IPCC Inventory Software for National GHG inventories
Overview of the AFOLU Sector

IPCC TFI Side Event

Sharm el-Sheikh - Climate Change Conference

UNFCCC COP27

November 2022

ipcc

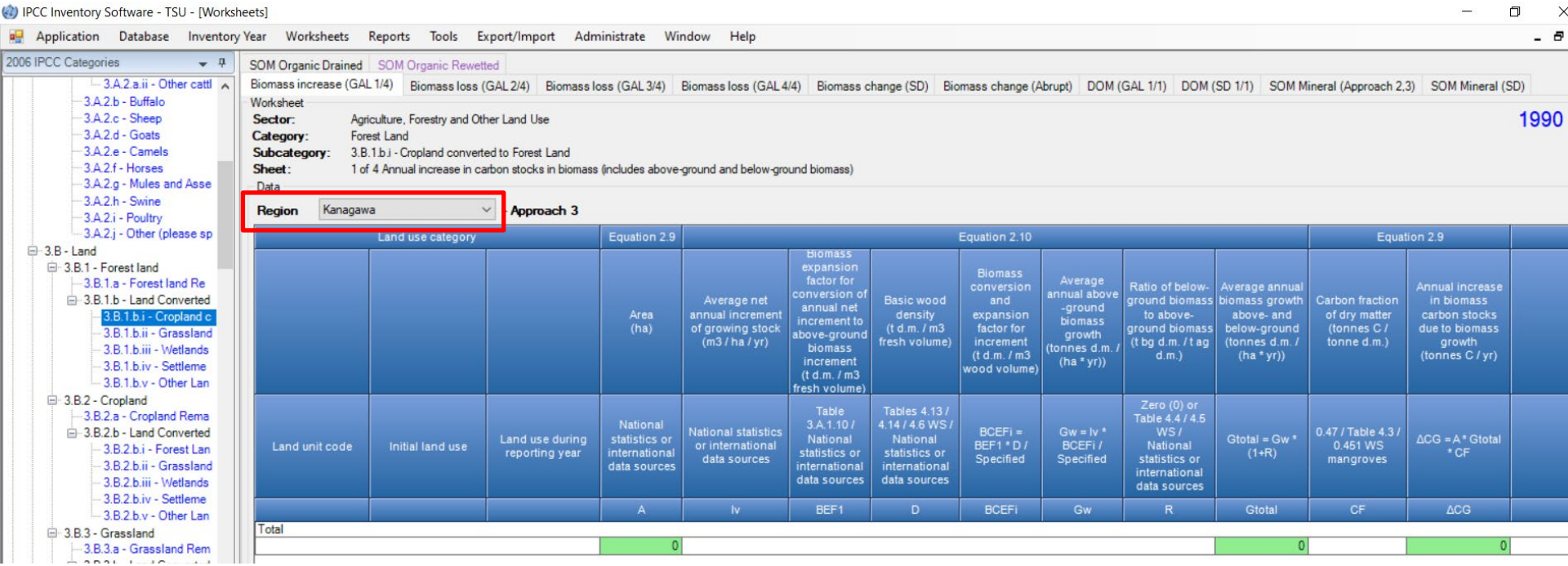
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Major updates

- Subnational disaggregation at a category level
- Land Representation Manager
- **Higher Tiers methods in 2006 IPCC Guidelines (Vol 4) and additional methods in Wetlands Supplement**
- Improvements in worksheet structure and layout

Subnational disaggregation



Region/Geographical zone stratification allows to report at subnational level as well as to further disaggregate estimates according to e.g. drivers/stakeholders and/or relevant variables

Land Representation Manager (LRM)

