Food and Agriculture Organization of the United Nations

FAO and the Enhanced transparency framework

TRAINING WORKSHOP FOR REPORTING SOIL CARBON STOCK CHANGE IN NATIONAL GREENHOUSE GAS INVENTORIES

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Office of Climate Change, Biodiversity and Environment

12 December 2022

Bangkok, Thailand

Food and Agriculture Organization of the United Nations

ENHANCED TRANSPARENCY FRAMEWORK (ETF) & ARTICLE 13 OF THE PARIS AGREEMENT

ETF & MPGs

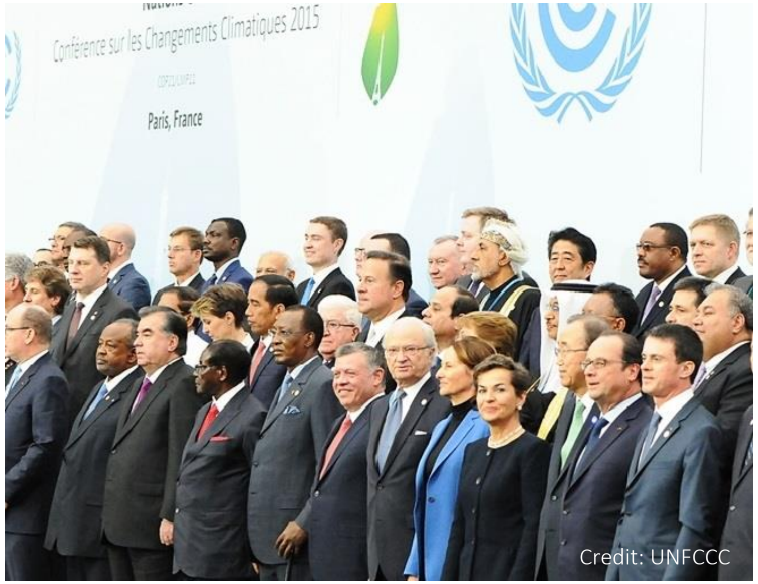
Paris Agreement (PA)

Implementation reflects equity & principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances (art. 2, para.2)

Establishes an **enhanced transparency framework (ETF)** for action & support (art. 13, par. 1)

Objective: builds mutual trust & confidence & promotes effective implementation

Characteristics:
- with built-in flexibility
- which takes into account Parties' different capacities
- builds upon collective experience



ETF & MPGs

Paris Agreement (PA)

Establishes an **enhanced transparency framework (ETF)** for [….] & [….] (art. 13, par. 1)

[purpose of action] (art. 13, par. 5)

provide a clear understanding of climate change action (Convention objective (art. 2)), incl.:

- clarity & tracking of progress towards achieving Parties' NDCs (art. 4) & Parties' adaptation actions (art.7)
- including good practices, priorities, needs & gaps

[purpose of support] (art. 13, par. 6)

provide:

- clarity on support provided & received by individual Parties in the context of climate change actions
- full overview of aggregate financial support provided, to the extent possible

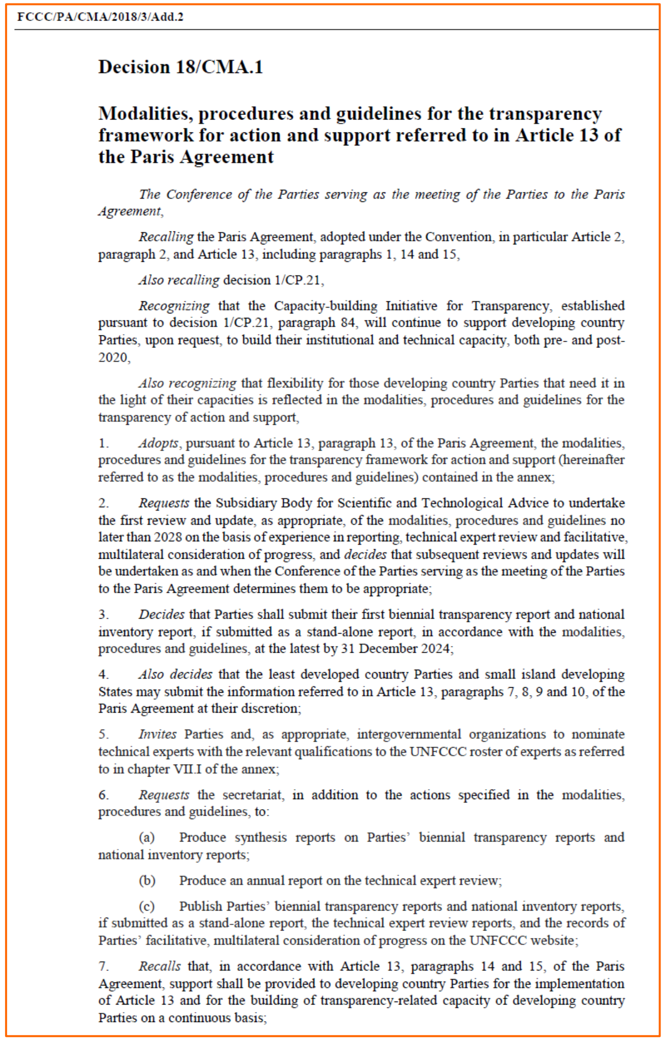
inform the global stocktake under Article 14

Decision 18/CMA.1

PA art.13(13): The CMA shall…building on experience from the arrangements related to transparency under the Convention… adopt common modalities, procedures and guidelines (MPGs), as appropriate, for the transparency of action and support

As part of the Katowice Climate Package, MPGs for the ETF were adopted, as contained in the annex to decision 18/CMA.1

Provide all necessary information for preparing & submitting the BTR, including the national GHG inventory report


FCCC/PA/CMA/2018/3/Add.2

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Recalling the Paris Agreement, adopted under the Convention, in particular Article 2, paragraph 2, and Article 13, including paragraphs 1, 14 and 15,

Also recalling decision 1/CP.21,

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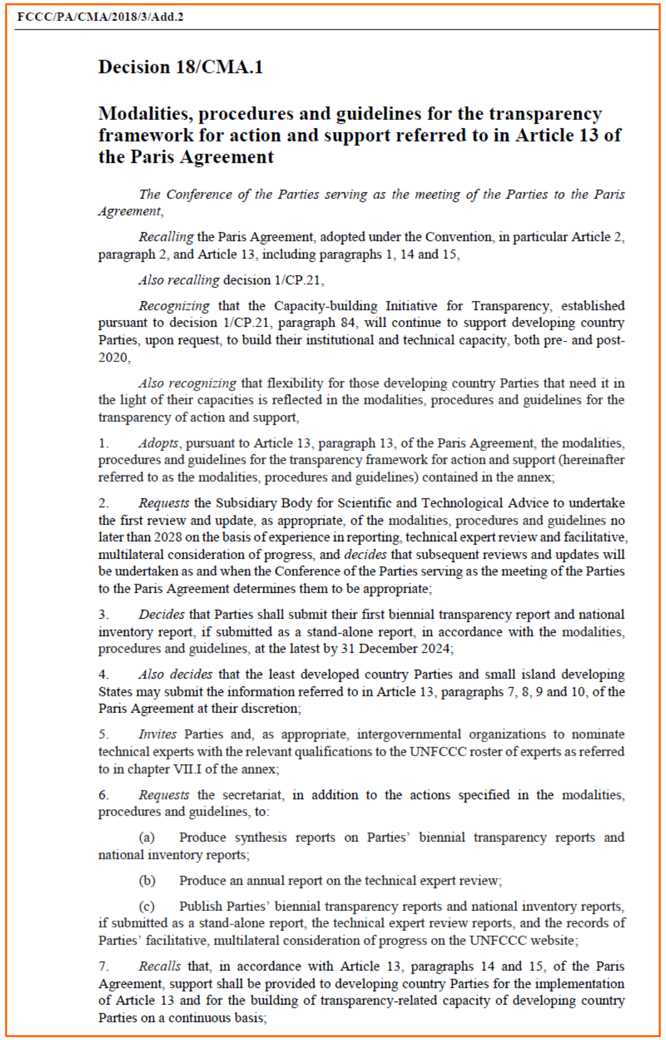
7. *Recalls* that, in accordance with Article 13, paragraphs 14 and 15, of the Paris Agreement, support shall be provided to developing country Parties for the implementation of Article 13 and for the building of transparency-related capacity of developing country Parties on a continuous basis;

Decision 18/CMA.1

Flexibility for the implementation of art. 13 of the PA for those developing country Parties that need it in the light of their capacities is reflected in the MPGs

Least developed countries (LDCs) & small island developing States (SIDS) → may submit at their discretion the information referred to in **art. 13, par. 7**, 8, 9 and 10 of the PA (**NIR**, information for tracking progress in implementing & achieving NDC, information on climate change impacts & adaptation, information on financial, technology transfer & capacity-building support provided, information on financial, technology transfer & capacity-building support needed and received)



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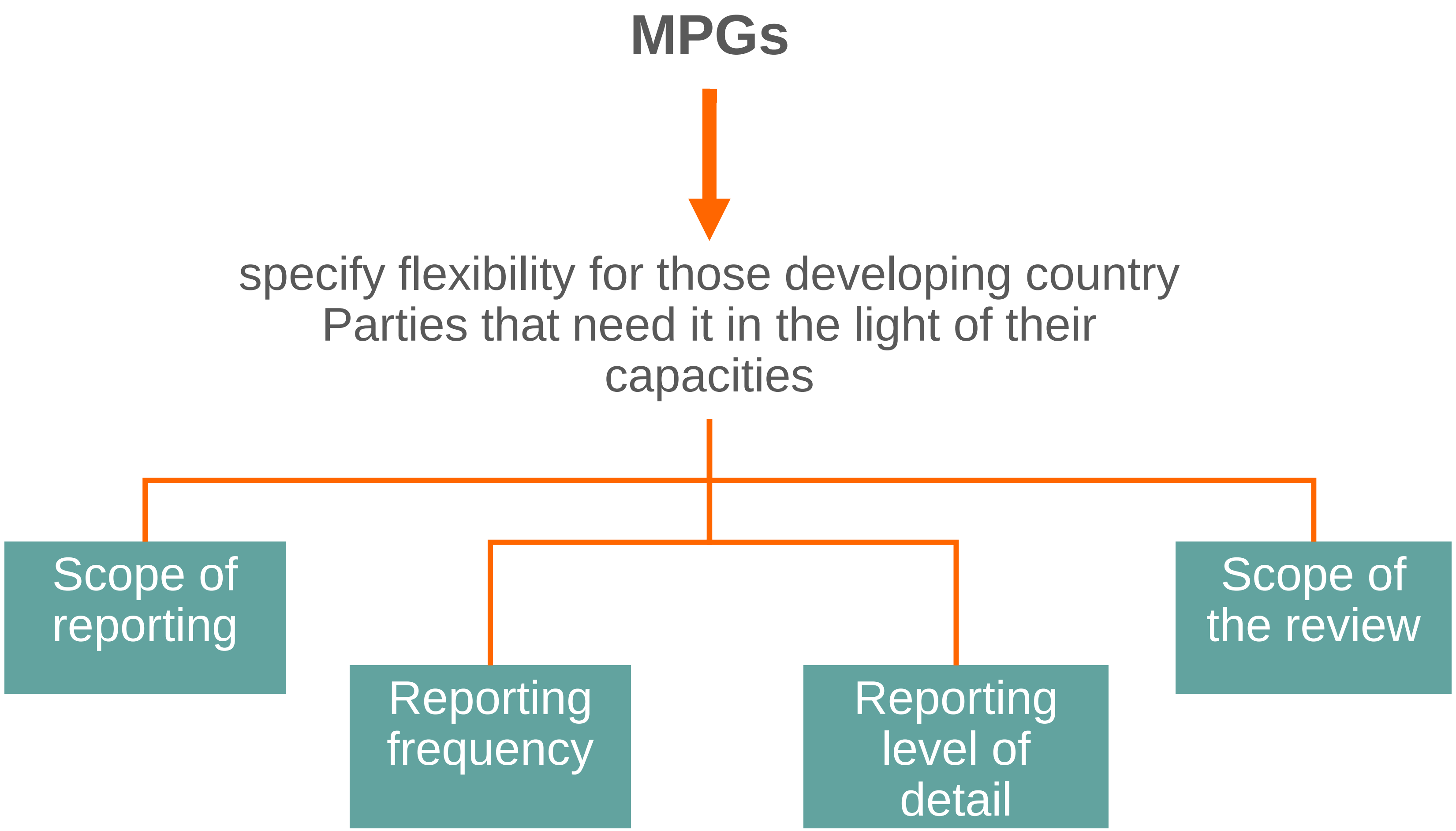
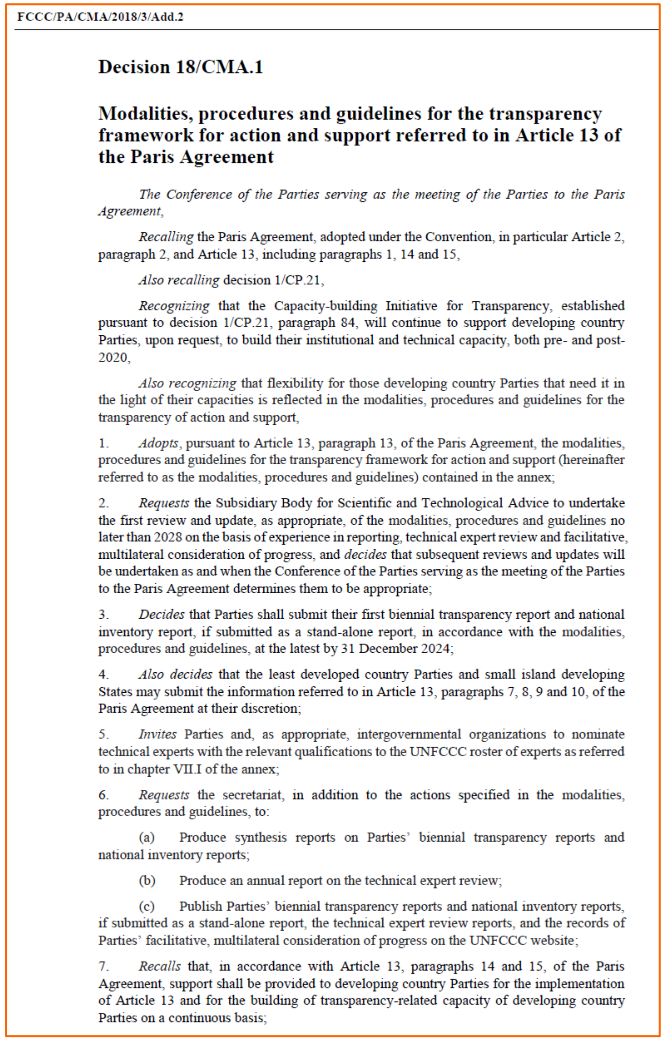
Guiding principles reflecting relevant provisions (art. 13 PA, par. 92, 93 dec. 1/CP.21)

- Building on & enhancing **existing transparency arrangements** under Convention
- …recognizing the special circumstances of the LDCs & SIDS …& respective national sovereignty
- **<u>The importance of facilitating improved reporting & transparency over time</u>**
- Avoid duplication of Parties' & secretariat's work & undue burden
- **<u>Promoting transparency, accuracy, completeness, consistency and comparability</u>**
- Ensuring maintenance at minimum of frequency & quality of reporting under the Convention
- **<u>Avoidance of double counting</u>**
- Ensuring environmental integrity
- Providing flexibility to those developing country Parties that need it in the light of their capacities

Decision 18/CMA.1





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Decision 18/CMA.1

Flexibility

↓

self-determined

shall

Parties
clearly indicate the provision to which flexibility is applied
concisely clarify capacity constraints
provide self-determined estimated time frames for improvements in relation to capacity constraints

shall not

TERT
review the Party's determination to apply such flexibility
whether the Party possesses the capacity to implement that specific provision without flexibility

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Decision 18/CMA.1

Area	MPGs para	Provision
Key categories	25	Each Party **shall** identify key categories for the starting year and the latest reporting year..., including and excluding LULUCF, using approach 1, for both level and trend assessment…; …have the flexibility to instead identify KCs using a threshold no lower than 85% in place of the 95%..., allowing a focus on improving fewer categories and prioritizing resources

This flexibility reduces the number of KC

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Area	MPGs para	Provision
Uncertainty	29	Each Party **shall** quantitatively estimate and qualitatively discuss the uncertainty of the emission/removal estimates for all source/sink categories, including inventory totals, for at least the starting year and the latest reporting year of the inventory time series... Each Party **shall** also estimate trend uncertainty of emission/removal estimates for all source/sink categories, including totals, between the starting year and the latest reporting year of the inventory time series...; …have the flexibility to instead provide, at a minimum, a qualitative discussion of uncertainty for key categories… where quantitative input data are unavailable to quantitatively estimate uncertainties, and are encouraged to provide a quantitative estimate of uncertainty for all source/sink categories

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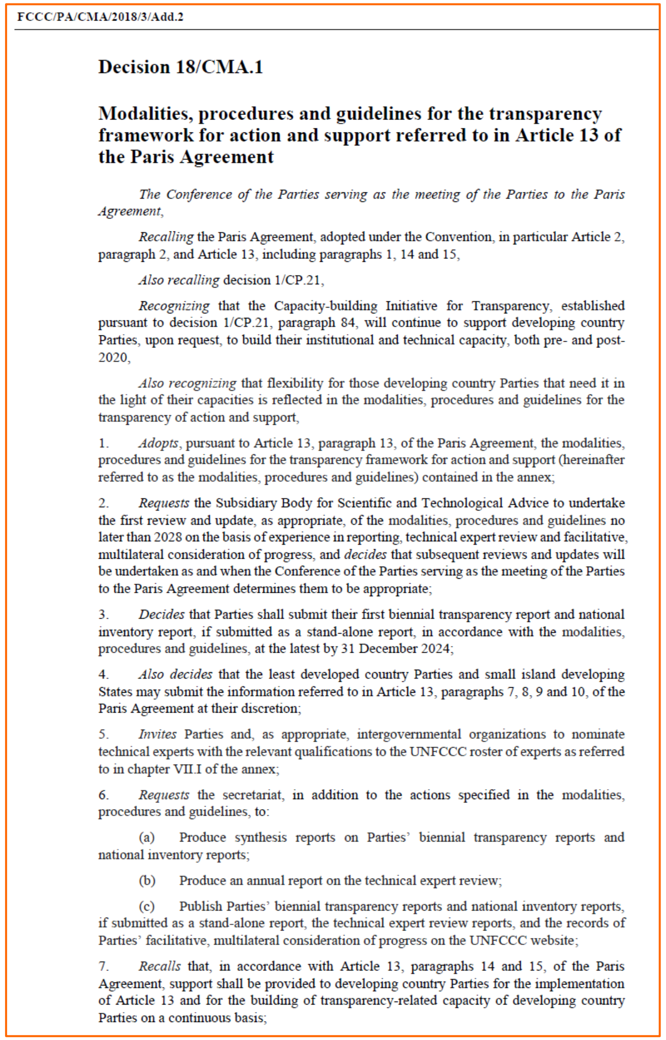
Area	MPGs para	Provision
‘insignificant’ source/sink categories	32	…have the flexibility to apply other thresholds in order to consider emissions/removals insignificant (see NKs)
QA/QC	34	Each Party **shall** elaborate an inventory QA/QC plan…, including information on the inventory agency responsible for implementing QA/QC; …that need flexibility…are instead encouraged to elaborate an inventory QA/QC plan…, including information on the inventory agency responsible for implementing QA/QC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Area	MPGs para	Provision
QA/QC	35	Each Party **shall** implement and provide information on general inventory QC procedures...; …that need flexibility …are instead encouraged to implement and provide information on general inventory QC procedures...
Gases	48	Each Party **shall** report seven gases (CO2, CH4, N2O, HFCs, PFCs, SF6, NF3; …have the flexibility to instead report at least three gases (CO2, CH4 and N2O) as well as any of the additional four gases (HFCs, PFCs, SF6 and NF3) that are included in the Party’s NDC under Article 4 of the Paris Agreement, are covered by an activity under Article 6 of the Paris Agreement, or have been previously reported

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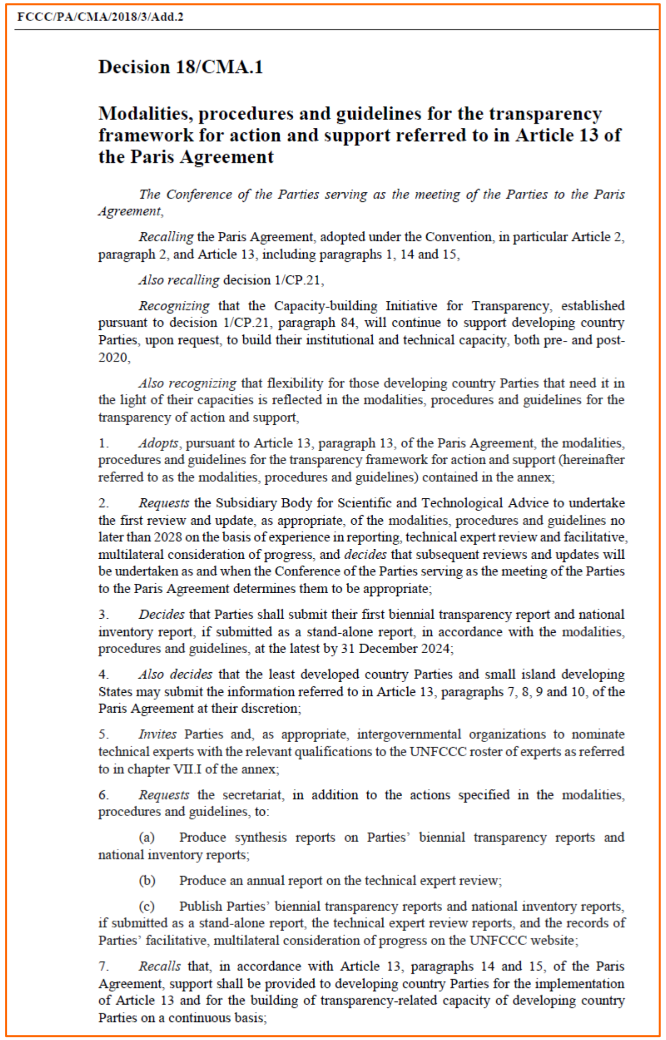
Area	MPGs para	Provision
Time series	57	Each Party **shall** report a consistent annual time series starting from 1990; …have the flexibility to instead report data covering, at a minimum, the reference year/period for its NDC under Article 4 of the Paris Agreement and, in addition, a consistent annual time series from at least 2020 onwards
Time series	58	For each Party, the latest reporting year **shall** be no more than two years prior to the submission of its national inventory report; …have the flexibility to instead have their latest reporting year as three years prior to the submission of their national inventory report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2. *Requests* the Subsidiary Body for Scientific and Technological Advice to undertake the first review and update, as appropriate, of the modalities, procedures and guidelines no later than 2028 on the basis of experience in reporting, technical expert review and facilitative, multilateral consideration of progress, and *decides* that subsequent reviews and updates will be undertaken as and when the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement determines them to be appropriate;

3. *Decides* that Parties shall submit their first biennial transparency report and national inventory report, if submitted as a stand-alone report, in accordance with the modalities, procedures and guidelines, at the latest by 31 December 2024;

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5. *Invites* Parties and, as appropriate, intergovernmental organizations to nominate technical experts with the relevant qualifications to the UNFCCC roster of experts as referred to in chapter VII.I of the annex;

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(a) Produce synthesis reports on Parties' biennial transparency reports and national inventory reports;

(b) Produce an annual report on the technical expert review;

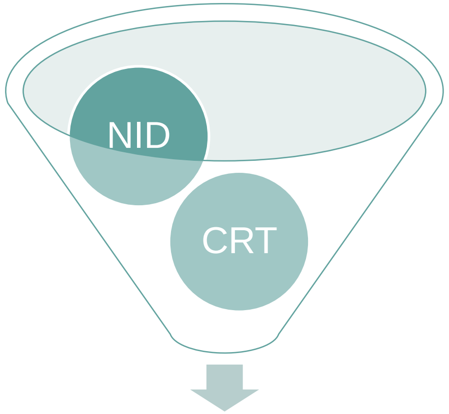
(c) Publish Parties' biennial transparency reports and national inventory reports, if submitted as a stand-alone report, the technical expert review reports, and the records of Parties' facilitative, multilateral consideration of progress on the UNFCCC website;

7. *Recalls* that, in accordance with Article 13, paragraphs 14 and 15, of the Paris Agreement, support shall be provided to developing country Parties for the implementation of Article 13 and for the building of transparency-related capacity of developing country Parties on a continuous basis;

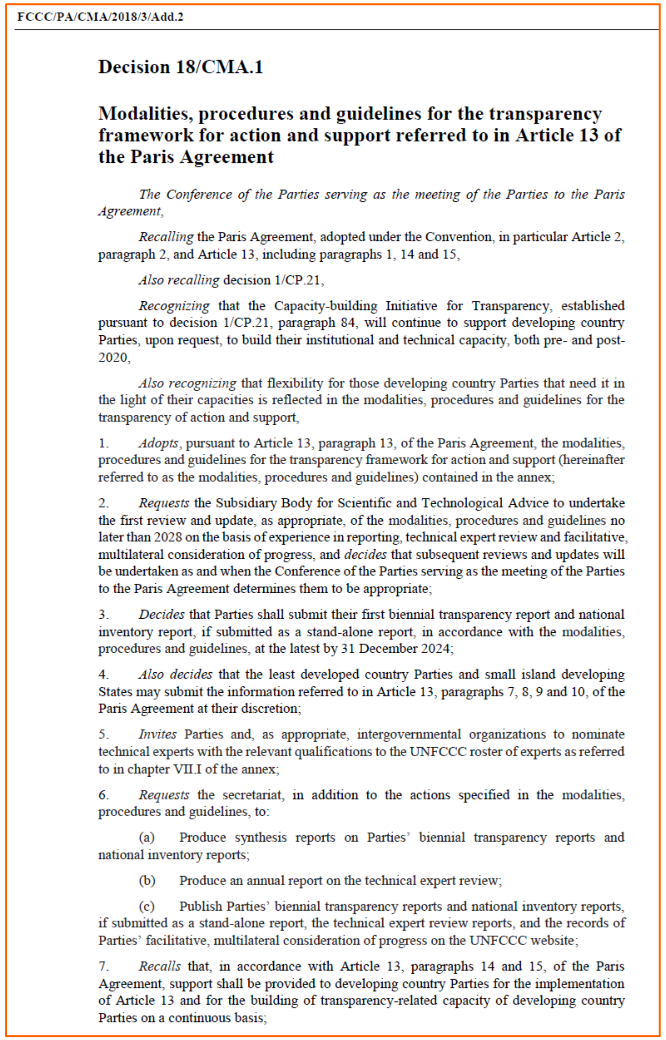
Decision 18/CMA.1

Establishes the BTR format & timing & make reference to the GHG inventory principles:

