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

Other GHG emissions

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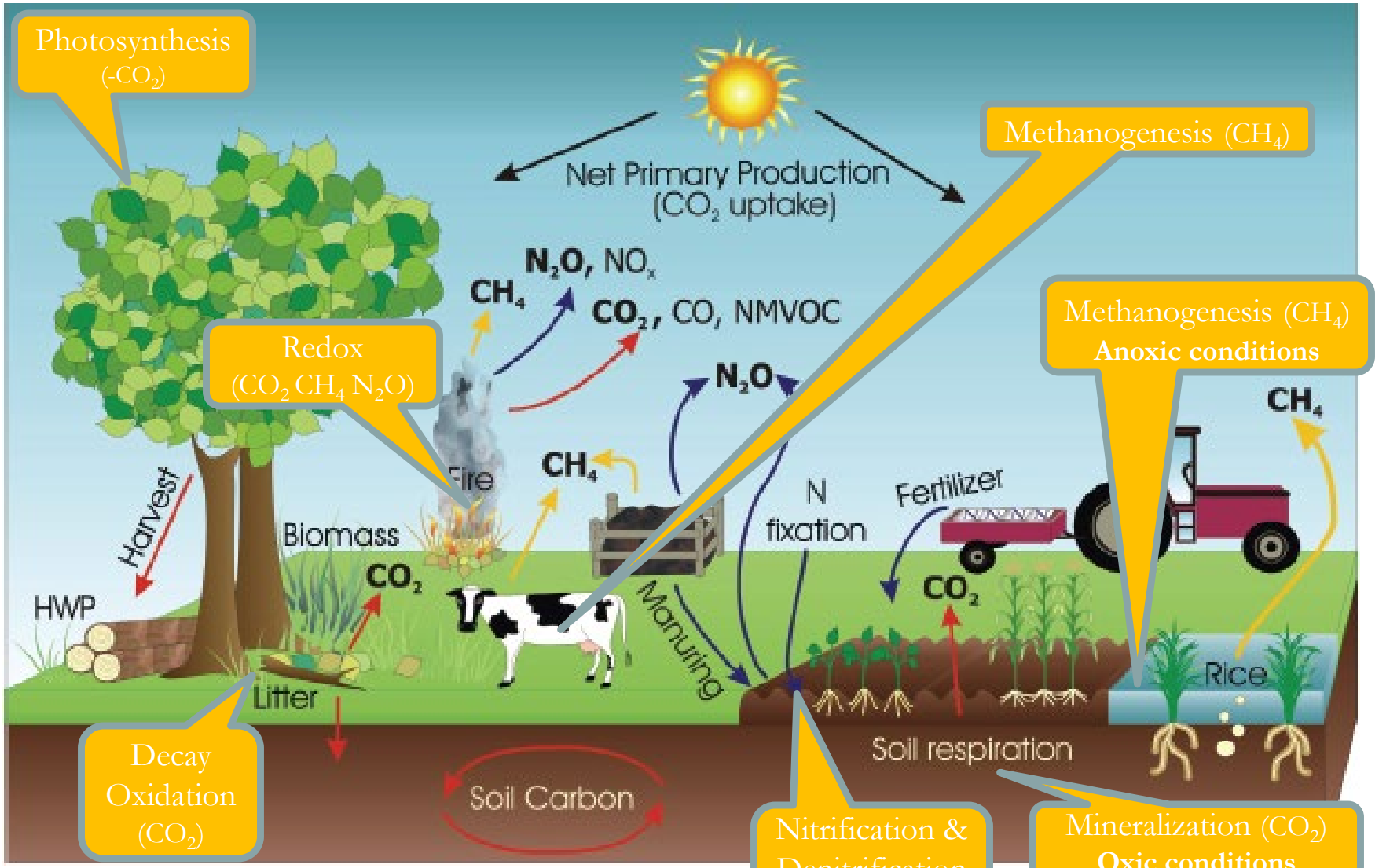
IPCC Guidelines

- **Volume 4 (AFOLU)**, Chapters 2, 7, 11
  - ✓ **2006 IPCC Guidelines**
  - ✓ **2019 Refinement**

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

Processes covered by IPCC Guidance on AFOLU



Organic Matter

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

Organic Matter

- **Organic matter redox/decay processes timescale**
  - *hours*
  - *within a year*
  - *years/centuries*
  - *centuries/millennia*

- **Organic matter redox/decay results in**
  - CO_2, CH_4, N_2O
  - NH_3/NH_4^+, NO_X
  - H_2O, N_2

Chemicals

- Nitrogen fertilizers => N_2O emissions
- Carbonaceous amendments => CO_2 emissions
- Nitrogen/Carbonaceous fertilizers (Urea) => N_2O + CO_2 emissions

Notations

- **Nitrogen** content of **N_2O is** indicated as **N_2O-N**, and emissions of N_2O-N are **converted** to N_2O emissions multiplying **by 44/28** (proportion of the atomic weight of the two molecules)
- **Carbon** content of **CH_4 is** indicated as **CH_4-C**, and emissions of **CH_4-C** are **converted** to **CH_4** emissions multiplying **by 16/12** (proportion of the atomic weight of the two molecules)
- **Carbon** content of **CO_2 is** indicated as **CO_2-C**, and emissions of **CO_2-C** are **converted** to **CO_2** emissions multiplying **by 44/12** (proportion of the atomic weight of the two molecules)
- Emissions have a positive sign, while CO_2 removals have a negative sign. *This is because the "point of view" of an NGHGI is the atmosphere, so a positive sign means an addition of GHG to the atmosphere, while a negative sign means a subtraction of CO_2 from the atmosphere*
- Carbon stock gains have a positive sign, while Carbon stock losses have a negative sign. *This is because the "point of view" is the C pool to which the C stock pertains, so a positive sign means an addition of Carbon to the C pool, while a negative sign means a subtraction of C stock from the C pool*
- Thus, **converting** a net **C stock** change **to CO_2** net **emission/removal** requires to multiplying the net C stock **by -44/12**, *given that the sign is to be changed*