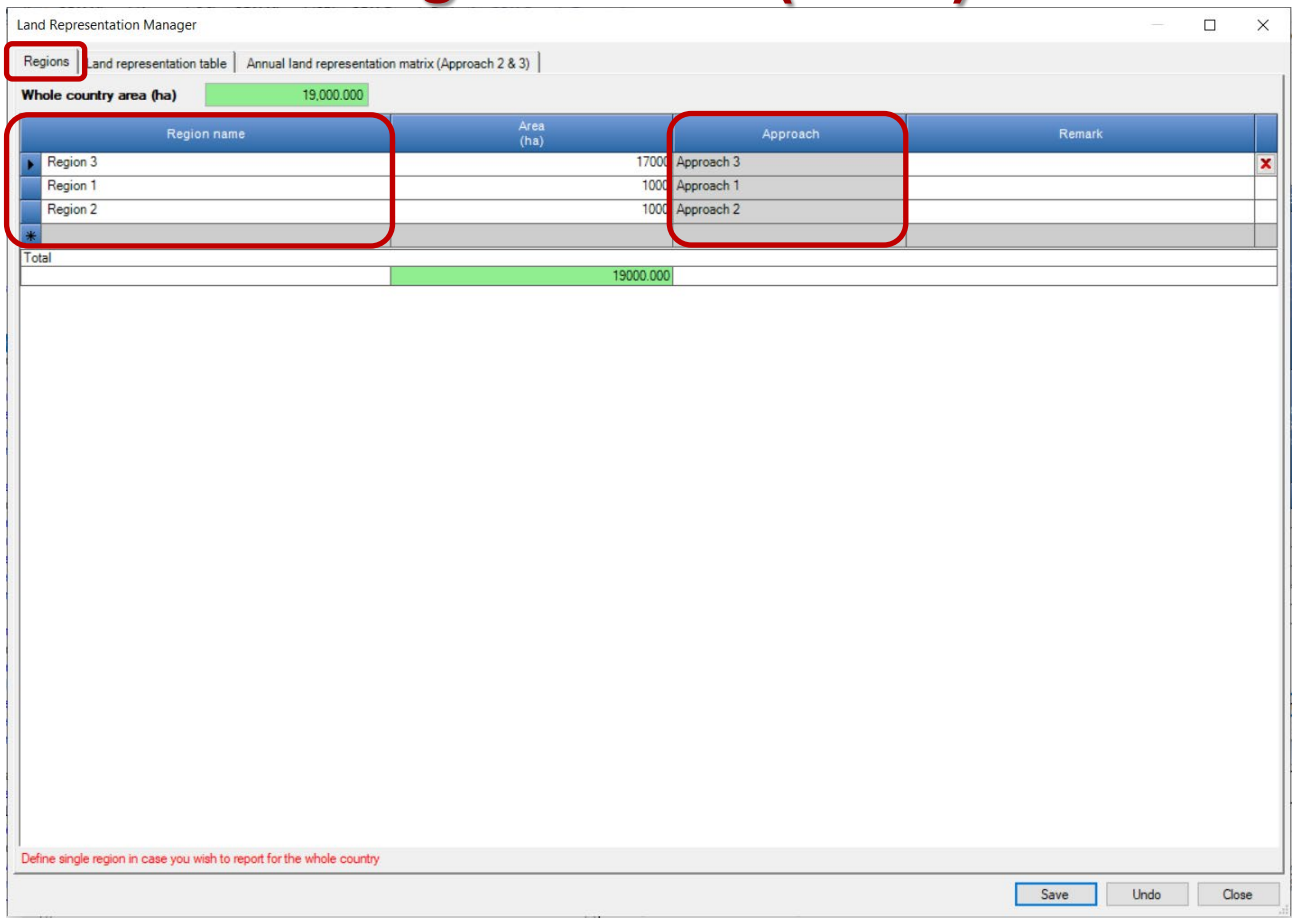
- **Allows to use any of the three IPCC approaches**:
  - ✓ Approach 1 *-no land use change identification-*
  - ✓ Approach 2 *-land use change identification-*
  - ✓ Approach 3 *-land use change identification and tracking across time-*
- **Ensures consistency of land representation** *-including through fully spatially explicit tracking of units of land-*

Unit of land, an area homogenous per

- ✓ physical conditions *-climate/vegetation zone and soil type-* and
- ✓ current and historical socio-economic functions **-***land use & management type-*

