnancy
Dairy cows	Tier 1	2,000	550												
Other cattle	Tier 1	8,000	389												
Mature dairy, High productivity	Detailed Tier 2	3,700	570					0.00	---	0.386	----	10.3	4	75	0.1
Other Cattle, Mature	Detailed Tier 2	2,500	410	----	----	410	1	0.36	3	0.333	calc	3	4.2	60	0.1
Mature dairy, Low productivity	Simplified Tier 2	1,500	530					0.00				4.4	4		
growing Dairy, High productivity	Simplified Tier 2	1,000	300	0.9				0.00				0	0		
growing Dairy, Low productivity	Simplified Tier 2	300	240	0.9				0.00				0	0		
growing Other	Simplified Tier 2	1,000	180	0.35				0.36				0	0		

Light Blue indicates Tier 2
Light Green indicates Tier 1

Case Study for Livestock Parameters II

species/category/subcategory	Method	DE %	FED MJ/kgDM	NEma MJ/kgDM	Ym %	UE	ASH	Bo	Nex kgN/t	CP %	Enteric Fermentation Tier 1 CH4 EF	Manure Management Tier 1 CH4 EF
Dairy cows	Tier 1								0.54		IPCC default	IPCC default
Other cattle	Tier 1								0.39		IPCC default	IPCC default
Mature dairy, High productivity	Detailed Tier 2	70			6.5	0.02	0.11	0.24		17		
Other Cattle, Mature	Detailed Tier 2	60			7	0.04	0.179	0.18		9		
Mature dairy, Low productivity	Simplified Tier 2	65	18.45		6	0.04	0.145	0.13		10		
growing Dairy, High productivity	Simplified Tier 2	70	18.45	7	4	0.02	0.11	0.24		10		
growing Dairy, Low productivity	Simplified Tier 2	65	18.45	6	4	0.04	0.145	0.13		9.5		
growing Other	Simplified Tier 2	60	18.45	5	7	0.04	0.179	0.18		9		

Light Blue indicates Tier 2
Light Green indicates Tier 1

Case Study for SOM in mineral soils

1. Case study on Eq. 2.25 (SOM in mineral soils)

<i>category</i>	Cropland		Cropland		Forest land	
<i>subcategory</i>	annual		perennial		managed	
<i>subdivision</i>	intensive		agroforestry - pepper		restoration AB (AC10)	
Year	<i>tot area</i>	<i>change area</i>	<i>tot area</i>	<i>change area</i>	<i>tot area</i>	<i>change area</i>
	<i>ha</i>		<i>ha</i>		<i>ha</i>	
1999	600	---	400	---	---	---
2000	500	-100	500	+100	---	---
2010	400	-100	600	+100	---	---
2020	400	---	500	-100	100	+100

2. Two additional areas to:

- Apply the Stock-Difference method to SOC changes in 500 ha of Cropland in rotation system (2-year annual + 8-year fallow)
- Estimate CH₄ emissions from created wetlands in inland wetland mineral soils (*lotus cultivation*)

Case Study for Eq 2.25 (SOM in mineral soils)

- Case study area: 1,000 ha
- 3 land use subdivisions:
 - A. Cropland, annual, intensive
 - B. Cropland, perennial, agroforestry – pepper
 - C. Forest land, managed, restoration AB (AC10)
- Time series 1999-2020, 3 land use changes identified:
 - ✓ In 1999, A. covers 600 ha and B. 400 ha
 - ✓ In 2000, 100 ha of A. are converted to B.
 - ✓ In 2010, 100 ha of A. are converted to B.
 - ✓ In 2020, 100 ha of B. are converted to C.
 - ✓ 2010 and 2020 changes occur on a land subject to a dedicated activity
- Three different land representations approaches(1, 2, 3)
 - ✓ Approach 1 -no land use change identification-
 - ✓ Approach 2 -land use change identification-
 - ✓ Approach 3 -land use change identification and tracking across time-

SOC Change estimates

- Land Use Manager (subdivisions' setting)
- Land Representation Manager (input of activity data)
- Mineral soil SOC change
 - Equation 2.25
 - ✓ (Formulation A)
 - ✓ (Formulation B)
 - *[Stock Difference Method]*
- Direct N₂O emissions from managed soils
- Indirect N₂O emissions from managed soils
- *[CH₄ emissions from rewetted/created wetlands inland mineral soils]*

Land Use Manager (LUM)

- **First step when preparing a GHG inventory for land-related sources/sinks**
- **Input subdivisions to the 12 main land subcategories are to be input here**
[managed Forest land, unmanaged Forest land, annual Cropland, perennial Cropland , managed Grassland, unmanaged Grassland, managed Wetlands, unmanaged Wetlands, Settlements (Treed), Settlements (Other), managed Other land, unmanaged Other land]
- **Describe as subdivisions, each and every different use/management of land in the area inventoried, further stratified by climate zone and soil type**
- **Parameters to be input are subcategory-specific and are used by the software to estimate C stock changes and associated GHG emissions/removals**
- **There are not limits to the number of subdivisions that can be input**

Land Use Manager (LUM) – *annual cropland*

Land Use Manager

Land use structure

- Forest Land
- Cropland
 - Cropland Annual Crops
 - Cropland Perennial Cro
- Grassland
- Wetlands
- Settlements
- Other Land

Land use subdivision - common parameters

Land use subdivision name: intensive production

Country/Territory: Brazil

Soil Type: High Activity Clay Mineral

Continent: Latin America and Caribbean

Soil Status: Natural

Climate Region: Tropical Moist

Land use subdivision - Annual Crops specific parameters

Rice ecosystem

Herbaceous biomass: t C / ha 5.000 C fraction (t C / t d.m.) 1.000

Ratio of below-ground biomass to above-ground biomass (R) (t root C / t shoot C)

Reference soil organic carbon stock (SOCref) (t C / ha) 65.000

Relative C stock change factors

Land use (FLU) 0.480

Tillage (FMG) 1.000

Input (FI) 0.920

Add Copy Delete Save Undo Close

Land Use Manager (LUM) – *perennial cropland*

Land Use Manager

Land use structure

- Forest Land
- Cropland
 - Cropland Annual Crops
 - intensive production
 - Cropland Perennial Cro
- Grassland
- Wetlands
- Settlements
- Other Land

Land use subdivision - common parameters

Land use subdivision name: agroforestry - pepper

Country/Territory: Brazil

Soil Type: High Activity Clay Mineral

Continent: Latin America and Caribbean

Soil Status: Natural

Climate Region: Tropical Moist

Land use subdivision - Perennial Crops specific parameters

Cropland type: User-defined | Acacia + pepper

Woody biomass: t C / ha | 150.000 | C fraction (t C / t d.m.): 1.000

Age class (yr): Unspecified | Value:

Perennial biomass carbon accumulation rate (G) (tonnes C / ha / yr): 7.500

Ratio of below-ground woody biomass to above-ground woody biomass (R) (t root C / t shoot C): 0.400

Harvest / Maturity cycle (yr): 20.000

Agroforestry | Herbaceous biomass: t C / ha | 5.000 | C fraction (t C / t d.m.): 1.000

Ratio of below-ground herbaceous biomass to above-ground herbaceous biomass (R) (t root C / t shoot C):

Reference soil organic carbon stock (SOCref) (t C / ha): 65.000

Relative C stock change factors

Land use (FLU): 1.010

Tillage (FMG): 1.100

Input (FI): 1.110

Add Copy Delete Save Undo Close

Land Use Manager (LUM) – forest land

Land Use Manager

Land use structure

- Forest Land
 - Managed Forest Land
 - Unmanaged Forest Land
- Cropland
- Grassland
- Wetlands
- Settlements
- Other Land

Land use subdivision - common parameters

Land use subdivision name: Restoration AB (AC 10)

Soil Type: High Activity Clay Mineral

Soil Status: Natural

Country/Territory: Brazil

Continent: Latin America and Caribbean

Climate Region: Tropical Moist

Land use subdivision - Managed Forest Land specific parameters

Ecological zone: User-defined
Atlantic bioma

Species: User-defined
indigenous species mix

Natural Forest Plantation

Abandoned managed land

Land mass: Unspecified

Age class (yr): ≤20 y

Above-ground biomass stock (t d.m. / ha): 110.000

Above-ground biomass growth (G) (t d.m. / ha / yr): 11.200

Ratio of below-ground biomass to above-ground biomass (R) (t root d.m. / t shoot d.m.): 0.200

Biomass carbon fraction (t C / t d.m.): 0.470

Growing stock level (V) (m³ / ha): 61-80

Average net annual increment of growing stock (lv) (m³ / ha / yr): 8.000

Biomass conversion and expansion factor for increment (BCEFI) (t d.m. / m³ wood volume): Specified 1.400

Biomass conversion and expansion factor for standing stock (BCEFs) (t d.m. / m³ wood volume): Specified 1.600

Biomass conversion and expansion factor for wood and fuelwood removal (BCEFR) (t d.m. / m³ wood volume): Specified 0.000

Basic wood density (D) (t d.m. / m³ fresh volume):

Biomass expansion factor for conversion of annual net increment to above-ground biomass increment (BEF1):

Biomass expansion factor for conversion of merchantable volume to above-ground biomass (BEF2):

Reference soil organic carbon stock (SOCref) (t C / ha): 65.000

Relative C stock change factors

Land use (FLU): 1.000

Management (FMG): 1.000

Input (FI): 1.000

Add Copy Delete Save Undo Close

LUM – Soil Type Manager

Soil Type Manager

Soil Type Name	Composition	Remark
Coastal Wetlands soil	Mixed	Table 4.11 WS
High Activity Clay Mineral	Mineral	Soils with high activity clay (HAC) minerals are lightly to moderately weathered soils, which are dominated by 2:1 silicate clay minerals (in the World Reference Base for Soil Resources (WRB) classification these include Leptosols, Vertisols, Kastanozems, Chernozems, Phaeozems, Luvisols, Alisols, Albeluvisols, Solonetz, Calcisols, Gypsisols, Umbrisols, Cambisols, Regosols; in USDA classification includes Mollisols, Vertisols, high-base status Alfisols, Aridisols, Inceptisols).
Inland Organic soil	Organic	Soils classified as histosols. See glossary of IPCC GPG 2003 for additional details.
Low Activity Clay Mineral	Mineral	Soils with low activity clay (LAC) minerals are highly weathered soils, dominated by 1:1 clay minerals and amorphous iron and aluminium oxides (in WRB classification includes Acrisols, Lixisols, Nitisols, Ferralsols, Durisols; in USDA classification includes Ultisols, Oxisols, acidic Alfisols).
Sandy Mineral	Mineral	Includes all soils (regardless of taxonomic classification) having > 70% sand and < 8% clay, based on standard textural analyses (in WRB classification includes Arenosols; in USDA classification includes Psamments).
Spodic Mineral	Mineral	Soils exhibiting strong podzolization (in WRB classification includes Podzols; in USDA classification Spodosols)
Volcanic Mineral	Mineral	Soils derived from volcanic ash with allophanic mineralogy (in WRB classification Andosols; in USDA classification Andisols)
Wetland Mineral	Mineral	Soils with restricted drainage leading to periodic flooding and anaerobic conditions (in WRB classification Gleysols; in USDA classification Aquic suborders).
* Terra preta	Mineral	average black carbon content 33 Mg ha ⁻¹ m ⁻¹
*		

User-specific soil classification can be input and applied to estimate SOC changes in mineral soils

Default soil types as well as soil types already used in any Land Use Subdivision cannot be changed nor deleted.