Stratification of Activity Data

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

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

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

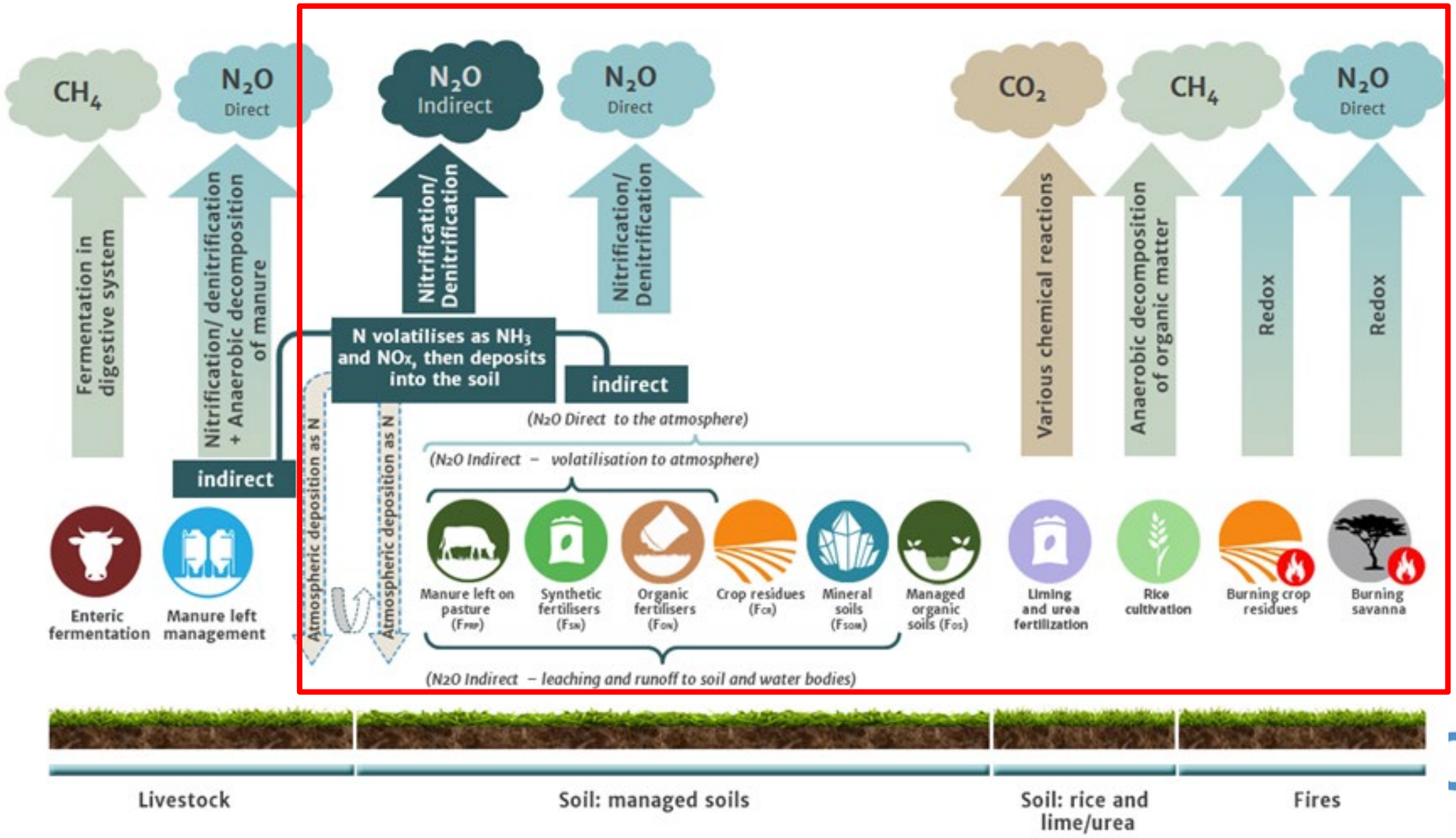
3.C categories: Aggregate sources & non-CO_2 emissions source on land

Tool:

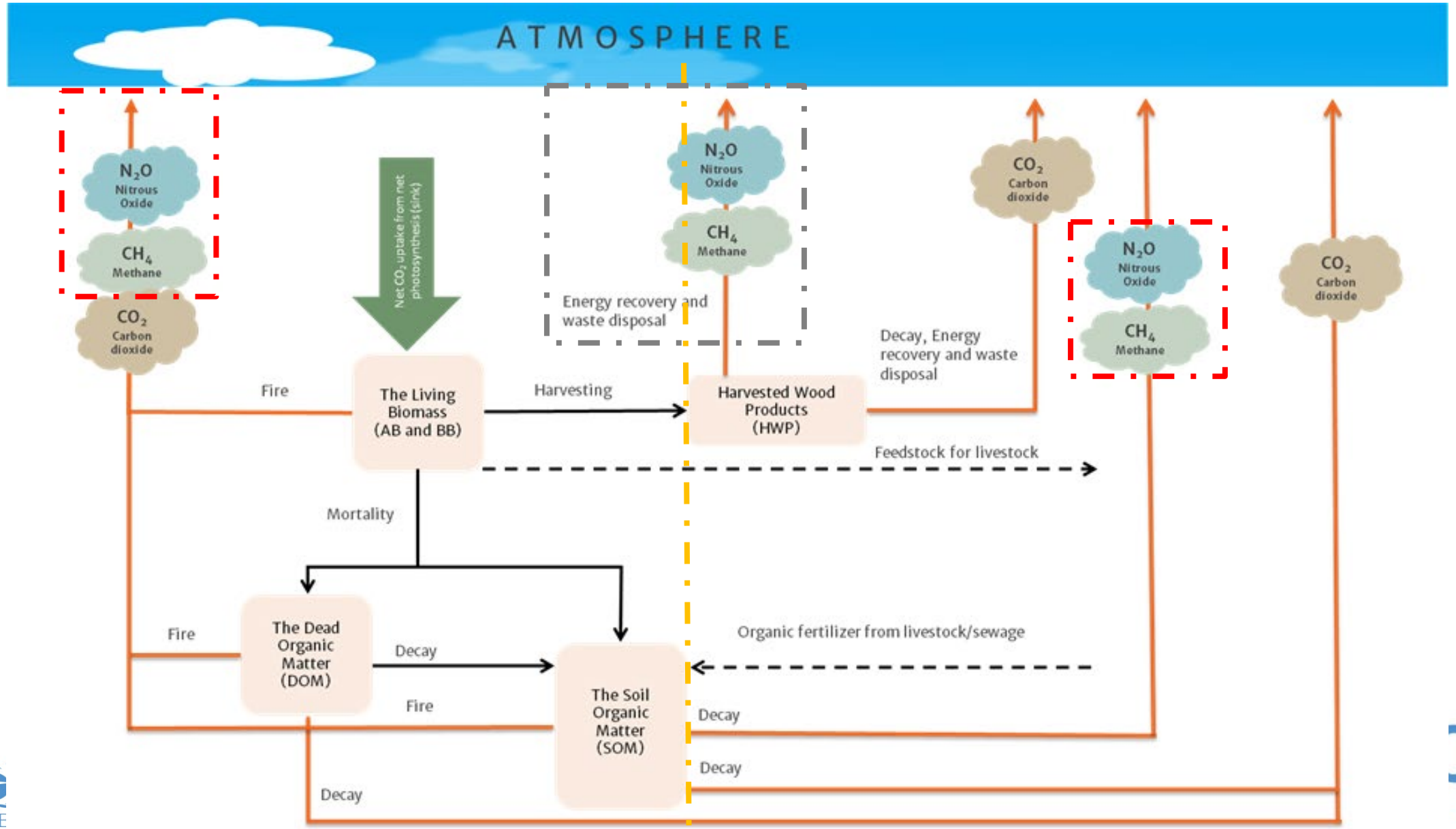
Land Representation *(limited to some sources)*

3.C Calculation Worksheets

GHG emissions in Agriculture



GHG emissions and CO_2 removals from land use



AFOLU anthropogenic GHG Emissions and Removals

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

1. Indirectly, as a net change in C stock in a C pool. *The use of C stock changes to infer CO_2 emissions and removals from C pools, is based on the fact that changes in ecosystem C stocks are predominately (but not exclusively*) through CO_2 exchange between the land surface and the atmosphere*

2. **Directly as flux rates** to(/from) the atmosphere *(used for estimating non-CO_2 emissions, CO_2 emissions not sourced from C pools and those CO_2 emissions and removals from SOM for which the C stock is not quantifiable in an operational way, e.g. drainage/rewetting of organic soils)*.