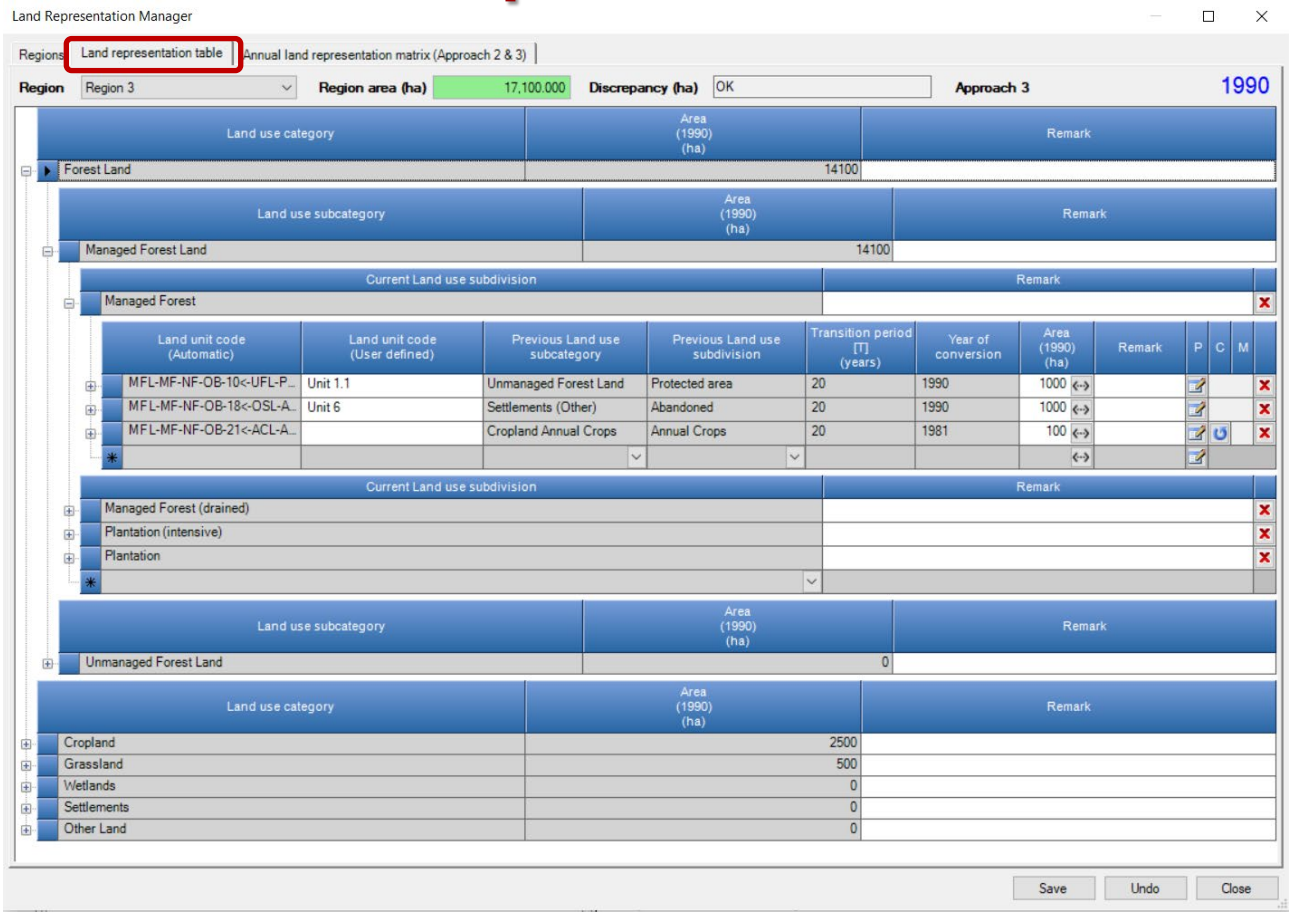
An excel-based tool to input at once the entire land representation is under preparation

Regions Tab (LRM)