- Each Party **shall** (=mandatory) provide a national inventory report (NIR) in accordance with MPGs
- The NIR *may* be submitted as a stand-alone or as part of the BTR
- Definitions of GHGI principles (TCCCA) are those provided in 2006 IPCC GLs



National Inventory Report (NIR)



FCCC/PA/CMA/2018/3/Add.2

Decision 18/CMA.1

Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement

The Conference of the Parties serving as the meeting of the Parties to the Paris Agreement,

Recalling the Paris Agreement, adopted under the Convention, in particular Article 2, paragraph 2, and Article 13, including paragraphs 1, 14 and 15,

Also recalling decision 1/CP.21,

Recognizing that the Capacity-building Initiative for Transparency, established pursuant to decision 1/CP.21, paragraph 84, will continue to support developing country Parties, upon request, to build their institutional and technical capacity, both pre- and post-2020,

Also recognizing that flexibility for those developing country Parties that need it in the light of their capacities is reflected in the modalities, procedures and guidelines for the transparency of action and support,

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7. *Recalls* that, in accordance with Article 13, paragraphs 14 and 15, of the Paris Agreement, support shall be provided to developing country Parties for the implementation of Article 13 and for the building of transparency-related capacity of developing country Parties on a continuous basis;

1st BTR (incl. national GHG inventory) at latest **31.12.2024**

Countries have to start their preparations (institutional arrangements, GHGI team set up, methodological choice, data collection, etc.), ASAP

Decision 18/CMA.1| GHGI principles

Transparency: There is sufficient and clear documentation such that individuals or groups other than the inventory compilers can understand how the inventory was compiled and can assure themselves it meets the good practice requirements for national GHGI. Documentation and reporting guidance is provided in Chapter 8, Reporting Guidance and Tables, of Volume 1 and in the respective chapters of Volume 2-6 (see also Volume 1, Chapter 6, QA/QC and Verification)

Source: Transparency under the Paris Agreement - A pocket guide for young people and beginners. Rome, 2022, FAO

Accuracy: The national GHGI contains neither over- nor under-estimates so far as can be judged. This means making all endeavors to remove bias from the inventory estimates (see especially Chapter 2, Approaches to Data Collection, and Chapter 3, Uncertainties, in Volume 1 and Volumes 2-5)

Decision 18/CMA.1| GHGI principles

Completeness: Estimates are reported for all relevant categories of sources and sinks, and gases. Geographic areas within the scope of the national GHGI are recommended in these Guidelines. Where elements are missing their absence should be clearly documented together with a justification for exclusion (see Volumes 2-5)

Source: Transparency under the Paris Agreement - A pocket guide for young people and beginners. Rome, 2022, FAO

Consistency: Estimates for different inventory years, gases and categories are made in such a way that differences in the results between years and categories reflect real differences in emissions. Inventory annual trends, as far as possible, should be calculated using the same method and data sources in all years and should aim to reflect the real annual fluctuations in emissions or removals and not be subject to changes resulting from methodological differences. (See Chapter 2: Approaches to Data Collection, Chapter 4: Methodological Choice and Identification of Key Categories, and Chapter 5: Time Series Consistency in Volume 1)

Decision 18/CMA.1| GHGI principles

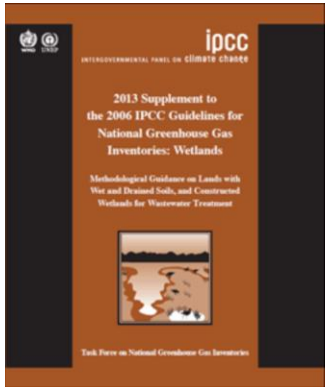
Comparability: The national GHGI is reported in a way that allows it to be compared with national GHGI for other countries. This comparability should be reflected in appropriate choice of key categories (see Volume 1, Chapter 4), and in the use of the reporting guidance and tables and use of the classification and definition of categories of emissions and removals presented in Table 8.2 of Chapter 8, and Volumes 2-5

Source: Transparency under the Paris Agreement - A pocket guide for young people and beginners. Rome, 2022, FAO

Decision 18/CMA.1| Methodologies

For preparing the national GHG inventory Parties:

- **shall** use the **2006 IPCC GLs** & any subsequent version or refinement agreed upon by CMA
- are encouraged to use the 2013 IPCC Wetlands Supplement



fundamental differences with the Revised 1996 IPCC GLs in methodologies, data requirements for LULUCF

Decision 18/CMA.1| IPCC Guidelines evolution

1996 IPCC GLs

- **Agriculture** and **Land Use and Change and Forestry** (LUCF) **separate** sectors
- Only the most important activities resulting in GHG emissions/removals
- Implicit assumption about estimating emissions and removals only over lands subject to human intervention
- Only accounted for above-ground biomass and soil C pools

GPG & GPG-LULUCF

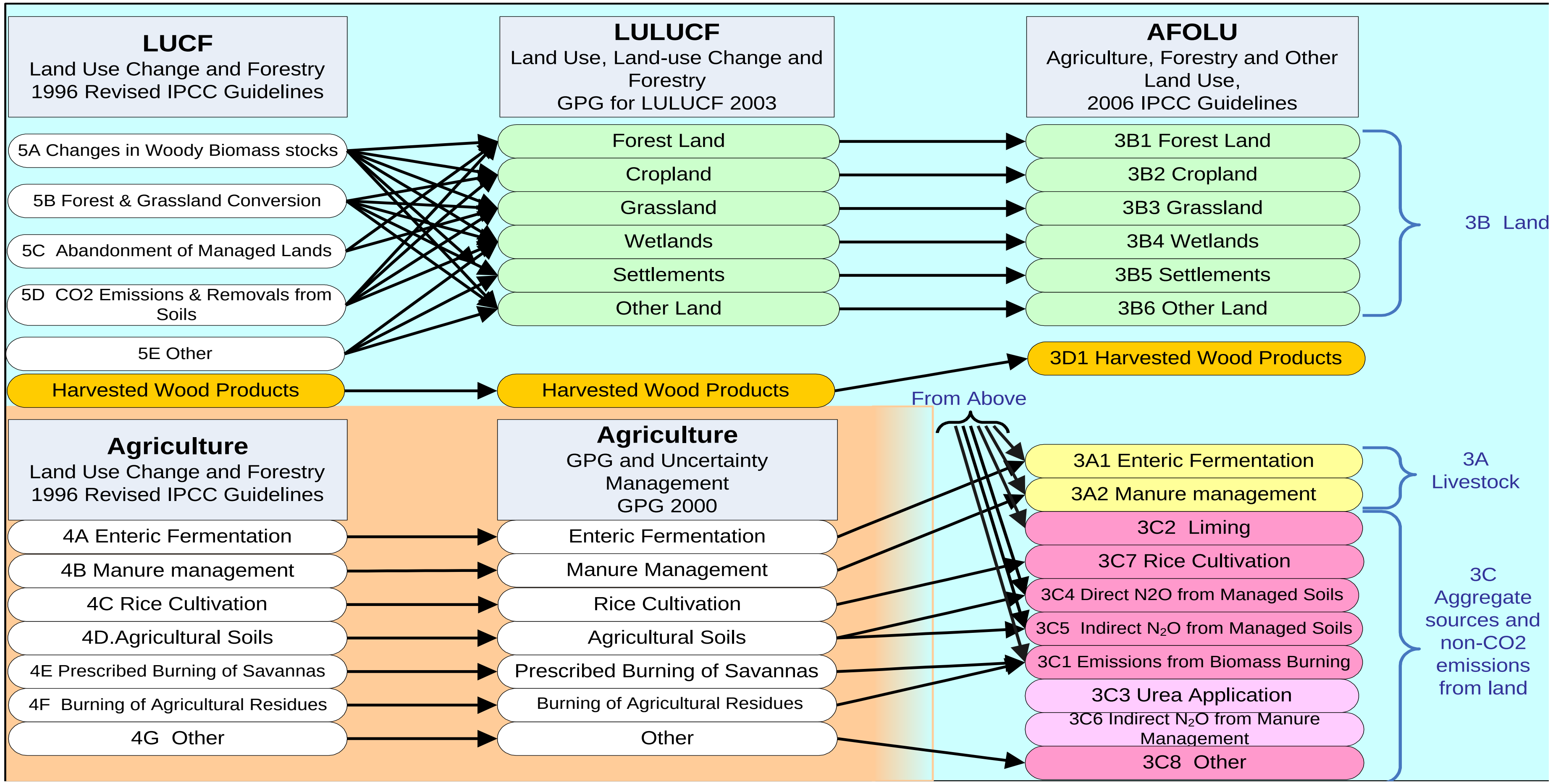
- **Agriculture** and **Land Use, Land-use Change and Forestry** (LULUCF) **separate** sectors
- Provides ***good practice*** and uncertainty management guidance
- Now includes all land use emissions/ removals split into six land-use categories from all pools
- Explicit Use of ***managed*** land as a proxy for anthropogenic emissions/removals

2006 IPCC Guidelines

- **Agriculture** and **Land Use and Change and Forestry** (LUCF) combined into a **single sector Agriculture, Forestry and Other Land Use** (AFOLU)
- Same approach as GPG-LULUCF
- Retained use of ***managed*** land
- Inclusion and consolidation of several previously optional categories
- Refinement of methods and improved defaults

Source: CGE Training material for NGHGI

Decision 18/CMA.1| IPCC Guidelines evolution



Source: CGE Training material for NGHGI

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
Methodologies	21. …shall use methods from the IPCC guidelines referred to in paragraph 20. …should make every effort to use a recommended method (tier level) for key categories (KCs) 22. ..may use nationally appropriate methodologies if they better reflect its national circumstances and are consistent with the IPCC guidelines & ..shall transparently explain national methods, data and/or parameters selected	9. ..may use different methods (tiers) included in the Guidelines, giving priority to those ..produce the most accurate estimates, depending on national circumstances and the availability of data. .. Parties can also use national methodologies .. provided …are consistent, transparent and well documented	

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
Methodologies	23. ..may be unable to adopt a higher tier method for a particular KC owing to lack of resources. In such cases...may use a tier 1, and shall clearly document why the methodological choice was not in line with the corresponding decision tree...should prioritize for future improvement		
AD, EFs	24. …is encouraged to use country-specific and regional emission factors (EFs), activity data (AD).. or propose plans to develop them	10. .. encouraged to use country-specific and regional EFs and AD for key sources or, where these do not exist, to propose plans to develop them …	

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
KCA	25. .. shall identify KC for the starting year and the latest reporting year.., including and excluding LULUCF categories, using approach 1, for both level and trend assessment; flexibility→ identify key categories using a threshold no lower than 85 % vs 95%	12. .. encouraged, to the extent possible, to undertake any key source analysis ..to assist in developing inventories that better reflect their national circumstances	
Consistency	26. ..should use the same methods and a consistent approach to underlying AD, EFs for each reported year. 27. ..should use …IPCC splicing techniques ..to estimate missing emission values resulting from lack of AD, EFs or other parameters ..to ensure a consistent time series		

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
Recalculations	28. ..shall perform recalculations …		
Uncertainty	29. ..shall quantitatively estimate and qualitatively discuss uncertainty ..for all source/sink categories, including inventory totals, for at least the SY and LY. ..shall also estimate the trend uncertainty ...using at least approach 1; flexibility→ provide, at a minimum, a qualitative discussion of uncertainty for key categories, ..are encouraged to provide a quantitative estimate of uncertainty for all source and sink categories	11. ..encouraged to apply IPCC Good Practice Guidance an Uncertainty Management in National Greenhouse Gas Inventories 24. ..encouraged to report on the level of uncertainty associated with inventory data, underlying assumptions, .. to describe methodologies for estimating uncertainties	

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
completeness	30. ..should indicate the sources and sinks not considered in the GHGI for which IPCC estimation methods are provided, and explain the reasons		
completeness	31. ..shall use notation keys (NKs) where numerical data are not available in CRTs, indicating the reasons why emissions/removals are not reported	22. ...Where numerical data are not provided, Parties should use the NKs	

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
GWP	37. .. shall use GWP values from the IPCC 5th AR…may in addition also use other metrics in which case… shall provide ..information on the values of the metrics used and the IPCC source	20. …should use GWP from the IPCC 2nd AR	
reporting	39-49. ..shall report… methods, rationale for their choice, assumptions, references for EFs & AD, category & gas & methodologies, EFs, AD used at the most disaggregated level to extent possible, KCs, recalculations, uncertainty, reasons for lack of completeness, methodological or data gaps, QA/QC etc.	21. ..encouraged to report on methodologies used.. including brief explanation of sources of EFs and AD. If country specific source/sinks are used…should explicitly describe the categories, methodologies, EFs and AD…are encouraged to identify areas for further improvement	

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
reporting	48. ..shall report seven gases CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3; flexibility → report at least 3 gases (CO_2, CH_4, N_2O) as well as any of the additional four gases (HFCs, PFCs, SF_6 and NF_3) that are included in the Party's NDC or have been previously reported	14. ..shall, as appropriate and to the extent possible…on a gas-by-gas basis ...of CO_2, CH_4, N_2O 15. .. encouraged HFCs, PFCs, SF_6	
reporting	50. .. shall report GHG for energy, IPPU, agriculture, LULUCF and waste	22. ..encouraged to use tables 1 and 2 ... In preparing those tables, .. should strive to be as complete as possible	6. ..encouraged to include... tables included in annex 3A.2 GPG LULUCF and sectoral report tables From 1996 IPCC Guidelines

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
reporting	51. ..should report on precursor gases: CO, NOx, NMVOCs, SOx.	16. ..encouraged ..report CO, NOx, NMVOCs 17. Other gases ..e.g, SOx may be included..	
reporting	52. ..may report indirect CO_2 from atmospheric oxidation of CH_4, CO and NMVOCs, and in that cases national totals shall be presented with and without indirect CO_2..should report indirect N_2O emissions from sources other than those in the agriculture and LULUCF sectors as a memo item, and those estimates of indirect N_2O shall not be included in national totals… may provide information on other substances that have an impact on climate		

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
reporting	53. ..should report international aviation and marine bunker fuel emissions as two separate entries and should not include such emissions in national totals	19. ..should.. report emissions from international aviation and marine bunker fuels separately…those emission should not be included in national totals	
reporting	54. ..should clearly indicate how feedstocks and non-energy use of fuels have been accounted for ..under the energy or IPPU		

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
reporting	55. In case of addressing emissions and subsequent removals from NDs...shall report information on approach, how it is consistent with IPCC guidance, and shall indicate if the estimates are indicated in national totals		
reporting	56. In the case other than the production approach is used for HWP... shall also provide supplementary information on emissions/removals using the production approach		

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
Time series	57. ..shall report a consistent annual time series starting from 1990; flexibility → report data covering, at a minimum, the reference year/period for its NDC and, in addition, a consistent annual time series from at least 2020 onwards	7. ..shall estimate national GHGI for 1994 for the initial NC or may provide data for 1990. For 2nd NC, ..shall estimate GHGI for 2000. The LDCs could estimate their GHGI for years at their discretion	7. …encouraged to provide consistent time series back to the years reported in previous NCs 8. nA1 Parties which have previously reported GHGI are encouraged to submit summary information tables for previous submission years (e.g. for 1994 and 2000)
Time series	58. .. the LY shall be no more than two years prior the GHGI submission; flexibility → LY as three years prior the GHGI submission		

Decision 18/CMA.1

	MPGs (18/CMA.1)	Current MRV NC 17/CP.8 (non-Annex I)	Current MRV BUR 2/CP.17 (non-Annex I)
completeness	47. .. shall report estimates of emissions and removals for **all categories, gases and carbon pools** considered in the GHG inventory throughout the reported period on a gas-by-gas basis in units of mass at the most disaggregated level, in accordance with the IPCC guidelines referred to in paragraph 20 above, using the CRTs…		

Reporting of carbon stock changes & of GHG emissions/removals is mandatory for all categories/subcategories/C pools for which 2006 IPCC Guidelines provide methodologies & default EFs/parameters. Countries should consult relevant chapters of Volume 4 of 2006 IPCC Guidelines

Reporting CSC in mineral soils

Reporting requirements in accordance with 2006 IPCC Guidelines

Tier 1		Land use												
		FL		CL		GL		WL			SL		OL	
Carbon pool – GHG		FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL PL-PL	L-WL L-PE	L-FlL	SL-SL	L-SL	OL-OL	L-OL
Living biomass	Above-ground	M	M	M [a]	M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
	Below-ground		M		M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
Dead organic matter	Deadwood		M [3]		M [c]		M [c]					M [c]		M [c]
	Litter		M		M [c]		M [c]					M [c]		M [c]
Soil organic matter	Mineral		M	M	M	M	M					M		M [d]
	Organic	M	M	M	M	M	M	M [f]				M		N/A
HWP		M (may be assumed 0 if net carbon stock change is judged insignificant)												
N_2O Direct	Fertilization [e]	M	M					M	M	M	M	M		
	N mineralization		M		M	M [g]	M					M		Y
	Drainage	M	M					M			M	M		
	Burning	M	M	M	M	M	M	M	M		M	M		Y
N_2O Indirect	Fertilization [e]	M	M					M	M	M	M	M		
	N mineralization		M		M	M [g]	M					M		Y
CH_4	Burning	M	M	M	M	M	M	M	M		M	M		M

For some C pools under some land use categories, 2006 IPCC Guidelines assume net C stock change is zero, namely the pool is in equilibrium

No C gains and losses are reported under IPCC tier 1 methodology

Carbon stock changes in soils

Why soil organic carbon (SOC) is important?

SOC (major component of soils organic matter) is the largest C stock in most terrestrial ecosystems. Second largest C pool after oceans

SOC is crucial to soil health, fertility, affecting soil's ability to provide essential ecosystem services, including food, production, biodiversity & contributing to the fight against climate change

SOM content is mainly influenced by natural factors (climate, topography, parent material, land cover) & human intervention (land use (cultivation practices, types of plants, etc.), management)

Carbon stock changes in soils

Why to report CSCs from soils?

- Helps in enhancing country's GHGI completeness, thus the GHGI quality
- Mobilizes action for collecting data & information, helps to identify gaps, challenges & technical/financial/research needs, and to attract support (domestic, international)
- Understanding SOC changes & dynamics assists in realizing human impact & taking proper action
- Informs policy-making
- Contributes to meet domestic goals & international targets
- Contributes to meet international obligations
- Learn from others, build on success and/or challenges from others, share knowledge & experiences, networking
- Helps in increasing ambition for climate targets
- Raises country's profile in the context of the efforts for climate change mitigation
- ….

Guiding questions

GHG inventories must follow decision 18/CMA.1 on Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement (MPGs), therefore

?

- ❑ Does your country's GHGI adhere to MPGs?
- ❑ Does the GHG inventory abide by the GHGI principles as defined in 2006 IPCC GLs?
- ❑ Is the GHG inventory in accordance with the 2006 IPCC GLs?
- ❑ How can the GHGI be further improved?
- ❑ Is there a systematic process for developing & implementing an improvement plan for the GHGI?

FCCC/PA/CMA/2018/3/Add.2

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Food and Agriculture Organization of the United Nations

FAO and the Enhanced transparency framework

NATIONAL GHG INVENTORY FOR LAND USE UNDER THE ETF (WITH A FOCUS ON SOIL)

Basic terminology

C stock

The amount of C contained in the organic matter. It is usually expressed in tonnes

C fraction

Conversion factor used to calculate the amount of C stock contained in organic matter (CF)

Activity data

Data on the magnitude of a human activity resulting in emissions/removals taking place during a given period of time (e.g., land areas)

C stock changes

Changes of carbon stock content in a carbon pool over time for which emissions and removals of C dioxide, methane and nitrous oxide correlate

C pool

A reservoir, or a component of the climate system where a GHG or a precursor of a GHG is stored. In particular, carbon pools have the capacity to accumulate and release carbon dioxide

Emission factor

Coefficient that relates the activity data to the amount of chemical compound which is the source of emissions. EFs are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions

Basic terminology

Good practice

Set of procedures intended to ensure that GHGIs are accurate in the sense that they are systematically neither over- nor underestimates so far as can be judged, and that uncertainties are reduced so far as possible. It covers choice of estimation methods appropriate to national circumstances, quality assurance and quality control at the national level, quantification of uncertainties and data archiving and reporting to promote transparency

SOM

Includes organic carbon in mineral soils to a specified depth chosen by the country and applied consistently through the time series. Live and dead fine roots and DOM within the soil, that are less than the minimum diameter limit (suggested 2 mm) for roots and DOM are included with soil organic matter where they cannot be distinguished from it empirically. The default depth for mineral soil is 30 cm

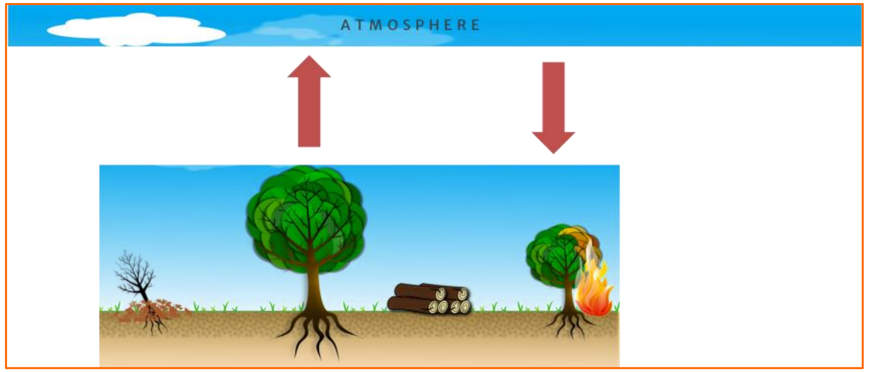
Tier

Level of methodological complexity. In the context of GHGIs three tiers are provided. Tier 1 is the basic method, Tier 2 intermediate and Tier 3 most demanding in terms of complexity and data requirements. Tiers 2 and 3 are sometimes referred to as higher tier methods and are generally considered to be more accurate

Background

The land sector is made of:

- ❑ Emissions to the atmosphere caused by losses of organic matter from terrestrial ecosystems &
- ❑ Removals of carbon dioxide (CO_2) from the atmosphere as uptake by vegetation and stored in the organic matter



Organic matter is composed of organic compounds that are part of organisms such as plants and their remains. It is essentially composed of the four elements (values present their weight in organic matter)

Carbon (C) : 45-55%
Oxygen (O) : 35-45%
Hydrogen (H): 3-5%
Nitrogen (N): 1-4%

These elements are constituents of the three important GHGs, that are reported in the land use sector: Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

Background

- C is the most relevant component of the organic matter
- The amount of organic matter in an ecosystem, regarded as a carbon stock (C Stock) is stratified into six so-called carbon pools

Living Biomass (LB) includes:

1. Above-Ground Biomass (AB)
2. Below-Ground Biomass (BB)

Dead Organic Matter (DOM) includes:

3. Dead Wood (DW)
4. Litter (LI)

5. Soil Organic Matter (SOM)
6. Harvested Wood Products (HWP)

Living Biomass:

- Table 4.3, Volume 4, 2006 IPCC Guidelines for Forest Land
- 0.5 for woody biomass and 0.47 for herbaceous biomass for Grassland (page 6.29. Volume 4, 2006 IPCC Guidelines)
- 0.5 for Flooded Lands (Equation 7.10, Volume 4, 2006 IPCC Guidelines)
- 0.5 for Settlements (page 8.9, Volume 4, 2006 IPCC Guidelines)

Litter:

- 0.37 (from Equation 2.19, Volume 4, 2006 IPCC Guidelines)
- 0.4 for Cropland, Grassland and Settlements (pages 5.14,6.11, 8.21, Volume 4, 2006 IPCC Guidelines)

Dead wood:

- 0.50 for Cropland, Grassland and Settlements (pages 5.14, 6.11, 8.21, Volume 4, 2006 IPCC Guidelines)

SOM in mineral soils: 0.58 (page 2.38, Volume 4, 2006 IPCC Guidelines)

Peat: Table 7.5, Volume 4, 2006 IPCC Guidelines

- To convert dry organic matter into carbon, the 2006 IPCC Guidelines provide default CF values for the C pools

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

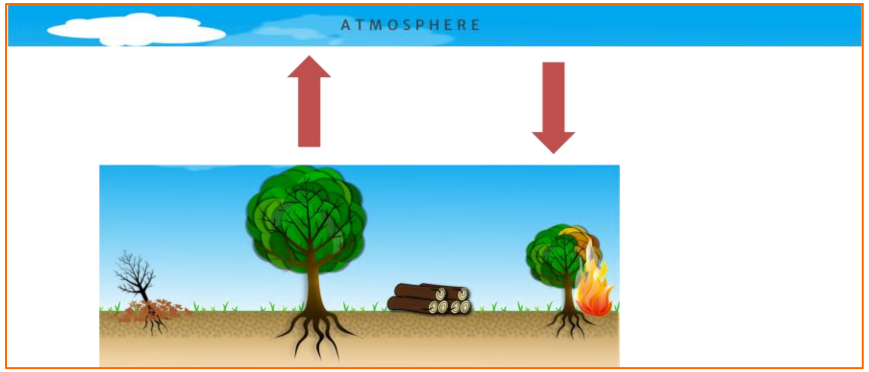
Background

- Factors governing emissions/removals can be both natural and anthropogenic and can be difficult to distinguish between causal factors

- Inventory methods have to be operational, practical and globally applicable while being scientifically sound

- In 2006 IPCC Guidelines the ‘managed land’ proxy is maintained as the approach for defining anthropogenic GHG emissions by sources and removals by sinks as all those occurring on land