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

AFOLU anthropogenic GHG Emissions and Removals

- **Organic matter decays to CH_4** under anoxic conditions in waterlogged soils, in:
  - 3.C.7 Rice cultivation
  - 3.C.8 Drained organic soils
  - 3.C.9 Drainage ditches on organic soils
  - 3.C.10 Rewetting organic soils
  - 3.C.11 Rewetting of Mangroves and Tidal marshes
  - 3.C.13 Rewetting inland wetland mineral soils

- **Organic matter** is **reduced to CH_4** and **oxidised to N_2O** & **CO_2** by combustion, in:
  - 3.C.1 Burning

- **Organic matter is oxidised to N_2O** under oxic conditions in soils, in
  - 3.C.4 Direct N_2O emissions from managed soils

AFOLU anthropogenic GHG Emissions and Removals

- **CO_2 and N_2O emissions originates from addition of chemical-mineral components** (fertilizers, amendments)
  - 3.C.2 Liming
  - 3.C.3 Urea application
  - 3.C.4 Direct N_2O emissions from managed soils
- **Indirect N_2O emissions originate from N volatilized or leached**
  - 3.C.5 Indirect N_2O emissions from managed soils
  - 3.C.6 Indirect N_2O emissions from manure management
- **Direct N_2O emissions originate from N added to aquaculture**
  - 3.C.12 N_2O emissions from aquaculture

3.C Aggregate sources and non-CO_2 emissions source on land

3.C categories are a mix of:

- ✓ land-based sources of non-CO_2 emissions, which requires the land to be identified, and possibly tracked, through the Land Representation:
  - 3.C.1 – Burning *(on-site)* – ***CH_4, N_2O*** *(,* ***CO_2****)*
  - 3.C.8 – CH_4 emissions from drained organic soils – ***CH_4***
  - 3.C.9 – CH_4 emissions from drainage ditches on organic soils – ***CH_4***
  - 3.C.10 – CH_4 emissions from rewetting of organic soils – ***CH_4***
  - 3.C.11 – CH_4 emissions from rewetting of mangroves and tidal marshes – ***CH_4***
  - 3.C.14 – CH_4 emissions from rewetted and created wetland on IWMS* – ***CH_4***
- ✓ Aggregated sources, which are thus not land-based:

** Inland Wetland Mineral Soils*

3.C Aggregate sources and non-CO_2 emissions source on land

3.C categories are a mix of:

- ✓ land-based sources of non-CO_2 emissions, which requires the land to be identified, and possibly tracked, through the Land Representation:
- ✓ Aggregated sources, which are thus not land-based:
  - 3.C.2 – Liming – ***CO_2 (mineral)***
  - 3.C.3 – Urea application – ***CO_2 (non-biogenic)***
  - 3.C.4 – Direct N_2O emissions from managed land [*excluding N mineralization in mineral soils*] – ***N_2O***
  - 3.C.5 – Indirect N_2O emissions from managed soils – ***N_2O***
  - 3.C.6 – Indirect N_2O emissions from manure management – ***N_2O***
  - 3.C.7 – Rice cultivation – ***CH_4***
  - 3.C.12 – N_2O emissions from aquaculture – ***N_2O***

The IPCC Inventory Software

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

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

- **Subnational disaggregation (Geographical Zone)**

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

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

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

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

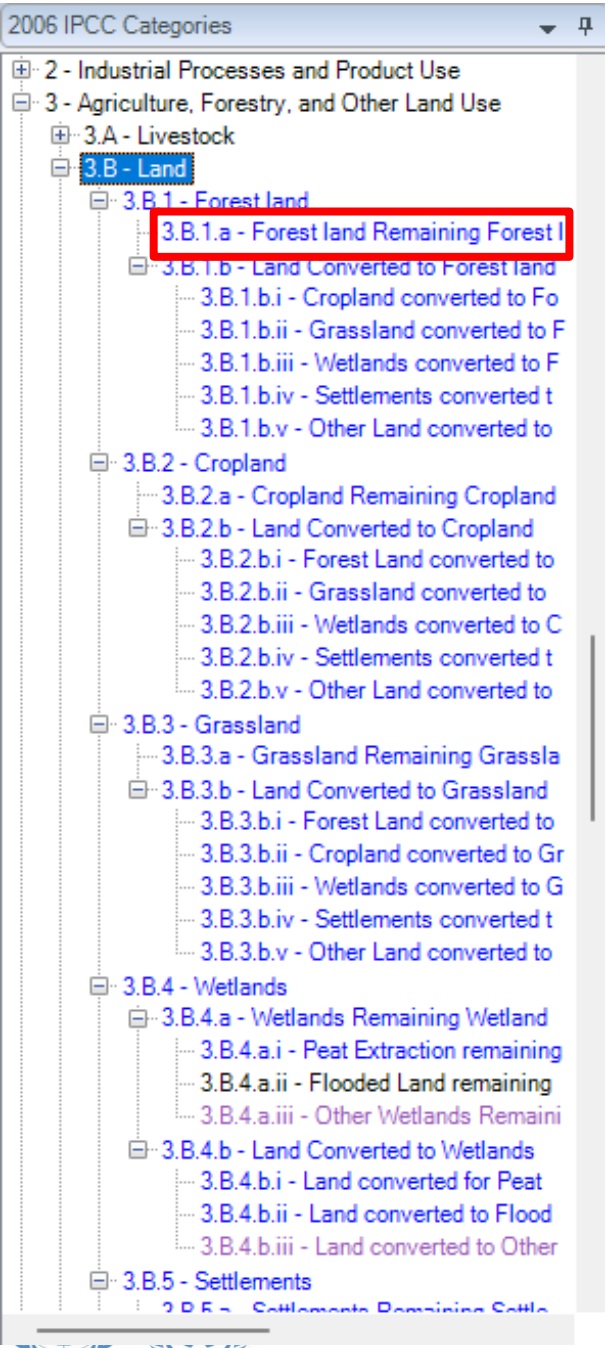
Case Study for Land – Land dynamic

- **Region 1:**
  - Forest land is first expanded on Grassland, and then deforested likely for Settlements
  - Settlements is expanded likely on Grassland, and then likely on Forest land
- **Region 2:**
  - Primary forest converted to Forest plantation
  - Mangrove forest is deforested to urban park, and a fraction subsequently abandoned to Tidal marsh
  - Oil Palm plantation is converted to Lotus cultivation; thus, land is rewetted
  - Tidal marshes excavated and converted to Harbor
- **Region 3:**
  - Rotation Rice (1y) – Maize (1y) – Poplar (5y) established on land cultivated at rice for long-term; then replaced with a rotation Rice (2y) – Maize (2y) – Poplar (10y)
    Maize is limed; Maize - Rice – Poplar are fertilized with Urea and manure

Case Study for 3.C – GHG emissions

- **Estimate CO_2 emissions** from:
  - 3.C.2 Liming
  - 3.C.3 Urea application
- **Estimate Direct & Indirect N_2O emissions** from:
  - 3.C.4 Direct N_2O emissions from managed soils
  - 3.C.5 Indirect N_2O emissions from managed soils
- **Estimate CH_4 emissions** from:
  - 3.C.7 Rice cultivation
  - 3.C.8 Drained organic soils
  - 3.C.9 Drainage ditches on organic soils
  - 3.C.11 Rewetting of Mangroves and Tidal marshes
  - 3.C.13 Rewetting inland wetland mineral soils

Open the Calculation Worksheets



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

Calculation Worksheets

- The *Software* maps each unit of land to the relevant TAB, for those 3.C categories which are land-based, although users have to select each unit of land from the dropdown menu
- Although land categories are shown in blue ink -e.g. 3.B.1 Forest land-, calculation worksheets are limited to subcategories -e.g. 3.B.1.a Forest land remaining Forest land-.
- Although land conversion categories are shown in blue ink -e.g. 3.B.1.b Land converted to Forest land-, calculation worksheets are limited to subcategories -e.g. 3.B.1.b.i Cropland converted to Forest land-.