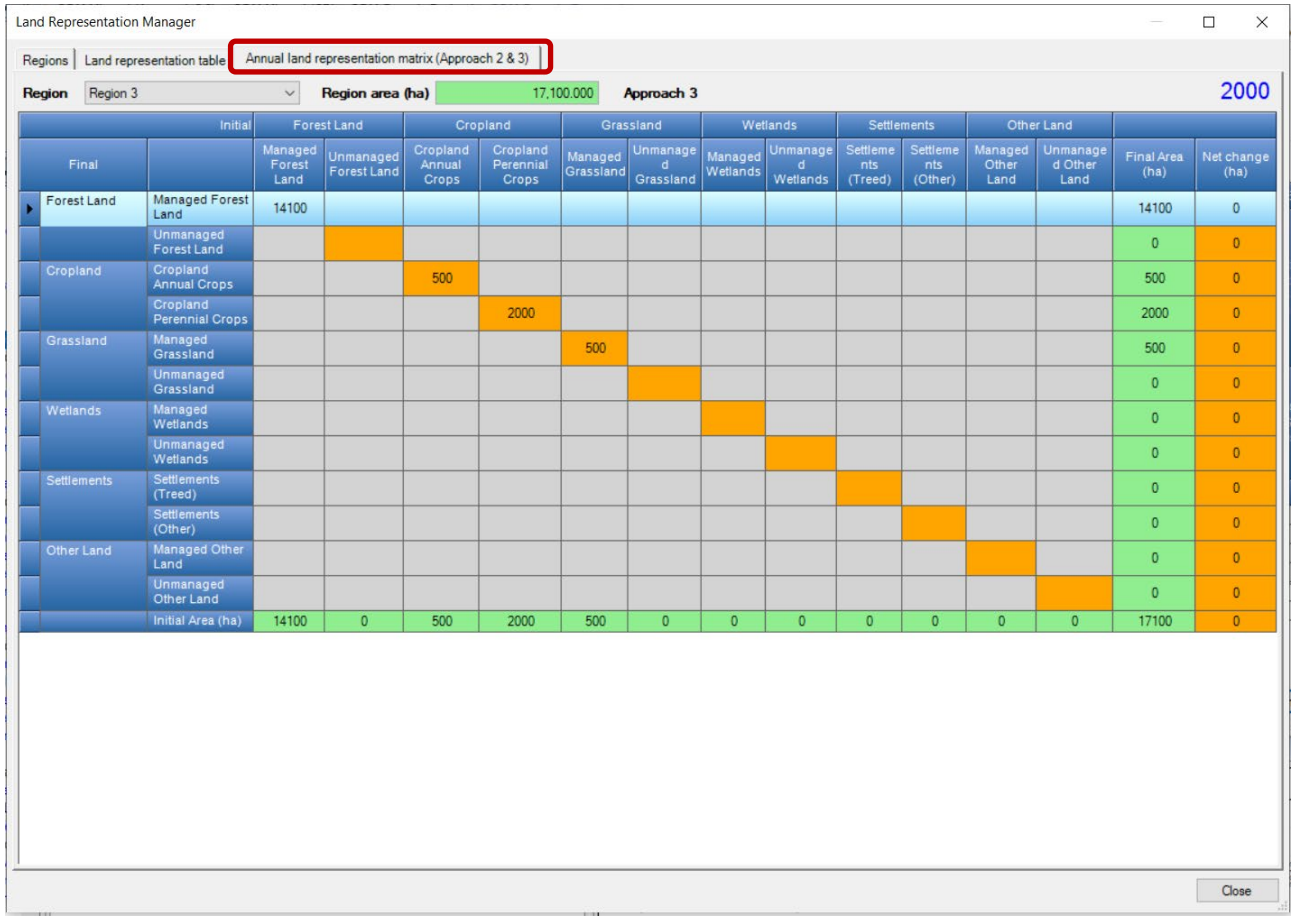
- ✓ A country can be represented in a single set of National data or in a number of Regions
- ✓ For each Region the land representation approach is to be selected

Land Representation Tab



- ✓ A Table for each Region
- ✓ All info on land use and land use changes is to be input in this Tab
- ✓ Each unit of land is identified by a code and contains information on the current and previous land use/management
- ✓ For each conversion, input *Transition Period* and *Conversion Year*, so the software tracks it across time
- ✓ Data input in the time series is to be done from its first year forward

Annual land representation matrix Tab



Final		Initial: 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	Final Area (ha)	Net change (ha)
Forest Land	Managed Forest Land	14100												14100	0
	Unmanaged Forest Land													0	0
Cropland	Cropland Annual Crops			500										500	0
	Cropland Perennial Crops				2000									2000	0
Grassland	Managed Grassland					500								500	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)	14100	0	500	2000	500	0	0	0	0	0	0	0	17100	0