- GHG emissions/removals do not need to be reported for unmanaged land in GHGI



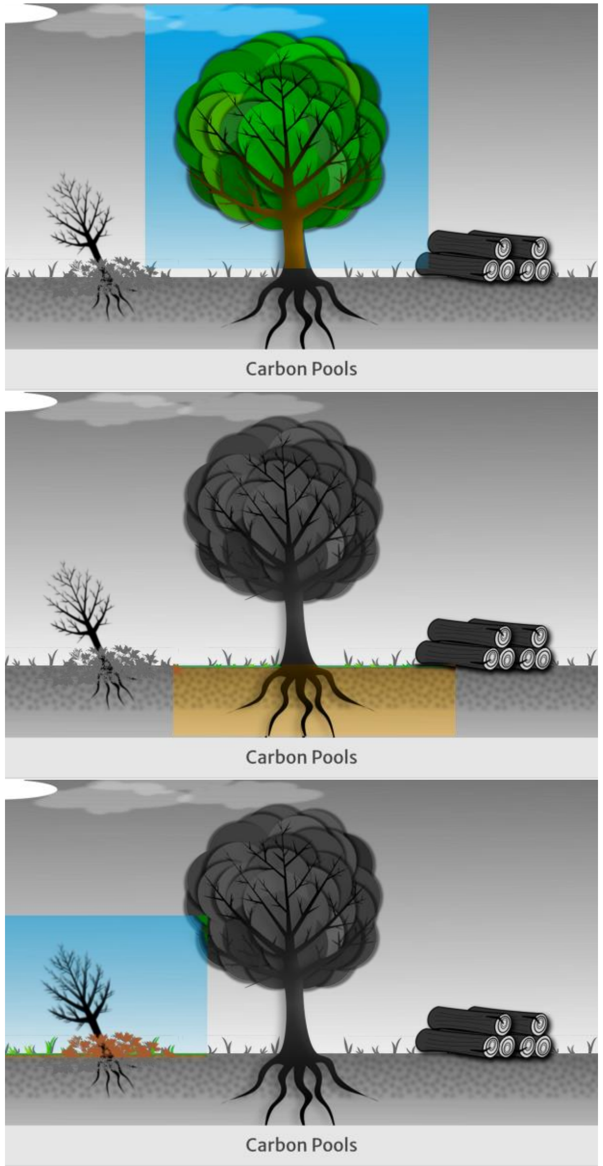
Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

Background

Above ground biomass: All living biomass above the soil incl. stem, stump, branches, bark, seeds & foliage

Below ground biomass: All biomass of live roots, often excl. fine roots of less than (suggested) 2 mm diameter

Dead wood: All non-living woody biomass not litter either standing, lying on the ground, or in the soil (Incl. surface wood, dead roots, stumps larger than dia. used by country to distinguish from litter (e.g., 10 cm))



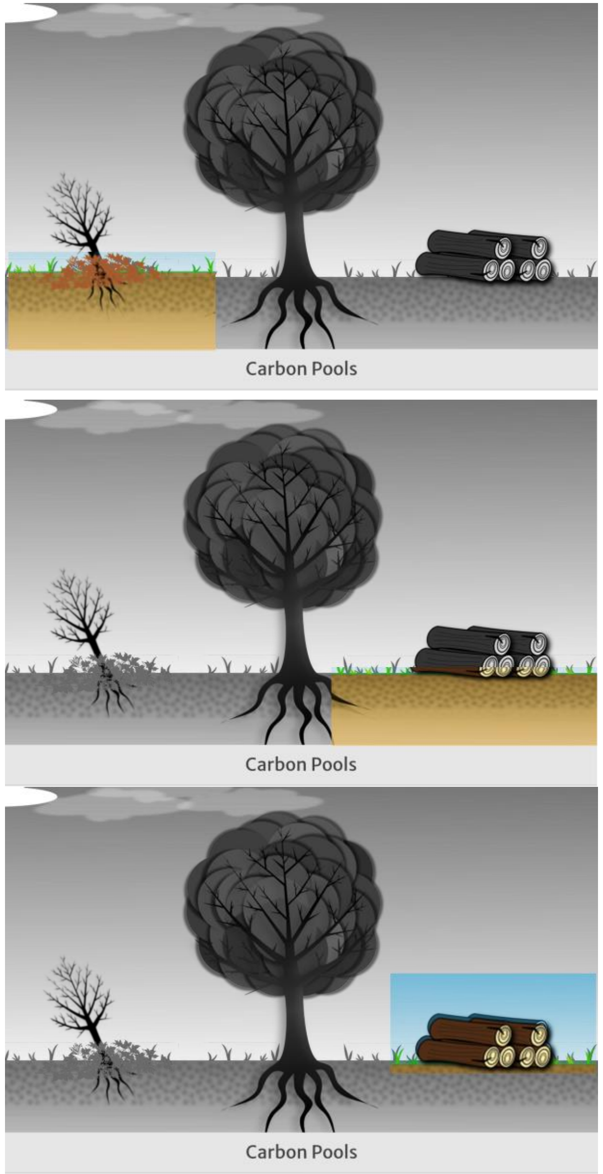
Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

Background

Litter: All non living biomass of dia. < chosen by the country (e.g., 10 cm) lying dead above soil (Incl. litter, fumic and humic layers & live fine roots > dia. used to distinguish below ground biomass (e.g., 2 mm))

Soil C: organic C in mineral and organic soils (including peat) to a specified depth chosen by country (default depth 30 cm for Tier 1 & 2 methods) (incl. live fine roots if cannot be distinguished empirically)

HWP: An anthropogenic pool. HWP includes all wood material (inc. bark) that leaves harvest sites but remains in man-made products for different lengths of time. Other material left at harvest sites should be regarded as dead organic matter in the associated land-use category



Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

Background

- C pools exchange GHG as removals from the atmosphere through photosynthesis & as emissions to the atmosphere through different processes, such as biochemical (decay of C stocks) & physiochemical (fires) processes

- Emissions occur as C stock losses from C pools & removals as C stock gains. CO2 emissions & removals are proportional to the SOC change

- C stock changes are a proxy for estimating GHG emissions/removals for land categories

Background

- Transfers (as gains or losses) of organic matter among C pools occur as a consequence of mortality (natural & man-made) and decay, so determining C stock losses in the C pools from which the stock is transferred & C stock gains in the pools in which the C stock is transferred

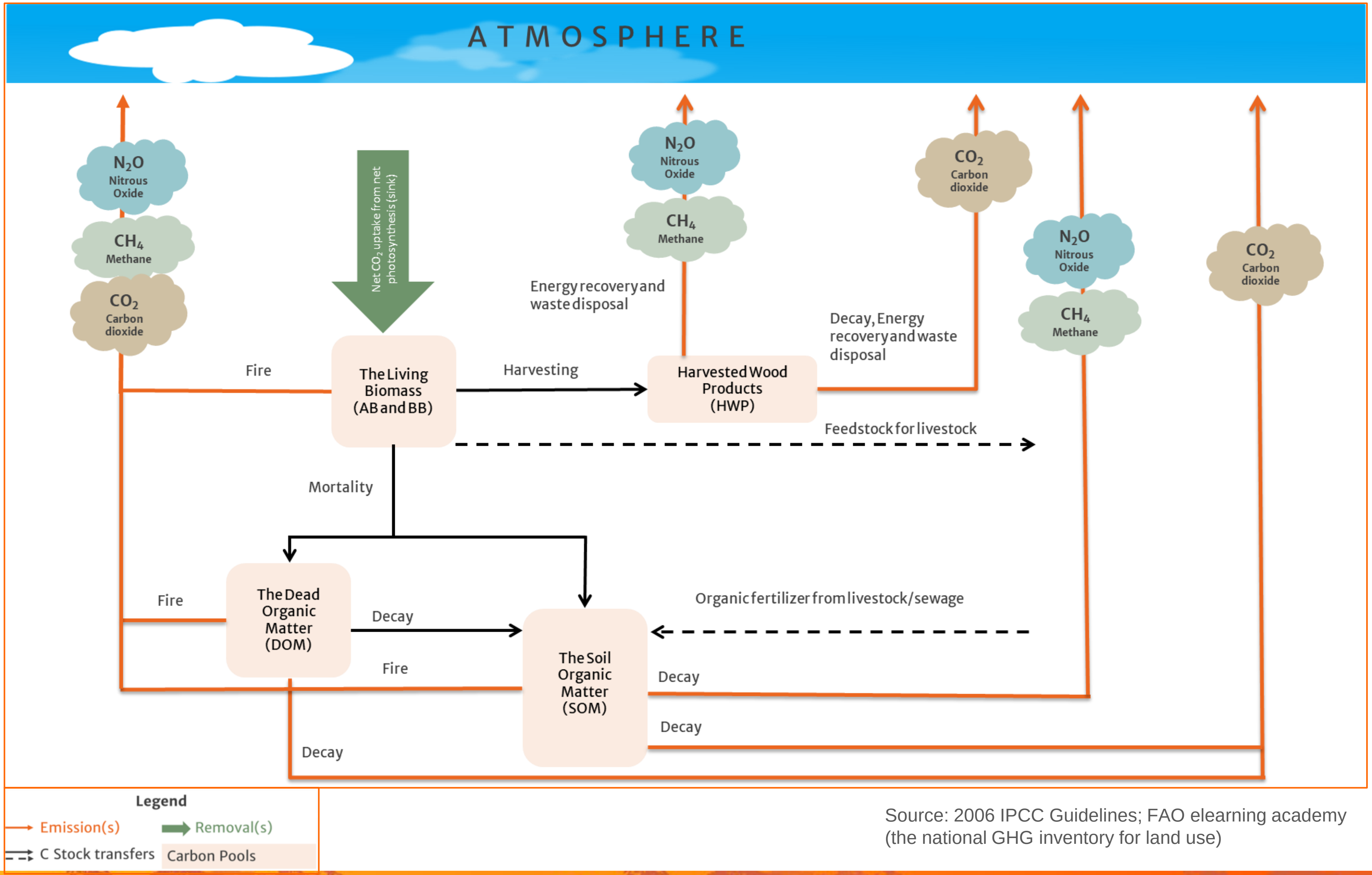
- Biomass is the only sink among C pools

- Both, C stock gains (positive sign) and C stock losses (negative sign) are multiplied by -44/12 to convert them in CO_2 removals and emissions respectively (44 is the molecular weight of CO_2 and 12 is the atomic weight of C)

Background

- The SOM pool does not remove directly CO_2 from the atmosphere
- SOC stock mineralization (inverse of C stock accumulation) causes a net loss from SOM determining both CO_2 & N_2O (both direct and indirect) emissions
- IPCC methodology distinguishes two types of soils according to its SOM content: mineral & organic soils
- In case of SOC accumulation, also N_2O emissions associated with mineralization of organic matter are avoided, however, such N_2O “removals” **are not** counted for under tier 1 (only under tier 3)
- N_2O emissions are proportional to the C:N ratio (that determines the N content of SOM)

Background



Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

Background

SOC constitutes the most significant C stock in many ecosystems where the biomass component is low (e.g. cropland) or where there is high accumulation of organic matter, like in organic soils (e.g. peatlands)

SOC changes are driven →

- Changes in land use
- Changes in land management
- Drainage/rewetting of soil

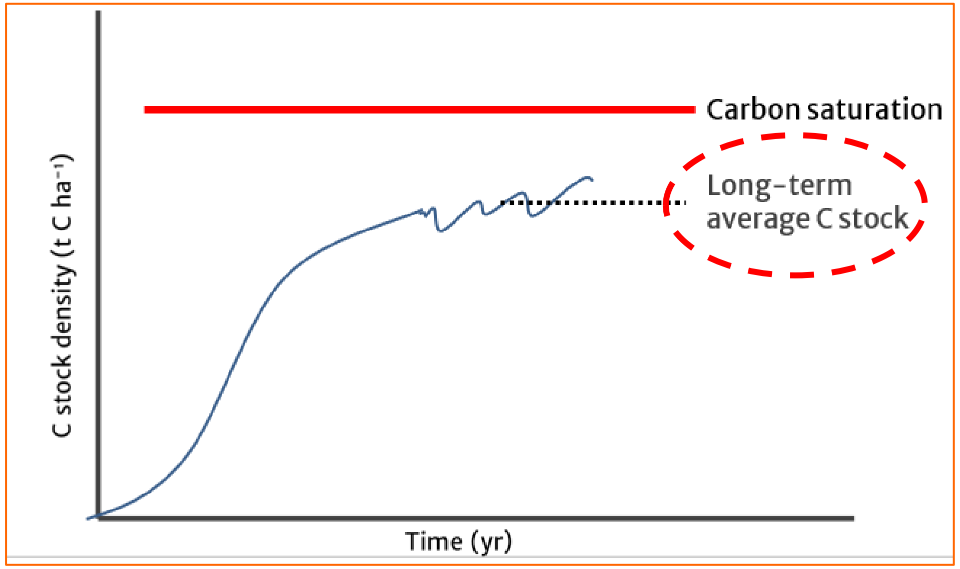
❑ For mineral soils, IPCC methods focus on changes in the long-term average SOC (i.e. SOC at equilibrium)

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

Background

- C stock contained at a certain point in time in a C pool is a function of the use of the land. This includes the dynamic of the C stock and therefore, the so-called long term average. The use of land includes the management practices, as well as of natural variables (e.g. climate, soil)
- In addition, C pools have physical limits in their capacity to store carbon known as carbon saturation

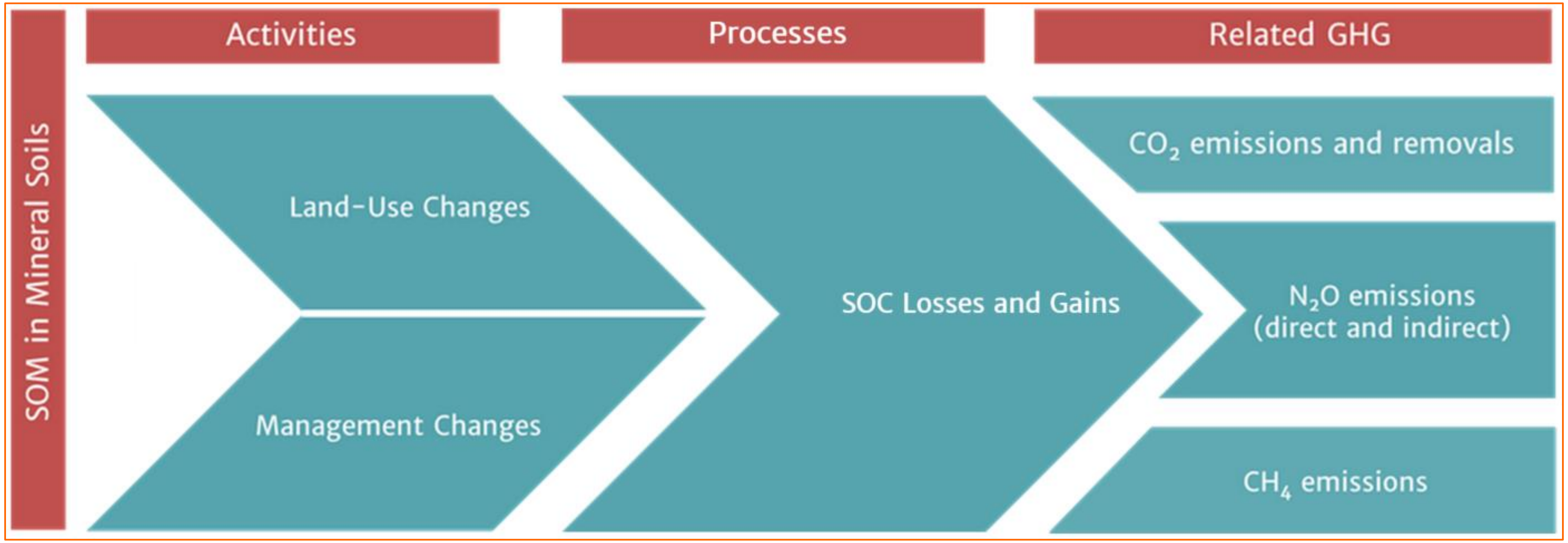
Evolution of C stocks in a afforested land



Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

Background

Overview scheme of estimating GHG emissions/removals from mineral soils



Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation

- The default IPCC method (Tier 1) is based on the stock difference method
- Annual SOC CSC → by dividing total SOC *diff* between the two land uses and/or management systems/practices by the time period needed for the SOM pool to achieve the new long term average equilibrium SOC (20 years IPCC default)
- If not any change occurs, it is assumed that the long term net SOC change is null

$$\Delta C_{Mineral} = \frac{(SOC_0 - SOC_{(0-T)})}{D}$$

$$SOC = \sum_{c,s,i} \left(SOC_{REF_{c,s}} \times F_{LU_{c,i}} \times F_{MG_{c,i}} \times F_{I_{c,i}} \times A_{c,s,i} \right)$$ Equation 2.25

SOC_0, SOC_{0-T}: Soil organic carbon stock at two points in time (0 and 0−T) (t C). Note that both are calculated as t C ha^{-1} and then multiplied by the area of the land stratum.
T: Number of years over a single inventory period (e.g. in case the GHG inventory is compiled every two years, T is equal to two years).
D: Transition period needed for SOM to achieve the new equilibrium after a change (by default, 20 years). D is replaced by T if T>D.
SOC_{REF}: The reference C stock (t C ha^{-1}) representing the C stock level under natural vegetation, i.e. forest land and unmanaged grassland, for the specific combination of climate zone and soil type.
F_{LU}: Dimensionless factor used to calculate the C stock level associated with a land use category.
F_{MG}: Dimensionless factor used to calculate the C stock level associated with a land management regime.
F_I: Dimensionless factor used to calculate the C stock level associated with a level of organic matter input.
A: Land area, ha.
c,s,i: Climate, soil, management system of practices.

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation

$$\Delta C_{Mineral} = \frac{(SOC_0 - SOC_{(0-T)})}{D}$$

$$SOC = \sum_{c,s,i} \left(SOC_{REF_{c,s}} \times F_{LU_{c,i}} \times F_{MG_{c,i}} \times F_{I_{c,i}} \times A_{c,s,i} \right)$$ Equation 2.25

2006 IPCC Guidelines

TABLE 2.3
DEFAULT REFERENCE (UNDER NATIVE VEGETATION) SOIL ORGANIC C STOCKS (SOC_{REF}) FOR MINERAL SOILS
(TONNES C HA^{-1} IN 0-30 CM DEPTH)

Climate region	HAC soils[1]	LAC soils[2]	Sandy soils[3]	Spodic soils[4]	Volcanic soils[5]	Wetland soils[6]
Boreal	68	NA	10#	117	20#	146
Cold temperate, dry	50	33	34	NA	20#	87
Cold temperate, moist	95	85	71	115	130	
Warm temperate, dry	38	24	19	NA	70#	88
Warm temperate, moist	88	63	34	NA	80	
Tropical, dry	38	35	31	NA	50#	86
Tropical, moist	65	47	39	NA	70#	
Tropical, wet	44	60	66	NA	130#	
Tropical montane	88*	63*	34*	NA	80*	

Updated SOCref for Wetlands soils in 2013 IPCC Supplement on Wetlands

TABLE 5.2
DEFAULT REFERENCE SOIL ORGANIC CARBON STOCKS (SOC_{REF}) FOR WETLAND MINERAL SOILS[A] UNDER NATIVE VEGETATION (0-30 CM DEPTH).

Climate region	tonnes C ha^{-1}	Standard deviation	Error (95% confidence interval[B])	Number of sites
Boreal	116	94	±99	6
Cold temperate, dry	87[C]	n/a[D]	n/a[D]	n/a[D]
Cold temperate, moist	128	55	±17	42
Warm temperate, dry	74	45	±13	49
Warm temperate, moist	135	101	±39	28
Tropical, dry	22	11	±4	32
Tropical, moist	68	45	±12	55
Tropical, wet	49	27	±9	33
Tropical, montane	82	73	±46	12

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation

$$\Delta C_{Mineral} = \frac{(SOC_0 - SOC_{(0-T)})}{D}$$

$$SOC = \sum_{c,s,i} \left(SOC_{REF_{c,s}} \times F_{LU_{c,i}} \times F_{MG_{c,i}} \times F_{I_{c,i}} \times A_{c,s,i} \right)$$ Equation 2.25

Land representation

SOC change factor in mineral soils	Stratification
F_{LU}	The land use factor is stratified by land use and crop type, taking also into consideration timing under specific practices.
F_{MG}	The management factor is stratified by the management intensity. This varies between reduced or full tillage.
F_I	The organic C input factor is stratified by the amount of organic C inputs to the soil. This is due to crop residues and/or the addition of organic fertilizers, as manure.

Forest land	Tier 1 default value for each factor (F_{LU}, F_{MG}, and F_I) = 1
Cropland	2006 IPCC GLs, table 5.5 provides a list of default values for each factor. 2013 Wetlands Supplement, table 5.3 provides default F_{LU} for long-term cultivation of Cropland with IWMS
Grassland	2006 IPCC GLs, table 6.2 provides a list of default values for each factor
Wetlands	No SOC-change factors are provided
Settlements	The default assumption is that mineral soils under Settlements contain 80% of the SOC of the previous land use
Other land	The default assumption is that mineral soils under Other land do not contain any significant SOC, i.e., SOC = 0

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation

$$\Delta C_{Mineral} = \frac{(SOC_0 - SOC_{(0-T)})}{D}$$

$$SOC = \sum_{c,s,i} \left(SOC_{REF_{c,s}} \times F_{LU_{c,i}} \times F_{MG_{c,i}} \times F_{I_{c,i}} \times A_{c,s,i} \right)$$ Equation 2.25

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

- ❑ Equation 2.25 can be implemented by using two different formulations according to the availability of AD on land representation

Formulation A (Approach 1 for Activity Data Collection)

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

- With approach 1 for land representation
- Calculates SOC net change at the level of total country area (stratified by climate, soil type, land use and management type)

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

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

- With approaches 2 & 3 for land representation
- Calculates SOC net change at the level of each single unit of land, since AD allow for the identification of changes in management type for each single unit of land

SOC CSC estimation

Formulation A

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

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

SOC_{0_GHGI}: Is the SOC at equilibrium for combination of the current land uses and management systems of practices in the entire territory inventoried (t C).

$SOC_{(0-T)\_GHGI}$: Is the SOC at equilibrium for the combination of land uses and management systems of practices of D years before the inventory year in the entire territory inventoried (t C).

$\left(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i}\right)_0$: Is the SOC at equilibrium for the combination of current land uses and management systems of practices in the entire territory inventoried (t C).

$\left(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i}\right)_{(0-D)}$: Is the SOC at equilibrium for the combination of land uses an management systems of practices of D years before the inventory year in the entire territory inventoried (t C).

D: The transition period needed for SOM to achieve the new equilibrium level after a change (by default, 20 years). D Is replaced by T if T>D.

c is for climate zone; *s* for mineral soil type; *i* for use and management system of practices.

SOC at equilibrium for the combination of land uses and management systems present D years before the inventory year are subtracted from the SOC at equilibrium of the current combination of land uses and management systems & the result is divided by the number of years of D to calculate the annual constant rate of SOC CSCs across the entire transition period D

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation

Formulation B

SOC_0

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

$\left(SOC_{REF_{c,s,p}} \cdot F_{LU_{c,i,p}} \cdot F_{MG_{c,i,p}} \cdot F_{I_{c,i,p}} \right)_0$: Is the SOC at equilibrium for the current land use and management system of practices of one hectare of parcel p (t C ha^{-1}).

$SOC_{@conversion}$: Is the actual SOC of one hectare of parcel p when the last land use and/or management change occurred (t C ha^{-1}). Note that if the latest land use and/or management change occurred D years before the current inventory year then $SOC_{@conversion}$ is equal to SOC at equilibrium of one hectare of parcel p under current land use and management system of practices.

SOC_{0_GHGI}: Is the actual SOC of one hectare of parcel p in the current inventory year (t C).

$SOC_{(0-T)\_GHGI}$: Is the actual SOC of one hectare of parcel p in the previous inventory year (t C).

T: Number of years over a single inventory period (e.g. in case the GHG inventory is compiled every two years, T is equal to 2).

D: The transition period needed for SOM to achieve the new equilibrium level after a change (by default, 20 years). D is replaced by T if T>D.

Note that if the latest land use and/or management change occurred D years before the current inventory year, then $SOC_{@conversion}$ is equal to SOC at equilibrium of one hectare of parcel p under current land use and management system of practices. Consequently, $SOC_{0\_GHGI} = SOC_{(0-T)\_GHGI}$ (when time passed from latest change in p is > D) and $\Delta C_{Mineral} = 0$.

$SOC_{(0-T)}$

When calculating the annual SOC change between 2 subsequent inventory years (i.e. time 0 and time 0-T), $SOC_{(0-T)\_GHGI}$ is equivalent to SOC_{0_GHGI} as calculated for year 0-T

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

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

SOC_{0_GHGI}: is the actual SOC of parcel p in the current inventory year T (t C) .

$SOC_{(0-T)\_GHGI}$: is the actual SOC of parcel p in the previous inventory year 0-T (t C).

$\left(SOC_{REF_{c,s,p}} \cdot F_{LU_{c,i,p}} \cdot F_{MG_{c,i,p}} \cdot F_{I_{c,i,p}} \right)_0$ SOC at equilibrium for the current land use and management system of practices of one hectare of parcel p (t C ha^{-1}).