Calculation Worksheets

- Carbon Dioxide:
  - ✓ Liming
  - ✓ Urea application
- Methane:
  - ✓ Rice Cultivation
  - ✓ Drainage (Organic soils, Coastal Wetlands soils, Ditches)
  - ✓ Rewetting (Organic soils, Coastal Wetlands soils, Wetland mineral soils)
- Nitrous Oxide:
  - ✓ Direct N_2O (Managed manure N available, Synthetic N applied. Organic N applied, Crop residues N, SOM Mineralized N, Manure N left on pasture, Drainage of organic soils)
  - ✓ Indirect N_2O (volatilization, leaching)

Case Study Data

CO_2 emissions from:

3.C.2 - Liming

3.C.3 - Urea application

3.C.2 - Liming

Annual CO2 Emissions from Liming

Worksheet

Sector: Agriculture, Forestry, and Other Land Use
Category: Aggregate Sources and Non-CO2 Emissions Sources on Land
Subcategory: 3.C.2 - Liming
Sheet: Annual CO2 Emissions from Liming

2020

Data

Region Unspecified

Equation 11.12											
Land use category	Land use subdivision	Lime Type	Subdivision, if any, according to the purity of carbonate limes as well as site-level and hydrological characteristics	Annual amount of lime (tonnes / yr)	Emission Factor (tonnes of C / tonne of lime)	Annual C emissions from liming (tonnes C / yr)	Annual CO2 emissions from liming (tonnes CO2 / yr)				
				M	EF	CO2-C Emissions = M * EF	CO2 Emissions = CO2-C Emissions * 44/12				
Unspecified	Unspecified	Dolomite	Unspecified	256.000	0.13	33.280	122.027				
		Limestone	Unspecified	97.000	0.12	11.640	42.680				
Total											
				353.000		44.920	164.707				

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3.C.3 - Urea Application

Annual CO2 Emissions from Urea application

Worksheet

Sector: Agriculture, Forestry, and Other Land Use

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

Subcategory: 3.C.3 - Urea application

Sheet: Annual CO2 Emissions from Urea application

2020

Data

Region Unspecified

Equation 11.13

Land use category	Land use subdivision	Type of carbonate N fertilizer	Annual amount of Carbonate N-fertilizer (tonnes / yr)	Emission Factor (tonnes of C / tonne of Carbonate N-fertilizer)	Annual CO2-C emissions from Urea application (tonnes C / yr)	Annual CO2 emissions from Urea application (tonnes CO2 / yr)
			M	EF	CO2-C Emissions = M * EF	CO2 Emissions = CO2-C Emissions * 44/12
Unspecified	Unspecified	Ammonium Bicarbonate	852.000	0.150	127.800	468.600
		Urea	323.000	0.200	64.600	236.867
Total						
			1,175.000		192.400	705.467

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N_2O emissions from:

3.C.4 – Direct N_2O emissions from managed soils

3.C.5 – Indirect N_2O emissions from managed soils

3.C.6 – Indirect N_2O emissions from manure management

3.C.4 – Manure N available as organic fertilizer

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 | Urine and dung inputs to grazed soils (1 of 2)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

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

Sheet: Managed manure N available for application to managed soils, feed, fuel or construction uses

2020

Data

Equation 10.34											
Geographical zone	Manure Management System	Livestock Category	Livestock Subcategory	Livestock Subdivision	Total N excretion for the MMS (kg N/yr)	Fraction of manure N that is lost in the MMS (%) Table 10.23	Number of Animals (head)	Fraction of livestock category's manure handled using MMS in geographical zone	N in organic Bedding (solid storage and deep bedding MMS - otherwise zero) (kg N/animal/yr)	Amount of managed manure N available for application to managed soils or for feed, fuel, or construction purposes	
Z	S	T	Tsc	Tsd	NEmms = N(T) * Nex(T) * MS(T,S)	Frac(LossMS)	N(T)	MS(T,S)	N(BeddingMS)	N(MMSavb)	
A	Pasture/Paddock (6...	Dairy Cows	Unspecified	Unspecified	530,617.325	64.000	6,226.000	1.000	3.500	212,813.237	
B	Anaerobic digester		Mature Dairy Cows	High-producing cows...	55,862,100.341	10.000	1,556,463....	0.500	1.500	51,443,237.557	
		Other Cattle	Growing Cattle	Calves pre-weaning	2,669,925.822	10.000	463,597.000	0.250	1.500	2,576,782.114	
				Feedlot-fed cattle on...	13,095,104.100	10.000	726,873.000	0.250	1.500	12,058,171.065	
				Feedlot-fed cattle on...	5,126,266.386	10.000	260,935.000	0.250	1.500	4,711,490.372	
				Feedlot-fed cattle on...	422,785.737	10.000	22,574.000	0.250	1.500	388,972.413	
				Feedlot-fed cattle on...	12,518,839.788	10.000	526,175.000	0.250	1.500	11,464,271.434	
				Growing / fattening ca...	14,207,023.830	10.000	1,253,974....	0.250	1.500	13,256,561.697	
				Replacement dairy he...	12,970,395.701	10.000	509,720.000	0.500	1.500	12,055,646.131	
	Pasture/Paddock (6...		Other Mature Cattle	Bulls used principally...	12,104,235.821	70.000	101,006.000	1.000	3.500	3,984,791.746	
				Cows used to produc...	26,776,743.579	70.000	361,142.000	1.000	3.500	9,297,020.074	
	Liquid Slurry (6 month...	Dairy Cows	Mature Dairy Cows	High-producing cows...	55,862,100.341	64.000	1,556,463....	0.500	1.500	21,277,703.373	
		Other Cattle	Growing Cattle	Calves pre-weaning	8,009,777.465	64.000	463,597.000	0.750	0.750	3,144,293.200	
				Feedlot-fed cattle on...	39,285,312.300	64.000	726,873.000	0.750	0.750	14,551,578.490	
				Feedlot-fed cattle on...	15,378,799.157	64.000	260,935.000	0.750	0.750	5,683,143.634	
				Feedlot-fed cattle on...	1,268,357.211	64.000	22,574.000	0.750	0.750	469,306.471	
				Feedlot-fed cattle on...	37,556,519.364	64.000	526,175.000	0.750	0.750	13,816,320.409	
				Growing / fattening ca...	42,621,071.491	64.000	1,253,974....	0.750	0.750	16,048,946.112	
				Replacement dairy he...	12,970,395.701	64.000	509,720.000	0.500	0.750	4,860,487.452	
C	Anaerobic digester	Dairy Cows	Mature Dairy Cows	High-producing cows...	4,703,905.433	10.000	81,919.000	0.500	1.500	4,294,954.140	
	Pasture/Paddock (6...			High-producing cows...	4,703,905.433	64.000	81,919.000	0.500	3.500	1,836,764.206	
		Other Cattle	Growing Cattle	Replacement dairy he...	1,954,770.259	70.000	26,827.000	1.000	3.500	680,325.578	
Total										208,113,580.905	

