Plan d’assurance et de contrôle qualité (AQ/CQ) de l’inventaire des gaz à effet de serre (GES) 1990–2022: UTCAF

ICAT Initiative for Climate Action Transparency

UN environment programme | copenhagen climate centre

Initiative pour la transparence de l'action climatique – ICAT

Plan d'assurance et de contrôle qualité (QA/QC) de l'inventaire des gaz à effet de serre (GES) 1990–2022 : UTCAF

Livrable 2.d

Auteur : Traute Köther, Consultante Indépendant, Novembre 2025

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PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF THE ENVIRONMENT AND QUALITY OF LIFE

QA/QC Plan
to the
GHG inventory 1990-2022
- LULUCF -

November 2025

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6 Land Use, Land Use Change and Forestry (LULUCF) (IPCC sector 4)

6.1 Overview of the sector and background information

In the sector land use, land-use change and forestry, emissions and removals originating from land use and land use conversions.

Folder	06_Inventory\2024_submission\10_CRT		
File	4_CRT_Tables_Input.xlsx		
NID CHAPTER	6 Land Use, Land Use Change and Forestry (LULUCF) (IPCC sector 4)		
ToDo	Check for updated reasons for trend in sectoral chapter		
	Update GHG emissions and AD in tables & graphs		
	from sheet TT_Table4_GHG_Eq_T (4_CRT_Tables_Input.xlsx)		
	from sheet _ LandUse.xlsx sheet MADR_LandUse (AD)		
		AD	Emissions
	Table	J-BJ	B-W
	Graph	BM-BQ	M-Q
	Check for updated reasons for trend in chapter • Trend -> 6.Land Use, Land Use Change and Forestry (LULUCF) (IPCC sector 4) • Executive Summary		

6.2 Forestland (IPCC category 4.A)

6.2.1 Category description

Folder	\06_Inventory\2024_submission\04_LULUCF
File	LULUCF_4A1_FL_remaining_FL_v11.xlsx
NID CHAPTER	Forestland remaining Forestland (IPCC category 4.A.1)

This section describes the estimation of CO_2 emissions resulting from Forestland as described in the 2006 IPCC Guidelines (Volume 4, chapter 4). Emissions and removals of CO_2 within the LULUCF Sector are generally estimated based on changes in ecosystem carbon stocks.

Carbon pool: A reservoir, A system which has the capacity to accumulate or release carbon. Examples of carbon pools are forest biomass, wood products, soils, and the atmosphere. The units are in mass.[1]

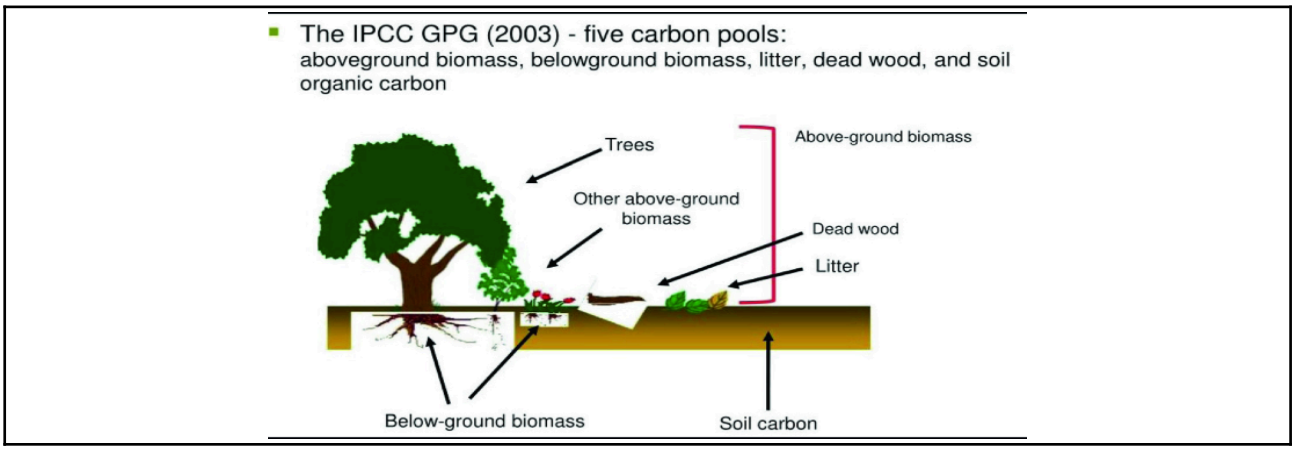

Figure 6-1 The IPCC GPG (2003) – five carbon pools

Net losses in total ecosystem carbon stocks are used to estimate CO_2 emissions to the atmosphere, and net gains in total ecosystem carbon stocks are used to estimate removal of CO_2 from the atmosphere.

orest remaining Forest areas over the period 1990-2022. The annual increase in biomass carbon demonstrates a general upward trend over time. In the other side, losses of carbon are due mainly to disturbances by fires.