Save Undo Close

LUM – Climate Region Manager

Climate domain	Climate Region	Remark
Tropical	Tropical Dry	Mean Annual Temperature >18°C and ≤7 days of frost/year; Elevation <1,000m; Mean Annual Precipitation ≤1,000mm
	Tropical Moist	Mean Annual Temperature >18°C and ≤7 days of frost/year; Elevation <1,000m; Mean Annual Precipitation ≤2,000mm
	Tropical Montane Dry	Mean Annual Temperature >18°C and ≤7 days of frost/year; Elevation ≥1,000m; Mean Annual Precipitation ≤1,000mm
	Tropical Montane Moist	Mean Annual Temperature >18°C and ≤7 days of frost/year; Elevation ≥1,000m; Mean Annual Precipitation >1,000mm
	Tropical Wet	Mean Annual Temperature >18°C and ≤7 days of frost/year; Elevation <1,000m; Mean Annual Precipitation >2,000mm
Subtropical (Mediterranean)	Warm Temperate Dry	Mean Annual Temperature >10°C and ≤18°C; Mean Annual Precipitation lower than Potential Evapo-Transpiration
	Warm Temperate Moist	Mean Annual Temperature >10°C and ≤18°C; Mean Annual Precipitation higher than Potential Evapo-Transpiration
Temperate	Cool Temperate Dry	Mean Annual Temperature >0°C and ≤10°C; Mean Annual Precipitation lower than Potential Evapo-Transpiration
	Cool Temperate Moist	Mean Annual Temperature >0°C and ≤10°C; Mean Annual Precipitation higher than Potential Evapo-Transpiration
Boreal	Boreal Dry	Mean Annual Temperature ≤0°C; Each Month Mean Temperature ≥10°C; Mean Annual Precipitation lower than Potential Evapo-Transpiration
	Boreal Moist	Mean Annual Temperature ≤0°C; Each Month Mean Temperature ≥10°C; Mean Annual Precipitation higher than Potential Evapo-Transpiration
Polar	Polar Dry	Mean Annual Temperature ≤0°C; Each Month Mean Temperature <10°C; Mean Annual Precipitation lower than Potential Evapo-Transpiration
	Polar Moist	Mean Annual Temperature ≤0°C; Each Month Mean Temperature <10°C; Mean Annual Precipitation higher than Potential Evapo-Transpiration
* Tropical	eastern amazonia climate	mean annual precipitation > 2,500 mm; mean annual temperature 31 C

User-specific climate classification can be input and applied to estimate CSC changes in C pools

Default climate regions as well as climate regions already used in any Land Use Subdivision cannot be changed nor deleted.

Save Undo Close

Land Representation Approaches

Approach I - 1,000 ha					
Unit	Year	Land use			Area ha
		category	subcategory	subdivision	
1	1999	Cropland	Annual	Soybean intensive	600 ha
	2000 - 2009				500 ha
	2010-2020				400 ha
2	1999	Cropland	Perennial	Agroforestry - pepper	400 ha
	2000 - 2009				500 ha
	2010 - 2019				600 ha
	2020				500 ha
--	1999 - 2019	Forest land	Managed	Restoration AB (AC10)	--
3	2020				100 ha

Approach II - 1,000 ha					
Unit	Year	Land use			Area ha
		category	subcategory	subdivision	
1	1999	Cropland	Annual	Soybean intensive	600 ha
	2000-2009				500 ha
	2010-2020				400 ha
2.1	1999-2019	Cropland	Perennial	Agroforestry - pepper	400 ha
[2.2]	2020				400 ha
--	1999	Cropland to Cropland	Annual to Perennial	Soybean intensive to Agroforestry - pepper	--
2.2	2000-2019				100 ha
[2.1]	2020				--
--	1999-2009	Cropland to Cropland	Annual to Perennial	Soybean intensive to Agroforestry - pepper	--
2.3	2010-2020				100 ha
--	1999	Cropland to Forest land	Perennial to Managed	Agroforestry - pepper to Restoration AB (AC10)	--
3	2020				100 ha

Approach III - 1,000 ha					
Unit	Year	Land use			Area ha
		category	subcategory	subdivision	
---	1999	Cropland	Perennial	Agroforestry - pepper	--
0	2000-2019				100 ha
[3]	2020				--
1	1999	Cropland	Annual	Soybean intensive	600 ha
	2020-2009				500 ha
	2010-2020				400 ha
2	1999-2009	Cropland	Annual	Soybean intensive	--
	2010-2019				100 ha
	2020	Forest land	Managed	Restoration AB (AC10)	--
3	1999 - 2019	Cropland	Perennial	Agroforestry - pepper	400 ha
	[0]				2020

- Units of *Land remaining* in blue
- Units of *Land under conversion* in orange
- “---”, the unit does not exist in that/those years (no area)
- “[2.1]” “[3]”, means that the unit has been merged, in the year, into the unit of land indicated within the brackets
- “[2.2]” “[0]”, means that the unit indicated within the brackets has been merged, in the year, into the unit

Land Representation Approaches

Approach I - 1,000 ha					
Unit	Year	Land use			Area
		category	subcategory	subdivision	ha
1	1999	Cropland	Annual	Soybean intensive	600 ha
	2000 - 2009				500 ha
	2010-2020				400 ha
2	1999	Cropland	Perennial	Agroforestry - pepper	400 ha
	2000 - 2009				500 ha
	2010 - 2019				600 ha
	2020				500 ha
---	1999 - 2019	Forest land	Managed	Restoration AB (AC10)	---
3	2020				100 ha

- Units of *Land remaining* in blue
- Units of *Land under conversion* in orange

Land Representation Approaches

Approach II - 1,000 ha					
Unit	Year	Land use			Area
		category	subcategory	subdivision	ha
1	1999				600 ha
	2000-2009	Cropland	Annual	Soybean intensive	500 ha
	2010-2020				400 ha
2.1	1999-2019	Cropland	Perennial	Agroforestry - pepper	400 ha
[2.2]	2020				
--	1999				--
2.2	2000-2019	<i>Cropland to</i>	<i>Annual to</i>	<i>Soybean intensive to</i>	100 ha
[2.1]	2020	Cropland	Perennial	Agroforestry - pepper	--
--	1999-2009	<i>Cropland to</i>	<i>Annual to</i>	<i>Soybean intensive to</i>	--
2.3	2010-2020	Cropland	Perennial	Agroforestry - pepper	100 ha
--	1999	<i>Cropland to</i>	<i>Perennial to</i>	<i>Agroforestry - pepper</i>	--
3	2020	Forest land	Managed	Restoration AB (AC10)	100 ha

- Units of *Land remaining* in blue
- Units of *Land under conversion* in orange
- “---”, the unit does not exist in that/those years (no area)
- “[2.1]” “[3]”, means that the unit has been merged, in the year, into the unit of land indicated within the brackets
- “[2.2]” “[0]”, means that the unit indicated within the brackets has been merged, in the year, into the unit

Land Representation Approaches

Approach III - 1,000 ha					
Unit	Year	Land use			Area
		category	subcategory	subdivision	ha
---	1999				---
0	2000-2019	Cropland	Perennial	Agroforestry - pepper	100 ha
[3]	2020				---
1	1999	Cropland	Annual	Soybean intensive	600 ha
	2020-2009				500 ha
	2010-2020				400 ha
2	1999-2009	Cropland	Annual	Soybean intensive	
	2010-2019	Cropland	Perennial	Agroforestry - pepper	100 ha
	2020	Forest land	Managed	Restoration AB (AC10)	
3	1999 - 2019	Cropland	Perennial	Agroforestry - pepper	400 ha
[0]	2020				500 ha

- Units of *Land remaining* in blue
- Units of *Land under conversion* in orange
- “---”, the unit does not exist in that/those years (no area)
- “[2.1]” “[3]”, means that the unit has been merged, in the year, into the unit of land indicated within the brackets
- “[2.2]” “[0]”, means that the unit indicated within the brackets has been merged, in the year, into the unit

Land Representation

Approach 1

- land use categories are identified, and areas quantified
- land use/management changes are neither identified nor quantified since data are not spatially-explicit

Approach 2

- land use categories are identified, and areas quantified
- land use/management changes are identified (data spatially explicit)
- the areas of changes (between 2 points in time) are:
 - * quantified
 - * not tracked over time


Approach 3

- land use categories are identified, and areas quantified
- land use/management changes are identified (data spatially explicit)
- the areas of changes (between 2 points in time) are:
 - * quantified
 - * tracked over time

Land Representation

- **To be used for the GHG inventory, land use data needs to be:**
 - ✓ adequate, i.e., capable of representing the all land-use/management categories, and conversions between land-use categories (*excluding for Approach 1*);
 - ✓ consistent, i.e., capable of representing land-use categories consistently over time, without being unduly affected by artificial discontinuities in time-series data;
 - ✓ complete, which means that all land within a country should be included, with increases in some areas balanced by decreases in others, recognizing the bio-physical stratification of land;
 - ✓ transparent, i.e., data sources, definitions, methodologies and assumptions should be clearly described.