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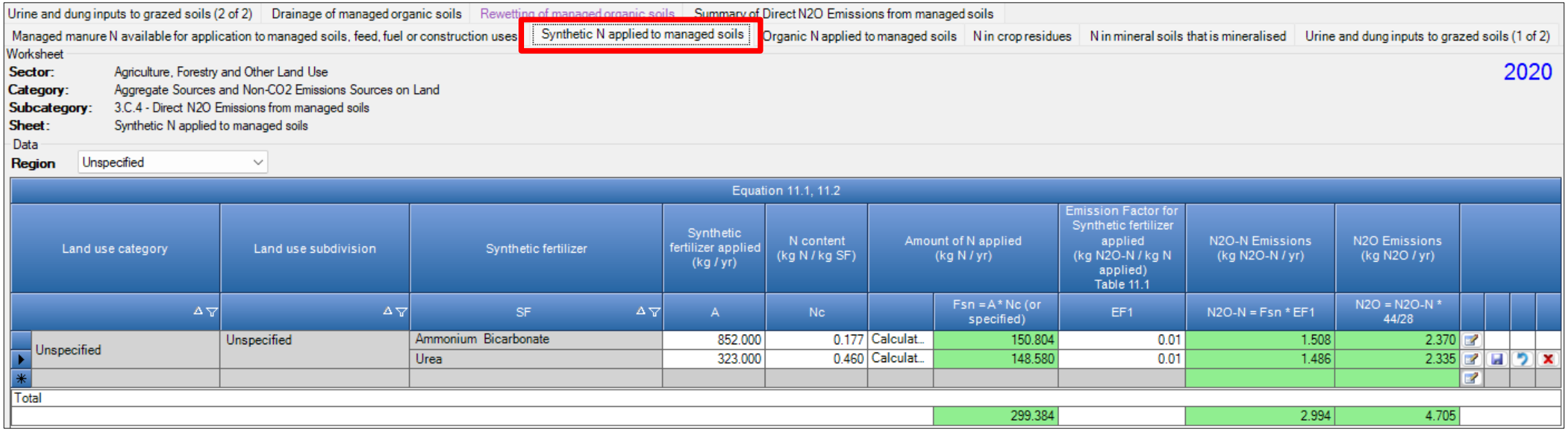
3.C.4 – Synthetic N applied



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 | Urine and dung inputs to grazed soils (1 of 2)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

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

Sheet: Synthetic N applied to managed soils

2020

Data

Region Unspecified

Equation 11.1, 11.2													
Land use category	Land use subdivision	Synthetic fertilizer	Synthetic fertilizer applied (kg / yr)	N content (kg N / kg SF)	Amount of N applied (kg N / yr)		Emission Factor for Synthetic fertilizer applied (kg N2O-N / kg N applied) Table 11.1	N2O-N Emissions (kg N2O-N / yr)	N2O Emissions (kg N2O / yr)				
		SF	A	Nc		Fsn = A * Nc (or specified)	EF1	N2O-N = Fsn * EF1	N2O = N2O-N * 44/28				
Unspecified	Unspecified	Ammonium Bicarbonate	852.000	0.177	Calculat...	150.804	0.01	1.508	2.370				
		Urea	323.000	0.460	Calculat...	148.580	0.01	1.486	2.335				
Total						299.384		2.994	4.705				

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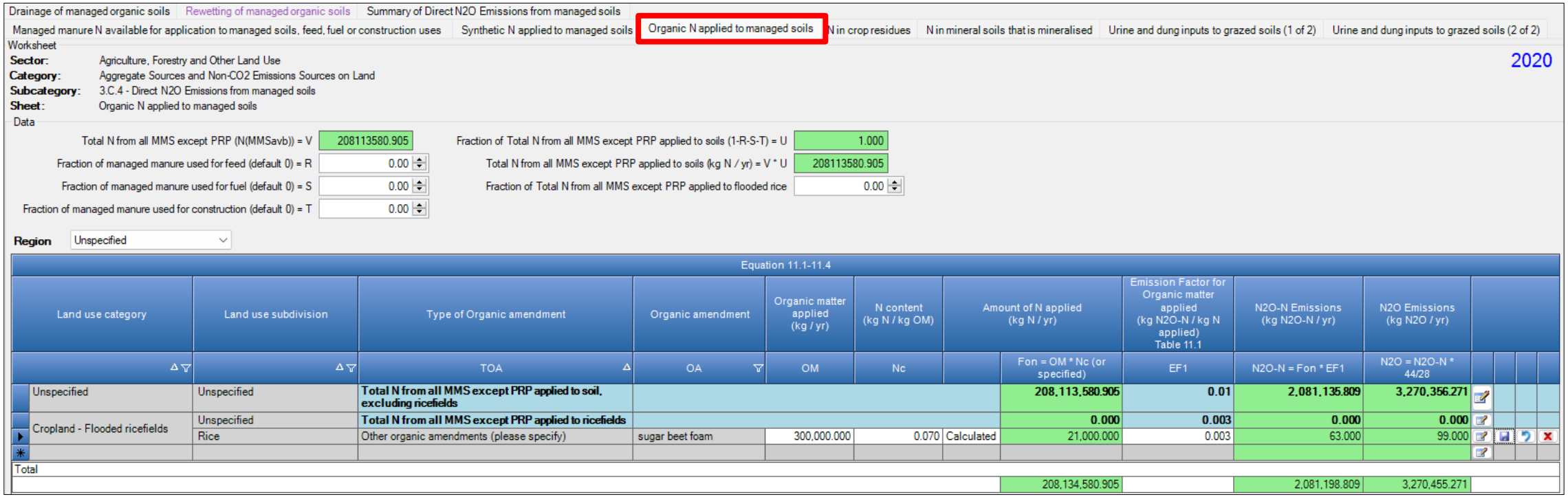
3.C.4 – Organic N applied



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 | Urine and dung inputs to grazed soils (1 of 2) | Urine and dung inputs to grazed soils (2 of 2)

Worksheet

Sector: Agriculture, Forestry and Other Land Use
Category: Aggregate Sources and Non-CO2 Emissions Sources on Land
Subcategory: 3.C.4 - Direct N2O Emissions from managed soils
Sheet: Organic N applied to managed soils

2020

Data

Total N from all MMS except PRP (N(MMSavb)) = V	208113580.905	Fraction of Total N from all MMS except PRP applied to soils (1-R-S-T) = U	1.000
Fraction of managed manure used for feed (default 0) = R	0.00	Total N from all MMS except PRP applied to soils (kg N / yr) = V * U	208113580.905
Fraction of managed manure used for fuel (default 0) = S	0.00	Fraction of Total N from all MMS except PRP applied to flooded rice	0.00
Fraction of managed manure used for construction (default 0) = T	0.00		

Region Unspecified

Equation 11.1-11.4

Land use category	Land use subdivision	Type of Organic amendment	Organic amendment	Organic matter applied (kg / yr)	N content (kg N / kg OM)	Amount of N applied (kg N / yr)		Emission Factor for Organic matter applied (kg N2O-N / kg N applied) Table 11.1	N2O-N Emissions (kg N2O-N / yr)	N2O Emissions (kg N2O / yr)
		TOA	OA	OM	Nc		Fon = OM * Nc (or specified)	EF1	N2O-N = Fon * EF1	N2O = N2O-N * 44/28
Unspecified	Unspecified	**Total N from all MMS except PRP applied to soil, excluding ricefields**					**208,113,580.905**	**0.01**	**2,081,135.809**	**3,270,356.271**
Cropland - Flooded ricefields	Unspecified	**Total N from all MMS except PRP applied to ricefields**					**0.000**	**0.003**	**0.000**	**0.000**
	Rice	Other organic amendments (please specify)	sugar beet foam	300,000.000	0.070	Calculated	21,000.000	0.003	63.000	99.000
Total							208,134,580.905		2,081,198.809	3,270,455.271