6.2.2 Methodological issues

Tier 1 is feasible even when country-specific estimates of activity data and emission/removal factors are not available and works when changes of the carbon pool in biomass on *Forestland Remaining Forestland* are relatively small. Emission and removal factors are default from the 2006 IPCC Guidelines.

Folder	\06_Inventory\2024_submission\04_LULUCF
File	LULUCF_4A1_FL_remaining_FL_v11.xlsx
Sheet	4 A 1_ChoiceMethology
	Result_detailed

6.2.2.1 Choice of methods

The **biomass gain-loss method** is applied. According to the 2006 IPCC Guidelines, the biomass gain-loss method is applicable for all tiers estimating **Gains** include total (above-ground and below-ground) biomass

[1] 2006 IPCC Guidelines, Volume 4, Chapter 4 FOREST LAND Glossary.

growth. Losses are roundwood removal/harvest, fuelwood removal/harvest/gathering, and losses from disturbances by fire, insects, diseases, and other disturbances.

Tier 1 is feasible even when country-specific estimates of activity data and emission/removal factors are not available and works when changes of the carbon pool in biomass on *Forestland Remaining Forestland* are relatively small. Emission and removal factors are default from the 2006 IPCC Guidelines.

Equation 2.2: Annual carbon stock changes for a land-use category as a sum of changes in each stratum within the category (2006 IPCC Guidelines, Volume 4, Chapter 2)

$$\Delta C_{LU} = \sum_{i,j} \Delta C_{LUi}$$

Where:

ΔCG = carbon stock changes for a land-use (LU) category

i = denotes a specific stratum or subdivision within the land-use category (by any combination of species, climatic zone, ecotype, management regime etc

Calculation steps for TIER 1

Step 1: **categorize the area (A)** of *Forestland Remaining Forestland* into forest types of different climatic or ecological zones, as adopted by the country.

The method requires the biomass carbon loss to be subtracted from the biomass carbon gain (Equation 2.7). The annual change in carbon stocks in biomass can be estimated using the gain-loss method, where the annual increase in carbon stocks due to biomass growth and annual decrease in carbon stocks due to biomass losses are estimated:

- The annual increase in biomass carbon stock is estimated using Equation 2.9, where area under each forest sub-category is multiplied by mean annual increment in tons of dry matter per hectare per year.

Step 2: **Estimate the annual biomass gain** in *Forestland Remaining Forestland* (ΔC_G)

- Since the biomass growth is usually in terms of merchantable volume or above-ground biomass, the belowground biomass is estimated with a below-ground biomass to above-ground biomass ratio (Equation 2.10).
- Biomass Expansion Factors (BEFI) expand merchantable volume to total aboveground biomass volume to account for non-merchantable components of the tree, stand and forest. BEFI is dimensionless.
- The average above-ground biomass of forest areas affected by disturbances are given in Tables 4.7 and 4.8 of 2019 Refinements to 2006 IPCC GL.
- Net average annual above-ground biomass growth values are provided in Tables 4.9, 4.10, and 4.12;
- Net volume annual increment values are provided in Tables 4.11A and 4.11B.
- Wood density is given in Tables 4.13 and 4.14; and below-ground biomass to above-ground biomass ratios (R) are given in Table 4.4. Refer to Box 4.2 for detailed explanation on how to convert and expand volumes of growing stock, increment and wood removals to biomass.
- In some ecosystems, basic wood density (D) can influence spatial patterns of forest biomass (Baker et al., 2004b). Tier 1 users who do not have measurements of wood density at the desired sub-strata level can
- estimate wood density by estimating the proportion of total forest biomass contributed by the 2-3 dominant species and using species-specific wood density values (Tables 4.13 and 4.14) to calculate a weighted average wood density value.
- Annual biomass loss or decrease in biomass carbon stocks is estimated using Equation 2.11, which requires estimates of annual carbon loss due to wood removals (Equation 2.12), fuelwood removal (Equation 2.13) and disturbances (Equation 2.14). Transfer of biomass to dead organic matter is estimated using Equation 2.20, based on estimates of annual biomass carbon lost due to mortality (Equation 2.21), annual carbon transfer to slash (Equation 2.22).
- Biomass estimates are converted to carbon values using carbon fraction of dry matter (Table 4.3).