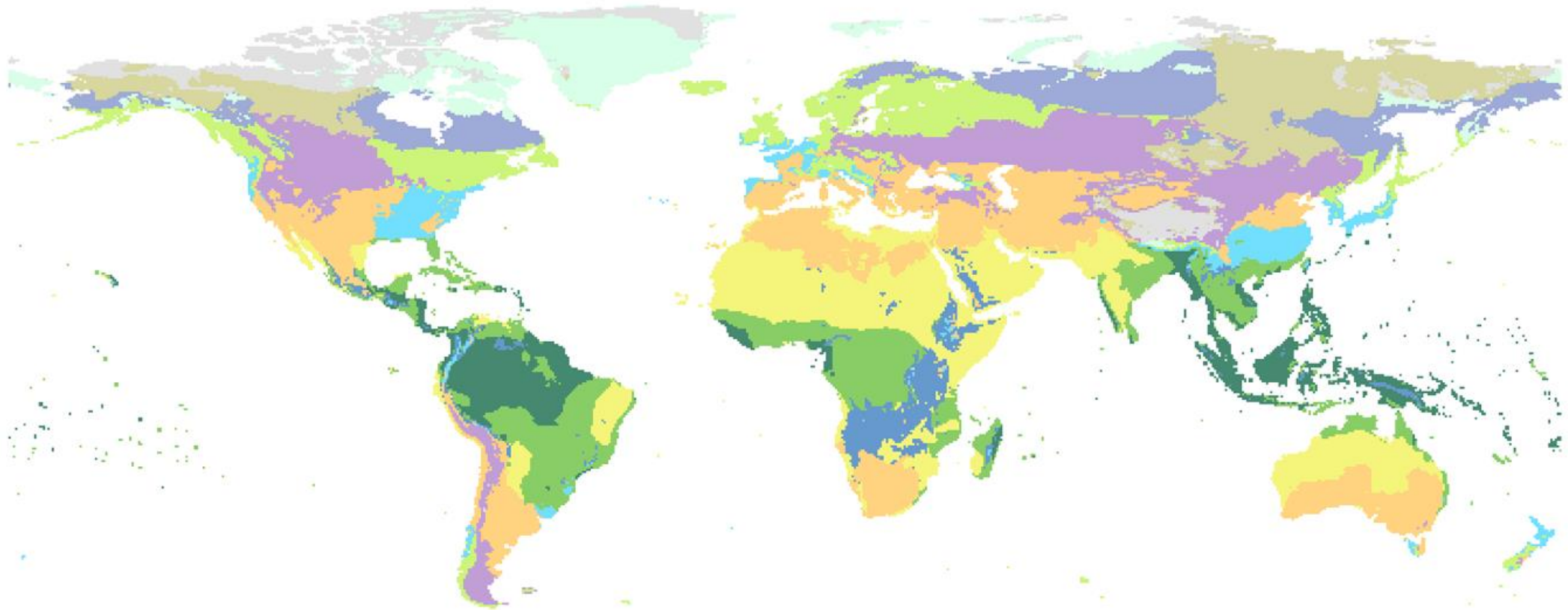
Land Representation



Bio-physical characteristics	<ul style="list-style-type: none">• Climate• Ecological zone (vegetation)• Soil
Land Use	<ul style="list-style-type: none">• Managed vs unmanaged land• IPCC Land use categories (6)• Current and historical land-use
Management practices	<ul style="list-style-type: none">• Current and historical management• Natural vs planted forest• Improved/unimproved grassland etc.
Disturbances	<ul style="list-style-type: none">• Fires• Pest• etc.
Other specific variables	<ul style="list-style-type: none">• Trees age class
Homogeneous Stratum	<ul style="list-style-type: none">• Unit of land

**Stratification of land is aimed at identifying areas with homogeneous characteristics,
Thus, C stocks and C-stock changes have the lowest variability within the stratum**

Land Representation *Bio-physical Characteristics (Climate)*



IPCC Climate Zones



Land Representation

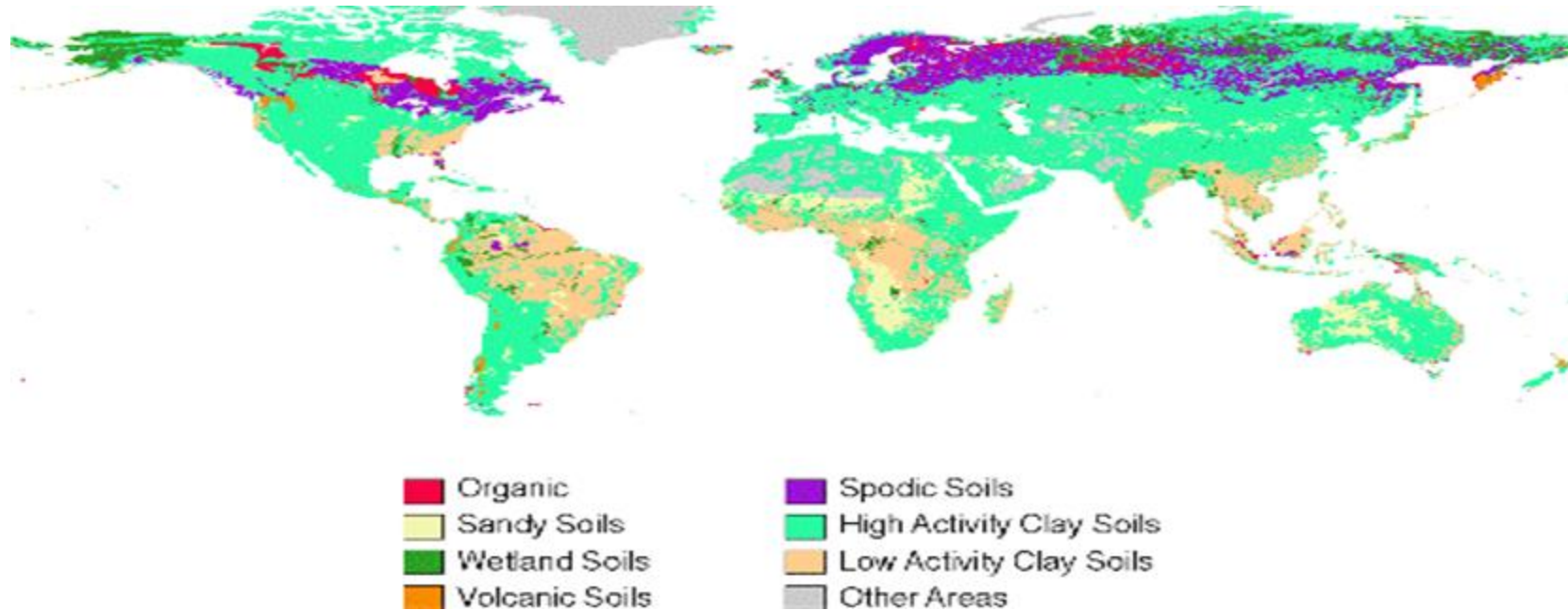
Bio-physical Characteristics (Vegetation)

Global Ecological Zones (GEZ)*

Tropical rainforest	Tropical moist deciduous forest	Tropical dry forest	Tropical shrubland	Tropical desert
Tropical mountain systems	Subtropical humid forest	Subtropical dry forest	Subtropical steppe	Subtropical desert
Subtropical mountain systems	Temperate oceanic forest	Temperate continental forest	Temperate steppe	Temperate desert
Temperate mountain systems	Boreal coniferous forest	Boreal tundra woodland	Boreal mountain systems	Polar

* provided by FAO

Land Representation *Bio-physical Characteristics (Soil)*



from the World Harmonized Soil Database

Consistent Land Representation

- A consistent land representation is a time series of annual area estimates of units of land, as disaggregated according to stratification, that reports:
 - ✓ The total area of the territory is constant across the entire time series
 - ✓ The land classification methodology is consistent across the entire timeseries (*no artifact land conversions caused by changes in the classification method/background-data*)
 - ✓ In each year Y, all units of land under conversion are reported within the *Land under conversion* relevant categories until the end of the transition period (D)
 - ✓ In each year Y, all units of land that did not undergo a conversion in the last Y-D years are reported within the *Land remaining* relevant categories

Land Representation Manager (LRM)

- **Allows to use any of the three IPCC approaches:**
 - ✓ Approach 1 *-no land use change identification-*
 - ✓ Approach 2 *-land use change identification-*
 - ✓ Approach 3 *-land use change identification and tracking across time-*
- **Ensures consistency of land representation**
 - ✓ Discrepancy-check in area data input
 - ✓ Tracking of unit of lands across the time series - *spatially explicit tracking under Approach 3-*
- Area data are automatically transferred to relevant worksheets where GHG emissions/removals from land-related activities are estimated
- Each unit of land gets assigned an identification code on the basis of the current and previous land use/management
- To ease the work of compilers, an additional user-defined code can be assigned to each unit of land

Land Representation Manager (LRM)

- **Data input shall be done from the first inventory year forward**
- Once input in an inventory year, the unit of land is copied by the software in all years of the time series updating its “conversion-status” according to the time passed since its conversion and the transition period set
- Approach 1 does not identify land-use conversions, thus:
 - ✓ SOC changes are estimated comparing total SOC stock across the land representation (Region/Country) in the inventory year and 20 years before the inventory year
 - ✓ The Land Representation Manager requires for each unit of land to input the area in the inventory year as well as the area of 20 years before
- Any Unit of land is an area homogenous per
 - ✓ physical conditions *-climate/vegetation zone and soil type-* and
 - ✓ current and historical socio-economic functions *-land use & management type-*

LRM – Regions Tab

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Whole country area (ha) 3,000,000

Region name	Area (ha)	Approach	Remark
Region 1	1000	Approach 1	
Region 2	1000	Approach 2	
* Region 3	1000	Approach 3	✘
* Total	3000.000		

- ✓ A country can be represented in a single set of National data or in a number of Regions
- ✓ For each Region the land representation approach is to be selected

Define single region in case you wish to report for the whole country

Save Undo Close

LRM – Land Representation Tab [1999] [Appr. 1]

Input the area of each unit of land, by default, the area is assigned to the current and subsequent years

Input area (ha) the unit of land had 20-year before (*Formulation A, Eq 2.25*)

Select, for each C pool, the methodological approach to be applied to estimate Carbon-Stock-Changes (CSCs)

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region I | Region area (ha): 1,000,000 | Discrepancy (ha): 1999: OK; 1979: OK | Approach 1 | 1999