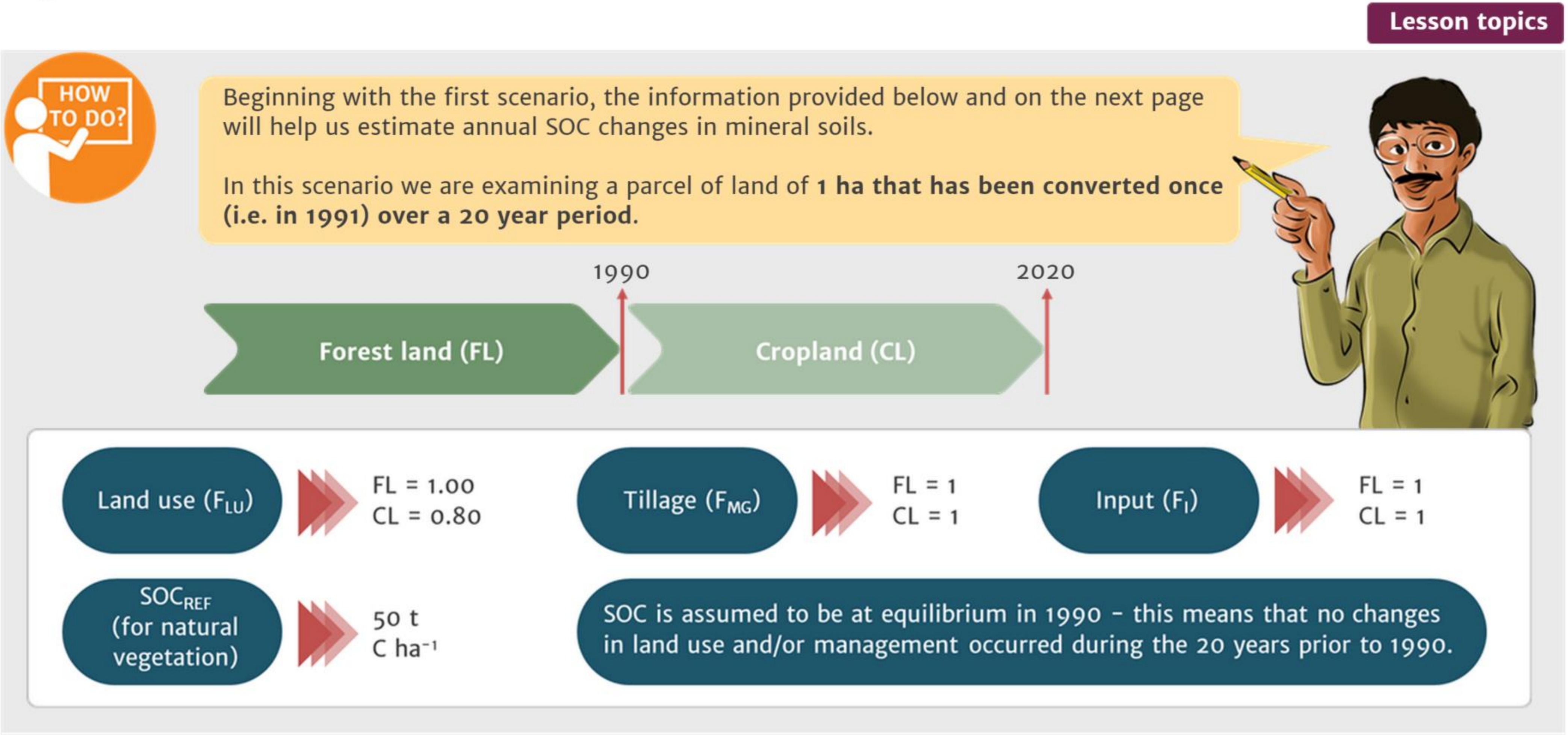
$SOC_{@conversion_{c,s,i,p}}$: Is the actual SOC of one hectare of parcel p when the last land use and/or management change occurred (t C ha^{-1}). Note that if latest land use and/or management change occurred D years before the current inventory year then $SOC_{@conversion}$ is equal to SOC at equilibrium of one hectare of parcel p under current land use and management system of practices and consequently $\Delta C_{Mineral}$=0.

D: The transition period needed for SOM to achieve the new equilibrium level after a change (by default, 20 years). D Is replaced by T if T>D.

$A_{c,s,i,p}$: Is the area of parcel of land p (ha).

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example



Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example | formulation A

This parcel of land of 1 ha area is monitored for 20 years and reported in GHG inventories every five years. At the end of the transition period (20 years), SOC achieves a new equilibrium level. In other words, in the year 2011 there are no more SOC changes.

The table below summarizes the classification of land surface over time by land use. As you will notice, values are provided after each five year inventory period.

SCENARIO 1 – Formulation A							
Year	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Land Use Category	FL	CL	CL	CL	CL	CL	CL
FL area (ha)	1	0	0	0	0	0	0
CL area (ha)	0	1	1	1	1	1	1

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example | formulation A

We will now apply Formulation A and start by calculating the SOC at equilibrium for each land use category.

Let’s recall the equation used to calculate SOC at equilibrium:

$$SOC = \sum_{c,s,i} \left(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \right)$$

Equation 2.25

SOC at equilibrium can be calculated for each of the land use categories, as follows:

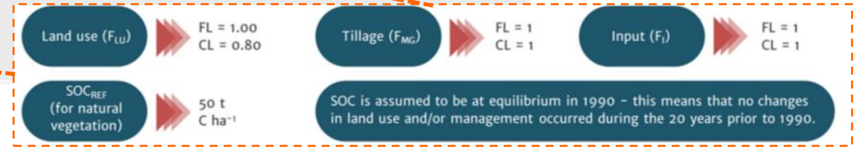
When we apply the **values** for **FL**, we get the following equation and result for SOC at equilibrium for FL:

$$SOC_{FL} = 50 \cdot 1 \cdot 1 \cdot 1 = 50 \text{ t C ha}^{-1}$$

When we apply the **values** for **CL**, we get the following equation and result for SOC at equilibrium for CL:

$$SOC_{CL} = 50 \cdot 0.80 \cdot 1 \cdot 1 = 40 \text{ t C ha}^{-1}$$

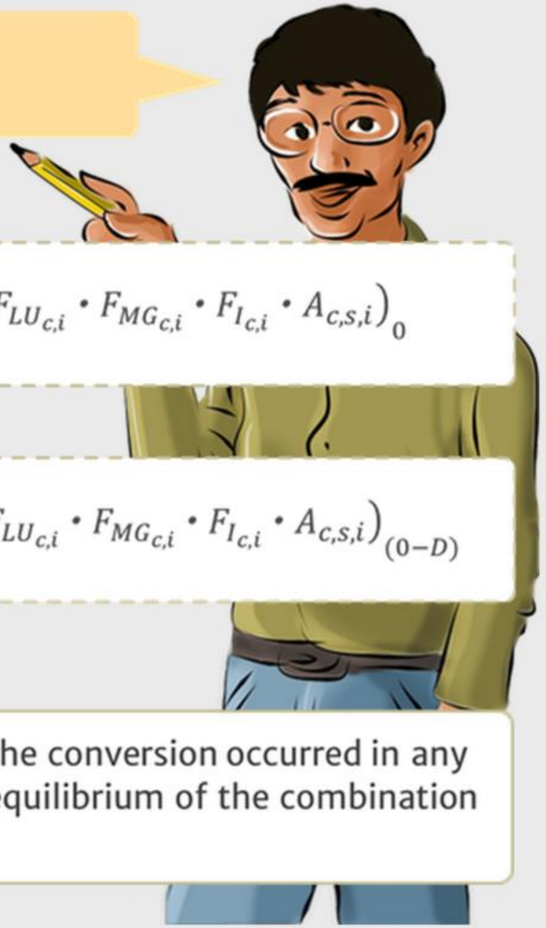
Remember, they are used for every inventory year.



Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example | formulation A

Let's recall how SOC_{0_GHGI} and $SOC_{(0-T)\_GHGI}$ are calculated for Formulation A.



In any inventory year, SOC_{0_GHGI} is the SOC at equilibrium of the combination of current land uses and management systems of practices (for this example, see value of SOC_{CL} previously calculated).

$$SOC_{0\_GHGI} = \sum_{c,s,i} \left(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i} \right)_0$$

In any inventory year, $SOC_{(0-T)\_GHGI}$ is the value of SOC at equilibrium of the combination of land uses and management systems of practices of D years (20 years, as per IPCC default) before the inventory year (for this example, see value of SOC_{FL} previously calculated).

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

Considering that the land-use change occurred in 1991, $SOC_{(0-T)}$ is the value at 1990 –i.e. before the conversion occurred in any inventory year X that is earlier than 2010 (i.e. 1990+20), $SOC_{(0-T)\_GHGI}$ corresponds to the SOC at equilibrium of the combination of land uses and management systems of practices of the year 1990.

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example | formulation A

Using Formulation A, we now calculate SOC_{0_GHGI} and $SOC_{(0-T)\_GHGI}$.

While for the year 1990 SOC_{0_GHGI} and $SOC_{(0-T)\_GHGI}$ are equivalent, and correspond to the SOC at equilibrium of Forest land, for the year 1995 SOC_{0_GHGI} and $SOC_{(0-T)\_GHGI}$ are:

$$SOC_{0\_GHGI} = 40 \text{ t C ha}^{-1} \cdot 1 \text{ ha} = 40 \text{ t C}$$

$$SOC_{(0-T)\_GHGI} = 50 \text{ t C ha}^{-1} \cdot 1 \text{ ha} = 50 \text{ t C}$$

Now you may calculate SOC_{0_GHGI} and $SOC_{(0-T)\_GHGI}$ for all other years.

In order to keep track of our answers, it is useful to add them to a table like this one on the right.

SCENARIO 1 – Formulation A

Year	1990	1995	2000	2005	2010	2015	2020
Land Use Category	FL	CL	CL	CL	CL	CL	CL
FL area (ha)	1	0	0	0	0	0	0
CL area (ha)	0	1	1	1	1	1	1
SOC_{0_GHGI} (t C)	50.00	40.00	40.00	40.00	40.00	40.00	40.00
$SOC_{(0-T)\_GHGI}$ (t C)	50.00	50.00	50.00	50.00	50.00	40.00	40.00

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example | formulation A

Next, we will calculate the annual SOC change of the entire time series.

Let's recall the equation used to calculate annual SOC change for each inventory period:

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

Annual SOC change for the conversion of FL to CL is:

$$\Delta C_{Mineral_{(1991-2010)}} = \frac{(40-50)}{20} = -0.5 \text{ t C yr}^{-1}$$

While the total change between consecutive inventory years is:

$$\Delta C_{Mineral(between\ inventory\ years)} = \Delta C_{Mineral_{(1991-2010)}} \cdot T = -0.5 \text{ t C yr}^{-1} \cdot 5\ yr = 2.5 \text{ t C}$$

After 20 years, the SOC of the land is at its new equilibrium, so that $\Delta SOC_{Mineral(total\ across\ inventory\ years)}$:

SCENARIO 1 – Formulation A							
Year	1990	1995	2000	2005	2010	2015	2020
Land Use Category	FL	CL	CL	CL	CL	CL	CL
FL area (ha)	1	0	0	0	0	0	0
CL area (ha)	0	1	1	1	1	1	1
SOC_{0_GHGI} (t C)	50.00	40.00	40.00	40.00	40.00	40.00	40.00
$SOC_{(0-T)\_GHGI}$ (t C)	50.00	50.00	50.00	50.00	50.00	40.00	40.00
ΔC (t C yr^{-1})	0.00	-0.50	-0.50	-0.50	-0.50	0.00	0.00

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example | formulation A

Finally, we can now calculate the total SOC change using Formulation A.

Here is the equation used to calculate the total SOC change:

$$\Delta SOC_{TOTAL} = \sum_{1991}^{2020} (\Delta C_{Mineral})$$

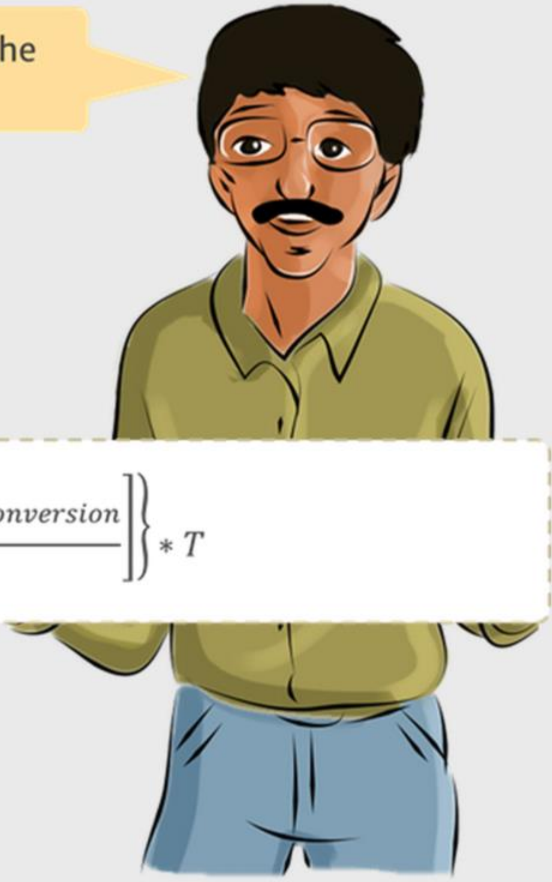
The total SOC change for the time series is:

$$\Delta SOC_{TOTAL} = (-0.50\ \mathrm{t\,C\,yr^{-1}} \cdot 5\ yr + -0.50\ \mathrm{t\,C\,yr^{-1}} \cdot 5\ yr + -0.50\ \mathrm{t\,C\,yr^{-1}} \cdot 5\ yr - 0.50\ \mathrm{t\,C\,yr^{-1}} \cdot 5\ yr) = -10\ \mathrm{t\,C}$$

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example | formulation B

Using the same data, we will now apply Formulation B to scenario 1. Remember, the below equation is used to calculate SOC_{0_GHGI}.



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

Recall that $SOC_{(0-T)\_GHGI}$ is equal to SOC_{0_GHGI} at time 0−T. In the next page we will calculate SOC_{0_GHGI} and $SOC_{(0-T)\_GHGI}$.

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example | formulation B

HOW TO DO?

Applying the equation for SOC_{0_GHGI} values, we get the below equation and answer for the 1995 inventory year.

As shown here, this value is then placed under the 1995 column of the table.

SCENARIO 1 – Formulation B							
Year	1990	1995	2000	2005	2010	2015	2020
Land Use Category	FL	CL	CL	CL	CL	CL	CL
FL area (ha)	1	0	0	0	0	0	0
CL area (ha)	0	1	1	1	1	1	1
SOC_{0_GHGI} (t C)	50.00	47.50	45.00				
$SOC_{(0-T)\_GHGI}$ (t C)	50.00	50.00	47.50	45.00			

$$50 + \left(\frac{40-50}{20}\right) t\ C\ ha^{-1} yr^{-1} * 1\ ha * 5\ yr = 47.50\ t\ C$$

In line with the above information provided by Efren, 47.50 t C represents the SOC_{0_GHGI} value for the 1995 inventory year and is equal to the $SOC_{(0-T)\_GHGI}$ value for the 2000 inventory year.

To calculate SOC_{0_GHGI} for 2000 you apply the value of **47.50** to the equation and add the result to the table.

$$47.50 + \left(\frac{40-50}{20}\right) t\ C\ ha^{-1} yr^{-1} \cdot 1\ ha \cdot 5\ yr = 45.00\ t\ C$$

Recall that the values of SOC at equilibrium for each land use category are applied to every inventory year.

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

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example | formulation B

HOW TO DO?

Next, we will calculate the annual SOC change ($\Delta C_{Mineral}$) for the portion of time series corresponding to the transition period of the land conversion of FL to CL (i.e. 1990-2010).

Let's recall the equation used to calculate annual SOC change for each inventory period:

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

Applying this equation to the 1995 inventory year provides us with the below equation.

Annual SOC change from the conversion of FL to CL in the 1995 inventory year (recall that this should be done for every inventory year):

$$\Delta C_{Mineral(1991-1995)} = \frac{(40-50)}{20} t\ C\ ha^{-1} yr^{-1} * 1\ ha = -0.50\ t\ C\ yr^{-1}$$

SCENARIO 1 – Formulation B					
Year	**1990**	**1995**	**2000**	**2005**	**2010**
Land Use Category	FL	CL	CL	CL	CL
FL area (ha)	1	0	0	0	0
CL area (ha)	0	1	1	1	1
SOC_{0_GHGI} (t C)	50.00	47.50	45.00	42.50	40.00
$SOC_{(0-T)\_GHGI}$ (t C)	50.00	50.00	47.50	45.00	42.50
ΔC (t C yr^{-1})	0.00	-0.50	-0.50	-0.50	-0.50

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

SOC CSC estimation | example | formulation B

To complete the table, we need to calculate the annual SOC change for the portion of time series beyond the end of the transition period of the conversion of FL to CL (i.e. 2015–2020).

Recall that $SOC_{@conversion}$ is equal to SOC at equilibrium under current land use and management system of practices if the latest land use and/or management change occurred D years before the current inventory year.

This is the equation with values:

$$\Delta C_{Mineral(2011-2020)} = \frac{(40-40)}{20} ha^{-1} yr^{-1} \cdot 1\ ha = 0\ \mathrm{t\ C\ yr}^{-1}$$

Finally, we can now calculate the total SOC change using equation shown here.

$$\Delta SOC_{TOTAL} = \sum_{1991}^{2020} (\Delta C_{Mineral})$$

SCENARIO 1 – Formulation B							
Year	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Land Use Category	FL	CL	CL	CL	CL	CL	CL
FL area (ha)	1	0	0	0	0	0	0
CL area (ha)	0	1	1	1	1	1	1
SOC_{0_GHGI} (t C)	50.00	47.50	45.00	42.50	40.00	40.00	40.00
$SOC_{(0-T)\_GHGI}$ (t C)	50.00	50.00	47.50	45.00	42.50	40.00	40.00
ΔC (t C yr^{-1})	0.00	-0.50	-0.50	-0.50	-0.50	0.00	0.00

The total SOC change for the time series is:

$$\Delta SOC_{TOTAL} = (-0.50\ \mathrm{t\ C\ yr}^{-1} \cdot 5\ yr - 0.50\ \mathrm{t\ C\ yr}^{-1} \cdot 5\ yr - 0.50\ \mathrm{t\ C\ yr}^{-1} \cdot 5\ yr - 0.50\ \mathrm{t\ C\ yr}^{-1} \cdot 5\ yr) = -10\ \mathrm{t\ C}$$

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

Land representation | introduction

Land representation is the analysis undertaken to identify & quantify human activities on land & to track their changes over time

Results in a **stratification** of the total country area

Source: FAO e-learning course: The national GHG inventory for land use

Division of country into units of land (strata) homogeneous for a number of variables

Explanation of current level & dynamic of C stocks within the stratum, with the purpose of making the GHG inventory development practicable & enhance accuracy of GHG estimates

Land representation | introduction

Why land representation information is important?

When estimating GHG emissions & removals, land area information is mainly used as activity data (AD)

Source: FAO e-learning course: The national GHG inventory for land use

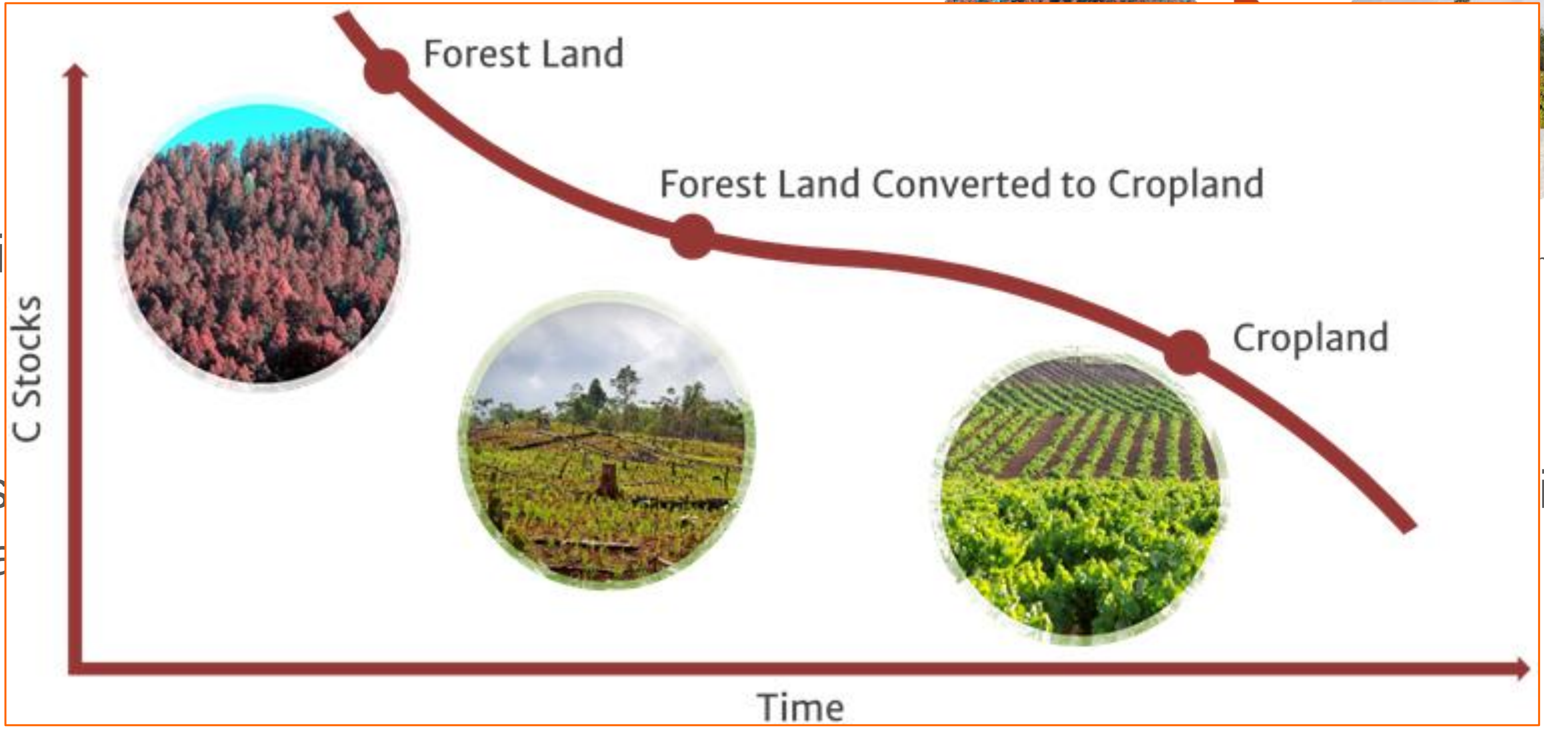
Recall: AD represent the magnitude of a human activity that generates GHG emissions and/or removals during a given period of time

Land representation | introduction

Why land representation information is important?

When estimating
area information i

ntory for land use



Recall: AD repres ions and/or
removals during a

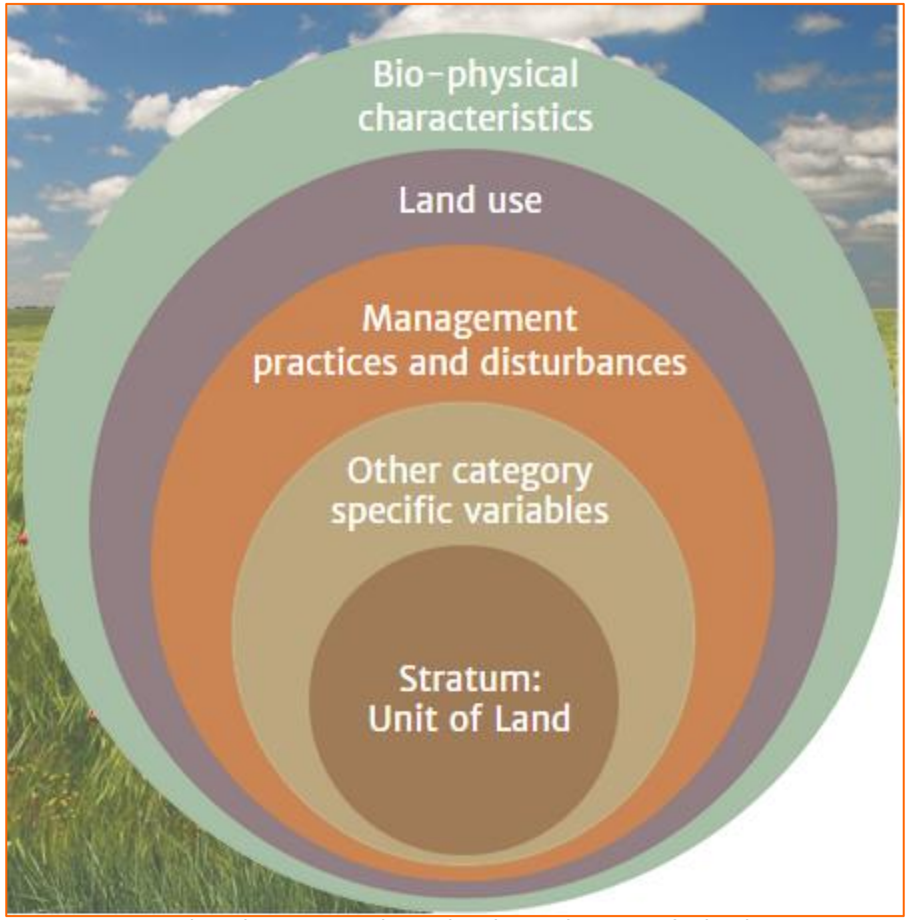
Land representation | stratification

Land is characterized by **bio-physical variables** and various **human activities**

Land use & management influence a variety of ecosystem processes (e.g. photosynthesis, decomposition, etc.) that affect GHG fluxes

These processes involve removing & emitting GHGs

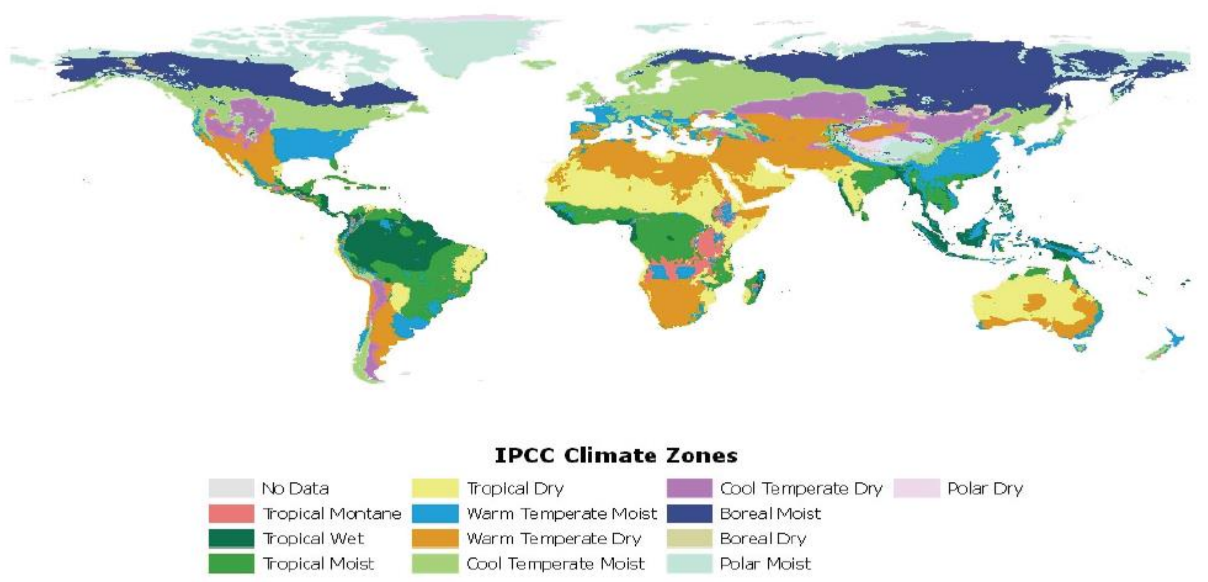
Human activities cover all impacts caused by human activities including disturbances