Step 3: Estimate the **annual carbon loss due to wood removals** ($L_{wood\text{-}removals}$) using Equation 2.12 in Chapter 2 of Vol.4 of the 2006 IPCC GL.

Step 4: Estimate **annual carbon loss due to fuelwood removal** ($L_{fuelwood}$) using Equation 2.13 in Chapter 2 of Vol.4 of the 2006 IPCC GL.

Step 5: Estimate **annual carbon loss due to disturbance** ($L_{disturbance}$) using Equation 2.14 in Chapter 2 of Vol.4 of the 2006 IPCC GL, avoid double counting of losses already covered in wood removals and fuelwood removals;

Step 6: From the estimated losses in Steps 3 to 5, estimate the **annual decrease in carbon stocks due to biomass losses** (ΔC_L) using Equation 2.11 in Chapter 2 Chapter 2 of Vol.4 of the 2006 IPCC GL.

Step 7: Estimate the **annual change in carbon stocks in biomass** (ΔC_B) using Equation 2.7 in Chapter 2 Chapter 2 of Vol.4 of the 2006 IPCC GL.

6.2.2.1.1 Annual biomass gains in Forestland Remaining Forestland

For estimation of **annual biomass gain** (ΔC_G) in *Forestland Remaining Forestland* using estimates of area and biomass growth, for each forest type and climatic zone in the country available using Equations 2.9 and 2.10 in Chapter 2 of Volume 4 of the 2006 IPCC GL[2].

Equation 2.9: Annual increase in biomass carbon stock due to biomass increment in land remaining in Forestland remaining land forest (2006 IPCC Guidelines, Volume 4, Chapter 2)

$$\Delta C_G = \sum_{i,j} (A_{i,j} * G_{TOTAL_{i,j}} * CF_{i,j})$$

Where:

ΔC_G = annual increase in biomass carbon stocks due to biomass growth in land remaining in the same land-use category by vegetation type and climatic zone , tons C yr^{-1}

A = area of land remaining in the same land-use category, ha

G_{TOTAL} = mean annual biomass growth, tons d. m .ha^{-1}, yr^{-1}

i = ecological zone (i=1 to n)

j = *Climate domain (j= 1 to m)*

CF= carbon fraction of dry matter , tons C (tons d.m)$^{-1}$

Equation 2.10: Annual increment in biomass in land remaining in Forestland remaining land forest (2006 IPCC Guidelines, Volume 4, Chapter 2)

$$G_{TOTAL} = \sum \{G_w * (1 + R)\}$$

Biomass increment data (dry matter) are used directly

Where:

G_{TOTAL} = average annual growth above and below-ground , tons d. m. ha^{-1} yr^{-1}

G_W = average annual above-ground biomass growth for a specific woody vegetation type, tons d. m. ha^{-1} yr^{-1}

R = ratio of below-ground biomass to above-ground for a specific vegetation type, in tons d.m below-ground biomass (tons d.m. above-ground biomass)$^{-1}$.

R must be set to zero if assuming no changes of below allocation patterns (**Tier 1**)

6.2.2.1.1.1 Choice of activity data

Folder	\06_Inventory\2024_submission\04_LULUCF
File	. LandUse.xlsx
based on	• Sheet FRA_2020 • Sheet MADR_Series_B • PN_IFN-data.xlsx • FLremFL_BiomassGain_Detail_FRST • FLremFL_BiomassGain_Detail_MAQ

[2] 2006 IPCC Guidelines, Volume 4, Chapter 2, 2.3 Generic methods for CO_2 emissions and removals

NID Chapter	• FLremFL_BiomassGain_Detail_REMB • chapter 6.3.1 *Information on approaches used for representing land areas and on land-use databases used for the inventory preparation*

The area of Forestland Remaining Forestland was taken from the FAO Global Forest Resource Assessment (FRA) 2020[3] which was prepared by DGF - Direction Générale des Forêts Algérie[4].

6.2.2.1.1.2 Choice of Removal factor

Folder	\06_Inventory\2024_submission\04_LULUCF\
File	LULUCF_4A1_FL_remaining_FL_v11.xlsx
Sheet	2006_IPCC_GL_EF

Default values for the above-ground biomass growth (GW) were taken from Tables 4.9 and 4.10 of the 2006 IPCC Guidelines and are presented in the next tables.