Land use category	Area (1999) (ha)	Area (1979) (ha)	Remark
Forest Land			
Cropland			
Land use subcategory			
Cropland Annual Crops			
Current Land			
soybean intensive			
Land unit code (Automatic)			
ACL-SI-1			
*			
Current Land			
*			
Land use subcategory			
Cropland Perennial Crops			
Current Land			
agroforestry - pepper			
Land unit code (Automatic)			
PCL-AP-UD-2	2	400 ↔ 400	
*			

Land Unit Parameters

C pools / Methods

- Biomass change: Gain & Loss
- DOM - Deadwood: Gain & Loss
- DOM - Litter: Gain & Loss
- SOM - Mineral: Default

Save | Cancel

Save | Undo | Close

LRM – Land Representation Tab [2000] [Appr. 1]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region I | Region area (ha): 1,000,000 | Discrepancy (ha): 2000: OK; 1980: OK | Approach 1 | 2000

Land use category	Area (2000) (ha)	Area (1980) (ha)	Remark
Forest Land	0	0	
Cropland	1000	1000	
agroforestry - pepper	500	600	
PCL-AP-UD-2	2	500	400

Area update mode

- Current inventory year only
- Current inventory year and all subsequent inventory years
- Current inventory year and all previous inventory years
- All inventory years

Update Cancel

Save Undo Close

Select the time period to which the revised area value applies

Input area (ha) the unit of land had 20-year before (Formulation A, Eq 2.25)

LRM – Land Representation Tab [2010] [Appr. 1]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region I | Region area (ha): 1,000,000 | Discrepancy (ha): 2010: OK; 1990: OK | Approach 1 | 2010

Land use category	Area (2010) (ha)	Area (1990) (ha)	Remark		
Forest Land	0	0			
Cropland	1000	1000			
Land use subcategory	Area (2010) (ha)	Area (1990) (ha)	Remark		
Cropland Annual Crops	400	600			
Current Land use subdivision		Remark			
soybean intensive					
Land unit code (Automatic)	Land unit code (User defined)	Area (2010) (ha)	Area (1990) (ha)	Remark	P
ACL-SI-1	1	400	600		
Current Land use subdivision		Remark			
*					
Land use subcategory	Area (2010) (ha)	Area (1990) (ha)	Remark		
Cropland Perennial Crops	600	400			
Current Land use subdivision		Remark			
agroforestry - pepper					
Land unit code (Automatic)	Land unit code (User defined)	Area (2010) (ha)	Area (1990) (ha)	Remark	P
PCL-AP-UD-2	2	600	400		
*					

Save | Undo | Close

Select the time period to which the revised area value applies

Input area (ha) the unit of land had 20-year before
(Formulation A, Eq 2.25)

LRM

Land Representation Tab [2020]

[Appr. 1]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region I | Region area (ha): 1,000.000 | Discrepancy (ha): 2020: OK; 2000: OK | Approach 1 | 2020

Land use category	Area (2020) (ha)	Area (2000) (ha)	Remark		
Forest Land	100	0			
Land use subcategory	Area (2020) (ha)	Area (2000) (ha)	Remark		
Managed Forest Land	100	0			
Current Land use subdivision	Remark				
Restoration AB (AC 10)	✖				
Land unit code (Automatic)	Land unit code (User defined)	Area (2020) (ha)	Area (2000) (ha)	Remark	P
MFL-RAA1-NF-UD-4	3	100	0		✖
Current Land use subdivision	Remark				
Land use subcategory	Area (2020) (ha)	Area (2000) (ha)	Remark		
Unmanaged Forest Land	0	0			
Land use category	Area (2020) (ha)	Area (2000) (ha)	Remark		
Cropland	900	1000			
Land use subcategory	Area (2020) (ha)	Area (2000) (ha)	Remark		
Cropland Annual Crops	400	500			
Current Land use subdivision	Remark				
soybean intensive	✖				
Land unit code (Automatic)	Land unit code (User defined)	Area (2020) (ha)	Area (2000) (ha)	Remark	P
ACL-SI-1	1	400	500		✖
Current Land use subdivision	Remark				
Land use subcategory	Area (2020) (ha)	Area (2000) (ha)	Remark		
Cropland Perennial Crops	500	500			
Current Land use subdivision	Remark				
agroforestry - pepper	✖				
Land unit code (Automatic)	Land unit code (User defined)	Area (2020) (ha)	Area (2000) (ha)	Remark	P
PCL-AP-UD-2	2	500	500		✖

Select the time period to which the revised area value applies

The software automatically update the area (ha) the unit of land had 20-year before
(Formulation A, Eq 2.25)

LRM – Land Representation Tab [1999] [Appr. 2]

Input the area of each unit of land, by default, the area is assigned to the current and subsequent years

For each unit of land, Approach 2 requires information on the transition period applied to conversions. For those units of land not undergoing a conversion the software automatically fills the field with “NA”

Select, for each C pool, the methodological approach to be applied to estimate Carbon-Stock-Changes (CSCs)

The screenshot shows the 'Land Representation Manager' software interface. The main window is titled 'Land Representation Manager' and has three tabs: 'Regions', 'Land representation table', and 'Annual land representation matrix (Approach 2 & 3)'. The 'Land representation table' tab is active. At the top, there are several input fields: 'Region' (Region II), 'Region area (ha)' (1,000,000), 'Discrepancy (ha)' (OK), 'Approach 2', and '1999'. Below these fields is a tree view of land use categories: Forest Land, Cropland, Cropland Annual Crops, soybean intensive, Cropland Perennial Crops, and agroforestry - pepper. A table at the bottom shows land unit details. A 'Land Unit Parameters' dialog box is open, showing 'C pools / Methods' with dropdown menus for 'Biomass change', 'DOM - Deadwood', 'DOM - Litter', and 'SOM - Mineral'. The 'Save' button is highlighted in the dialog box. The bottom of the interface has 'Save', 'Undo', and 'Close' buttons.

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (1999) (ha)	Remark	P	M
PCL-AP-UD-6	2.1	Cropland Perennial Crops	agroforestry - pepper	NA	NA	400			

LRM – Land Representation Tab [2000] [Appr. 2]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region II | Region area (ha): 1,000,000 | Discrepancy (ha): OK | Approach 2 | 2000

Land use category: Area (2000) (ha) | Remark

Forest Land

Cropland

Cropland

soybean intensive

Cropland Perennial Crops

agroforestry - pepper

Area update mode

Current inventory year only
 Current inventory year and all subsequent inventory years
 Current inventory year and all previous inventory years
 All inventory years

Update | Cancel

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2000) (ha)	Remark	P	M
PCL-AP-UD-6	2.1	Cropland Perennial Crops	agroforestry - pepper	NA	NA	400			
PCL-AP-UD-17<-ACL-SI-C0	2.2	Cropland Annual Crops	soybean intensive	20	2000	100			

Save | Undo | Close

For each unit of land converted in the year, input the transition period

Select the time period to which the revised area value applies

LRM – Land Representation Tab [2010] [Appr. 2]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region II | Region area (ha): 1,000,000 | Discrepancy (ha): OK | Approach 2 | 2010

Land use category		Area (2010) (ha)	Remark
Forest Land		0	
Cropland		1000	

Land use subcategory		Area (2010) (ha)	Remark
Cropland Annual Crops		400	

Current Land use subdivision		Remark	
soybean intensive			

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2010) (ha)	Remark	P	M
ACL-SI-5	1	Cropland Annual Crops	soybean intensive	NA	NA	400			

Current Land use subdivision		Remark	
*			

Land use subcategory		Area (2010) (ha)	Remark
Cropland Perennial Crops		600	

Current Land use subdivision		Remark	
agroforestry - pepper			

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2010) (ha)	Remark	P	M
PCL-AP-UD-6	2.1	Cropland Perennial Crops	agroforestry - pepper	NA	NA	400			
PCL-AP-UD-7<-ACL-SI-C0	2.3	Cropland Annual Crops	soybean intensive	20	2010	100			
PCL-AP-UD-17<-ACL-SI-C10	2.2	Cropland Annual Crops	soybean intensive	20	2000	100			

Buttons: Save, Undo, Close

For each unit of land converted in the year, input the transition period

Select the time period to which the revised area value applies

LRM

Land Representation Tab [2020]

[Appr. 2]

Land Representation Manager

Regions Land representation table Annual land representation matrix (Approach 2 & 3)

Region Region II Region area (ha) 1,000.000 Discrepancy (ha) OK Approach 2 2020

Land use category	Area (2020) (ha)	Remark							
Forest Land	100								
Land use subcategory	Area (2020) (ha)	Remark							
Managed Forest Land	100								
Unmanaged Forest Land	0								
Land use category	Area (2020) (ha)	Remark							
Cropland	900								
Land use subcategory	Area (2020) (ha)	Remark							
Cropland Annual Crops	400								
Current Land use subdivision	Area (2020) (ha)	Remark							
soybean intensive									
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2020) (ha)	Remark	P	M
ACL-SI-5	1	Cropland Annual Crops	soybean intensive	NA	NA	400			
*									
Current Land use subdivision	Area (2020) (ha)	Remark							
*									
Land use subcategory	Area (2020) (ha)	Remark							
Cropland Perennial Crops	500								
Current Land use subdivision	Area (2020) (ha)	Remark							
agroforestry - pepper									
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2020) (ha)	Remark	P	M
PCL-AP-UD-6	2.1	Cropland Perennial Crops	agroforestry - pepper	NA	NA	400			
PCL-AP-UD-7<-ACL-SI-C10	2.3	Cropland Annual Crops	soybean intensive	20	2010	100			
*									

Save Undo Close

Any unit of land ends that ends its conversion period is reclassified automatically by the software as a land remaining under its land use/management. Thus, the user may decide to merge it with any other unit of land with identical soil/climate and current/historical use/management. This can be done by using the functionality "m" E.g. unit of land 2.2. that ended its transition period is merged into unit of land 2.1



NTAL PANE

LRM – Land Representation Tab [1999] [Appr. 3]

Input the area of each unit of land, by default, the area is assigned to the current and subsequent years

For each unit of land, Approach 3 requires information on the transition period applied to conversions. For those units of land not undergoing a conversion the software automatically fills the field with “NA”

Select, for each C pool, the methodological approach to be applied to estimate Carbon-Stock-Changes (CSCs)