Source: FAO e-learning course: The national GHG inventory for land use

Land representation | stratification | climate

- ❑ stratification by climate is important because temperature & water are the two main parameters determining accumulation of biomass & decay of organic matter



Source: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_03_Ch3_Representation.pdf#page=38

List of climate zones covering most managed lands

- Boreal
- Cold temperate dry
- Cold temperate wet
- Warm temperate dry
- Warm temperate moist
- Tropical dry
- Tropical moist
- Tropical wet

Potential data sets

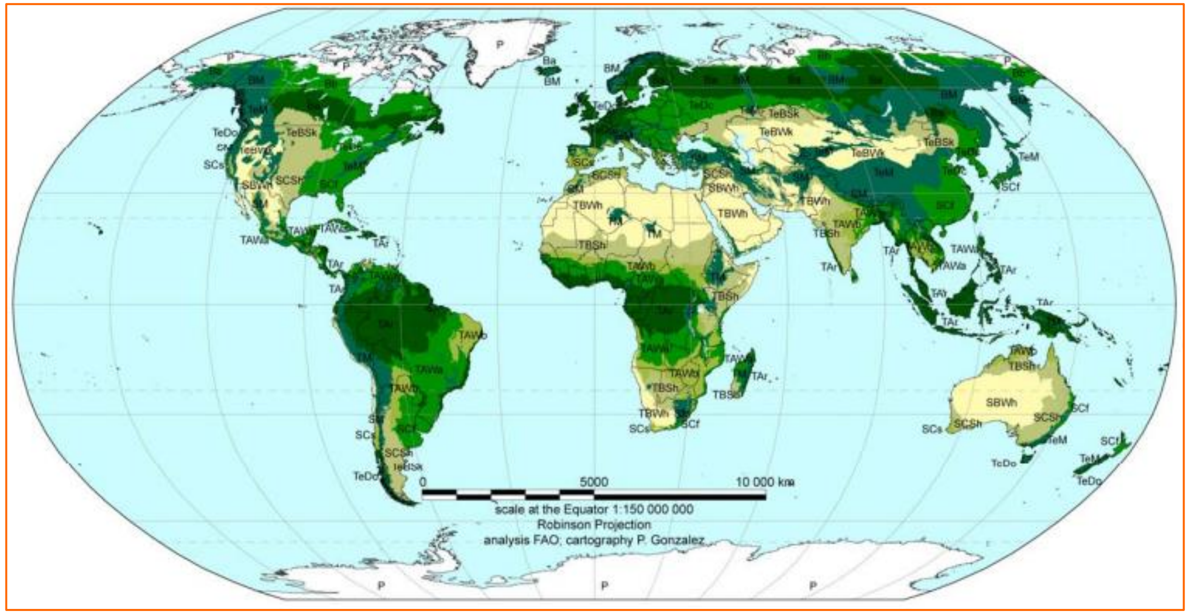
https://www.ipcc-nggip.iges.or.jp/public/2019rf/corrigenda1.html

https://philipaudebert.users.earthengine.app/view/ipcc-climate-zones

https://esdac.jrc.ec.europa.eu/content/support-renewable-energy-directive#tabs-0-description=1

Land representation | stratification | ecological zone

- stratification by ecological zone is important since woody biomass is the 2nd largest terrestrial C pool after soil
- IPCC uses the FAO Global Ecological Zone (GEZ) classification



Source: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf#page=9

List of GEZ

- Tropical rainforest
- Tropical most 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

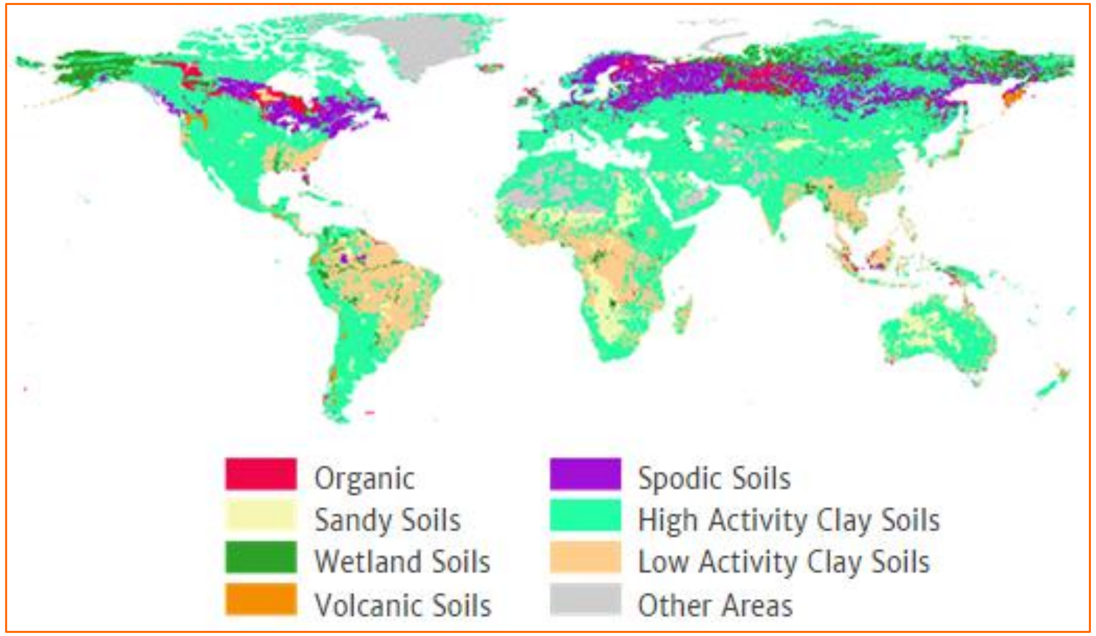
Potential data sets

https://www.fao.org/3/ap861e/ap861e00.pdf

https://data.apps.fao.org/map/catalog/srv/eng/catalog.search#/metadata/2fb209d0-fd34-4e5e-a3d8-a13c241eb61b

Land representation | stratification | soil type

- stratification by soil type is important because soil contains the largest portion of terrestrial C stocks in SOM carbon pool
- 2006 IPCC Guidelines classify country's soils in default types derived from the World Harmonized Soil Database



Source: European Commission: Soil Projects, Support to Renewable Energy Directive

Mineral soils

Organic soils

Potential data sets

https://esdac.jrc.ec.europa.eu/content/support-renewable-energy-directive#tabs-0-description=1

http://webarchive.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/

Land representation | stratification | land use

- Stratification by land use is one of the most laborious steps in land representation
- It requires national data
- The more detailed data available, the more detailed stratification can be applied
- 2006 IPCC Guidelines as applied through MPGs require that countries stratify their land for the following
  - Managed & unmanaged land
  - Six IPCC top-level (main) land use categories
  - History of land use
  - Land conversion categories

Source: FAO e-learning course: The national GHG inventory for land use

Land representation | stratification | land use

Managed land

2006 IPCC GLs maintain the managed-land proxy

- Forest land
- Cropland
- Grassland
- Wetlands
- Settlements
- Other land

current land use & changes in use over time

Unmanaged land

Area quantification & tracking over time, in order to maintain consistency in area accounting (since land-use changes occurs)

- Forest land
- Grassland
- Wetlands
- Other land

current cover

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

Land representation | stratification | land use

Can countries apply their own country specific land use definitions?

YES

- a hierarchy must be established among the country specific definitions (Forest land, Cropland, Grassland, Settlements, Wetlands, Other land)
- Country specific definitions need to cover the entire range of land uses represented in the country's territory & avoid mixing areas with very different C stocks and C stock dynamics together in the same category
- When country-specific definitions are based on land cover classes, they need to be reconciled with IPCC land use categories
- Definitions must be applied consistently across space & time

Land representation | stratification | land use

land under conversion in the new land use category
(conversion within the last 20 years)

IPCC default

Source: FAO e-learning course: The national GHG inventory for land use

land remaining in the same land use category
(no conversion in the last 20 years)

Source: FAO e-learning course: The national GHG inventory for land use

Differentiation of land use categories according to their history of use is very important when selecting the appropriate methodology for estimating GHG emissions/removals

Different C stock levels & dynamics in C stock changes occur between those two subcategories

Land remaining in a land use category for more than 20 years	Land converted to a new category in the last 20 years 20 years
Forest Land Remaining Forest Land	Land Converted to Forest Land
Grassland Remaining Grassland	Land Converted to Grassland
Cropland Remaining Cropland	Land Converted to Cropland
Wetlands Remaining Wetlands	Land Converted to Wetlands
Settlements Remaining Settlements	Land Converted to Settlements
Other Land Remaining Other Land	Land Converted to Other Land

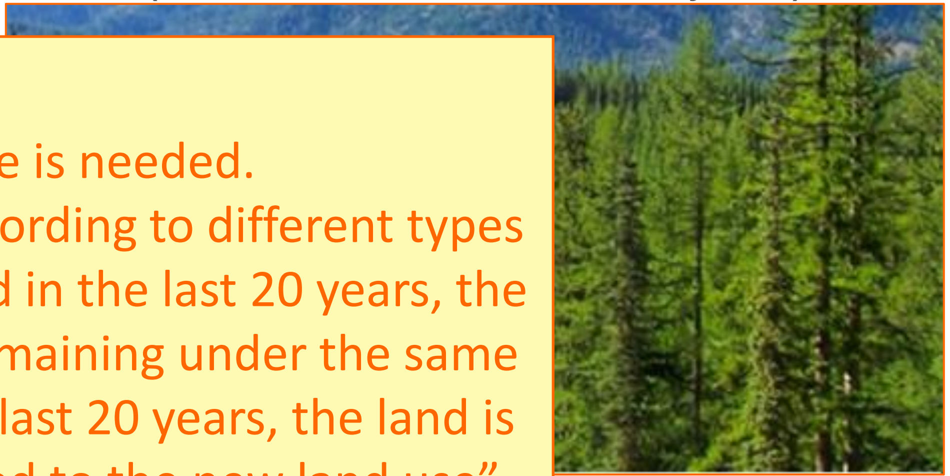
Land representation | stratification | land use

land under conversion in the new land use category
(conversion within the last 20 years)

IPCC default

land remaining in the same land use category
(no conversion in the last 20 years)

Source: FAO e-learning cours



inventory for land use

Information on historical land use is needed.
It allows the application of different CSCF according to different types of conversion. If the land use has not changed in the last 20 years, the land is reported under the category "Land remaining under the same land use." If the land use has changed in the last 20 years, the land is reported under the category "Land converted to the new land use" and in the relevant subcategory

Differentiation c
history of use is
appropriate methodology for estimating GHG emissions/removals

Different C stock levels & dynamics in C stock changes occur between those two subcategories

	nd converted to a new category in the last 20 ars 20 years
Forest Land Remaining Forest Land	Land Converted to Forest Land
Grassland Remaining Grassland	Land Converted to Grassland
Cropland Remaining Cropland	Land Converted to Cropland
Wetlands Remaining Wetlands	Land Converted to Wetlands
Settlements Remaining Settlements	Land Converted to Settlements
Other Land Remaining Other Land	Land Converted to Other Land

Land representation | stratification | land use

land under conversion in the new land use category
(conversion within the last 20 years)

Source: FAO e-learning course: The national GHG inventory for land use

Differentiation of land conversion subcategories according to the previous land-use

In total 30 land-use change sub-categories

Forest land	Cropland converted to Forest land
	Grassland converted to Forest land
	Wetland converted to Forest land
	Settlements converted to Forest land
	Other land converted to Forest land
Cropland	Forest land converted to Cropland
	Grassland converted to Cropland
	Wetland converted to Cropland
	Settlements converted to Cropland
	Other land converted to Cropland
Grassland	Forest land converted to Grassland
	Cropland converted to Grassland
	Wetland converted to Grassland
	Settlements converted to Grassland
	Other land converted to Grassland

.....

.....

Land representation | stratification | other variables

Stratification by management system/practices on land is a proxy for the expected level & dynamic of C stocks

Management system of practices	C pools for which C stocks changes and associated emissions need to be estimated at Tier 1
Management of Natural Forest	Biomass (LB), Harvested Wood Products (HWP)
Managed Forest Plantation	Biomass (LB), Harvested Wood Products (HWP)
Improved Grassland	Soil Organic Matter (SOM)
Annual Crop Management	Soil Organic Matter (SOM)
Perennial Crop Management	Biomass (LB), Soil Organic Matter (SOM)
Drainage/Rewetting	Soil Organic Matter (SOM)
Tillage	Soil Organic Matter (SOM)
Peat Extraction	Soil Organic Matter (SOM)
Prescribed Burning	Biomass (LB), Dead Organic Matter (DOM)
Organic Fertilizaton	Soil Organic Matter (SOM)

It can be used as a further level of land stratification

Stratification by **management system** is required **especially for the SOM pool**

Stratification by disturbance regime

Additional level of stratification can be added according to data availability (e.g. crop/tree species)

Land representation | methodological approach

IPCC provides **three** methodological approaches for land representation

Approach 1

- land use/management categories are identified & areas quantified
- land use/management changes between categories are neither identified nor quantified (spatially-explicit data are not available)
- Net area change of each land use/management category over time are quantified

Approach 2

- land use/management categories are identified and areas quantified
- land use/management changes are identified and their areas quantified
- areas of changes are not spatially-explicit tracked over time

Approach 3

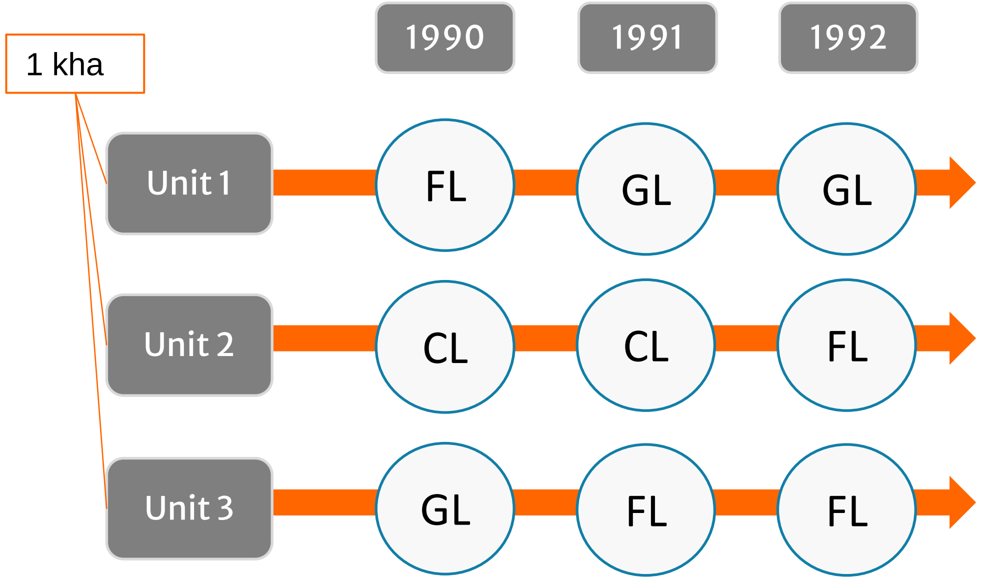
- land use/management categories are identified and areas quantified
- land use/management changes are identified and their areas quantified
- areas of changes are spatially-explicit tracked over time

Land representation | methodological approach

- The choice of the approach **depends on** the availability of data over time and space
- Approach 1: when data **do not** allow land use/management conversions identification
- Approaches 2/3: when data **allow** land use/management conversions identification between two consecutive inventory years
- Approaches are applied to classify the territory according to the stratification scheme applied & to quantify the area of each unit of land
- A combination of approaches can be used to better adapt to data availability over time and space. Although, to ensure consistency of land representation, each unit of land identified must be reported with the same approach across the entire time series
- The most efficient tactic to build a consistent land representation is to apportion the land in macro-units of land homogeneous for climate, ecological zone and soil and to build a land representation for each of the macro-units

Land representation | methodological approach

- ❑ The GHG inventory is composed of a number of annual estimates (time series), thus the land representation is expected to provide area information (AD) for the entire time series



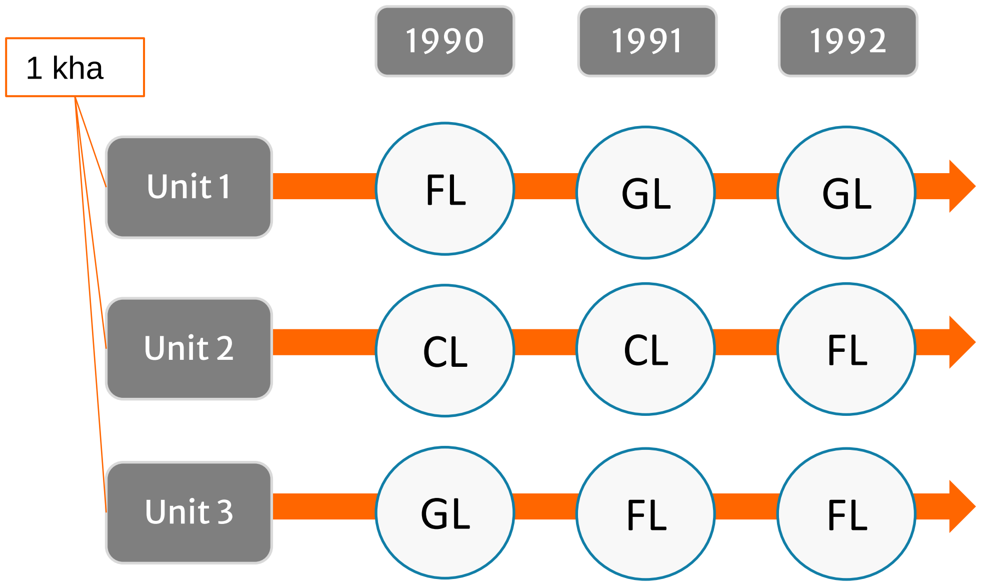
Approach 1

	Total area (kha)		
Category	1990	1991	1992
Forest land	1	1	2
Cropland	1	1	0
Grassland	1	1	1
Total	**3**	**3**	**3**

	Net area changes (kha)		
Category	1990	1991	1992
Forest land	0	0	+1
Cropland	0	0	-1
Grassland	0	0	0
Total	**0**	**0**	**0**

- ❑ The area of land use categories are quantified over time (just ‘land remaining in same land use category’)
- ❑ The land use changes are not identified (only net area changes are quantified), e.g. between 1990 and 1991 approach 1 does not report any conversion

Land representation | methodological approach



Approach 2

Category	Total area (kha)		
	1990	1991	1992
Forest land remaining forest land	1	0	0
Cropland remaining cropland	1	1	0
Grassland remaining grassland	1	0	0
Cropland converted to forest land	0	0	1
Grassland converted to forest land	0	1	1
Forest land converted to grassland	0	1	1
Total	**3**	**3**	**3**

- ❑ Provides gross land use conversions (i.e. area losses & gains) between 2 points in time
- ❑ Emission/removal factors can be applied to reflect different rates of change in C stocks according to the land use categories (previous and current) of the unit of land under conversion
- ❑ Area information can be organized in land use change matrix

Land representation | methodological approach

Approach 2

1990				
	FL	CL	GL	**Area at the beginning of year**
FL	1	0	0	1
CL	0	1	0	1
GL	0	0	1	1
Area at the end of year	**1**	**1**	**1**	**3**

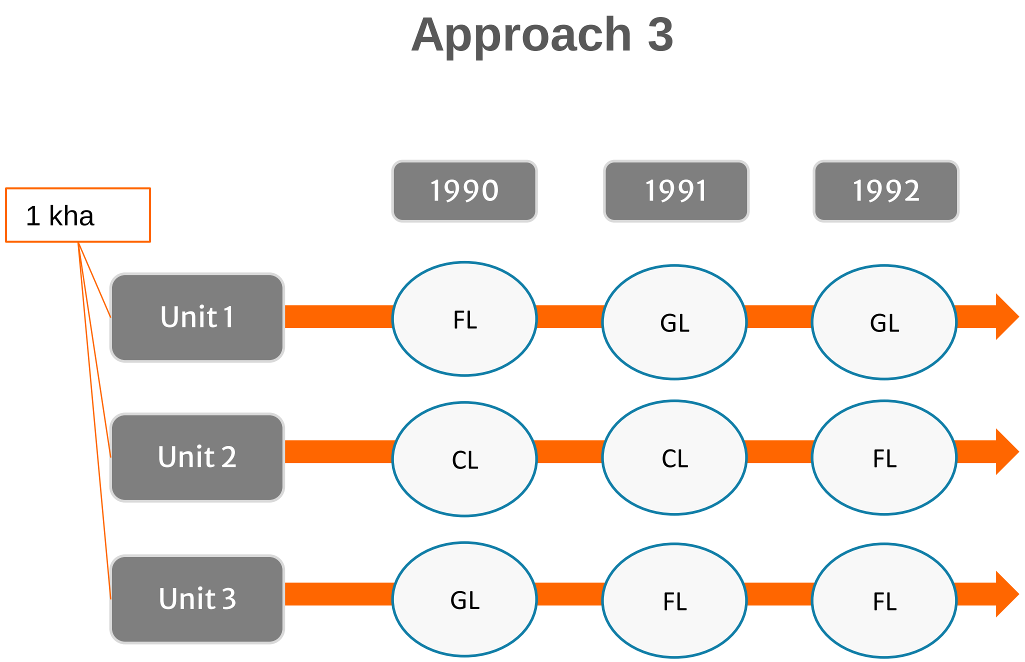
1991				
	FL	CL	GL	**Area at the beginning of year**
FL	0	0	1	1
CL	0	1	0	1
GL	1	0	0	1
Area at the end of year	**1**	**1**	**1**	**3**

1992				
	FL	CL	GL	**Area at the beginning of year**
FL	0	0	1	1
CL	1	0	0	1
GL	1	0	0	1
Area at the end of year	**2**	**0**	**1**	**3**

- Provides gross land use conversions (i.e. area losses & gains) between 2 points in time
- Emission/removal factors can be applied to reflect different rates of change in C stocks according to the land use categories (previous and current) of the unit of land under conversion
- Area information can be organized in land use change matrix

Land representation | methodological approach

- Data provide fully spatially-explicit information on the use/management of each unit of land over the entire time series. So, it is capable to track over time each land converted
- Similar to approach 2, data may be obtained through sampling or wall-to-wall mapping techniques or a combination of the two methods
- Emission/removal factors can be chosen to reflect different rates of change in carbon stocks according to the history of each tracked unit of land
- Although Approach 3 may be illustrated by means of land use and land use change matrices, Geographic Information Systems are likely needed to track across time each single unit of land



Land representation | methodological approach

Country X has been subdivided in a number of strata homogeneous by climate zone, ecological zone and soil type. For each stratum a time series of annual matrices has been prepared as shown in the below matrices. For instance, a stratum could be: Warm Temperate Moist climate zone (WTM), Temperate Mountain Systems ecological zone (TMS), and High Activity Clay soil type (HAC). As reported in the example below for the 'Inventory year 2005'

	Hectares	2004									Total
		Unmanaged Forest land	Manged Forest Land	Cropland	Unmanaged Grassland	Managed Grassland	Unmanaged Wetlands	Managed Wetlands	Settlements	Other Land	2005
2005	Unmanaged Forest land	6,308	0	0	0	0	0	0	0	0	6,308
	Manged Forest Land	0	322,330	352	0	0	0	0	0	0	322,682
	Cropland	0	130	324,480	0	260	0	0	0	0	324,870
	Unmanaged Grassland	0	0	0	1,965	0	0	0	0	0	1,965
	Managed Grassland	0	0	708	0	648,840	0	0	0	0	649,548
	Unmanaged Wetlands	0	0	0	0	0	6,254	0	0	0	6,254
	Managed Wetlands	0	0	0	0	0	0	5,191	0	0	5,191
	Settlements	0	0	196	0	66	0	0	25,954	0	26,216
	Other Land	0	0	0	0	0	0	0	0	6,488	6,488
Total 2004		6,308	322,460	325,736	1,965	649,166	6,254	5,191	25,954	6,488	1,349,522

Land representation | methodological approach

- A time series is composed by a number of tables corresponding to the number of years for which the land representation is built plus 19 (when the IPCC default 20 years transition period is applied)

- When a change occurs, it must be reported cumulated for 20 years in the respective land conversion category (e.g. FL→CL). Therefore, to accurately report the starting year areas for converted land, areas converted in that year plus the areas converted in the previous 19 years are needed (e.g. in the year 2005, the area reported in the conversion category "Forest land converted to Cropland" is the area of forest land converted to cropland over the entire time period 1986-2005)

- To construct a consistent time series for the years before the starting year of the inventory, alternative data sources may be utilized (e.g., dataset on authorization of deforestation, dataset on afforestation) & proxies (e.g., use of the same conversion type(s) observed in the inventory period for the years before the starting year)

Land representation | MPGs principles

The data collection & analysis system (including land classification) should respect the **guiding principles** of MPGs to ensure quality of data outputs (i.e. the land representation) & sustainability of operations

- **Transparent**: Related documentation is sufficient, data sources, definitions, methodologies & assumptions are clearly described, such that individuals other than the inventory compilers can understand how the land representation was developed & are confident it meets good practice
- **Accurate**: The GHG estimates are neither over- nor under-estimated so far as can be judged, and are free of bias
- **Complete:** All land area within the country is represented
- **Consistent**: Capable of representing categories/subcategories/ subdivisions consistently across time
- **Comparable**: Categories are suitable to be aggregated according to the IPCC default categories

The data collection & analysis system should also be **adequate** in that is capable of representing all land use categories & associated subcategories/subdivisions

Land representation | MPGs principles

Now, let’s do an example !

- Open the ‘LUM_exercise.xlsx’ file

- Try to fill in the missing values with the correct areas

Land representation | MPGs principles

Now, let's do an example !