Table 6-1 Above-ground net biomass growth in natural forests

Domain	Ecological zone	Continent	Above-ground biomass growth		Status in Algeria
			tonnes d.m. ha^{-1} yr^{-1}		
Subtropical	Subtropical dry forest	Africa (≤20 y)	2.4	2.3-2.5	Zones de Montagne (ZdM)
		Africa (>20 y)	1.8	0.6-3.0	
	Subtropical steppe	Africa (≤20 y)	1.2	0.8-1.5	Sud
		Africa (>20 y)	0.9	0.2-1.6	
	Subtropical mountain systems	Africa (≤20 y)	3.50	2.0-5.0	HAUTS PLATEAUX (HPl)
		Africa (>20 y)	1.25	1.0-1.5	
	Subtropical desert (as default values for Subtropical steppe)	Africa (≤20 y)	1.2	0.8-1.5	Sud
		Africa (>20 y)	0.9	0.2-1.6	
Sources: Table 4.9 Above-ground net biomass growth in natural forests; 2019 Refinements to 2006 IPCC GL, Volume 4, Chapter 4					

[3] https://www.fao.org/3/cb0128fr/cb0128fr.pdf

[4] http://www.dgf.org.dz/fr

Table 6-2 Above-ground net biomass growth in tropical and sub-tropical forest plantation

Domain	Ecological zone	Continent	Above-ground biomass growth tonnes d.m. ha^{-1} yr^{-1}		Status in Algeria
Subtropical	Subtropical dry forest	Africa Eucalyptus sp. ≤20 y	13	-	Zones de Montagne (ZdM)
		Africa Pinus sp. > 20 y	10	-	
		Africa Pinus sp. ≤ 20 y	8	-	
		Africa other ≤ 20 y	10	4-20	
	Subtropical steppe	Africa Eucalyptus sp. >20 y	8	5-14	Sud
		Africa Eucalyptus sp. ≤20 y	5	3-7	
		Africa Pinus sp. > 20 y	2.5	2.5	
		Africa Pinus sp. ≤ 20 y	3	0.5-6	
		Africa other > 20 y	10	10	
		Africa other ≤ 20 y	15	15	
	Subtropical mountain systems	Africa	10	10	HAUTS PLATEAUX (HPl)
	Subtropical desert	(as default values for Subtropical steppe)	(as default values for Subtropical steppe)	(as default values for Subtropical steppe)	Sud

Sources: Table 4.10 Above-ground net biomass growth in tropical and sub-tropical forest plantations; 2019 Refinements to 2006 IPCC GL, Volume 4, Chapter 4

The ratios of below-ground biomass to above-ground biomass for a specific vegetation type (R) should be taken from Tables 4.4 of the 2006 IPCC Guidelines and are presented in the next table.

However, as Tier 1 is applied which is based on the assumption that there are no changes of below allocation patterns, R must be set to zero.

6.2.2.1.2 Annual decrease in carbon stocks due to biomass losses

6.2.2.1.2.1 Choice of method

Loss estimates are needed for calculating biomass carbon stock change using the Gain-Loss Method. For this, the annual biomass loss ΔC_L is the sum of losses from

- wood removal (harvest),
- fuelwood removal (not counting fuelwood gathered from woody debris), and
- disturbances, such as fire, storms, and insect and diseases.

For estimating ΔCL we used equation 2.11 in Chapter 2 of Volume 4 of the 2006 IPCC GL ***Error! Bookmark not defined.***.

*Equation 2.11 Annual decrease in carbon stocks due to biomass losses in land remaining in the same land-use category (2006 IPCC Guidelines, Volume 4, Chapter 2)****Error! Bookmark not defined.***

$$\Delta C_L = L_{wood-removals} + L_{fuelwood} + L_{distrubances}$$

Where:

ΔC_L = annual decrease in carbon stocks due to biomass loss in land remaining in the same land-use category, tons C yr^{-1}

L wood-removals = annual carbon loss due to wood removals, tons C yr^{-1}
(Calculated using equation2.12)
L fuelwood = annual biomass carbon loss due to fuelwood removals, tons C yr^{-1}
(Calculated using equation 2.13)
L disturbance = annual biomass carbon losses due to disturbances, tons C yr^{-1}
(Calculated using equation 2.14)

The carbon loss due to biomass removals, fuelwood removal and disturbances are provided in the following table. The underlying methodology, activity data and parameter are described in the following chapters.