100% as fertilizer

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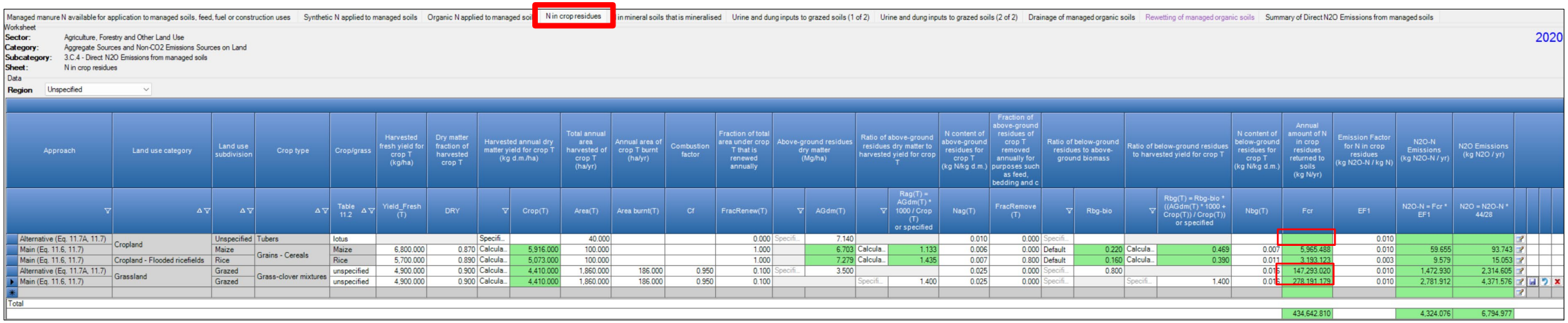
3.C.4 – N in crop residues



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 soil | N in crop residues | in mineral soils that is mineralised | 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

Worksheet
Sector: Agriculture, Forestry and Other Land Use
Category: Aggregate Sources and Non-CO2 Emissions Sources on Land
Subcategory: 3.C.4 - Direct N2O Emissions from managed soils
Sheet: N in crop residues
Data
Region Unspecified

2020

Approach	Land use category	Land use subdivision	Crop type	Crop/grass	Harvested fresh yield for crop T (kg/ha)	Dry matter fraction of harvested crop T	Harvested annual dry matter yield for crop T (kg d.m./ha)		Total annual area harvested of crop T (ha/yr)	Annual area of crop T burnt (ha/yr)	Combustion factor	Fraction of total area under crop T that is renewed annually	Above-ground residues dry matter (Mg/ha)		Ratio of above-ground residues dry matter to harvested yield for crop T		N content of above-ground residues for crop T (kg N/kg d.m.)	Fraction of above-ground residues of crop T removed annually for purposes such as feed, bedding and c	Ratio of below-ground residues to above-ground biomass		Ratio of below-ground residues to harvested yield for crop T		N content of below-ground residues for crop T (kg N/kg d.m.)	Annual amount of N in crop residues returned to soils (kg N/yr)	Emission Factor for N in crop residues (kg N2O-N / kg N)	N2O-N Emissions (kg N2O-N / yr)	N2O Emissions (kg N2O / yr)
				Table 11.2	Yield_Fresh (T)	DRY		Crop(T)	Area(T)	Area burnt(T)	Cf	FracRenew(T)		AGdm(T)		Rag(T) = AGdm(T) * 1000 / Crop (T) or specified	Nag(T)	FracRemove (T)		Rbg-bio		Rbg(T) = Rbg-bio * ((AGdm(T) * 1000 + Crop(T)) / Crop(T)) or specified	Nbg(T)	Fcr	EF1	N2O-N = Fcr * EF1	N2O = N2O-N * 44/28
Alternative (Eq. 11.7A, 11.7)	Cropland	Unspecified	Tubers	Iotus			Specifi...		40.000			0.000	Specifi...	7.140			0.010	0.000	Specifi...						0.010			
Main (Eq. 11.6, 11.7)		Maize	Grains - Cereals	Maize	6,800.000	0.870	Calcula...	5,916.000	100.000			1.000		6.703	Calcula...	1.133	0.006	0.000	Default	0.220	Calcula...	0.469	0.007	5,965.488	0.010	59.655	93.743
Main (Eq. 11.6, 11.7)	Cropland - Flooded ricefields	Rice		Rice	5,700.000	0.890	Calcula...	5,073.000	100.000			1.000		7.279	Calcula...	1.435	0.007	0.800	Default	0.160	Calcula...	0.390	0.011	3,193.123	0.003	9.579	15.053
Alternative (Eq. 11.7A, 11.7)	Grassland	Grazed	Grass-clover mixtures	unspecified	4,900.000	0.900	Calcula...	4,410.000	1,860.000	186.000	0.950	0.100	Specifi...	3.500			0.025	0.000	Specifi...	0.800			0.015	147,293.020	0.010	1,472.930	2,314.605
Main (Eq. 11.6, 11.7)		Grazed		unspecified	4,900.000	0.900	Calcula...	4,410.000	1,860.000	186.000	0.950	0.100			Specifi...	1.400	0.025	0.000	Specifi...		Specifi...	1.400	0.015	278,191.179	0.010	2,781.912	4,371.576
Total																								434,642.810		4,324.076	6,794.977

3.C.4 – N mineralised as SOM losses in mineral soils

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** | Urine and dung inputs to grazed soils (1 of 2) | Urine and dung inputs to grazed soils (2 of 2)

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

2020

Data

Region (All)

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 N2O-N / kg N) Table 11.1	N2O-N Emissions (kg N2O-N / yr)	N2O Emissions (kg N2O / yr)			
					ΔCmineral,LU	R	Fsom = | ΔCmineral,LU * (1/R) * 1000 |	EF1	N2O-N = Fsom * EF1	N2O = N2O-N * 44/28			
Approac...	NA	NA	Unspecifi...	Unspecified	-10.395	15	693.000	0.01	6.930	10.890			
CL-CL_11	Cropland...	Rice	Cropland...	Poplar (10-year)	-19.870	10	1,987.000	0.01	19.870	31.224			
CL-CL_20					-2.370	10	236.950	0.01	2.370	3.724			
CL-CL_31					-19.870	10	1,987.000	0.01	19.870	31.224			
CL-CL_51					-19.231	10	1,923.100	0.01	19.231	30.220			
CL-CL_70					-1.890	10	189.025	0.01	1.890	2.970			
CL-CL_50	Cropland...	Poplar (10-year)	Cropland...	Maize	-82.656	10	8,265.550	0.01	82.656	129.887			
CL-CL_61					-74.172	10	7,417.150	0.01	74.172	116.555			
UWL-OS...	Unmana...	Tidal marshes (unmanaged)	Settleme...	Harbor	-12,750.000	15	850,000.000	0.01	8,500.000	13,357.143			
Total													
							872,698.775		8,726.988	13,713.838			

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3.C.4 – N in manure left on pasture

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 | Urine and dung inputs to grazed soils (1 of 2) | Urine and dung inputs to grazed soils (2 of 2)

Worksheet

Sector: Agriculture, Forestry and Other Land Use
Category: Aggregate Sources and Non-CO2 Emissions Sources on Land
Subcategory: 3.C.4 - Direct N2O Emissions from managed soils
Sheet: Urine and dung inputs to grazed soils (2 of 2)