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region III | Region area (ha): 1,000,000 | Discrepancy (ha): OK | Approach 3 | 1999

Land use category	Area (1999) (ha)	Remark
Forest Land	0	
Cropland	1000	

Land use subcategory	Area (1999) (ha)	Remark
Cropland Annual Crops	600	

Current Land use subdivision	Remark
soybean intensive	

Land unit code (Automatic)	Land unit code	Previous Land use	Previous Land use	Transition Period	Year of	Area (1999) (ha)	Remark	P	C	M
ACL-SI-8						500				X
ACL-SI-14						100				X
*										
*										
Cropland Perennial Crops										
agroforestry - pepper										
Land unit code (Automatic)										
PCL-AP-UD-10						400				X
*										

Area (1999) (ha)	Remark	P	C	M
400				X

Land Unit Parameters

C pools / Methods

Biomass change: Gain & Loss

DOM - Deadwood: Gain & Loss

DOM - Litter: Gain & Loss

SOM - Mineral: Default

Save | Cancel

Save | Undo | Close

LRM – Land Representation Tab [2000] [Appr. 3]

Land Representation Manager

Regions: Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region III | Region area (ha): 1,000,000 | Discrepancy (ha): OK | Approach 3 | 2000

Land use category	Area (2000) (ha)	Remark
Forest Land	0	
Cropland	1000	

Area update mode

Current inventory year only
 Current inventory year and all subsequent inventory years
 Current inventory year and all previous inventory years
 All inventory years

Update Cancel

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2000) (ha)	Remark	P	C	M
PCL-AP-UD-10	3	Cropland Perennial Crops	agroforestry - pepper	NA	NA	400				
PCL-AP-UD-18<-ACL-SI-C0	0	Cropland Annual Crops	soybean intensive	20	2000	100				

Save Undo Close

For each unit of land converted in the year, input the transition period

Select the time period to which the revised area value applies

LRM – Land Representation Tab [2010] [Appr. 3]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region III | Region area (ha): 1,000,000 | Discrepancy (ha): OK | Approach 3 | 2010

Land use category		Area (2010) (ha)	Remark							
Forest Land		0								
Cropland		1000								
Land use subcategory		Area (2010) (ha)	Remark							
Cropland Annual Crops		400								
Current Land use subdivision		Remark								
soybean intensive										
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2010) (ha)	Remark	P	C	M
ACL-SI-8	1	Cropland Annual Crops	soybean intensive	NA	NA	400				
ACL-SI-14	2 (till 2009)	Cropland Annual Crops	soybean intensive	NA	NA	0				
*										
Current Land use subdivision		Remark								
*										
Land use subcategory		Area (2010) (ha)	Remark							
Cropland Perennial Crops		600								
Current Land use subdivision		Remark								
agroforestry - pepper										
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2010) (ha)	Remark	P	C	M
PCL-AP-UD-10	3	Cropland Perennial Crops	agroforestry - pepper	NA	NA	400				
PCL-AP-UD-15<-ACL-SI-C0	2	Cropland Annual Crops	soybean intensive	20	2010	100				
PCL-AP-UD-18<-ACL-SI-C...	0	Cropland Annual Crops	soybean intensive	20	2000	100				
*										

Save | Undo | Close

In tracking units of land across time in a spatially explicit way Approach 3 requires tracking of multiple conversions of each unit of land, where relevant. This can be done by using the functionality “C”

LRM – Land Representation Tab [2020] [Appr. 3]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region III | Region area (ha): 1,000,000 | Discrepancy (ha): OK | Approach 3 | 2020

Land use category	Area (2020) (ha)	Remark									
Forest Land	0										
Land use subcategory	Area (2020) (ha)	Remark									
Managed Forest Land	0										
Current Land use subdivision		Remark									
Restoration AB (AC 10)											
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory									
*											
Current Land use subdivision											
*											
Land use subcategory											
Unmanaged Forest Land											
Land use category											
Cropland											
Land use subcategory											
Cropland Annual Crops											
Cropland Perennial Crops											
Current Land use subdivision											
agroforestry - pepper											
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2020) (ha)	Remark	P	C	M	
PCL-AP-UD-10	3	Cropland Perennial Crops	agroforestry - pepper	NA	NA	500 (<->)					X
▶ PCL-AP-UD-19<-ACL-SI-C...	2	Cropland Annual Crops	soybean intensive	20	2010	100 (<->)					X
*						(<->)					X

New Land Unit Conversion

Current conversion status

From: Cropland Annual Crops / soybean intensive

To: Cropland Perennial Crops / agroforestry - pepper

Transition Period (D): 20 | Year of conversion: 2010

New conversion to

Land use subcategory: Managed Forest Land

Land use subdivision: Restoration AB (AC 10)

Transition Period (D): 20

Year of conversion: 2020

Remark:

Save | Cancel

Unit of land 0 that ended its transition period is merged into unit of land 3.

Unit of land 2 is further converted to Managed Forest land. Once information on the new conversion is input through functionality “c”, unit of land 2 is transferred from section of the LRM for Cropland to the section for Forest land

LRM

Land Representation Tab [2020]

[Appr. 3]

Regions Land representation table Annual land representation matrix (Approach 2 & 3) Region III Region area (ha) 1,000,000 Discrepancy (ha) OK Approach 3 2020

Land use category		Area (2020) (ha)		Remark						
Forest Land		100,000								
Land use subcategory		Area (2020) (ha)		Remark						
Managed Forest Land		100,000								
Current Land use subdivision		Area (2020) (ha)		Remark						
Restoration AB (AC 10)										
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2020) (ha)	Remark	P	C	M
MFL-RAA1-NF-UD-19-c-PC...	2	Cropland Perennial Crops	agroforestry - pepper	20	2020	100...				
Previous Land use subcategory		Previous Land use subdivision		Transition Period (D) (years)		Year of conversion		Remark		
Cropland Annual Crops		soybean intensive		20		2010				
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2020) (ha)	Remark	P	C	M
*										
Current Land use subdivision		Area (2020) (ha)		Remark						
*										
Land use subcategory		Area (2020) (ha)		Remark						
Unmanaged Forest Land		0,000								
Land use category		Area (2020) (ha)		Remark						
Cropland		900,000								
Land use subcategory		Area (2020) (ha)		Remark						
Cropland Annual Crops		400,000								
Current Land use subdivision		Area (2020) (ha)		Remark						
soybean intensive										
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2020) (ha)	Remark	P	C	M
ACL-SI-8	1	Cropland Annual Crops	soybean intensive	NA	NA	400...				
ACL-SI-14	2 (till 2009)	Cropland Annual Crops	soybean intensive	NA	NA	0,000				
*										
Current Land use subdivision		Area (2020) (ha)		Remark						
*										
Land use subcategory		Area (2020) (ha)		Remark						
Cropland Perennial Crops		500,000								
Current Land use subdivision		Area (2020) (ha)		Remark						
agroforestry - pepper										
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2020) (ha)	Remark	P	C	M
PCL-AP-UD-10	3	Cropland Perennial Crops	agroforestry - pepper	NA	NA	500...				
*										

Save Undo Close

Select the time period to which the revised area value applies

Upon use of functionality "c", unit of land 2 is transferred within the LRM from Cropland section to Forest land section

Annual land representation matrix – 2010 [Appr. 2&3]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region II | Region area (ha): 1,000,000 | Approach: Approach 2 | Year: 2000

Initial		Forest Land		Cropland		Grassland		Wetlands		Settlements		Other Land		Final Area (ha)	Net change (ha)
Final		Managed Forest Land	Unmanaged Forest Land	Cropland Annual Crops	Cropland Perennial Crops	Managed Grassland	Unmanaged Grassland	Managed Wetlands	Unmanaged Wetlands	Settlements (Treed)	Settlements (Other)	Managed Other Land	Unmanaged Other Land		
Forest Land	Managed Forest Land													0	0
	Unmanaged Forest Land													0	0
Cropland	Cropland Annual Crops			500										500	-100
	Cropland Perennial Crops			100	400									500	100
Grassland	Managed Grassland													0	0
	Unmanaged Grassland													0	0
Wetlands	Managed Wetlands													0	0
	Unmanaged Wetlands													0	0
Settlements	Settlements (Treed)													0	0
	Settlements (Other)													0	0
Other Land	Managed Other Land													0	0
	Unmanaged Other Land													0	0
Initial Area (ha)		0	0	600	400	0	0	0	0	0	0	0	0	1000	0

No data Input - for verification only (not exportable yet)

Annual land representation matrix – 2010 [Appr. 2&3]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region II | Region area (ha): 1,000,000 | Approach: Approach 2 | Year: 2010

Initial		Forest Land		Cropland		Grassland		Wetlands		Settlements		Other Land		Final Area (ha)	Net change (ha)
Final		Managed Forest Land	Unmanaged Forest Land	Cropland Annual Crops	Cropland Perennial Crops	Managed Grassland	Unmanaged Grassland	Managed Wetlands	Unmanaged Wetlands	Settlements (Treed)	Settlements (Other)	Managed Other Land	Unmanaged Other Land		
Forest Land	Managed Forest Land													0	0
	Unmanaged Forest Land													0	0
Cropland	Cropland Annual Crops			400										400	-100
	Cropland Perennial Crops			100	500									600	100
Grassland	Managed Grassland													0	0
	Unmanaged Grassland													0	0
Wetlands	Managed Wetlands													0	0
	Unmanaged Wetlands													0	0
Settlements	Settlements (Treed)													0	0
	Settlements (Other)													0	0
Other Land	Managed Other Land													0	0
	Unmanaged Other Land													0	0
Initial Area (ha)		0	0	500	500	0	0	0	0	0	0	0	0	1000	0

No data Input - for verification only (not exportable yet)

Annual land representation matrix – 2020 [Appr. 2/3]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: Region III | Region area (ha): 1,000,000 | Approach 3 | 2020