No data Input, just for verification (not exportable yet)

Higher Tiers and additional methods

- **Stock difference approach**
  - ✓ in each carbon pool of each land use

- **Formulation B for SOC change in mineral soils**
  - ✓ When Approach 3 for land representation is applied, the software calculates SOC net changes associated with land use/management change based on the actual SOC content of the unit of land

- **Wetlands Supplement**
  - ✓ Additional methods provided, identified through the use of Lilac color
  - ✓ Additional source/sink categories, identified through the use of Lilac color

Improvements in worksheet structure and layout

- Combination of Tiers within the same set of worksheets, where the structure of IPCC equations allows e.g. Enteric fermentation
- Addition of (set of) worksheets for each different Tier, where IPCC equations do not allow combination of multiple tiers e.g. Gain & Loss vs Stock-Difference
- 492 worksheets in total available, among which the user selects those that better deal with national circumstances.
- Such a large number allows any combinations of tiers to be composed to estimate GHG emissions from the AFOLU sector.

Improvements in worksheet structure and layout

Livestock population | Average Daily Feed Intake - Tier 2 (Detailed) | Average Daily Feed Intake - Tier 2 (Simplified) | CH4 Emission Factor for Enteric Fermentation - Tier 2 | CH4 Emissions from Enteric fermentation

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Livestock

Subcategory: 3.A.1.a.i - Dairy Cows

Sheet: Livestock population

2020

Data

Geographical zone (All) **Livestock Subcategory** (All)

						Per animal										
Geographical zone	Livestock Subcategory	Livestock Subdivision	Tier (3.A.1)	Annual Average Population (head)	Typical Animal Mass (kg)	Gross Energy calculation method	Feeding situation	Mean daily temperature during winter season (°C)	Coefficient for calculating Net Energy for Maintenance (MJ/day/kg)	Coefficient for calculating Net Energy for Maintenance (in_cold) (MJ/day/kg)	Average daily milk production (kg/day)	Fat content of milk (% by weight)	% of females that give birth in a year (%)	Coefficient for calculating Net Energy for Pregnancy	Feed digestibility (%)	
Z	T	T		AAP	TAM		Ca	Tw	Cfi	Cfi(in_cold) =Cfi+ (0.0048*(20				Cp	DE%	
region 1	Mature Dairy...	average	Tier 1	2000	600											
		High-produci...	Tier 2	1000	900	Detailed	0	10	0.386	0.434	90	4	80	0.1	90	
		Low-produci...	Tier 2	500	300	Simplified					30	2			30	
region 2		average	Tier 1	100	275											
		High-produci...	Tier 1													
		Low-produci...	Tier 1													
Total																
				3600												

3 methodological options

- ✓ IPCC Default
- ✓ Tier 2 – Detailed
- ✓ Tier 2 – Simplified

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Improvements in worksheet structure and layout

SOM Mineral (Approach 2,3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Biomass increase (GAL 1/4) | Biomass loss (GAL 2/4) | Biomass loss (GAL 3/4) | Biomass loss (GAL 4/4) | Biomass change (SD) | Biomass change (Abrupt) | DOM (GAL 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Forest Land