2020

Data

Region Unspecified

Equation 11.1, 11.2, 11.5

N source	Geographical zone	Livestock Category	Livestock Subcategory	Livestock Subdivision	Total N from N source deposited on Pasture, range and paddock (kg N/yr)	Land use category	Land use subdivision	Fraction of N from N source deposited within land-use category/subcategory	Amount of N from N source deposited on PRP (kg N / yr)	Emission factor for N deposited by grazing livestock (kg N2O-N / kg N deposited) Table 11.1	N2O-N Emissions (kg N2O-N / yr)	N2O Emissions (kg N2O / yr)	
Ns	Z	T	Tsc	Tsd	NE(Ns)	LU	LU	F(Ns,LU)	Fprp = NE(Ns) * F (Ns,LU)	EF3prp	N2O-N = Fprp * EF3prp	N2O = N2O-N * 44/28	
Urine and dung	A	Other Cattle	Unspecified	Unspecified	361,201.798	Grassland	Grazed	1.000	361,201.798	0.02	7,224.036	11,352.057	
Total									361,201.798		7,224.036	11,352.057	

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3.C.4 – N from drained organic 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 | 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

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

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

Sheet: Drainage of managed organic soils

2020

Data

Region (All)

Equation 11.1, 11.2										
Land unit code	Initial land use		Land use during reporting year		Land area of drained organic soils (ha)	Emission Factor for drained organic soils (kg N2O-N / ha / yr) Table 11.1 / WS Table 2.5	N2O-N Emissions (kg N2O-N / yr)	N2O Emissions (kg N2O / yr)			
					Adrained	EF2	N2O-N = Adrained * EF2	N2O = N2O-N * 44/28			
MFL-MFL_1	Managed For...	Forest plantation	Managed For...	Forest plantation	2,000.000	2.4	4,800.000	7,542.857			
UFL-MFL_20...	Unmanaged...	Primary Forest			600.000	2.4	1,440.000	2,262.857			
UFL-MFL_20...					350.000	2.4	840.000	1,320.000			
UFL-MFL_20...					175.000	2.4	420.000	660.000			
UFL-MFL_20...					85.000	2.4	204.000	320.571			
TSL-TSL_1	Settlements (...	Urban park	Settlements (...	Urban park	100.000	0.800	80.000	125.714			
Total											
					3,310.000		7,784.000	12,232.000			

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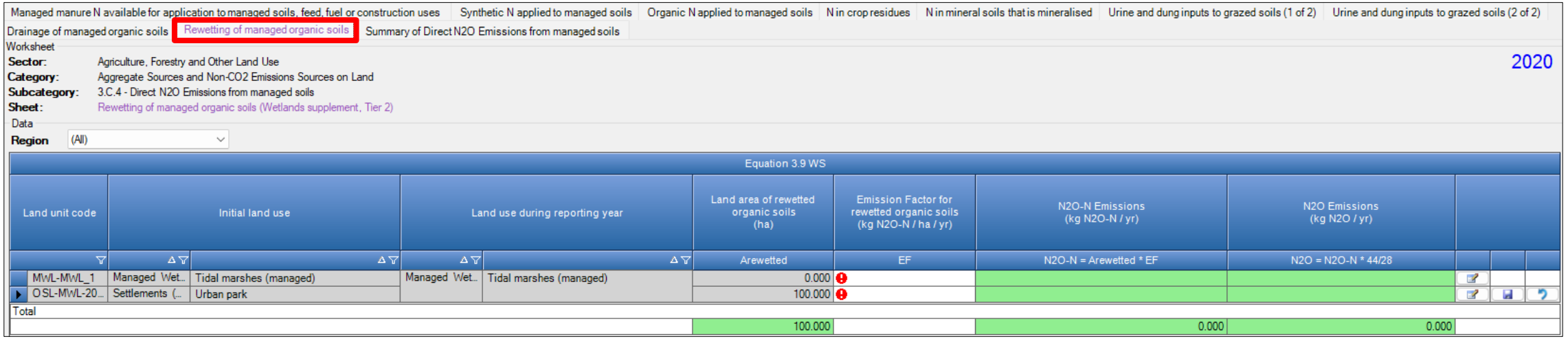
3.C.4 – N from rewetted organic soils



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 | 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

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

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

Sheet: Rewetting of managed organic soils (Wetlands supplement, Tier 2)

2020

Data

Region (All)

Equation 3.9 WS

Land unit code	Initial land use		Land use during reporting year		Land area of rewetted organic soils (ha)	Emission Factor for rewetted organic soils (kg N2O-N / ha / yr)	N2O-N Emissions (kg N2O-N / yr)	N2O Emissions (kg N2O / yr)			
					Arewetted	EF	N2O-N = Arewetted * EF	N2O = N2O-N * 44/28			
MWL-MWL_1	Managed Wet...	Tidal marshes (managed)	Managed Wet...	Tidal marshes (managed)	0.000						
OSL-MWL-20...	Settlements (...	Urban park			100.000						
Total											
					100.000		0.000	0.000			

Negligeable

3.C.4 – Direct N_2O – Summary

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 | 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

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

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

Sheet: Direct N2O emissions from managed soils (summary)

2020

Data

Equation 11.1				
N source		N2O-N Emissions (kg N2O-N / yr)	N2O Emissions (kg N2O / yr)	
		N2O-N	N2O = N2O-N * 44/28	
Managed soils (excluding flooded rice)	FSN: N in synthetic fertilizers	2.994	4.705	
	FON: N in animal manure, compost, sewage sludge, other	1,873,022.543	2,943,321.139	
	FCR: N in crop residues	4,314.497	6,779.924	
	FSOM: 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	8,726.988	13,713.838	
Flooded rice	FSN: N in synthetic fertilizers	0.000	0.000	
	FON: N in animal manure, compost, sewage sludge, other	62,434.085	98,110.705	
	FCR: N in crop residues	9.579	15.053	
	FSOM: 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	0.000	0.000	
FPRP: Urine and dung inputs to grazed soils		7,224.036	11,352.057	
FOS: Drainage of managed organic soils (OS_drained)		7,784.000	12,232.000	
FOS: Rewetting of managed organic soils (OS_rewetted)		0.000	0.000	
Total				
		1,963,518.722	3,085,529.420	

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3.C.5 – Indirect N_2O from volatilisation

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
Category: Aggregate Sources and Non-CO2 Emissions Sources on Land
Subcategory: 3.C.5 - Indirect N2O Emissions from managed soils
Sheet: N2O from Atmospheric Deposition of N Volatilised from Managed Soils

2020

Data

Region Unspecified

		Equation 11.9, 11.11									
Land use category	Land use subdivision	Annual amount of synthetic fertilizer N that volatilizes (kg NH3-N+NOx-N)		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)	Fraction of applied organic N fertilizer materials (FON) and of urine and dung N deposited by grazing animals (FPRP) that volatilises [(kg NH3-N+NOx-N) / (kg N)]	Emission factor for N2O emission from atmospheric deposition of N on soils and water surfaces [kg N2O-N/(kg NH3-N+NOx-N)]	Annual amount of N2O-N produced from atmospheric deposition of N volatilised from managed soils (kg N2O-N/yr)	N2O Emissions (kg N2O/yr)			
		∑(Fsn(i)*Frac(GASF)(i))		Fon	Fprp	Frac(GASM)	EF4	N2O-N	N2O			
Unspecified	Unspecified	29.938		187,302,254.314		0.2	0.01	374,604.808	588,664.698			
Cropland	Unspecified			20,811,358.090		0.2	0.01	41,622.716	65,407.125			
	Rice			3.500		0.2	0.01	0.007	0.011			
Grassland	Grazed				361,201.798	0.2	0.01	722.404	1,135.206			
Total												
		29.938		208,113,615.905	361,201.798			416,949.935	655,207.040			