- Open t
- Try to

Land Use Matrix for Year X							
Initial / Final	FL	CL	GL	WL	SL	OL	**Final Area**
FL	50	2	6	0	2	0	**??**
CL	5	35	8	0	2	0	**50**
GL	3	7	**??**	0	0	0	**37**
WL	8	0	0	20	3	0	**31**
SL	0	0	0	0	32	0	**32**
OL	0	0	0	0	0	5	**5**
Initial Area	**66**	**44**	**??**	**20**	**??**	**5**	**215**

Land representation & SOC changes | challenges

Every country has its own challenges, gaps, constraints

Challenges

- ❑ Activity data availability (e.g., land uses, land-use changes, land management, land-management changes)
- ❑ Soil-related data (e.g. SOC content, SOC reference values, stock change factors)
- ❑ Limited familiarity with 2006 IPCC GLs
- ❑ Limited resources
- ❑ …

Possible solutions

- ❑ Internal coordination (many times data exist, statistical services, research, expert judgment, etc.)
- ❑ Setting up proper/sustainable data collection systems, improve existing systems
- ❑ Networking (internally, externally)
- ❑ 2006 IPCC GLs provide information for tier 1
- ❑ Internal collaboration between experts, institutions
- ❑ Prioritize actions. Follow a step-by-step approach

Prioritize actions, follow a **step-by-step** approach. What is important is to **start**…

N_2O emissions (direct & indirect)

- N_2O is produced naturally in soils through microbial processes of nitrification, denitrification
- Main controlling factor → N availability in the soil (depends on N inputs, including N released from mineralization of SOM)
- Direct & indirect emissions of N_2O from managed soils occur
- N inputs include: Synthetic and organic fertilizer & N mineralisation associated with land use and/or management change
- Direct N_2O emissions from mineral soils are estimated when SOM is lost through oxidation, due to land-use or land management changes and this loss is accompanied by a mineralisation of N (F_{SOM})
- Indirect N_2O emissions occur through 2 pathways: volatilisation & leaching/runoff. Under tier 1, only indirect N_2O emissions from N leached resulting from mineralization of SOM associated with land use/management changes

N_2O emissions (direct & indirect)

$$N_2O - N_{emissions} = F_{SOM} \cdot EF_1$$

Equation 11.1

Activity Data | Emission Factor

TABLE 11.1
DEFAULT EMISSION FACTORS TO ESTIMATE DIRECT N_2O EMISSIONS FROM MANAGED SOILS

Emission factor	Default value	Uncertainty range
EF_1 for N additions from mineral fertilisers, organic amendments and crop residues, and N mineralised from mineral soil as a result of loss of soil carbon [kg N_2O–N (kg N)$^{-1}$]	0.01	0.003 - 0.03
EF_{1FR} for flooded rice fields [kg N_2O–N (kg N)$^{-1}$]	0.003	0.000 - 0.006

$$F_{SOM} = \sum_{LU} \left[\left(\Delta C_{Mineral,LU} \cdot \frac{1}{R} \right) \cdot 1000 \right]$$

Equation 11.8

F_{SOM}: The net annual amount of N mineralised in mineral soils as a result of loss of SOC associated with change in land use and/or *management system of practices*, kg N.
$\Delta C_{Mineral,LU}$: SOM oxidised in mineral soils as a consequence of land use and/or management change. This term is calculated by applying the methodology described in previous slides for estimating SOC changes, t C.
R: The C:N ratio of the soil organic matter.

The IPCC default value is **15** for forest land/grassland conversion to cropland & **10** for management changes in cropland

- To convert kg of N_2O-N emissions into tonnes of N_2O emissions, the result of equation 11.1 needs to be multiplied by 44/28 and by 10^{-3}

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

N_2O emissions (direct & indirect)

$$N_2O - N = F_{SOM} \cdot Frac_{LEACH(H)} \cdot EF_5$$

Equation 11.10

Activity Data — Emission Factor

$N_2O_{(L)}$ –N: Annual amount of N_2O–N produced from leaching and runoff of N released from SOM mineralized, as consequence of land use and/or management change, in regions where leaching/runoff occurs, kg N_2O–N yr^{-1}.
Frac $_{LEACH-(H)}$: Fraction of all N mineralised from SOC losses in mineral soils, associated with changes of land use and/or management change, that is leached and runoff, kg N (kg of N additions) $^{-1}$ (Table 11.3).
EF $_5$: emission factor for N_2O emissions from N leaching and runoff, kg N_2O–N(kg N leached and runoff) $^{-1}$ (Table 11.3).

- Input data needed are AD, leaching fraction and EF
- F_{SOM} is the same calculated for direct N_2O emissions

Leaching fraction kg N (kg N additions or deposition by grazing animals)$^{-1}$	Used for	Value
$Frac_{LEACH-(H)}$	N losses by leaching / runoff for regions where soil water-holding capacity is exceeded	0.30

TABLE 11.3
DEFAULT EMISSION, VOLATILISATION AND LEACHING FACTORS FOR INDIRECT SOIL N_2O EMISSIONS

Factor	Default value	Uncertainty range
EF_5 [leaching/runoff], kg N_2O–N (kg N leaching/runoff) $^{-1}$ [23]	0.0075	0.0005 - 0.025

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

CH_4 emissions

- CH_4 emissions from mineral soils occur on Inland Wetland Mineral Soils (IWMS) that are rewetted (e.g., for cultivation of crops)
- Management activities that alter the water table on lands containing IWMS can impact CH_4 emissions
- IWMS are aquic soils (USDA) or gleysols (World Reference Base), having restricted drainage, leading to periodic flooding and anaerobic conditions
- Only 2013 IPCC Wetlands Supplement provides default methodology for estimating CH_4 emissions from IWMS
- Recall that CH_4 emissions from rice cultivations are reported under the agriculture sector
- IWMS might occur in any of the six land-use categories

Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

CH_4 emissions

$$CH_{4-IWMS} = \sum_c \left(A_{IWMS} \times EF_{CH_4-IWMS}\right)_c$$

2013 IPCC Supplement on Wetlands, chapter 5, Equation 5.1

Activity Data — Emission Factor

CH_{4-IWMS}: Annual CH_4 emissions from managed lands on IWMS where management activities have raised the water table level to or above the land surface, kg CH_4 yr^{-1}.
A_{IWMS}: Total area of managed lands with mineral soil where the water table level has been raised, ha.
EF_{CH_4-IWMS}: Emission factor from managed lands with mineral soil where water table level has been raised, kg CH_4 ha^{-1} yr^{-1} (Table 5.4 of 2013 IPCC Supplement on Wetlands).
c: Climate region.

Land representation

- The area of managed lands with IWMS or dry mineral soil, where water table level has been raised, should be stratified by climate region

TABLE 5.4
DEFAULT EMISSION FACTORS FOR CH_4 FROM MANAGED LANDS WITH IWMS WHERE WATER TABLE LEVEL HAS BEEN RAISED

Climate Region	$EF_{CH4-IWMS}$ (kg CH_4 ha^{-1} yr^{-1})	95% Confidence Interval[A]	Number of Studies
Boreal	76	±76[B]	1[C]
Temperate	235	±108	21
Tropical	900	±456	18

AThe 95% confidence interval is calculated from the mean, standard deviation, and the critical values of the t distribution, according to the degrees of freedom. These are not expressed as a percentage of the mean.

B Bridgham *et al.* (2006)

C This study (Bridgham *et al.*, 2006) is a synthesis of numerous studies; see publication for details.

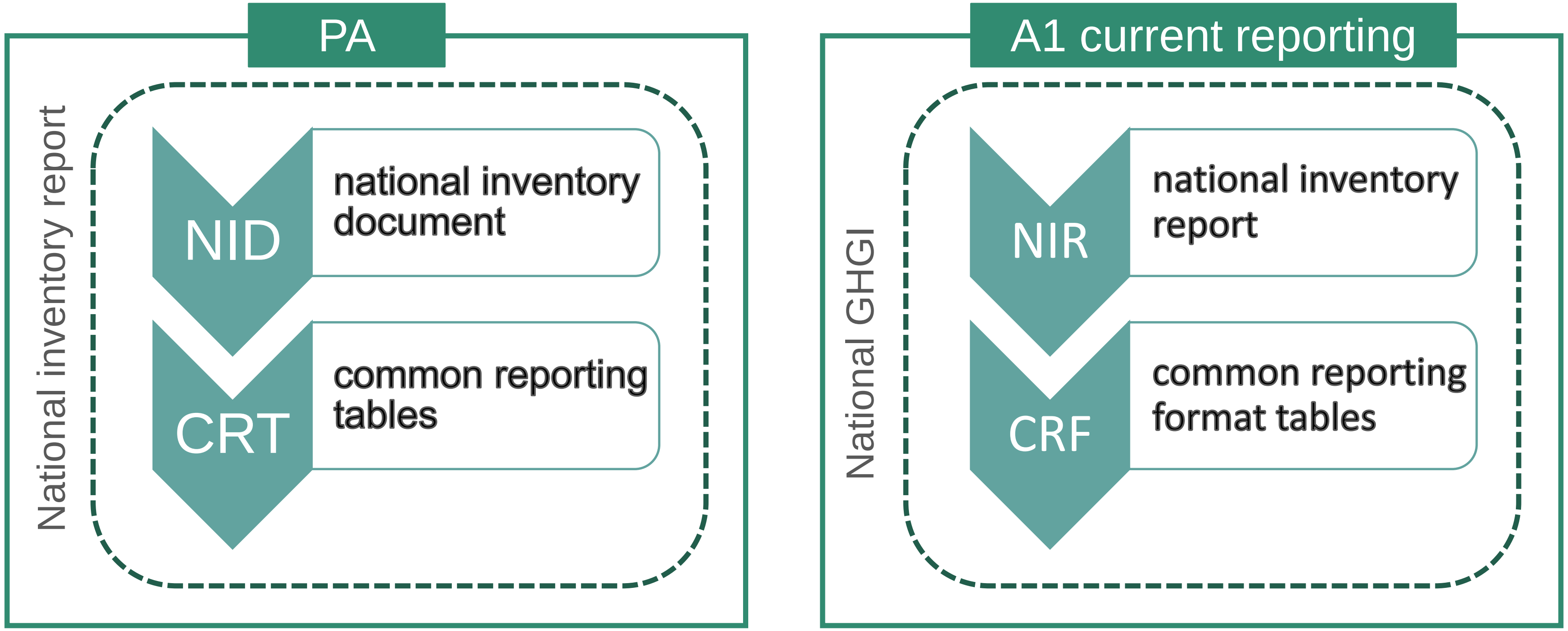
Source: 2006 IPCC Guidelines; FAO elearning academy (the national GHG inventory for land use)

Food and Agriculture Organization of the United Nations

FAO and the Enhanced transparency framework

REPORTING CARBON STOCK CHANGES FROM SOILS FROM LAND IN GHG INVENTORIES UNDER THE ETF

Reporting GHGIs under the ETF



Reporting GHGIs under the ETF

CRTs = Indispensable element of a national GHGI

CRT

GHG emissions/removals quantitative information

NID

Descriptive information on GHG inventory

Reporting GHGIs under the ETF

To put it simply:

✓ CRTs: a set of standardized tables that Parties must use which accompany the NID. Contain the ‘numbers’

✓ NID: the national report document. Contains all related information about how the numbers are produced (together with additional information)

✓ Developed Parties have long-lasting experience vs developing Parties in common format tables reporting because of the CRF tables currently used

?

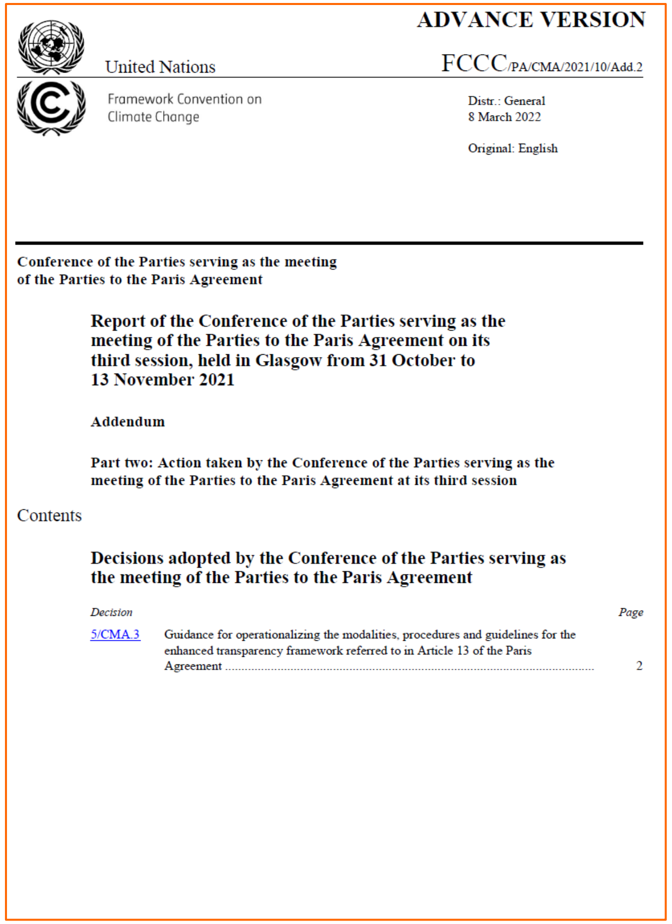
Reporting GHGIs under the ETF

- Dec. 18/CMA.1 (par. 12(a)), requests SBSTA to develop according to MPGs

> *common reporting tables for the electronic reporting of the information referred to in chapter II of the annex, taking into account the existing common reporting formats (CRFs)*

CRTs have been adopted through decision 5/CMA.3 (COP 26)

https://unfccc.int/documents/311076



ADVANCE VERSION

United Nations

FCCC/PA/CMA/2021/10/Add.2

Framework Convention on Climate Change

Distr.: General
8 March 2022

Original: English

Conference of the Parties serving as the meeting of the Parties to the Paris Agreement

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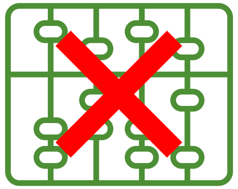
Reporting GHGIs under the ETF

WHAT ARE NOT CRTs?

- They are ***NOT*** a GHGI estimation tool



- They are tables in which Parties ***report*** their already estimated GHG emissions/removals, and related information

TABLE 5.C SECTORAL BACKGROUND DATA FOR WASTE ventory 2019

Incineration and open burning of waste sion 2021 v1

(Sheet 1 of 1) ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA Amount of wastes (incinerated/open burned)	IMPLIED EMISSION FACTOR			EMISSIONS		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
	(kt wet weight)	(kg/t waste)			(kt)		
1. Waste Incineration	91.36	551.78	0.06	0.14	50.41	0.01	0.01
Biogenic [(1)]	49.35	369.56	0.06	0.17	18.24	0.00	0.01
Municipal solid waste	49.35	369.56	0.06	0.17	18.24	0.00	0.01
Other *(please specify)* [(2)]	NO	NO	NO	NO	NO	NO	NO
Non-biogenic	42.01	1200.00	0.06	0.10	50.41	0.00	0.00
Municipal solid waste	42.01	1200.00	0.06	0.10	50.41	0.00	0.00
Other *(please specify)* [(3)]	NO	NO	NO	NO	NO	NO	NO
2. Open burning of waste	863.58	5.86	2.52	0.06	5.06	2.17	0.05
Biogenic [(1)]	858.16	NA	2.53	0.06	NA	2.17	0.05
Municipal solid waste	5.41	NA	NE	NE	NA	NE	NE
Other *(please specify)*	852.75	NA	2.55	0.06	NA	2.17	0.05
agricultural waste	852.75	NA	2.55	0.06	NA	2.17	0.05
Non-biogenic	5.41	935.00	NO,NE	NO,NE	5.06	NO,NE	NO,NE
Municipal solid waste	5.41	935.00	NE	NE	5.06	NE	NE
Other *(please specify)*	NO	NO	NO	NO	NO	NO	NO

Note: Only emissions from waste incineration without energy recovery are to be reported under the waste sector. Emissions from incineration with energy

[(1)] The CO_2 emissions from combustion of biomass materials (e.g. paper, food and wood waste) contained in the waste are biogenic emissions and should not be

[(2)] If data are available, Parties are encouraged to report at the disaggregated level available from the pre-defined drop-down menu. Furthermore, Parties are encouraged to the extent possible to use the pre-defined category definitions rather than to create similar categories. This ensures the highest possible degree of

[(3)] If data are available, Parties are encouraged to report at the disaggregated level available from the pre-defined drop-down menu. Furthermore, Parties are encouraged to the extent possible to use the pre-defined category definitions rather than to create similar categories. This ensures the highest possible degree of

[(4)] This category includes lubricants, solvents and waste oil. Unless fossil liquid waste is included in other types of waste (e.g. industrial or hazardous waste),

Documentation box:
- Parties should provide detailed explanations on the waste sector in Chapter 7: Waste (CRF sector 5) of the national inventory report (NIR). Use this
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- Provide a reference to the relevant section of the NIR, in particular with regard to the amount of incinerated waste (specify whether the reported data relate to

Documentation box	

Reporting GHGIs under the ETF

WHY CRTs?

- Their “common” characteristic ensures comparability of reported information among countries
- All countries should report the same information in the same way (e.g., source/sink categorization) & with the same allocation following specific rules as defined by the CRTs’ structure and the relevant decisions

TABLE 5.C SECTORAL BACKGROUND DATA FOR WASTE
Incineration and open burning of waste
(Sheet 1 of 1)

ventory 2019
sion 2021 v1
ITALY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA Amount of wastes (incinerated/open burned) (kt wet weight)	IMPLIED EMISSION FACTOR (kg/t waste)			EMISSIONS (kt)		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
1. Waste Incineration	91.36	551.78	0.06	0.14	50.41	0.01	0.01
Biogenic [(1)]	49.35	369.56	0.06	0.17	18.24	0.00	0.01
Municipal solid waste	49.35	369.56	0.06	0.17	18.24	0.00	0.01
Other *(please specify)* [(2)]	NO	NO	NO	NO	NO	NO	NO
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Municipal solid waste	5.41	NA	NE	NE	NA	NE	NE
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Note: Only emissions from waste incineration without energy recovery are to be reported under the waste sector. Emissions from incineration with energy

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Documentation box

Reporting GHGIs under the ETF

WHY CRTs?

- documentation boxes (background information and references to NID for additional information)
- space for reporting memo items and data: not added to emissions/removals totals (e.g. international bunkers, CO_2 emissions from biomass combustion in Energy, N_2O indirect emissions from sectors other than Agriculture and LULUCF)

TABLE 5.C SECTORAL BACKGROUND DATA FOR WASTE ventory 2019

Incineration and open burning of waste sion 2021 v1

(Sheet 1 of 1) ITALY

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Non-biogenic	5.41	935.00	NO,NE	NO,NE	5.06	NO,NE	NO,NE
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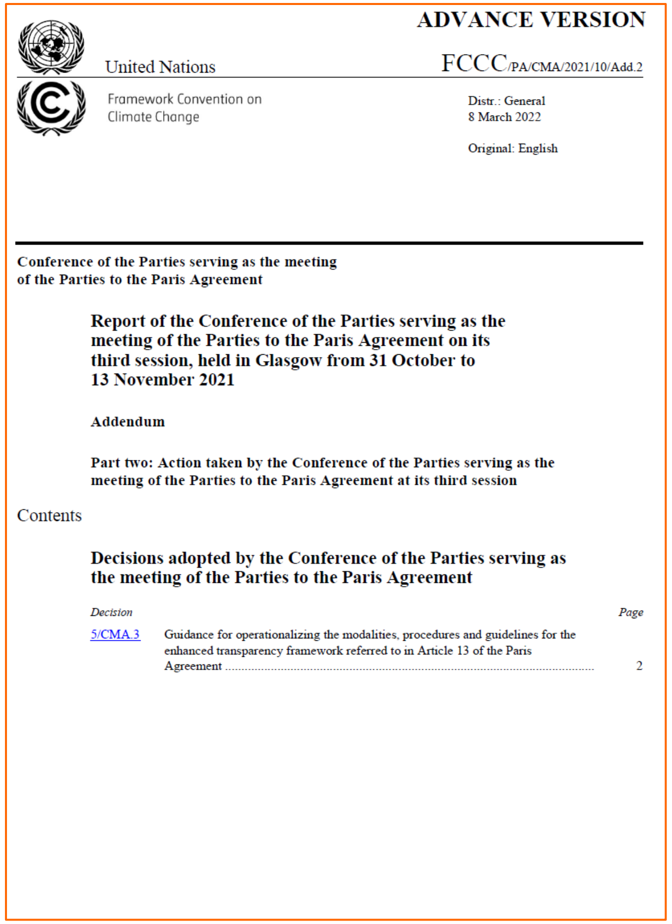
Documentation box	

Reporting GHGIs under the ETF

- UNFCCC secretariat will prepare a reporting tool (dedicated software application) for the preparation, filling, and electronic reporting of the CRTs by countries

- Test version is expected by June 2023 & final version of the tools expected to be completed by June 2024

- It is very important that GHG inventory compilers have adequate knowledge of the CRTs & the CRT reporting tool (structure, functionalities) → to prepare & submit appropriately the national GHG inventory


ADVANCE VERSION

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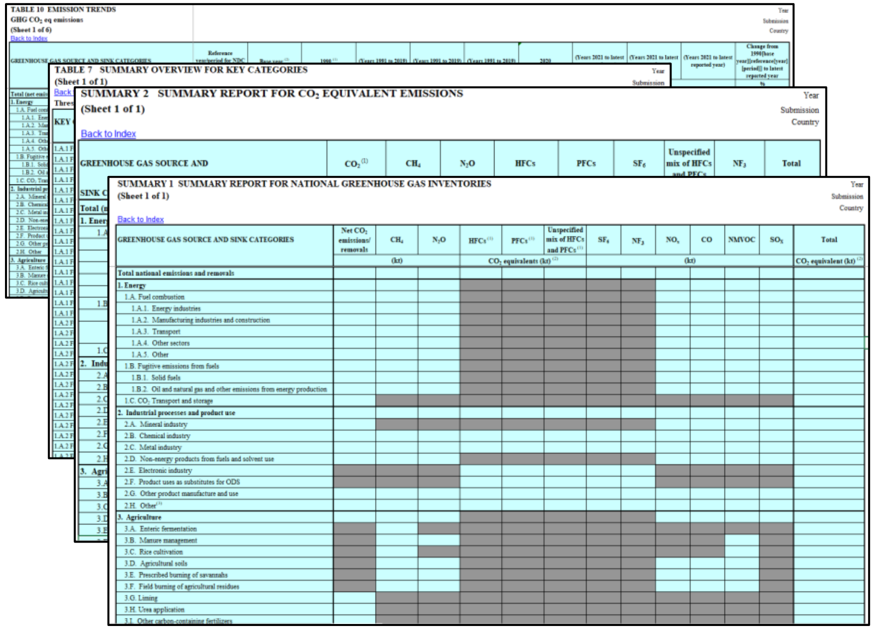
Reporting GHGIs under the ETF| CRT structure

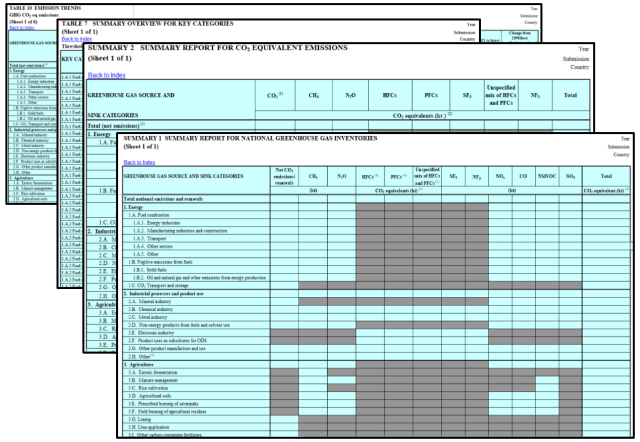
- CRTs → comprise 60 separate tables (some tables are split in multiple sheets)
- Each set of CRT = data for one inventory reporting year (except table 10)
- Parties: should submit a set for the whole time-series (e.g., 1990–2022 in the 2024 submission), meaning a large number of CRTs (for the 2024 submission, 60 tables x 33 years = 1,980 tables)

BUT

Don’t get panicked!!