6.2.2.1.2.2 Choice of activity data

Folder	\06_Inventory\2024_submission\04_LULUCF
File	. LULUCF_4A1_FL_remaining_FL_v11.xlsx
based on	• FEUX_DE_FORETS_from1990.xlsx • DGF_Production_Forestiere_v2.xlsx • Sheet FL_rem_FL_Biomass_Loss_Fire_For • Sheet FL_rem_FL_Biomass_Loss_Fire_Maq

6.2.2.1.2.3 Choice of Removal factor

Folder	\06_Inventory\2024_submission\04_LULUCF\
File	LULUCF_4A1_FL_remaining_FL_v11.xlsx
Sheet	2006_IPCC_GL_EF

Default values for the above-ground biomass growth (GW) were taken from Tables 4.9 and 4.10 of the 2006 IPCC Guidelines and are presented in the next tables

Table 6-3 Above-ground net biomass growth in natural forests

Domain	Ecological zone	Continent	Status/condition	Above-ground biomass growth	Status in Algeria
				tonnes d.m. ha^{-1} yr^{-1}	
Subtropical	Subtropical humid forest	Africa	Secondary >20 years	1.0	Not occurring (NO)
			Secondary ≤20 years	2.5	
	Subtropical dry forest		Secondary >20 years	1.8 (0.6-3.0)	Zones de Montagne (ZdM)
			Secondary ≤20 years	2.4 (2.3-2.5)	
	Subtropical steppe		Secondary >20 years	0.9 (0.2-1.6)	Sud
			Secondary ≤20 years	1.2 (0.8-1.5)	
	Subtropical mountain systems		Secondary >20 years	0.5	HAUTS PLATEAUX (HPl)
			Secondary ≤20 years	2.5	
	Sources: Table 4.9 Above-ground net biomass growth in natural forests; 2019 Refinement to 2006 IPCC Guidelines, Volume 4, Chapter 4				

Domain	Ecological zone	Continent	Above-ground biomass growth		Status in Algeria
			tonnes d.m. ha^{-1} yr^{-1}		
Subtropical	Subtropical dry forest	Africa Eucalyptus sp. ≤20 y	13	-	Zones de Montagne (ZdM)
		Africa Pinus sp. > 20 y	10	-	
		Africa Pinus sp. ≤ 20 y	8	-	
		Africa other ≤ 20 y	10	4-20	
	Subtropical steppe	Africa Eucalyptus sp. >20 y	8	5-14	Sud
		Africa Eucalyptus sp. ≤20 y	5	3-7	
		Africa Pinus sp. > 20 y	2.5	2.5	
		Africa Pinus sp. ≤ 20 y	3	0.5-6	
		Africa other > 20 y	10	10	
		Africa other ≤ 20 y	15	15	
	Subtropical mountain systems	Africa	10	10	HAUTS PLATEAUX (HPl)
	Subtropical desert	(as default values for Subtropical steppe)	(as default values for Subtropical steppe)	(as default values for Subtropical steppe)	Sud

Sources: Table 4.10 Above-ground net biomass growth in tropical and sub-tropical forest plantations; 2019 Refinements to 2006 IPCC GL, Volume 4, Chapter 4

Table 6-4 Above-ground net biomass growth in tropical and sub-tropical forest plantation

6.2.2.1.3 Annual carbon loss due to wood removals in Forestland Remaining Forestland

6.2.2.1.3.1 Choice of method

The method for estimating the annual biomass carbon loss due to wood-removals is provided in Equation 2.12 in Chapter 2 of Volume 4 of the 2006 IPCC GL[5].

Equation 2.12: Annual carbon loss in wood removals in land remaining in Forestland remaining land forest (2006 IPCC Guidelines, Volume 4, Chapter 2)

$$L_{wood-removals} = \{H * BCEF_R * (1 + R) * CF\}$$

Where:

L wood-removals = annual carbon loss due to biomass removals, tons C yr^{-1}

H = annual wood removals, roundwood, m^3 yr^{-1}

BCEF R = biomass conversion and expansion factor for conversion of removals in merchantable volume to total biomass removals (including bark), tons biomass removal (m^3 of removals)$^{-1}$, (Table 4.5 for Forestland).

R = ratio of below to above-ground biomass, in tons d.m below-ground biomass (ton d.m. above-ground biomass)$^{-1}$. **R must be set to zero if assuming no changes of below-ground biomass allocation patterns (TIER 1)**.

CF = carbon fraction of dry matter, ton C (ton d.m)$^{-1}$

6.2.2.1.3.2 Choice of activity data

Folder	\06_Inventory\2026_submission\04_LULUCF\4A
File	. FEUX_DE_FORETS_from1990.xlsx
	• DGF_Production_Forestiere_v2.xlsx

[5] 2006 IPCC Guidelines, Volume 4, Chapter 2, 2.3 Generic methods for CO_2 emissions and removals

	• Sheet DGF_Production_Forestieres • Sheet FL_rem_FL_Biomass_Loss_IndW

6.2.2.1.3.3 Choice of factors

Folder	\06_Inventory\2024_submission\04_LULUCF\
File	LULUCF_4A1_FL_remaining_FL_v11.xlsx
Sheet	2006_IPCC_GL_EF

The default values for above-ground net biomass growth (CF) were taken from Table 4.3 of the 2006 IPCC Guidelines.