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3.C.5 – Indirect N_2O from leaching

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

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

2020

Data

Region Unspecified

		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 soil 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							Table 11.3	Table 11.3	N2O-N=(Fsn + Fon + Fprp + Fcr + Fsom + (N from Fos)) * FracLEACH-(H) * EF5	N2O = N2O-N * (44/28)	
		Fsn	Fon	Fprp	Fcr	Fsom	N from Fos	FracLEACH-(H)	EF5	N2O-N	N2O	
Unspecified	N from oxidation of SOM in organic s...									0.000	0.000	
	Unspecified	299.384	187,302,254.314					0.3	0.0075	421,430.746	662,248.315	
Cropland	Unspecified		20,811,358.090					0.3	0.0075	46,825.556	73,583.016	
	Maize				5,965.488			0.3	0.0075	13.422	21.092	
	Rice		3.500		3,193.123			0.3	0.0075	7.192	11.302	
Grassland	Grazed			361,201.798	425,484.199			0.3	0.0075	1,770.043	2,781.497	
Total		299.384	208,113,615.905	361,201.798	434,642.810	0.000	0.000			470,046.960	738,645.222	

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CH_4 emissions from:

3.C.7 – Rice Cultivation

3.C.8 – Indirect N_2O emissions from managed soils

3.C.7 – Rice Cultivation

Annual CH4 emissions from rice

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

Subcategory: 3.C.7 - Rice cultivation

Sheet: Annual CH4 emissions from rice

2020

Data

Region Unspecified

		Equation 2.2	Equation 5.1		Equation 5.2			Equation 5.3		Equation 5.2		Equation 5.1					
			Annual harvested area (ha/yr)	Cultivation period (Day)	Baseline emission factor for continuously flooded fields without organic amendments (kg CH4/ha/Day)	Scaling factor to account for the differences in water regime during the cultivation period	Scaling factor to account for the differences in water regime in the pre-season before the cultivation period	Scaling factor for both type and amount of organic amendment applied		Scaling factor for soil type, rice cultivar, etc., if available	Adjusted daily emission factor for a particular harvested area (kg CH4/ha/Day)	Annual CH4 emissions from Rice cultivation (Gg CH4/yr)					
Rice ecosystem	Water regime	Land use subdivision			Table 5.11	Table 5.12	Table 5.13	SFo = (1 + ∑(ROAi*CFOAi)) ^0.59			EFi = EFc * SFw * SFp * SFo * SFs,r	CH4 = A * t * EFi * 10^-6					
			A	t	Efc	SFw	SFp	SFo		SFs,r	EFi	CH4					
Irrigated	Intermittently flooded -...	Rice	200.000	140.000	1.300	0.52	1.9	1.988			2.554	0.072					
Total																	
			200.000									0.072					

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3.C.8 – CH_4 from drained organic soils

CH4 Emissions from drained organic soils

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

Subcategory: 3.C.8 - CH4 from Drained Organic Soils

Sheet: CH4 Emissions from drained organic soils

2020

Data

Region (All)

Equation 2.6 WS								
Land unit code	Initial land use		Land use during reporting year		Land area of drained inland organic soil (ha)	Fraction of the total area of drained inland organic soil which is occupied by ditches	Emission factor for CH4 emissions from drained organic soils (kg CH4 / ha / yr) WS Table 2.3	CH4 Emissions (Gg CH4 / yr)
					Adrained	Fditch	EF	CH4 = (Adrained * (1-Fditch) * EF) * 10^-6
MFL-MFL_1	Managed Fo...	Forest plantation	Managed Fo...	Forest plantation	2,000.000		2.7	0.005
UFL-MFL_2...	Unmanaged...	Primary Forest			600.000		2.7	0.002
UFL-MFL_2...					350.000		2.7	0.001
UFL-MFL_2...					175.000		2.7	0.000
UFL-MFL_2...					85.000		2.7	0.000
Total								0.009

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3.C.9 – CH_4 from drained organic soils

CH4 Emissions from drainage ditches on drained organic soils

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

Subcategory: 3.C.9 - CH4 from Drainage Ditches on Organic Soils

Sheet: CH4 Emissions from drainage ditches on drained organic soils

2020

Data

Region (All)

Equation 2.6 WS								
Land unit code	Initial land use		Land use during reporting year		Land area of drained inland organic soil (ha)	Fraction of the total area of drained inland organic soil which is occupied by ditches	Emission factor for CH4 emissions from drainage ditches (kg CH4 / ha / yr) WS Table 2.4	CH4 Emissions (Gg CH4 / yr)
					Adrained	Fditch	EF	CH4 = (Adrained * Fditch * EF) * 10^-6
MFL-MFL_1	Managed Fo...	Forest plantation	Managed Fo...	Forest plantation	2,000.000	0.02	2,259	0.090
UFL-MFL_2...	Unmanaged...	Primary Forest			600.000	0.02	2,259	0.027
UFL-MFL_2...					350.000	0.02	2,259	0.016
UFL-MFL_2...					175.000	0.02	2,259	0.008
UFL-MFL_2...					85.000	0.02	2,259	0.004
Total								0.145

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3.C.11 – CH_4 from rewetting of Tidal marshes

CH4 Emissions from Rewetting of Mangroves and Tidal Marshes

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

Subcategory: 3.C.11 - CH4 Emissions from Rewetting of Mangroves and Tidal Marshes

Sheet: CH4 Emissions from Rewetting of Mangroves and Tidal Marshes

2020

Data

Region (All)

Equation 4.9 WS								
Land unit code	Initial land use		Land use during reporting year		Land area of rewetted mangroves and tidal marshes (ha)	Emission factor for CH4 emissions from rewetting of mangroves and tidal marshes (kg CH4 / ha / yr) WS Table 4.14	CH4 Emissions (Gg CH4 / yr)	
					Arewetted	EF	CH4 = (Arewetted * EF) * 10^-6	
MWL-MWL_1	Managed Wetla...	Tidal marshes (managed)	Managed Wetla...	Tidal marshes (managed)	0.000	193.7	0.000	
OSL-MWL-202...	Settlements (Tr...	Urban park			100.000	193.7	0.019	
Total							0.019	

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3.C.13 – CH_4 from rewetted/created IWMS

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

Worksheet

Sector: Agriculture, Forestry and Other Land Use

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

2020

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 CH4 emissions from rewetted and created Wetlands on inland Wetland mineral soils (kg CH4 / ha / yr) WS Table 5.4	CH4 Emissions (Gg CH4 / yr)	
					Arewetted	EF	CH4 = (Arewetted * EF) * 10^-6	
ACL-ACL_1	Cropland Annu...	Lotus (long-term)	Cropland Annu...	Lotus (long-term)	10.000	900	0.009	
PCL-ACL_200...	Cropland Peren...	Oil Palm		Lotus (converted)	5.000	900	0.005	
PCL-ACL_201...					15.000	900	0.014	
PCL-ACL_201...					5.000	900	0.005	
PCL-ACL_202...					5.000	900	0.005	
Total								
							0.036	

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Thank you

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