Reporting GHGIs under the ETF| CRT structure



- ❑ include data on all sectors, categories, C pools as defined in the MPGs + a number of summary tables
- ❑ source/sink definitions are based upon the 2006 IPCC GLs categorization
- ❑ 3 distinct levels are identified, with each level entailing a different degree of information aggregation

Allocation of GHG emissions/removals

- ❑ Confusion may arise in the beginning
- ❑ Follow the agreed CRTs

TIP
CRT familiarity comes with time & practice

Footnotes crucial great guidance

Reporting GHGIs under the ETF| CRT structure

LEVEL 1

Summary1
Summary2
Summary3

INDEX
Abbreviations & acronyms
Table6
Table7
Table8
Table9
Table10
Flex_Summary

LEVEL 2

ENERGY	IPPU	AGRICULTURE	LULUCF	WASTE
Table1	Table2(I) Table2(II)	Table3	Table4	Table5

LEVEL 3

ENERGY	IPPU	AGRICULTURE	LULUCF	WASTE
Table1.A(a) Table1.A(b) Table1.A(c) Table1.A(d) Table1.B.1 Table1.B.2 Table1.C Table1.D	Table2(I).A-H Table2(II)B-Hs1	Table3.A Table3.B(a) Table3.B(b) Table3.C Table3.D Table3.E Table3.F Table3.G-I	Table4.1 Table4.A Table4.B Table4.C Table4.D Table4.E Table4.F Table4(I) Table4(II) Table4(III) Table4(IV) Table4.G	Table5.A Table5.B Table5.C Table5.D

Reporting GHGIs under the ETF| CRT structure

Color coding

In some cases, the user can overwrite over the formula in green cells (through the software)

- **Grey shaded cells**: no need to be filled in
- **colored shaded cells**: automatically filled in
- **Unshaded cells**: **to be filled in by the Party**

Every unshaded cell: either a data entry (e.g., number) or one of the standard CRT notation keys (NKs)

Reporting GHGIs under the ETF| CRT structure

Level 3

- ❑ Most of the data in the CRTs are included in this level
- ❑ It consists of the sectoral background data tables
- ❑ These CRTs require detailed information on emissions, AD & other relevant information at a category, subcategory & C pool level

TABLE 4.A SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY
Forest land
(Sheet 1 of 1)

Year
Submission
Country

Back to Index

Additional Information

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA			IMPLIED CARBON STOCK CHANGE FACTORS (1)							CARBON STOCK CHANGES (1)							NET CO_2 EMISSIONS/ REMOVALS (9)	Simple Decay Approach - Carbon transferred to HWP
Land-use category	Subdivision (2)	Total area (3)	Area of mineral soil	Area of organic soil	Carbon stock change in living biomass per area (4,5)			Net carbon stock change in dead wood per area	Net carbon stock change in litter per area	Net carbon stock change in soils per area		Carbon stock change in living biomass (4,5)			Net carbon stock change in dead wood	Net carbon stock change in litter	Net carbon stock change in soils (7,8)			
					Gains	Losses	Net change			Mineral soils	Organic soils	Gains	Losses (6)	Net change			Mineral soils	Organic soils		
		(kha)			(t C/ha)							(kt C)							(kt CO_2)	(kt C)
4.A. Total forest land																				
4.A.1. Forest land remaining forest land																				
4.A.2. Land converted to forest land (10)																				
4.A.2.a. Cropland converted to forest land																				
4.A.2.b. Grassland converted to forest land																				
4.A.2.c. Wetlands converted to forest land																				
4.A.2.d. Settlements converted to forest land																				
4.A.2.e. Other land converted to forest land																				

(1) The signs are positive (+) for estimates of gains in carbon stocks and negative (–) for estimates of losses in carbon stocks.
(2) Land categories may be further divided according to climate zone, management system, soil type (including according to whether the soil is drained, rewetted or categorized as other), vegetation type, tree species, ecological zone or national land classification. If Parties estimate emissions and removals or carbon stock change separately for dry and wet soils, they are encouraged to use this column for this disaggregation. If a subdivision is included that separates organic and mineral soils, the area of, for example, mineral soils for an organic soil subdivision should be reported as "NA". If Parties report emissions and removals from coastal wetlands areas that are not part of the total land area of the country, Parties may use appropriate subcategories for indicating whether the emissions and removals come from areas included or excluded from the total land area of the country.
(3) The total area of the subcategories, in accordance with the subdivision used, should be entered here. For lands converted to forest land, report the cumulative area of land in transition to the category in the reported year and not the land-use change area of the reported year (which is reported only in table 4.1.). The total of the areas reported in this table should equal the final area reported in table 4.1. The total area should equal the area of mineral soils plus the area of organic soils by subcategory.
(4) Carbon stock gains and losses should be listed separately except in cases where, owing to the methods used, it is technically impossible to separate information on gains and losses.
(5) Parties that apply the stock-difference method may report annual carbon stock change in gains and the notation key "IE" under losses.
(6) When using the simple decay approach for HWP, reported losses from the carbon stock in living biomass do not include the carbon transferred to HWP, and should be reported as additional information column W.
(7) If Parties cannot estimate carbon stock changes for organic and mineral soil separately, these should be reported under mineral soils.
(8) Parties that wish to do so may report annual on-site CO_2-C emissions/removals and off-site CO_2-C emissions from drained and rewetted organic soils here.
(9) The signs are positive (+) for emissions and negative (–) for removals.
(10) Parties may report aggregated estimates for all conversions of land to forest land if data are not available to report them separately. They should specify in the documentation box which types of land conversion are included.

Note: Minimum level of aggregation is needed to protect confidential business and military information, where it would identify particular entity's/entities' confidential data.
Note: Parties that do not have information on the origin of HWP by land use category can provide aggregate information on HWP in column W.

- ❑ Several of the CRTs from higher levels are populated automatically by the CRT software based on data in these 3rd level
- ❑ Parties must enter all required information in these tables → the foundation for data used by other CRTs
- ❑ Totals (summed emissions/removals) & implied emission factors (IEFs)/implied carbon stock change factors (ICSCFs) are automatically populated

Reporting GHGIs under the ETF| CRT structure

TABLE 4.A SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY
Forest land
(Sheet 1 of 1)

Year
Submission
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Source/sink categories *D, CS* | Activity data *R* | Implied emission factor *NR* | Carbon stock changes emissions/removals *R*

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA			IMPLIED CARBON STOCK CHANGE FACTORS [1]							CARBON STOCK CHANGES [1]								Additional Information
Land-use category	Subdivision [2]	Total area [3]	Area of mineral soil	Area of organic soil	Carbon stock change in living biomass per area [4,5]			Net carbon stock change in dead organic matter per area	Net carbon stock change in litter per area	Net carbon stock change in soils per area		Carbon stock change in living biomass [4,5]			Net carbon stock change in dead organic matter	Net carbon stock change in litter	Net carbon stock change in soils [7,8]		NET CO_2 EMISSIONS/ REMOVALS [9]	Simple Decay Approach - Carbon transferred to HWP
					Gains	Losses	Net change			Mineral soils	Organic soils	Gains	Losses [6]	Net change			Mineral soils	Organic soils		
		(kha)			(t C/ha)							(kt C)							(kt CO_2)	(kt C)
4.A. Total forest land																				
4.A.1. Forest land remaining forest land																				
4.A.2. Land converted to forest land [10]																				
4.A.2.a. Cropland converted to forest land																				
4.A.2.b. Grassland converted to forest land																				
4.A.2.c. Wetlands converted to forest land																				
4.A.2.d. Settlements converted to forest land																				
4.A.2.e. Other land converted to forest land																				

Reporting GHGIs under the ETF| CRT structure

EF vs IEF: Are you fully aware of the difference??

EF	IEF
A coefficient that quantifies emissions/removals of a gas per unit activity. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions	Emissions divided by the relevant measure of activity (emissions / activity data)

Reporting GHGIs under the ETF| CRT structure

Are EF and IEF expected to have the same value??

- implied → automatically calculated based on emissions/removals divided by AD entered by a Party in the CRTs
- IEF may or may not match EFs used by the Party
- different categorization or more complex calculations may have been applied
- IEFs/ICSCFs are very useful as measures of a Party's emissions/removals indexed by its AD. Help in comparison among countries

Reporting GHGIs under the ETF| CRT structure

Level 2

- CRTs that aggregate data from sectoral background data tables at sectoral level
- Serve as a useful summary of the sector
- There are CRTs of level 2 for every IPCC GHGI sector

TABLE 4 SECTORAL REPORT FOR LAND USE, LAND-USE CHANGE AND FORESTRY
(Sheet 1 of 1)

Year
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals (1,2)	CH_4 (2)	N_2O (2)	NO_x	CO	NMVOC	Total GHG emissions/removals (3)
	(kt)						CO_2 equivalents (kt) (4)
4. Total LULUCF							
4.A. Forest land							
4.A.1. Forest land remaining forest land							
4.A.2. Land converted to forest land							
4.B. Cropland							
4.B.1. Cropland remaining cropland							
4.B.2. Land converted to cropland							
4.C. Grassland							
4.C.1. Grassland remaining grassland							
4.C.2. Land converted to grassland							
4.D. Wetlands (5)							
4.D.1. Wetlands remaining wetlands							
4.D.2. Land converted to wetlands							
4.E. Settlements							
4.E.1. Settlements remaining settlements							
4.E.2. Land converted to settlements							
4.F. Other land (6)							
4.F.1. Other land remaining other land							
4.F.2. Land converted to other land							
4.G. Harvested wood products (7)							
4.H. Other *(please specify)*							
Memo item:							
Emissions and subsequent removals from natural disturbances on managed lands (8)							

(1) For the purposes of reporting, the signs for removals are always negative (–) for removals and positive (+) for emissions.
(2) For each land-use category and subcategory, this table sums the net CO_2 emissions and removals shown in tables 4.A to 4.F, and the CO_2, CH_4 and N_2O emissions shown in tables 4(I)–(IV) and 4.G.
(3) "Total GHG emissions/removals" does not include NO_X, CO and NMVOC.
(4) As per decision 18/CMA.1, annex, para. 37, each Party shall use the 100-year time-horizon GWP values from the IPCC Fifth Assessment Report, or 100-year time-horizon GWP values from a subsequent IPCC assessment report as agreed upon by the CMA, to report aggregate emissions and removals of GHGs, expressed in CO_2 eq. Each Party may in addition also use other metrics (e.g. global temperature potential) to report supplemental information on aggregate emissions and removals of GHGs, expressed in CO_2 eq. In such cases, the Party shall provide in the national inventory document information on the values of the metrics used and the IPCC assessment report they were sourced from.
(5) Parties may decide not to prepare estimates for CH_4 emissions from flooded land contained in appendix 3 of vol. 4 of the 2006 IPCC Guidelines, although they may do so if they wish.
(6) This category includes bare soil, rock, ice, and all land areas that do not fall into any of the other five categories thus enabling the total of identified land areas to match the national area.
(7) End of life non-CO_2 emissions from HWP are covered in the energy sector or waste sector.
(8) Parties may report the emissions and subsequent removals from natural disturbances on managed lands, in the case of a Party addressing these emissions and subsequent removals, in accordance with decision18/CMA.1, annex, para. 55.

Note: Minimum level of aggregation is needed to protect confidential business and military information, where it would identify particular entity's/entities' confidential data.

Documentation box:

- Parties should provide a detailed description of the LULUCF sector in chapter 6 ("Land Use, Land-Use Change and Forestry" (CRT sector 4)) of the NID. Use this documentation box to provide references to relevant sections of the NID, if any additional information and/or further details are needed to understand the content of this table.
- If estimates are reported under the category 4.H. (other), use this documentation box to provide information regarding activities covered under this category and to provide a reference to the section of the NID where background information can be found.
- Parties may indicate in this documentation box whether national totals include estimates of the emissions and subsequent removals from natural disturbances on managed lands, in accordance with decision18/CMA.1, annex, para.55.

Reporting GHGIs under the ETF| CRT structure

Level 1

- ❑ Contains several CRTs for summary & cross-cutting information
- ❑ Summary tables for total emissions/removals on both molecular mass & CO_2-eq basis
- ❑ Summary table presenting quick reference for the types of methods & EFs applied by the Party in the GHGI estimation

SUMMARY 1 SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES
(Sheet 1 of 1)

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/ removals	CH_4	N_2O	HFCs (1)	PFCs (1)	Unspecified mix of HFCs and PFCs (1)	SF_6	NF_3	NO_x	CO	NMVOC	SO_X	Total
	(kt)			CO_2 equivalents (kt) (2)			(kt)						CO_2 equivalent (kt) (2)
Total national emissions and removals													
1. Energy													
1.A. Fuel combustion													
1.A.1. Energy industries													
1.A.2. Manufacturing industries and construction													
1.A.3. Transport													
1.A.4. Other sectors													
1.A.5. Other													
1.B. Fugitive emissions from fuels													
1.B.1. Solid fuels													
1.B.2. Oil and natural gas and other emissions from energy production													
1.C. CO_2 Transport and storage													
2. Industrial processes and product use													
2.A. Mineral industry													
2.B. Chemical industry													
2.C. Metal industry													
2.D. Non-energy products from fuels and solvent use													
2.E. Electronic industry													
2.F. Product uses as substitutes for ODS													
2.G. Other product manufacture and use													
2.H. Other (3)													
3. Agriculture													
3.A. Enteric fermentation													
3.B. Manure management													

- ❑ Cross-cutting CRTs:
  - ✓ indirect emissions of N_2O & CO_2
  - ✓ Key categories
  - ✓ Recalculations performed relatively to the previous submission
  - ✓ Categories or subcategories which were not estimated or included elsewhere
  - ✓ Summary of emission trends over the entire time series
  - ✓ Information on the use of flexibility provision

Reporting GHGIs under the ETF| CRT structure

TABLE 1.A(a) SECTORAL BACKGROUND DATA FOR ENERGY

Fuel combustion activities - sectoral approach

(Sheet 1 of 4)

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA		IMPLIED EMISSION FACTORS			EMISSIONS		
	Consumption		CO_2 [1]	CH_4	N_2O	CO_2 [2][3]	CH_4	
	(TJ)	NCV/GCV [5]	(t/TJ)	(kg/TJ)		(kt)		
1.A.1. Energy industries								
Liquid fuels								
Solid fuels								
Gaseous fuels [6]								
Other fossil fuels [7]								
Peat [8]								
Biomass [3]								
1.A.1.a. Public electricity and heat production [9]	PEHP = C+D+E+F+G+H							
Liquid fuels	C = 1+7+..							
Solid fuels	D = 2+8+..							
Gaseous fuels [6]	E = 3+9+..							
Other fossil fuels [7]	F = 4+10+..							
Peat [8]	G = 5+11+..							
Biomass [3]	H = 6+12+..							
Drop-down list:								
1.A.1.a.i. Electricity generation	A = 1+2+3+4+5+6							
Liquid fuels	1							
Solid fuels	2							
Gaseous fuels [6]	3							
Other fossil fuels [7]	4							
Peat [8]	5							
Biomass [3]	6							
1.A.1.a.ii. Combined heat and power generation	B = 7+8+9+10+11+12							
Liquid fuels	7							
Solid fuels	8							
Gaseous fuels [6]	9							
Other fossil fuels [7]	10							
Peat [8]	11							
Biomass [3]	12							

Reporting GHGIs under the ETF| CRT structure

When no numerical values are used to fill in the CRTs

↓

notation keys ***shall*** be used

↓

All cells should contain either a value or a notation key

Biomass Burning[1]
(Sheet 1 of 1)

Submission 2022 v3

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA			IMPLIED EMISSION FACTOR			EMISSIONS		
		Description[4]	Unit	Values	CO_2	CH_4	N_2O	CO_2[5][6]	CH_4	N_2O
Land-use category[2]	Subdivision[3]		(ha or kg dm)		(t/activity data unit)			(kt)		
Total for land-use categories			no unit					NO,IE,NA	0.43	0.02
A. Forest land			no unit					NO,IE	0.39	0.02
1. Forest land remaining forest land[7]			no unit					IE	0.37	0.02
Controlled burning			kg dm	52645918.08	IE	0.00	0.00	IE	0.25	0.01
Wildfires			ha	696.40	IE	0.17	0.01	IE	0.12	0.01
2. Land converted to forest land			ha	147.85	NO,IE	0.16	0.01	NO,IE	0.02	0.00
Controlled burning			ha	NO	NO	NO	NO	NO	NO	NO
Wildfires			ha	147.85	IE	0.16	0.01	IE	0.02	0.00
B. Cropland			ha	873.49	IE,NA	0.01	0.00	IE,NA	0.01	0.00
1. Cropland remaining cropland[8]			ha	873.49	NA	0.01	0.00	NA	0.01	0.00
Controlled burning			ha	436.74	NA	NA	NA	NA	NA	NA
Wildfires			ha	436.74	NA	0.02	0.00	NA	0.01	0.00
2. Land converted to cropland			ha	IE	IE	IE	IE	IE	IE	IE
Controlled burning			ha	IE	IE	IE	IE	IE	IE	IE
Wildfires			ha	IE	IE	IE	IE	IE	IE	IE
C. Grassland			ha	2255.56	NO,IE	0.01	0.00	NO,IE	0.03	0.00
1. Grassland remaining grassland[6]			ha	2255.56	NO,IE	0.01	0.00	NO,IE	0.03	0.00
Controlled burning			ha	NO	NO	NO	NO	NO	NO	NO
Wildfires			ha	2255.56	IE	0.01	0.00	IE	0.03	0.00
2. Land converted to grassland			ha	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
Controlled burning			ha	NO	NO	NO	NO	NO	NO	NO
Wildfires			ha	IE	IE	IE	IE	IE	IE	IE
D. Wetlands			ha	NO	NO	NO	NO	NO	NO	NO
1. Wetlands remaining wetlands			ha	NO	NO	NO	NO	NO	NO	NO
Controlled burning			ha	NO	NO	NO	NO	NO	NO	NO
Wildfires			ha	NO	NO	NO	NO	NO	NO	NO
2. Land converted to wetlands			ha	NO	NO	NO	NO	NO	NO	NO
Controlled burning			ha	NO	NO	NO	NO	NO	NO	NO
Wildfires			ha	NO	NO	NO	NO	NO	NO	NO
E. Settlements			ha	NO	NO	NO	NO	NO	NO	NO
F. Other land			ha	NO	NO	NO	NO	NO	NO	NO
H. Other (please specify)										

Reporting GHGIs under the ETF| CRT structure

- ❑ Land transition matrix
- ❑ To be completed with annual areas
- ❑ Basis for constructing land representation based on the transition period applied

Table 4.1 LAND TRANSITION MATRIX

Areas and changes in areas between the previous and the current inventory year (1)

Year
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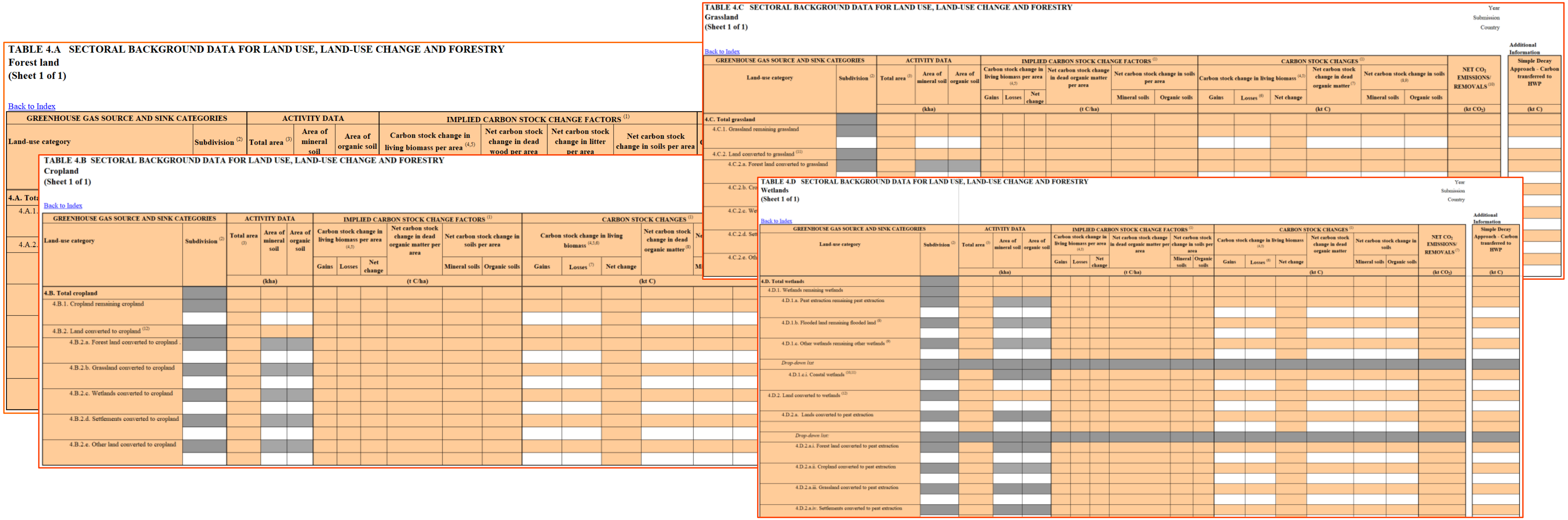
TO: / FROM:	Forest land (managed)	Forest land (unmanaged)	Cropland	Grassland (managed)	Grassland (unmanaged)	Wetlands (managed)	Wetlands (unmanaged)	Settlements	Other land	Total unmanaged land	**Initial area**
FROM:						(kha)					
Forest land (managed) (2)											
Forest land (unmanaged) (2)											
Cropland (2)											
Grassland (managed) (2)											
Grassland (unmanaged) (2)											
Wetlands (managed) (2)											
Wetlands (unmanaged) (2)											
Settlements (2)											
Other land (2)											
Total unmanaged land (3)											
Final area											
Net change (4)											

Reporting GHGIs under the ETF| CRT structure

In background tables 4.A-F, CSCs from all land uses and land-use change categories/subcategories & C pools, including SOM mineral are reported

Each of CRT 4.A-F covers one of the six land-use categories



Reporting GHGIs under the ETF| CRT structure

TABLE 4.A SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY

Forest land

(Sheet 1 of 1)

Year

Submission

Country

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REENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA			IMPLIED CARBON STOCK CHANGE FACTORS [1]							CARBON STOCK CHANGES [1]							NET CO_2 EMISSIONS/ REMOVALS [9]
e category	Subdivision [2]	Total area [3]	Area of mineral soil	Area of organic soil	Carbon stock change in living biomass per area [4,5]			Net carbon stock change in dead wood per area	Net carbon stock change in litter per area	Net carbon stock change in soils per area		Carbon stock change in living biomass [4,5]			Net carbon stock change in dead wood	Net carbon stock change in litter	Net carbon stock change in soils [7,8]		
					Gains	Losses	Net change			Mineral soils	Organic soils	Gains	Losses [6]	Net change			Mineral soils	Organic soils	
		(kha)			(t C/ha)							(kt C)							(kt CO_2)
4.A. Total forest land																			
4.A.1. Forest land remaining forest land																			
4.A.2. Land converted to forest land [10]																			
4.A.2.a. Cropland converted to forest land																			
4.A.2.b. Grassland converted to forest land																			
4.A.2.c. Wetlands converted to forest land																			
4.A.2.d. Settlements converted to forest land																			
4.A.2.e. Other land converted to forest land																			

Emissions/removals based on the stratification applied

AD (areas)

Net CSC from SOM mineral

CO2 emissions/ removals

Reporting GHGIs under the ETF| CRT structure

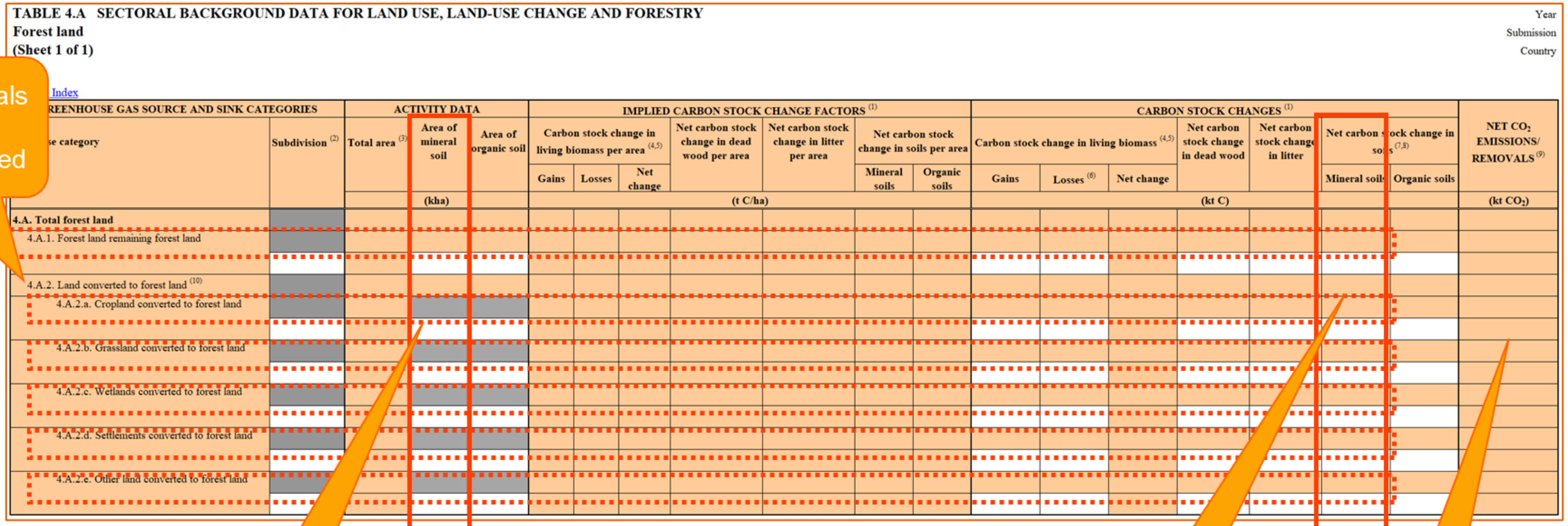

TABLE 4.A SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY
Forest land
(Sheet 1 of 1)

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REENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA			IMPLIED CARBON STOCK CHANGE FACTORS [1]							CARBON STOCK CHANGES [1]							NET CO_2 EMISSIONS/ REMOVALS [9]
se category	Subdivision [2]	Total area [3]	Area of mineral soil	Area of organic soil	Carbon stock change in living biomass per area [4,5]			Net carbon stock change in dead wood per area	Net carbon stock change in litter per area	Net carbon stock change in soils per area		Carbon stock change in living biomass [4,5]			Net carbon stock change in dead wood	Net carbon stock change in litter	Net carbon stock change in soils [7,8]		
					Gains	Losses	Net change			Mineral soils	Organic soils	Gains	Losses [6]	Net change			Mineral soils	Organic soils	
		(kha)			(t C/ha)							(kt C)							(kt CO_2)
4.A. Total forest land																			
4.A.1. Forest land remaining forest land																			
4.A.2. Land converted to forest land [10]																			
4.A.2.a. Cropland converted to forest land																			
4.A.2.b. Grassland converted to forest land																			
4.A.2.c. Wetlands converted to forest land																			
4.A.2.d. Settlements converted to forest land																			
4.A.2.e. Other land converted to forest land																			

Emissions/removals based on the stratification applied

AD (areas)

Net CSC from SOM mineral

CO2 emissions/ removals

SOS!!!