Table 6-5 Above-ground net biomass growth in tropical and sub-tropical natural forest

Domain	Part of tree	Carbon fraction, (CF) [ton **C** (ton **d.m.**)$^{-1}$]	
Default value	All	0.47	
	All	0.47	(0.44 - 0.49)
	wood	0.49	
	wood, tree d < 10 cm	0.46	
	wood, tree d ≥ 10 cm	0.49	
	foliage	0.47	
	foliage, tree d < 10 cm	0.43	
	foliage, tree d ≥ 10 cm	0.46	
Tropical and Subtropical	All	0.47	(0.47 - 0.49)
	broad-leaved	0.48	(0.46 - 0.50)
Temperate and Boreal	Conifers	0.51	(0.47 - 0.55)
Sources: Table 4.3 Carbon fraction of aboveground forest biomass, 2006 IPCC Guidelines, Volume 4, Chapter 4			

The default values for biomass conversion and expansion factor for conversion of removals in merchantable volume to biomass removals including bark ($BCEF_R$) were taken from Tables 4.5 of the 2006 IPCC Guidelines.

Table 6-6 Default biomass conversion and expansion factors (BCEF), tons biomass (m^3 of wood volume)$^{-1}$

Default biomass conversion and expansion factors (BCEF) (tons **biomass (m^3 of wood volume)$^{-1}$**)										
Climatic zone	**Forest type**	**BCEF**	**Growing stock level (m^3)**							
			<20		**21-40**		**41-80**		**>80**	
Mediterranean, dry tropical, subtropical	hardwoods	$BCEF_S$	**5**	2.0-8.0	**1,9**	1.0-2.6	**0,8**	0.6-1.4	**0,66**	0.4-0.9
		$BCEF_I$	1,5		0,5		0,55		0,66	
		$BCEF_R$	5,55		2,11		0,89		0,73	
	conifers	$BCEF_S$	**6**	3.0-8.0	**1,2**	0.5-2.0	**0,6**	0.4-0.9	0,55	0.4-0.7
		$BCEF_I$	1,5		0,4		0,45		0,54	
		$BCEF_R$	6,67		1,33		0,67		0,61	
Sources: Table 4.5 Default biomass conversion and expansion factors; 2006 IPCC Guidelines, Volume 4, Chapter 4										

The ratio of below to above-ground biomass is assumed to be zero if assuming no changes of below-ground biomass allocation patterns (TIER 1).

6.2.2.1.4 Annual carbon loss due to fuelwood removal in Forestland Remaining Forestland

Folder	\06_Inventory\2026_submission\04_LULUCF\4A
File	. FEUX_DE_FORETS_from1990.xlsx

Based on	• DGF_Production_Forestiere_v2.xlsx • Sheet FL_rem_FL_Biomass_Loss_FuelW

6.2.2.1.4.1 Choice of method

For estimating the CO_2 emissions and removals from fuelwood in Forestland remaining Forestland the Tier 1 of 2006 the IPCC Guidelines has been applied:

Equation 2.13: Annual carbon loss in biomass of fuelwood removal in land remaining in Forestland remaining land forest (2006 IPCC Guidelines, Volume 4, Chapter 2)

$$L_{fuelwood} = \left[\{FG_{trees} * BCEF_R * (1 + R)\} + FG_{part} * D\right] * CF$$

Where:

$L_{fuelwood}$ = annual carbon loss due to fuelwood removals, tons C yr^{-1}

FG_{trees} = annual volume of fuelwood removal of whole trees, m^3 yr^{-1}

FG_{part} = annual volume of fuelwood removal as tree parts, m^3 yr^{-1}

R = ratio of below-ground biomass to above-ground biomass, in ton d.m. below-ground biomass (ton d.m. above-ground biomass)$^{-1}$; R must be set to zero if assuming no changes of below-ground biomass allocation patterns. (Tier 1)

CF = carbon fraction of dry matter, ton C (ton d.m.)$^{-1}$

D = basic wood density, tons d.m. m^{-3}

BCEF R = biomass conversion and expansion factor for conversion of removals in merchantable volume to total biomass removals (including bark), tons biomass removal (m^3 of removals)$^{-1}$, (see Table 4.5 for Forestland). However, if BCEFR values are not available and if the biomass expansion factor for wood removals (BEFR) and basic wood density (D) values are separately estimated, then the following conversion can be used: BCEF R = BEFR * D.