Initial		Forest Land		Cropland		Grassland		Wetlands		Settlements		Other Land		Final Area (ha)	Net change (ha)
Final		Managed Forest Land	Unmanaged Forest Land	Cropland Annual Crops	Cropland Perennial Crops	Managed Grassland	Unmanaged Grassland	Managed Wetlands	Unmanaged Wetlands	Settlements (Treed)	Settlements (Other)	Managed Other Land	Unmanaged Other Land		
Forest Land	Managed Forest Land				100									100	100
	Unmanaged Forest Land													0	0
Cropland	Cropland Annual Crops			400										400	0
	Cropland Perennial Crops				500									500	-100
Grassland	Managed Grassland													0	0
	Unmanaged Grassland													0	0
Wetlands	Managed Wetlands													0	0
	Unmanaged Wetlands													0	0
Settlements	Settlements (Treed)													0	0
	Settlements (Other)													0	0
Other Land	Managed Other Land													0	0
	Unmanaged Other Land													0	0
Initial Area (ha)		0	0	400	600	0	0	0	0	0	0	0	0	1000	0

No data Input - for verification only (not exportable yet)

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

Stock-Change Factors for the case study



SOC is assumed to be at equilibrium in 1999
this means that no changes in land use and/or management occurred during the 20-year period 1979-1998

Equation 2.25 – Test

- **A comparison between results got from the software and excel-based calculations:**
 - ✓ Formulation A with Approach 1 Land Representation
 - ✓ Formulation B with Approach 2 Land Representation
 - ✓ Formulation B with Approach 3 Land Representation
- **The software properly calculates annual SOC changes in each unit of land**
- **The use of software vs excel-based**
 - ✓ minimizes errors in data input
 - ✓ Avoids errors in algorithms
 - ✓ Allows storage of all data of the entire time series
 - ✓ Allow consistency of SOC estimates within the time series as well as consistency with CSC estimates in other C pools

Equation 2.25 – Formulation A

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

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

Where, “D” is the transition period (IPCC default is 20 years), and “c” (climate), “s” (soil), “i” (management system) correspond to the variables, in each land use category/subcategory, according to which the estimate is stratified/dissaggregated

According to such variables, SOC at equilibrium, in any inventory year, for each stratum (unit of land) **c,s,i**, is calculated as:

- $\left(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i} \right)_0$

i.e. the combination of current land uses and management systems of practices in the current inventory year “0” (t C)

- $\left(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i} \right)_{(0-D)}$

i.e. the combination of land uses and management systems of practices of D years before the current inventory year (t C)

Equation 2.25 – Formulation A (2000)

Year	1999			2000			2010			2020		
Category	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp
Land unit	Area (ha)											
1	0	600	0	0	500	0	0	400	0	0	400	0
2	0	0	400	0	0	500	0	0	600	0	0	500
3	0	0	0	0	0	0	0	0	0	100	0	0
SOC ₀ tC	0	17,222	32,063	0	14,352	40,079	0	11,482	48,095	6,500	11,482	40,079
SOC _{0-T} tC	0	17,222	32,063	0	17,222	32,063	0	17,222	32,063	0	14,352	40,079
ΔC tC yr ⁻¹	0.000	0.000	0.000	0.000	-143.520	400.793	0.000	-287.040	801.587	325.000	-143.520	0.000

Worksheet: Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | **SOM Mineral (Approach 1 - Information item)** | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Sector: Agriculture, Forestry and Other Land Use
 Category: Cropland
 Subcategory: 3.B.2.a - Cropland Remaining Cropland
 Sheet: SOC Changes in mineral soils - Approach 1 (Information item)

Data

Region: Region I - Approach 1

Land use category	Equation 2.25 - A				
Land unit code	Land use during reporting year	Soil organic carbon stock in mineral soils in year 2000 (tonnes C / ha)	Soil organic carbon stock in mineral soils in year 1980 (tonnes C / ha)	Annual change in carbon stocks in mineral soils (tonnes C / yr)	
	Δ	Δ	SOC(2000)	SOC(1980)	ΔC _{mineral} = ((SOC(2000) - SOC(1980)) / 20)
1	Cropland Annual C... soybean intensive	14352	17222.4	-143.52	
2	Cropland Perennial... agroforestry - pepper	40079.325	32063.46	400.79325	
Total		54431.325	49285.86	257.27325	

Equation 2.25 – Formulation A (2010)

Year	1999			2000			2010			2020		
Category	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp
Land unit	Area (ha)											
1	0	600	0	0	500	0	0	400	0	0	400	0
2	0	0	400	0	0	500	0	0	600	0	0	500
3	0	0	0	0	0	0	0	0	0	100	0	0
SOC ₀ tC	0	17,222	32,063	0	14,352	40,079	0	11,482	48,095	6,500	11,482	40,079
SOC _{0-T} tC	0	17,222	32,063	0	17,222	32,063	0	17,222	32,063	0	14,352	40,079
ΔC tC yr ⁻¹	0.000	0.000	0.000	0.000	-143.520	400.793	0.000	-287.040	801.587	325.000	-143.520	0.000

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet

Sector: Agriculture, Forestry and Other Land Use 2010

Category: Cropland

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

Sheet: SOC Changes in mineral soils - Approach 1 (Information item)

Data

Region: Region I - Approach 1

Land use category		Equation 2.25 - A		
Land unit code	Land use during reporting year	Soil organic carbon stock in mineral soils in year 2010 (tonnes C / ha)	Soil organic carbon stock in mineral soils in year 1990 (tonnes C / ha)	Annual change in carbon stocks in mineral soils (tonnes C / yr)
		SOC(2010)	SOC(1990)	ΔC _{mineral} = ((SOC(2010) - SOC(1990)) / 20)
1	Cropland Annual C... soybean intensive	11481.6	17222.4	-287.04
2	Cropland Perennial... agroforestry - pepper	48095.19	32063.46	801.5865
Total		59576.79	49285.86	514.5465

Land Use Manager | Land Representation Manager | Uncertainties

Equation 2.25 – Formulation A (2020)

Year	1999			2000			2010			2020		
Category	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp
Land unit	Area (ha)											
1	0	600	0	0	500	0	0	400	0	0	400	0
2	0	0	400	0	0	500	0	0	600	0	0	500
3	0	0	0	0	0	0	0	0	0	100	0	0
SOC ₀ tC	0	17,222	32,063	0	14,352	40,079	0	11,482	48,095	6,500	11,482	40,079
SOC _{0-T} tC	0	17,222	32,063	0	17,222	32,063	0	17,222	32,063	0	14,352	40,079
ΔC tC yr ⁻¹	0.000	0.000	0.000	0.000	-143.520	400.793	0.000	-287.040	801.587	325.000	-143.520	0.000

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet

Sector: Agriculture, Forestry and Other Land Use 2020

Category: Cropland

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

Sheet: SOC Changes in mineral soils - Approach 1 (Information item)

Data

Region: Region I - Approach 1

Land use category	Equation 2.25 - A						
Land unit code	Land use during reporting year	Soil organic carbon stock in mineral soils in year 2020 (tonnes C / ha)	Soil organic carbon stock in mineral soils in year 2000 (tonnes C / ha)	Annual change in carbon stocks in mineral soils (tonnes C / yr)			
	$\Delta \nabla$	$\Delta \nabla$	SOC(2020)	SOC(2000)	$\Delta C_{\text{mineral}} = ((\text{SOC}(2020) - \text{SOC}(2000)) / 20)$		
1	Cropland Annual C... soybean intensive	11481.6	14352	-143.52			
2	Cropland Perennial... agroforestry - pepper	40079.325	40079.325	0			
Total		51560.925	54431.325	-143.52			

Equation 2.25 – Formulation B – Approach 2

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

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

Where, “D” is the **transition period** (*IPCC default is 20 years*), and “c” (*climate*), “s” (*soil*), “i” (*management system*) **correspond to the variables, in each land use category/subcategory, according to which the estimate is stratified/disaggregated**

According to such variables, **SOC at equilibrium**, in any inventory year, for each stratum (unit of land) **c,s,i**, is calculated as:

- $(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i})_0$

i.e. the combination of current land uses and management systems of practices in the current inventory year “0” (t C)

- $(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i})_{(0-D)}$

i.e. the combination of land uses and management systems of practices of in the latest year “T” before the conversion (t C)

Equation 2.25 – Formulation B - A2 (2000)

Year	1999			2000			2010			2020		
Category	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp
Land unit	Area (ha)											
1	0	600	0	0	500	0	0	400	0	0	400	0
2.1	0	0	400	0	0	400	0	0	400	0	0	400
2.2	0	0	0	0	0	100	0	0	100	0	0	0
2.3	0	0	0	0	0	0	0	0	100	0	0	100
3	0	0	0	0	0	0	0	0	0	100	0	0
SOC ₀ tC						8,016			16,032	6,500		8,016
SOC _{0-T} tC						2,870			5,741	8,016		2,870
ΔC tC yr ⁻¹	0.000	0.000	0.000	0.000	0.000	257.273	0.000	0.000	514.547	-75.793	0.000	257.273

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet: Agriculture, Forestry and Other Land Use
 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)

2000

Region: Region II - Approach 2

Land use category			Equation 2.25 - B											
Land unit code	Initial land use	Land use during reporting year	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)
			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) = SOCref * Flu(0) + Fmg(0) * Fi(0)	IPCC defaults or country-specific	IPCC defaults or country-specific	IPCC defaults or country-specific	SOC(c) = SOCref * Flu(c) + Fmg(c) * Fi(c)	ΔC _{mineral} = ((SOC(0) - SOC(c)) * A) / D
	Δ	Δ	A	SOCref	D	Flu(0)	Fmg(0)	Fi(0)	SOC(0)	Flu(c)	Fmg(c)	Fi(c)	SOC(c)	
2.2	Δ	Δ	100	65	20	1.01	1.1	1.11	80.15865	0.48	1	0.92	28.704	257.27325
Total			100											257.27325

Equation 2.25 – Formulation B - A2 (2010)

Year	1999			2000			2010			2020		
Category	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp
Land unit	Area (ha)											
1	0	600	0	0	500	0	0	400	0	0	400	0
2.1	0	0	400	0	0	400	0	0	400	0	0	400
2.2	0	0	0	0	0	100	0	0	100	0	0	0
2.3	0	0	0	0	0	0	0	0	100	0	0	100
3	0	0	0	0	0	0	0	0	0	100	0	0
SOC ₀ tC						8,016			16,032	6,500		8,016
SOC _{0-T} tC						2,870			5,741	8,016		2,870
ΔC tC yr ⁻¹	0.000	0.000	0.000	0.000	0.000	257.273	0.000	0.000	514.547	-75.793	0.000	257.273

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

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 soil organic matter of mineral soils - Approach 2 and Approach 3 (Default method)