When reporting CSCs: **Gains** are positive (**+**) & **losses** are negative (**–**)

When reporting emissions/removals: **Emissions** are positive (**+**) & **removals** are negative (**–**)

Reporting GHGIs under the ETF| CRT structure

TABLE 4(II) SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY
Emissions and removals from drainage and rewetting and other management of organic and mineral soils
(Sheet 1 of 1)

Year
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GREENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA	IMPLIED EMISSION FACTORS			EMISSIONS		
Land-use category [1]	Subdivision [2]	Area (kha)	CO_2 per area (kg CO_2/ha)	N_2O–N per area [3] (kg N_2O–N/ha)	CH_4 per area (kg CH_4/ha)	CO_2 [4] (kt)	N_2O	CH_4
4(II). Total for all land use categories								
4(II).A. Forest land [5]								
4(II).A.1 Forest land remaining forest land								
Total organic soils								
Drop-down list:								
Drained organic soils								
Rewetted organic soils								
Other *(please specify)*								
Total mineral soils								
Drop-down list:								
Rewetted mineral soils								
Other *(please specify)*								
4(II).A.2 Land converted to forest land								
Total organic soils								
Drop-down list:								
Drained organic soils								
Rewetted organic soils								
Other *(please specify)*								

CH_4 emissions from rewetted and created wetlands on IWMS

CO_2 emissions from rewetting of cropland with IWMS unless they are included in CRT 4.B

Reporting GHGIs under the ETF| CRT structure

Direct & indirect N_2O emissions from N mineralization/immobilization as a result of the loss/gain of SOM due to land-use/-management changes on mineral soils

TABLE 4(III) SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY

Direct and indirect nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils [1]

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA AND OTHER RELATED INFORMATION		IMPLIED EMISSION FACTORS		N_2O EMISSIONS		
Land-use category [2]	Area [3] (kha)	N mineralised in mineral soils associated with loss of soil C from soil organic matter [4] (t N/year)	N_2O–N emissions per area [5] (kg N_2O–N/ha)	N_2O–N emissions per unit of N lost through leaching and run-off (kg N_2O–N/kg N)	Direct Emissions	Indirect Emissions [4,6]	Total Emissions
					(kt)		
4(III). Total for all land-use categories							
4(III).A. Forest land [7]							
4(III).A.1. Forest land remaining forest land							
4(III).A.2. Lands converted to forest land [8]							
Drop down list:							
4(III).A.2.a. Cropland converted to forest land							
4(III).A.2.b. Grassland converted to forest land							
4(III).A.2.c. Wetlands converted to forest land							
4(III).A.2.d. Settlements converted to forest land							
4(III).A.2.e. Other land converted to forest land							
4(III).B. Cropland [2][7]							
4(III).B.2. Lands converted to cropland [7][8]							
Drop down list:							
4(III).B.2.a. Forest land converted to cropland							
4(III).B.2.b. Grassland converted to cropland							
4(III).B.2.c. Wetlands converted to cropland							
4(III).B.2.d. Settlements converted to cropland							
4(III).B.2.e. Other land converted to cropland							
4(III).C. Grasslands [7]							
4(III).C.1. Grasslands remaining grasslands							
4(III).C.2. Lands converted to grasslands [8]							
Drop down list:							
4(III).C.2.a. Forest land converted to grasslands							
4(III).C.2.b. Cropland converted to grasslands							
4(III).C.2.c. Wetlands converted to grasslands							
4(III).C.2.d. Settlements converted to grasslands							
4(III).C.2.e. Other land converted to grasslands							
4(III).D. Wetlands [7]							
4(III).D.1. Wetlands remaining wetlands							

Reporting GHGIs under the ETF| CRT structure

Allocation of emissions between LULUCF and Agriculture

Source/sink category	Agriculture	LULUCF	
		Agricultural land	Non-agricultural land
Fertilization, liming, urea application	N_2O (cropland, grassland) and CO_2 emissions		N_2O emissions if disaggregated information is available ensuring consistency with agriculture sector, otherwise aggregated N_2O emissions from all land-use categories in agriculture
Drained and rewetted organic soils	N_2O emissions from drainage of soils (cultivation of cropland, grassland)	• CO_2 emissions from drainage of soils • (CH_4 emissions from drainage of soils) • (CO_2 removals from rewetting of soils) • (CH_4 emissions from rewetting of soils) • (N_2O emissions from rewetting of soils, higher tier)	
			N_2O emissions from drainage
N mineralization/ Immobilization associated with loss/gain of soil organic matter due to land-use/management changes	N_2O emissions/avoidance in agricultural land, except land converted to cropland and land converted to grassland	N_2O emissions/avoidance from land converted to cropland and land converted to grassland	N_2O emissions/avoidance
Biomass burning	N2O, CH4 from crop residues burning, prescribed burning of savannahs	• CO2 emissions from burning of perennial biomass, DOM and SOM, if any • non-CO2 emissions from burning of any C stocks, except from those reported under agriculture	• CO2 emissions from burning of perennial biomass, DOM and SOM, if any • non-CO2 emissions from burning of any C stocks
Rice cultivation	CH4 emissions		

(When 2013 IPCC Wetlands Supplement is applied)

Reporting GHGIs under the ETF| notation keys

‘NO’ (not occurring)	for categories or processes, including recovery, under a particular source or sink category that do not occur within a Party
‘NE’ (not estimated)	for activity data and/or emissions by sources and removals by sinks of GHGs that have not been estimated but for which a corresponding activity may occur within a Party
‘NA’ (not applicable)	for activities under a given source/sink category that do occur within the Party but do not result in emissions or removals of a specific gas

Reporting GHGIs under the ETF| notation keys

‘IE’ (included elsewhere)	for emissions by sources and removals by sinks of GHGs estimated but included elsewhere in the inventory instead of under the expected source/sink category
‘C’ (confidential)	for emissions by sources and removals by sinks of GHGs where the reporting would involve the disclosure of confidential information
‘FX’ (flexibility)	for reflecting the application of a specific flexibility as contained in the annex to dec. 18/CMA.1

Reporting GHGIs under the ETF| notation keys

However, NE …

when a category is considered ‘insignificant’ in terms of the overall level in national total* emissions

Parties should use approximated AD and default IPCC EFs to derive a likely level of emissions for the respective category

Once emissions from a specific category have been reported in a previous submission, figures shall be reported in subsequent submissions

Insignificant

likely level of emissions is

< 0.05 % of the national total GHG emissions

< 500 kt CO2eq

total national aggregate of emissions for all gases and categories ‘insignificant’ **shall** remain < 0.1 % of the national total GHG emissions

*total emissions: excluding LULUCF

Reporting GHGIs under the ETF| notation keys

However, NE …

when a category is considered ‘insignificant’ in terms of the overall level in national total* emissions

Parties should use approximated AD and default IPCC EFs to derive a likely level of emissions for the respective category

Once emissions from a specific category have been reported in a previous submission, figures shall be reported in subsequent submissions

flexibility

Insignificant

likely level of emissions is

< 0.1 % of the national total GHG emissions

< 1,000 kt CO_2eq

total national aggregate of emissions for all gases and categories ‘insignificant’ **shall** remain < 0.2 % of the national total GHG emissions

*total emissions: excluding LULUCF

Reporting GHGIs under the ETF| NID

- The outlines for the BTR (annex IV) & the national inventory document (NID) (annex V), as well as the technical expert review report (FCCC/PA/CMA/2021/L.21) have been adopted through decision 5/CMA.3
- Parties are encouraged to follow the NID outline
- It facilitates a structured and consistent developmend of the report & ensures transparency

FCCC/PA/CMA/2021/L.21

Annex V*

Outline of the national inventory document, pursuant to the modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement[1]

[English only]

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ES.1. Background information on GHG inventories and climate change (e.g. as it pertains to the national context)

ES.2. Summary of trends related to national emissions and removals

ES.3. Overview of source and sink category emission estimates and trends

ES.4. Other information (e.g. indirect GHGs, precursor gases)

ES.5. Key category analysis (flexibility provided to those developing country Parties that need it in the light of their capacities as per para. 25 of the MPGs)

ES.6. Improvements introduced (related to a non-mandatory provision as per para. 7 of the MPGs, with flexibility provided to those developing country Parties that need it in the light of their capacities as per para. 7(c) of the MPGs)

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1.2.2. Inventory preparation process

1.2.3. Archiving of information

1.2.4. Processes for official consideration and approval of inventory

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1.4. Brief description of key categories (flexibility provided to those developing country Parties that need it in the light of their capacities as per para. 25 of the MPGs)

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Reporting GHGIs under the ETF| NID

- EXECUTIVE SUMMARY
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- Chapter 2: Trends in greenhouse gas emissions and removals
- Chapter 3: Energy (CRT sector 1)
- Chapter 4: Industrial processes and product use (CRT sector 2)
- Chapter 5: Agriculture (CRT sector 3)

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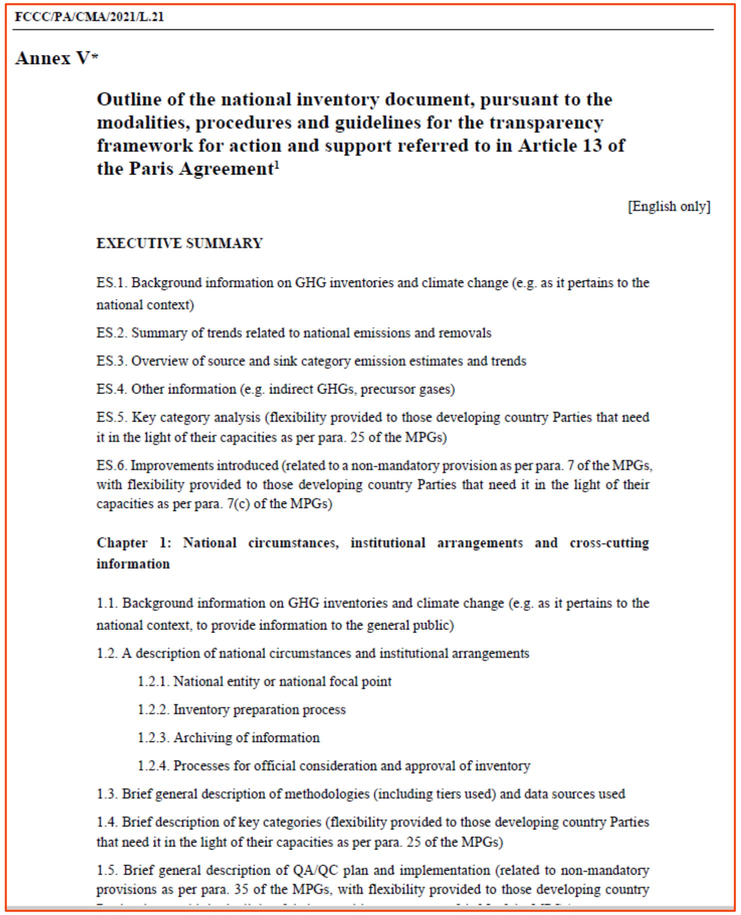
Reporting GHGIs under the ETF| NID

- Chapter 6: Land use, land-use change and forestry (CRT sector 4)
- Chapter 7: Waste (CRT sector 5)
- Chapter 8: Other (CRT sector 6) (if applicable)
- Chapter 9: Indirect carbon dioxide and nitrous oxide emissions
- Chapter 10: Recalculations and improvements



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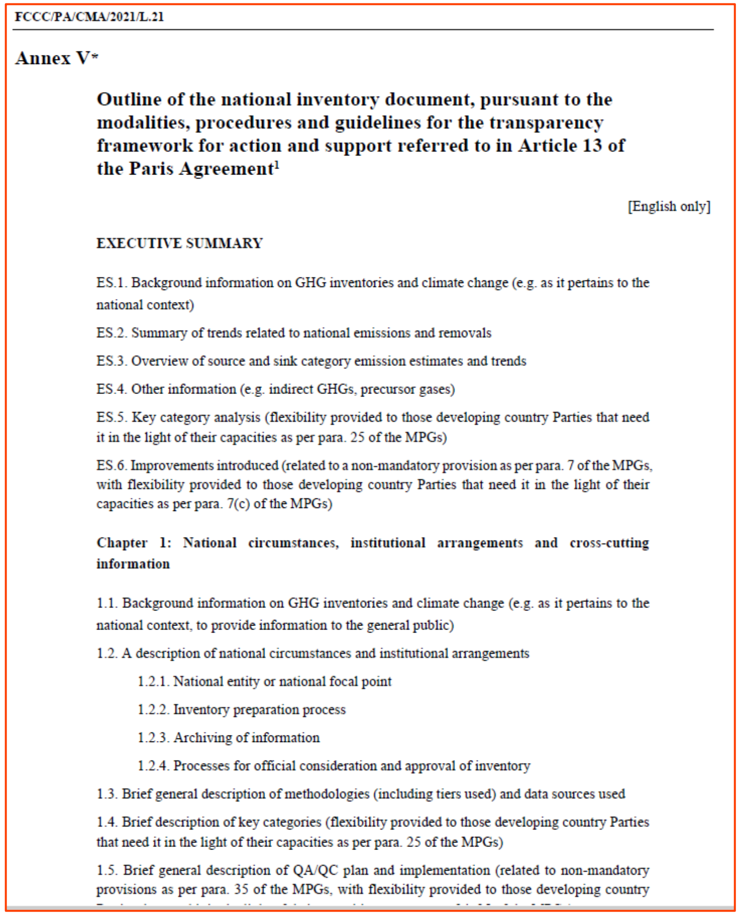
- Annex 1: Key categories
- Annex 2: Uncertainty assessment
- Annex 3: Detailed description of the reference approach (incl. inputs to the RA) and the results of the comparison of national estimates of emissions with those obtained using the reference approach)
- Annex 4: QA/QC plan
- Annex 5: Any additional information, as applicable, incl. methodological descriptions of source or sink categories and the national emission balance
- Annex 6: Common reporting tables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Reporting GHGIs under the ETF| NID

- Developing country Parties that need flexibility may report information on specific flexibility applied in a separate chapter and/or within relevant sectoral chapters

- Parties may also include a summary table on the flexibilities applied

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1.6. General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals (flexibility provided to those developing country Parties that need it in the light of their capacities as per para. 29 of the MPGs)

1.7. General assessment of completeness (related to a non-mandatory provision as per para. 30 of the MPGs, with flexibility provided to those developing country Parties that need it in the light of their capacities as per para. 32 of the MPGs)

1.7.1. Information on completeness (including information on non-reported categories or any methodological or data gaps in the inventory) (related to a non-mandatory provision as per para. 30 of the MPGs)

1.7.2. Description of insignificant categories, if applicable (related to a non-mandatory provision as per para. 32 of the MPGs, with flexibility provided to those developing country Parties that need it in the light of their capacities as per para. 32 of the MPGs)

1.7.3. Total aggregate emissions considered insignificant, if applicable (related to a non-mandatory provision as per para. 32 of the MPGs, with flexibility provided to those developing country Parties that need it in the light of their capacities as per para. 32 of the MPGs)

1.8. Metrics (related to a non-mandatory provision as per para. 37 of the MPGs)

1.9. Summary of any flexibility applied (i.e. by developing country Parties that need it in the light of their capacities as per paras. 4–6 of the MPGs)[2]

Reporting GHGIs under the ETF| NID

Chapter 2: Trends in greenhouse gas emissions and removals

2.1. Description of emission and removal trends for aggregated GHG emissions and removals

2.2. Description of emission and removal trends by sector and by gas

Chapter 6: Land use, land-use change and forestry (CRT sector 4)

6.1. Overview of the sector (e.g. quantitative overview and description, including trends and methodological tiers by category, and coverage of pools) and background information

6.2. Land-use definitions and the land representation approach(es) used and their correspondence to the land use, land-use change and forestry categories (e.g. land use and land-use change matrix)

6.3. Country-specific approaches

6.3.1. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

6.3.2. Information on approaches used for natural disturbances, if applicable

6.3.3. Information on approaches used for reporting harvested wood products

6.4. Category (CRT category number)

6.4.1. Description (e.g. characteristics of category)

6.4.2. Methodological issues (e.g. choice of methods/activity data/emission factors and activity data and emission factors used, assumptions, parameters and conventions underlying the emission and removal estimates and the rationale for their selection, any specific methodological issues (e.g. description of national methods and models))

6.4.3. Uncertainty assessment and time-series consistency (flexibility provided to those developing country Parties that need it in the light of their capacities as per para. 29 of the MPGs)

6.4.4. Description of any flexibility applied (i.e. by developing country Parties that need flexibility in the light of their capacities as per paras. 4–6 of the MPGs)[9]

6.4.5. Category-specific QA/QC and verification, if applicable (related to a non-mandatory provision as per para. 35 of the MPGs, with flexibility provided to those developing country Parties that need it in the light of their capacities as per paras. 34–35 of the MPGs)

6.4.6. Category-specific recalculations, if applicable, including explanatory information and justifications for recalculations, changes made in response to the review process and impacts on emission trends

6.4.7. Category-specific planned improvements, if applicable (e.g. methodologies, activity data, emission factors), including those in response to the review process (related to a non-mandatory provision as per para. 7 of the MPGs, with flexibility provided to those developing country Parties that need it in the light of their capacities as per para. 7(c) of the MPGs)

Japan GHGI 2022

b) Methodological Issues

1) Carbon Stock Changes in Soils in "Grassland remaining Grassland"

- ***Estimation Method***

➢ ***Estimation of Carbon stock changes in mineral soils***

Carbon stock change in mineral soils in pasture land was estimated by using the Tier 3 modeling method same as 6.6.1.b)2) cropland remaining cropland (4.B.1.).

➢ ***Estimation of on-site CO_2 emissions resulting from cultivation in organic soils***

With respect to CO_2 emissions from organic soils in pasture land were estimated by applying the Tier 1 estimation method described in section 6.2.3.1 in the *2006 IPCC Guidelines*. The estimation method is the same as cropland remaining cropland (4.B.1.).

➢ ***Estimation of off-site CO_2 emissions via waterborne carbon losses from drained inland organic soils***

Off-site CO_2 emissions via waterborne carbon losses from drained inland organic soils were estimated by applying Tier 1 estimation method described in section 2.2.1.2 in the *Wetlands Guidelines*. The estimation method is the same as cropland remaining cropland (4.B.1.).

- ***Parameters***

➢ ***Assumption for the Roth C model and parameters for estimating mineral soils***

The parameters used are omitted because they are the same as cropland remaining cropland (4.B.1.).

➢ ***Parameters for estimation of CO_2 emissions from organic soils***

Because there is little research data on CO_2 emission factor that is suitable for grassland in Japan, the default value provided in *the Wetlands Guidelines* (Table 2.1, 6.1 t-C/ha/year) which is considered to be most appropriate for the emission factor under the distribution of pasture land and current management system in Japan, was applied. As for off-site CO_2 emissions, the same parameters as cropland remaining cropland (4.B.1.) were used.

Italy GHGI 2022

Table 6.18 Cropland management practices and relative data sources

cropland subcategory	management practice	data source
annual crops	Ordinary	ISTAT
	Organic	National Information system on organic agriculture (SINAB)
	Sustainable	Annual Implementation Reports (RAE) and Annual Report on Operational Programs: 2000-2018
	Set aside	Eurostat: 1990-2016
	Conservative practices	Annual Implementation Reports (RAE): 2008-2018
perennial crops	Ordinary	ISTAT
	Organic	National Information system on organic agriculture (SINAB)
	Sustainable	Annual Implementation Reports (RAE) and Annual Report on Operational Programs: 2000-2018

The annual areas subject to the abovementioned management practices, at regional level, have been estimated, also considering the transition to and from different management practices (e.g. ordinary annual crops to organic annual crops, ordinary annual crops to sustainable annual crops, etc.). Changes in carbon stocks in mineral soils has been calculated by applying the equation 2.25 of the IPCC, 2006 (vol. 4, chapter 2). The IPCC default transition period, i.e. 20 years, has been considered.
The SOC_{ref} classification of the soils is based on the default reference SOC stocks for mineral soils (tC/ha in 0-30 cm) provided in table 2.3 of IPCC 2006. The identification of country specific SOC_{ref} have been performed using a combination of the following map layers:

- IPCC climate zones (JRC) - http://eusoils.jrc.ec.europa.eu/projects/RenewableEnergy/
- Corine Land cover 2006 (grassland: legend codes: 2.3 ad 3.2) - http://sia.eionet.europa.eu/CLC2006
- Soil map of Italy - (reclassified according to the main groups of soil types as in table 2.3) - Costantini E.A.C., L'Abate G., Barbetti R., Fantappiè M., Lorenzetti R., Magini S. (2013) Carta dei suoli d'Italia, scala 1:1.000.000 - http://www.soilmaps.it/
- Map of Italy with administrative boundaries.

Overlapping the abovementioned layers, the Italian soils have been classified according to the IPCC soil classes (table 2.3, vol. 4, chapter 2 of the 2006 IPCC Guidelines), and their related climate zones as percentage in each region. According to the thereby defined distribution of the soil types and climate zones in each Italian region, it was possible to define the SOC_{ref}. The stock change factors (F_{LU}, F_{MG}, F_I) adapted to the national circumstances, have been derived by the default values provided in table 5.5 of the 2006 IPCC Guidelines (vol.4, chapter 5) and have been applied considering the percentage of moist and dry climates in each administrative region. The F factors considered, and are reported in the following Table 6.19.

Table 6.19 Stock change factors

	Management practice	F_{LU}		F_{MG}		F_I	
		Moist	*Dry*	*Moist*	*Dry*	*Moist*	*Dry*
annual crops	Ordinary	0.69	0.8	1	1	0.92	0.95
	Organic	0.69	0.8	1	1	1.44	1.37
	Sustainable	0.69	0.8	1.08	1.02	1	1
	Set aside	0.82	0.93	1.15	1.1	0.92	0.95
	Conservative	0.69	0.8	1.15	1.1	1.11	1.04
perennial crops	Ordinary	1	1	1	1	1	1
	Organic	1	1	1.08	1.02	1.44	1.37
	Sustainable	1	1	1.08	1.02	0.92	0.95

The SOC stocks per hectare in the mineral soil, calculated on the basis of the previously described procedure, are shown in the table 6.20, per region and per management practices, for annual and perennial crops. Estimates of SOC stock changes in annual and perennial crops are reported in Table 6.21.

Table 6.20 SOC stocks per region and management practice

Region	annual crops Ordinary	Organic	Sustainable	Set aside	Conservative	perennial crops Ordinary	Organic	Sustainable
	SOC stock (t C ha⁻¹)					*SOC stock (t C ha⁻¹)*		
Piemonte	49.04	74.86	56.02	65.64	65.18	72.91	109.79	71.92
Valle D'Aosta	57.29	89.45	67.07	78.13	79.15	89.72	139.09	89.08
Liguria	51.15	78.64	58.89	68.87	68.82	77.29	117.47	76.40
Lombardia	52.32	80.88	60.59	70.76	71.06	80.06	122.53	79.26
Trentino – Alto Adige	56.84	88.97	66.73	77.68	78.87	89.54	139.26	88.97
Veneto	46.88	71.05	53.14	62.38	61.55	68.60	102.36	67.53
Friuli - Venezia Giulia	55.94	87.56	65.67	76.45	77.62	88.12	137.05	87.56
Emilia - Romagna	40.13	59.60	44.50	52.53	50.87	56.17	81.60	54.94
Toscana	38.18	56.43	42.11	49.78	47.98	52.88	76.32	51.64
Umbria	46.72	70.81	52.96	62.17	61.34	68.37	102.01	67.30
Marche	39.05	57.86	43.18	51.02	49.29	54.36	78.72	53.14
Lazio	39.33	58.52	43.69	51.55	50.01	55.26	80.48	54.09
Abruzzo	40.97	60.98	45.54	53.72	52.13	57.61	83.93	56.39
Molise	32.74	47.67	35.52	42.18	40.09	43.94	62.20	42.72
Campania	31.64	45.99	34.26	40.71	38.63	42.31	59.75	41.11
Puglia	29.21	42.21	31.43	37.42	35.30	38.60	54.07	37.42
Basilicata	30.64	44.37	33.05	39.31	37.17	40.67	57.16	39.46
Calabria	34.42	50.34	37.53	44.51	42.48	46.63	66.39	45.39
Sicilia	28.70	41.38	30.81	36.69	34.56	37.76	52.77	36.59
Sardegna	30.11	43.56	32.44	38.60	36.47	39.89	55.99	38.69

Austria GHGI 2022

6.3.4.1.4 Changes of carbon stocks in mineral soils of "annual cropland remaining annual cropland" and "perennial cropland remaining perennial cropland" (4.B.1.a)

According to national soil inventories organic soils are not occurring in cropland in Austria.

Emissions/removals due to soil C stock changes in "annual cropland remaining annual cropland" were calculated using a country specific methodology (Tier 2). For the soil organic carbon content the Austrian specific average value of 50 t C ha^{-1} for 0–30 cm depth of cropland was assumed for 1990 which is based on the results of the Austrian soil inventory (GERZABEK et al. 2003., STREBL et al. 2003). This assumption is supported by the fact that the soil inventories were carried out between

1988 and 1996. Furthermore, we assumed that this Austrian specific soil C stock for cropland represents a steady state that already includes the effects of the management for the period before 1990 and that cropland management was rather stable in that period.

The further methodology follows closely the 2006 IPCC GL, where the IPCC equation 2.25 includes a management factor (F_{MG}), a land-use factor (F_{LU}) and an input factor for input of organic matter (F_I) (Table 5.5, IPCC 2006).

In a study by the Austrian Agency for Health and Food Safety (AGES) and Umweltbundesamt (UMWELTBUNDESAMT 2010b) the IPCC default management factors for SOC (soil organic carbon) stock change have been assessed against results from national long-term field experiments of AGES (SPIEGEL et al., 2007). The results of the C stock change rates for the agricultural experimental plots were allocated to different management types (management factors) like tillage types and input types:

The country-specific land-use factor (F_{LU}) for long-term cultivated cropland soils of 0.93 is applied according to the results of the long-term field experiments of AGES (UMWELTBUNDESAMT 2010b).

The stock change factors for management (F_{MG}) were also applied according to the results of the long-term field experiments of AGES (UMWELTBUNDESAMT 2010b, SPIEGEL et al. 2007), showing the effects of different tillage types (minimum, reduced and conventional tillage) on soil organic carbon. According to these results, F_{MG} full and F_{MG}-reduced have the same country specific management factor of 1.0. For F_{MG} no-till the country specific management factor of 1.09 was derived (UMWELTBUNDESAMT 2010b).

The stock change factors for input (F_I) were also revisited: F_I-Low does not occur in Austria, F_I-medium was assigned a management factor of 1.0 according to UMWELTBUNDESAMT (2010b), F_I-high-without manure was assigned with a factor of 1.05 and for the input type F_I-high-with manure a factor of 1.11 was derived as mean value of the found results in the long-term field experiments (UMWELTBUNDESAMT 2010b).Table 264 shows the revised national factors used compared to the IPCC default values (for cool, temperate, moist regime).

Table 264: Relative stock change factors for cropland according to IPCC default values and revised national factors

Factor value type		Level	IPCC default 2006 IPCC GL (cool, temperate, moist regime)	Applied revised national factors (UMWELTBUNDESAMT 2010b)
Land use (F_{LU})	F_{LU}	Long-term cultivated	0.69	0.93
Tillage (F_{MG})	F_{MG1}	Full	1.00	1.00
	F_{MG2}	Reduced	1.08	1.00
	F_{MG3}	No-Till	1.15	1.09
Input (F_I)	F_{I1}	Low	0.92	0.95
	F_{I2}	Medium	1.00	1.00
	F_{I3}	High – without manure	1.11	1.05
	F_{I4}	High – with manure	1.44	1.11

The methodological regime for splitting the annual cropland into the different tillage and input types and assigning the specific management factors is as following:

FAO and the Enhanced transparency framework

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Thank you !