6.2.2.1.4.2 choice of activity data

Folder	\06_Inventory\2026_submission\04_LULUCF\4A
File	. FEUX_DE_FORETS_from1990.xlsx
Based on	• DGF_Production_Forestiere_v2.xlsx • Sheet DGF_Production_Forestieres • Sheet FL_rem_FL_Biomass_Loss_FuelW

6.2.2.1.4.3 Choice of removal factors

Folder	\06_Inventory\2024_submission\04_LULUCF\
File	LULUCF_4A1_FL_remaining_FL_v11.xlsx
Sheet	2006_IPCC_GL_EF

The default value for above-ground net biomass growth (CF) were taken from Table 4.3 of the 2006 IPCC Guidelines.

Table 6-7 Above-ground net biomass growth in tropical and sub-tropical natural forest

Domain	Part of tree	Carbon fraction, (CF) [ton C (ton d.m.)$^{-1}$]	
Default value	All	0.47	
Tropical and Subtropical	All	0.47	(0.44 - 0.49)
	wood	0.49	
	wood, tree d < 10 cm	0.46	
	wood, tree d ≥ 10 cm	0.49	
	foliage	0.47	
	foliage, tree d < 10 cm	0.43	
	foliage, tree d ≥ 10 cm	0.46	
Temperate and Boreal	All	0.47	(0.47 - 0.49)
	broad-leaved	0.48	(0.46 - 0.50)
	Conifers	0.51	(0.47 - 0.55)
Sources: Table 4.3 Carbon fraction of aboveground forest biomass, 2006 IPCC Guidelines, Volume 4, Chapter 4			

The default values for biomass conversion and expansion factors for conversion of removals in merchantable volume to biomass removals including bark ($BCEF_R$) were taken from Tables 4.5 of the 2006 IPCC Guidelines.

Table 6-8 Default biomass conversion and expansion factors (BCEF), tons biomass (m^3 of wood volume)$^{-1}$

Default biomass conversion and expansion factors (BCEF) (tons biomass (m3 of wood volume)$^{-1}$)										
Climatic zone	**Forest type**	**BCEF**	**Growing stock level (m^3)**							
			<20		**21-40**		**41-80**		**>80**	
Mediterranean, dry tropical, subtropical	hardwoods	$BCEF_S$	**5**	2.0-8.0	**1,9**	1.0-2.6	**0,8**	0.6-1.4	**0,66**	0.4-0.9
		$BCEF_I$	1,5		0,5		0,55		0,66	
		$BCEF_R$	5,55		2,11		0,89		0,73	
	conifers	$BCEF_S$	**6**	3.0-8.0	**1,2**	0.5-2.0	**0,6**	0.4-0.9	0,55	0.4-0.7
		$BCEF_I$	1,5		0,4		0,45		0,54	
		$BCEF_R$	6,67		1,33		0,67		0,61	
Sources: Table 4.5 Default biomass conversion and expansion factors; 2006 IPCC Guidelines, Volume 4, Chapter 4										

The ratio of below to above-ground biomass is assumed to be zero if assuming no changes of below-ground biomass allocation patterns (TIER 1).

6.2.2.1.5 Annual carbon loss due to disturbance in Forestland Remaining Forestland

Folder	\06_Inventory\2024_submission\04_LULUCF
File	. LULUCF_4A1_FL_remaining_FL_v11.xlsx
based on	• FEUX_DE_FORETS_from1990.xlsx • DGF_Production_Forestiere_v2.xlsx • Sheet FL_rem_FL_Biomass_Loss_Fire_For • Sheet FL_rem_FL_Biomass_Loss_Fire_Maq

6.2.2.1.5.1 Choice of method

A generic approach for estimating the amount of carbon lost from disturbances is provided in Equation 2.14 in Chapter 2 of Volume 4 of the 2006 IPCC GL. In the specific case of losses from fire on managed land, including wildfires and controlled fires, this method should be used to provide input to the methodology to estimate CO_2 and non-CO_2 emissions from fires. The Tier 1 assumption is that all of fuelwood is emitted in the year of disturbance:

Equation 2.14: Annual carbon losses in biomass due to disturbances
(2006 IPCC Guidelines, Volume 4, Chapter 2)

$$L_{distrubance} = \{A_{distrubance} * B_w * (1 + R) * CF * fd$$

Where:

$L_{disturbance}$ = annual other losses of carbon, tons C yr^{-1}
(Note that this is the amount of biomass that is lost from the total biomass. The partitioning of biomass that is transferred to dead organic matter and biomass that is oxidized and released to the atmosphere is explained in Equations 2.15 and 2.16).