Data

Region: Region II - Approach 2

2010

Land use category					Equation 2.25 - B												
Land unit code	Initial land use	Land use during reporting year			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)	
					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) = SOCref * Flu(0) * Fmg(0) * Fi(0)	IPCC defaults or country-specific	IPCC defaults or country-specific	IPCC defaults or country-specific	SOC(c) = SOCref * Flu(c) * Fmg(c) * Fi(c)	ΔCmineral = ((SOC(0) - SOC(c)) * A) / D	
	Δ	Δ	Δ	Δ	A	SOCref	D	Flu(0)	Fmg(0)	Fi(0)	SOC(0)	Flu(c)	Fmg(c)	Fi(c)	SOC(c)	ΔCmineral	
2.3	Cropland...	soybean...	Cropland...	agrofores...	100	65	20	1.01	1.1	1.11	80.15865	0.48	1	0.92	28.704	257.27325	
2.2		soybean...		agrofores...	100	65	20	1.01	1.1	1.11	80.15865	0.48	1	0.92	28.704	257.27325	
Total					200											514.5465	

Equation 2.25 – Formulation B - A2 (2020)

Year	1999			2000			2010			2020		
Category	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp
Land unit	Area (ha)											
1	0	600	0	0	500	0	0	400	0	0	400	0
2.1	0	0	400	0	0	400	0	0	400	0	0	400
2.2	0	0	0	0	0	100	0	0	100	0	0	0
2.3	0	0	0	0	0	0	0	0	100	0	0	100
3	0	0	0	0	0	0	0	0	0	100	0	0
SOC ₀ tC						8,016			16,032	6,500		8,016
SOC _{0-T} tC						2,870			5,741	8,016		2,870
ΔC tC yr ⁻¹	0.000	0.000	0.000	0.000	0.000	257.273	0.000	0.000	514.547	-75.793	0.000	257.273

Biomass increase (G&L 1/4) Biomass loss (G&L 2/4) Biomass loss (G&L 3/4) Biomass loss (G&L 4/4) Biomass change (SD) Biomass change (Abrupt) DOM (G&L 1/1) DOM (SD 1/1) SOM Mineral (Approaches 2 and 3) SOM Mineral (SD) SOM Organic Drained SOM Organic Rewetted

Worksheet
Sector: Agriculture, Forestry and Other Land Use
Category: Forest Land
Subcategory: 3.B.1.b) - Cropland converted to Forest Land
Sheet: Annual net C stock change in soil organic matter of mineral soils - Approach 2 and Approach 3 (Default method)

2020

Region: Region II - Approach 2

Land use category	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)	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	IPCC defaults or country-specific	IPCC defaults or country-specific	IPCC defaults or country-specific	SOC(0) = SOCref * Flu(0) * Fmg(0) * Fi(0)	IPCC defaults or country-specific	IPCC defaults or country-specific	ΔCmineral = ((SOC(0) - SOC(c)) * A) / D				
	Δ	Δ	A	SOCref	D	Flu(0)	Fmg(0)	Fi(0)	SOC(0)	Flu(c)	Fmg(c)	Fi(c)	SOC(c)	ΔCmineral		
3	Cropland...	agrofores...	Manage...	Restorati...	100	65	20	1	1	1	65	1.01	1.1	1.11	80.15865	-75.79325
Total													-75.79325			

Land use category	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)	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) = SOCref * Flu(0) * Fmg(0) * Fi(0)	IPCC defaults or country-specific	IPCC defaults or country-specific	IPCC defaults or country-specific	SOC(c) = SOCref * Flu(c) * Fmg(c) * Fi(c)	ΔCmineral = ((SOC(0) - SOC(c)) * A) / D		
	Δ	Δ	A	SOCref	D	Flu(0)	Fmg(0)	Fi(0)	SOC(0)	Flu(c)	Fmg(c)	Fi(c)	SOC(c)	ΔCmineral		
2.3	Cropland...	soybean...	Cropland...	agrofores...	100	65	20	1.01	1.1	1.11	80.15865	0.48	1	0.92	28.704	257.27325
Total													257.27325			



Equation 2.25 – Formulation B – Approach 3

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

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

Where, “D” is the transition period (IPCC default is 20 years), and “c” (climate), “s” (soil), “i” (management system) correspond to the variables, in each land use category/subcategory, according to which the estimate is stratified/disaggregated

According to such variables, **SOC at equilibrium**, in any inventory year, for each stratum (unit of land) **c,s,i**, is calculated as:

- $(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i})_0$

i.e. the combination of current land uses and management systems of practices in the current inventory year “0” (t C)

While the SOC just before the conversion ($SOC_{@conversion}$) of the unit land is not calculated as SOC at equilibrium of the combination of land uses and management systems of practices of in the latest year “T” before the conversion (t C).

$SOC_{@conversion}$ is the actual SOC of the unit of land in the latest year “T” before the conversion (t C)

Equation 2.25 – Formulation B – A3 (2000)

Year	1999			2000			2010			2020		
Category	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp
Land unit	Area (ha)											
0	0	0	0	0	0	100	0	0	100	0	0	0
1	0	600	0	0	500	0	0	400	0	0	400	0
2	0	100	0	0	100	0	0	0	100	100	0	0
3	0	0	400	0	0	400	0	0	400	0	0	500
SOC ₀ tC						8,016			16,032	6,500		0
SOC _{0-T} tC						2,870			5,741	5,443		0
ΔC tC yr ⁻¹	0.000	0.000	0.000	0.000	0.000	257.273	0.000	0.000	514.547	52.843	0.000	0.000

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet: 2000

Sector: Agriculture, Forestry and Other Land Use

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 III - Approach 3

Land use category					Equation 2.25 - B								
Land unit code	Initial land use	Land use during reporting year	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)		
			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) = SOCref * Flu(0) + Fmg(0) * Fi(0)	SOC(c)	ΔC _{mineral} = ((SOC(0) - SOC(c)) * A) / D		
	Δ	Δ	A	SOCref	D	Flu(0)	Fmg(0)	Fi(0)	SOC(0)	SOC(c)	ΔC _{mineral}		
0	Cropland An...	soybean int...	Cropland Pe...	agroforestry...	100	65	20	1.01	1.1	1.11	80.15865	28.704	257.27325
Total					100							257.27325	

Equation 2.25 – Formulation B – A3 (2010)

Year	1999			2000			2010			2020		
Category	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp
Land unit	Area (ha)											
0	0	0	0	0	0	100	0	0	100	0	0	0
1	0	600	0	0	500	0	0	400	0	0	400	0
2	0	100	0	0	100	0	0	0	100	100	0	0
3	0	0	400	0	0	400	0	0	400	0	0	500
SOC ₀ tC						8,016			16,032	6,500		0
SOC _{0-T} tC						2,870			5,741	5,443		0
ΔC tC yr ⁻¹	0.000	0.000	0.000	0.000	0.000	257.273	0.000	0.000	514.547	52.843	0.000	0.000

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet: Agriculture, Forestry and Other Land Use 2010

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 III - Approach 3

Land use category				Equation 2.25 - B								
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources	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)
	Δ	Δ	Δ	A	SOCref	D	F _{lu} (0)	F _{mg} (0)	F _i (0)	SOC(0)	SOC(e)	ΔC _{mineral}
0	Cropland An...	soybean int...	Cropland Pe...	100	65	20	1.01	1.1	1.11	80.15865	28.704	257.27325
2		soybean int...	agroforestry...	100	65	20	1.01	1.1	1.11	80.15865	28.704	257.27325
Total				200								514.5465

Equation 2.25 – Formulation B – A3 (2020)

Year	1999			2000			2010			2020		
Category	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp	F	CLa	CLp
Land unit	Area (ha)											
0	0	0	0	0	0	100	0	0	100	0	0	0
1	0	600	0	0	500	0	0	400	0	0	400	0
2	0	100	0	0	100	0	0	0	100	100	0	0
3	0	0	400	0	0	400	0	0	400	0	0	500
SOC ₀ tC						8,016			16,032	6,500		0
SOC _{0-T} tC						2,870			5,741	5,443		0
ΔC tC yr ⁻¹	0.000	0.000	0.000	0.000	0.000	257.273	0.000	0.000	514.547	52.843	0.000	0.000

Biomass increase (G&L 1/4) Biomass loss (G&L 2/4) Biomass loss (G&L 3/4) Biomass loss (G&L 4/4) Biomass change (SD) Biomass change (Abrupt) DOM (G&L 1/1) DOM (SD 1/1) SOM Mineral (Approaches 2 and 3) SOM Mineral (SD) SOM Organic Drained SOM Organic Rewetted

Worksheet

Sector: Agriculture, Forestry and Other Land Use 2020

Category: Forest Land

Subcategory: 3.B.1.b.i - Cropland converted to Forest Land

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

Data

Region: Region III - Approach 3

Land use category			Equation 2.25 - B									
Land unit code	Initial land use	Land use during reporting year	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 in the year of conversion (tonnes C / ha)	Annual change in carbon stocks in mineral soils (tonnes C / yr)	
			National statistics or international data sources	Tables 2.3 / 5.2 WS	Default value is 20	IPOC defaults or country-specific	IPOC defaults or country-specific	IPOC defaults or country-specific	SOC(0) = SOCref * Flu(0) + Fmg(0) * Fi(0)		ΔCmineral = ((SOC(0) - SOC(c)) * A) / D	
			A	SOCref	D	Flu(0)	Fmg(0)	Fi(0)	SOC(0)	SOC(c)	ΔCmineral	
2	Cropland Pe...	agroforestry...	100	65	20	1	1	1	65	54.43133	52.84337	
Total			100								52.84337	

Stock-Difference Method (IPCC Eq. 2.5)

Can be selected in the **Land Representation Manager** for each C pool (biomass/DOM/SOM) of each unit of land

SOM Organic Rewetted

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained

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 (Stock difference method)

Data

Region: Region IV - Approach 2

Land use category					Equation 2.5				
Land unit code	Initial land use	Land use during reporting year			Area (ha)	Soil organic carbon stock in mineral soils at time 0 (tonnes C / ha)	Soil organic carbon stock in mineral soils at time 0-T (tonnes C / ha)	Number of years over a single inventory time period (Year)	Annual change in carbon stocks in mineral soils (tonnes C / yr)
					National statistics or international data sources	National statistics or international data sources	National statistics or international data sources		$\Delta C_{\text{mineral}} = ((\text{SOC}(0) - \text{SOC}(0-T)) / T)$
					A	SOC(0)	SOC(0-T)	T	$\Delta C_{\text{mineral}}$
SD	Cropland Ann...	Rotation A	Cropland Per...	Rotation P	500	94	90	8	0.5
Total					500				0.5