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

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

2020

Data

Region Region 3 - **Approach 3**

Land use category					Equation 2.8																
			Area (ha)	Biomass conversion and expansion factor for standing stock (t d.m. / m3 volume)	Biomass expansion factor for conversion of merchantable volume to above-ground biomass (t d.m. / m3 fr	Basic wood density (t d.m. / m3 fresh volume)	Merchantable growing stock volume at the beginning of the inventory period (t1) (m3 / ha)	Total initial above-ground biomass (t d.m. / ha)	Merchantable growing stock volume at the end of the inventory period (t2) (m3 / ha)	Total final above-ground biomass (t d.m. / ha)	Ratio of below-ground biomass to above-ground biomass (R) (t bg d.m. / t ag d.m.)	Biomass carbon fraction (tonnes C / tonne d.m.)	Total initial biomass C stock (tonne C / ha)	Total final biomass C stock (tonne C / ha)	Time period between two inventories (Year)	Annual change in carbon stocks in biomass (tonnes C / yr)					
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources	BCEFs=BEF2 *D or specified	Table 3.A.1.10 / National statistics or international data sources	Tables 4.13 / 4.14 / 4.6 WS / National statistics or international data sources	National statistics or international data sources	AB(t1)=V(t1)*BCEFs or specified	National statistics or international data sources	AB(t2)=V(t2)*BCEFs or specified	Zero (0) or Table 4.4 / 4.5 WS / National statistics or international data sources	0.47 / Table 4.3 / 0.451 WS mangroves	CB(t1) = AB(t1) * (1+R) * CF	CB(t2) = AB(t2) * (1+R) * CF	T = t2 - t1	ΔCB = (CB(t2) - CB(t1)) / T *A					
			A	BCEFs	BEF2	D	V(t1)	AB(t1)	V(t2)	AB(t2)	R	CF	CB(t1)	CB(t2)	T	ΔCB					
Unit 7.2	Managed For..	Plantation	Managed Fore..	Plantation	6500	1			200	Calculated	200	220	Calculated	220	0.29	0.51	131.58	144.738	5	17105.4	
Total													131.58	144.738		17105.4					

- BCEFs or BEF2 x D
- Aboveground biomass (both, initial and final values):
  - ✓ either calculated as Growing Stock (merchantable volume) x BCEF
  - ✓ or input

Improvements in worksheet structure and layout

Biomass increase (GAL 1/4) | Biomass loss (GAL 2/4) | Biomass loss (GAL 3/4) | Biomass loss (GAL 4/4) | Biomass change (SD) | Biomass change (Abrupt) | DOM (GAL 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item)

SOM Mineral (Approach 2,3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet

Sector: Agriculture, Forestry and Other Land Use

Category: Forest Land

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

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

2020

Data

Region Temperate - **Approach 2**

Land use category			Equation 3.3, 3.4, 3.5, 4.9 WS							
			Area (ha)	CO2 on-site emission factor for climate type and nutrient status of peat and drainage class in rewetted soils (tonnes CO2-C / ha / yr)	Net flux of DOC from natural (undrained) and rewetted organic soil (tonnes C / ha / yr)	Conversion factor for proportion of DOC converted to CO2 following export from site	CO2 off-site emission factor for climate type and nutrient status of peat and drainage class in rewetted soils (tonnes CO2-C / ha / yr)	CO2 emissions from peat fire in rewetted land (tonnes CO2-C / ha / yr)	Annual carbon loss from rewetted organic soils (tonnes C / yr)	
Land unit code	Initial land use	Land use during reporting year	National statistics or international data sources	Table 3.1 WS / 4.12 WS or national statistics	Table 3.2 WS or national statistics	0.9 (0.8-1) or national statistics	Table 3.2 WS / Eq. 3.6 or national statistics	From 3.C.1	CO2-C(r) = A(r) * (EF(os) + EF (DOC)) + L(fr)	
			A(r)	EF(os)	DOC(flux)	Frac(DOC)	EF(DOC)	L(fr)	CO2-C(r)	
Total			0						0	

Wetlands Supplement additional methods, identified through the use of Lilac color

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, base don 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 N_2O emissions	10	9 +1		
3.C.5 – Indirect N_2O emissions from managed soils	2	2		
3.C.6 – Indirect N_2O emissions from manure management	4	4		
3.C.7 – Rice cultivation	1	1		
3.C.8 – CH_4 emissions from drained inland organic soils	1	1		
3.C.9 – CH_4 from drainage ditches on organic soils	1	1		
3.C.10 – CH_4 from rewetting of inland organic soils	1	1		
3.C.11 – CH_4 from rewetting of mangroves and tidal marshes	1	1		
3.C.12 – N_2O emissions from aquaculture	1	1		
3.C.13 – CH_4 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 CO_2 emissions estimated as C stock losses in 3.B categories could be higher than that of non-CO_2 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-CO_2 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_2O emissions	10
3.C.5 – Indirect N_2O emissions from managed soils	2
3.C.6 – Indirect N_2O 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_2O 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

******* The 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**

Thank you

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

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