Land Unit Parameters

C pools / Methods

Biomass change: Gain & Loss

DOM - Deadwood: Gain & Loss

DOM - Litter: Gain & Loss

SOM - Mineral: Stock difference

Save Cancel

Calculation is performed with C density –i.e. tC/ha- at time t_2 (current inventory year) and t_1 (a previous year) and scaled up to the entire area of the unit of land at time t_2

Direct N₂O emissions from managed soils (IPCC Eq. 11.8)

Urine and dung inputs to grazed soils (1 of 2) | Urine and dung inputs to grazed soils (2 of 2) | Drainage of managed organic soils | Rewetting of managed organic soils | Summary of Direct N₂O Emissions from managed soils | Managed manure N available for application to managed soils, feed, fuel or construction uses | Synthetic N applied to managed soils | Organic N applied to managed soils | N in crop residues | N in mineral soils that is mineralised

Worksheet

Sector: Agriculture, Forestry and Other Land Use 2020

Category: Aggregate Sources and Non-CO₂ Emissions Sources on Land

Subcategory: 3.C.4 - Direct N₂O Emissions from managed soils

Sheet: N in mineral soils that is mineralised, in association with loss of soil C from soil organic matter as a result of changes to land use or management

Data

Region: Region II

Equation 11.8											
Land unit code	Initial land use		Land use during reporting year		Average loss of soil carbon (tonnes C / yr)	C:N ratio of the soil organic matter	The net amount of N mineralised in mineral soils as a result of loss of soil carbon through change in land use or management (kg N / yr)	Emission Factor for N mineralised (kg N ₂ O-N / kg N) Table 11.1	N ₂ O-N Emissions (kg N ₂ O-N / yr)	N ₂ O Emissions (kg N ₂ O / yr)	
	▽	△▽	△▽	△▽	△▽	△C _{mineral,LU}	R	F _{som} = ΔC _{mineral,LU} * (1/R) * 1000	EF1	N ₂ O-N = F _{som} * EF1	N ₂ O = N ₂ O-N * 44/28
3	Cropla..	agroforestry - pepper	Manag..	Restoration AB (AC 10)	-75.79325	15	5052.88333	0.01	50.52883	79.40245	
Total									50.52883	79.40245	

Activity Data are automatically transferred from relevant worksheets where SOC losses in mineral soils are estimated

Indirect N₂O emissions from managed soils (E.g. 11.10) leaching/runoff

N2O from Atmospheric Deposition of N Volatilised from Managed Soils | N2O from N leaching/runoff from Managed Soils

Worksheet

Sector: Agriculture, Forestry and Other Land Use 2020

Category: Aggregate Sources and Non-CO2 Emissions Sources on Land

Subcategory: 3.C.5 - Indirect N2O Emissions from managed soils

Sheet: N2O from N leaching/runoff from Managed Soils

Data

Region: Region II

Equation 11.10

		Annual amount of synthetic fertilizer N applied to soils (kg N / yr)	Amount of animal manure, compost, sewage sludge and other organic N additions applied to soils (kg N / yr)	Amount of urine and dung N deposited by grazing animals (kg N / yr)	Amount of N in crop residues (above- and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils (kg N / yr)	Amount of N mineralised in mineral soils associated with loss of soil C from SOM as a result of changes to land use or management (kg N / yr)	Amount of N mineralised in organic soils associated with loss of soil C from organic matter as a result of changes to land use or management (kg N / yr)	Fraction of all N added to/mineralised in managed soils that is lost through leaching and runoff [kg N / (kg of N additions)]	Emission factor for N2O emissions from N leaching and runoff [kg N2O-N/(kg N leaching/runoff)]	Amount of N2O-N produced from leaching and runoff of N additions to managed soils (kg N2O-N/yr)	N2O Emissions (kg N2O/yr)
Land use category	Land use subdivision	F _{sn}	F _{on}	F _{prp}	F _{cr}	F _{som}	N from Fos	FracLEACH-(H)	EF5	N2O-N	N2O = N2O-N * (44/28)
Forest Land	Restoration AB (AC 10)					5052.88333	0	0.3	0.0075	11.36899	17.86555
Total		0	0	0	0	5052.88333	0			11.36899	17.86555

Activity Data are automatically transferred from category 3.C.4 - Direct N₂O emissions from managed soils

CH₄ emissions from rewetted/created wetlands in inland mineral soils

Land Use Manager

Land use structure

- Forest Land
- Cropland
 - Cropland Annual Crops
 - lotus flower
 - rotation A
 - soybean intensive
 - Cropland Perennial Cro
- Grassland
- Wetlands
- Settlements
- Other Land

Land use subdivision - common parameters

Land use subdivision name: lotus flower

Soil Type: High Activity Clay Mineral

Soil Status: Rewetted

Country/Territory: Brazil

Continent: Latin America and Caribbean

Climate Region: Tropical Moist

It is not possible to change some of the parameters since subdivision is already being used in Land Representation Manager

Land use subdivision - Annual Crops specific parameters

Rice ecosystem

Herbaceous biomass (t C / ha): 5.000

C fraction (t C / t d.m.): 1.000

Ratio of below-ground biomass to above-ground biomass (R) (t root C / t shoot C): 0.300

Reference soil organic carbon stock (SOCref) (t C / ha): 65.000

Relative C stock change factors

Land use (FLU): 1.100

Tillage (FMG): 1.220

Input (FI): 1.440

Add Copy Delete Save Undo Close

CH₄ emissions from rewetted/created wetlands in inland mineral soils (IPCC Eq. 5.1 WS)

Worksheet: CH₄ Emissions from Rewetted and Created Wetlands on Inland Wetland Mineral Soils

Sector: Agriculture, Forestry and Other Land Use 2020

Category: Aggregate Sources and Non-CO₂ Emissions Sources on Land

Subcategory: 3.C.13 - CH₄ Emissions from Rewetted and Created Wetlands on Inland Wetland Mineral Soils

Sheet: CH₄ Emissions from Rewetted and Created Wetlands on Inland Wetland Mineral Soils

Data Region: (All)

Equation 5.1 WS							
Land unit code	Initial land use		Land use during reporting year		Land area of rewetted inland mineral soil (ha)	Emission factor for CH ₄ emissions from rewetted and created Wetlands on inland Wetland mineral soils (kg CH ₄ / ha / yr) WS Table 5.4	CH ₄ Emissions (Gg CH ₄ / yr)
					Arewetted	EF	CH ₄ = (Arewetted * EF) * 10 ⁻⁶
ACL-LF-23	Cropland A.	lotus flower	Cropland A.	lotus flower	500	900	0.45
Total							0.45

All elements sourced from the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands* are clearly identifiable because of the liliac color used.



Thank you

<https://www.ipcc-nggip.iges.or.jp/index.html>

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LRM – Land Representation Tab

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition period [T] (years)	Year of conversion	Area (1990) (ha)	Remark	P	C	M
MFL-PP-PL-P-4<MGL-P-P...	Approccio 3 esempio	Managed Grassland	Pasture	20	1984	1000				

Additional functionalities

- **Area entry:** once area of a unit of land is input the user may select the portion of the time series to which that area is to be assigned to the unit

Area update mode

Current inventory year only

Current inventory year and all subsequent inventory years

Current inventory year and all previous inventory years

All inventory years

Update Cancel

LRM – Land Representation Tab

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition period [T] (years)	Year of conversion	Area (1991) (ha)	Remark	P	C	M
MFL-PP-PL-P-4<MGL-P-P...	Approccio 3 esempio	Managed Grassland	Pasture	20	1984	1000 <->				
*						<->				

Additional functionalities

- **Button “P”** (Pools) to assign to each C pool the method to estimate C stock changes i.e. **IPCC default method** vs **Stock-Difference method**

Land Unit Parameters

C pools / Methods

Biomass change: Gain & Loss

DOM - Deadwood: Gain & Loss

DOM - Litter: Gain & Loss

SOM - Mineral: Default

Save Cancel

LRM – Land Representation Tab

Land use subcategory		Area (ha)	Remark						
Cropland annual crops									
Current Land use subdivision		Remark							
Organic 1 (A) rewetted									
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition period [T] (years)	Year of conversion	Area (ha)	Remark	C	M
ACL-O1AR-104<-MFL-...		Managed Forest land	Tectona grandis NF	20	1990	100 000			

Additional functionalities

Button “C” (Conversion) to input a further conversion to a unit of land that is still undergoing a conversion (*no 20-year period passed since the previous conversion*)

New Land Unit Conversion

Current conversion status

From: Managed Forest land / Tectona grandis NF

To: Cropland annual crops / Organic 1 (A) rewetted

Transition period: 20 Year of conversion: 1990

New conversion to

Land use subcategory: Settlements (Treed)

Land use subdivision: Settlement 1 (T)

Transition period: 20

Year of conversion: 1995

Remark:

Save Cancel

It is available in Approach 3 land representation only

LRM – Land Representation Tab

Land use subcategory		Area (1991) (ha)		Remark				
Managed Forest Land		120						
Current Land use subdivision				Remark				
Pine plantation								
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition period [T] (years)	Year of conversion	Area (1991) (ha)	Remark	M
MFL-PP-PL-P-23		Managed Forest Land	Pine plantation	NA	NA	100 (↔)		
MFL-PP-PL-P-24<MGL-P-P...		Managed Grassland	Pasture	20	1990	10 (↔)		
MFL-PP-PL-P-25		Managed Forest Land	Pine plantation	NO	NO	10 (↔)		

Additional functionalities

Button “M” (Merge) to merge a unit of land that has completely undergone through the transition period.

Merging is allowed with any other unit with identical land use (category/subcategory/subdivision) as well as with identical climate/vegetation zone and soil type.

Merge Land Unit ✕

Source Land Unit

Land use subcategory:

Land use subdivision:

Land unit:

Area [ha]:

Target Land Unit

Land use subcategory:

Land use subdivision:

Land unit:

Area [ha]: +10 [ha]

It is available in Approaches 2 and 3 land representation only

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