$A_{disturbance}$ = area affected by disturbances, ha yr^{-1} ,

B_W = average above-ground biomass of land areas affected by disturbances, tons d.m. ha^{-1},

R = ratio of below-ground biomass to above-ground biomass, in ton d.m. below-ground biomass (ton d.m. above-ground biomass)$^{-1}$. R must be set to zero if no changes of below-ground biomass are assumed (Tier 1)

C_F = carbon fraction of dry matter, ton C (tons d.m.)$^{-1}$

fd = fraction of biomass lost in disturbance (see note below).

Equation 2.14 does not specify the fate of the carbon removed from the biomass carbon stock. The Tier 1 assumption is that all of $L_{disturbances}$ is emitted in the year of disturbance.

6.2.2.1.5.2 Choice of activity data

Folder	\06_Inventory\2026_submission\04_LULUCF\4A
File	. FEUX_DE_FORETS_from1990.xlsx
Based on	• DGF_Production_Forestiere_v2.xlsx • Sheet DGF_Production_Forestieres • Sheet FL_rem_FL_Biomass_Loss_FuelW

6.2.2.1.5.3 Choice of disturbances factors

Folder	\06_Inventory\2024_submission\04_LULUCF\
File	LULUCF_4A1_FL_remaining_FL_v11.xlsx
Sheet	2006_IPCC_GL_EF

The default values for above-ground biomass of areas affected were taken from table 4.7 of the 2019 Refinements to the 2006 IPCC GL

Table 6-9 Above-ground biomass in forests

Domain	Ecological zone	Continent	Status/condition	Above-ground biomass (tonnes d.m. ha $^{-1}$)	Status in Algeria
Subtropical	Subtropical humid forest	Africa	Primary	54.1	Not occurring (NO)
			Secondary >20 years		
			Secondary ≤20 years		
	Subtropical dry forest	Africa	Primary	65.2	Zones de Montagne (ZdM)
			Secondary >20 years		
			Secondary ≤20 years		
	Subtropical steppe Subtropical desert	Africa	Primary	50.5	Sud
			Secondary >20 years		
			Secondary ≤20 years		
	Subtropical mountain systems	Africa	Primary	35.1	HAUTS PLATEAUX (HPl)
			Secondary >20 years		
			Secondary ≤20 years		
Sources: table 4.7 Above-ground biomass in forests; 2006 IPCC Guidelines, Volume 4, Chapter 4					

The ratio of below to above-ground biomass is assumed to be zero if assuming no changes of below-ground biomass allocation patterns (TIER 1).

6.2.2.2 Uncertainty assessment and time-series consistency

No uncertainties provided for IPCC category 4.A Forestland due to lack of detailed information of background data of activity data.

6.2.2.3 Category-specific planned improvements

Folder	\06_Inventory\2026_submission\04_LULUCF\4A
File	LULUCF_4A1_FL_remaining_FL_v11.xlsx
Sheet	PlannedImprovements

Due to a lack of national expertise in utilizing FAO data satellite data, it was not possible to estimate changes in forest soil carbon stocks using available data from FAO or national sources. Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in forest soils.

6.2.3 Land converted to Forestland (IPCC category 4.B.2)

Folder	\06_Inventory\2024_submission\04_LULUCF
NID CHAPTER	Land converted to Forestland (IPCC category 4.A.2)

This category was not estimated due to lack of data.

6.2.3.1 Category-specific planned improvements

Folder	\06_Inventory\2026_submission\04_LULUCF\4A
File	LULUCF_4A1_FL_remaining_FL_v11.xlsx
Sheet	PlannedImprovements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in the following table will be explored.

6.3 Cropland (IPCC category 4.B)

This chapter includes information and description of methodologies used for estimating GHG emissions as well as references to activity data and emission factors reported under IPCC category 4. B Cropland. It's to mention that only IPCC category 4.B.1 was estimated in the IPCC category 4. B for this cycle of inventory.

The time series was developed as it's mentioned in chapter **6.3.1 Information on approaches** used for representing land areas and on land-use databases used for the inventory preparation.

To estimate this category, it's considered only perineal cultures mentioned in the table below.

This figure shows the area of perineal cultures by cultivation with a significant increase in cultivated area, particularly after the year 2000 for olive trees. The areas dedicated to vines wine and trees, citrus, and fig trees exhibit more fluctuations during the period 1990-2022.

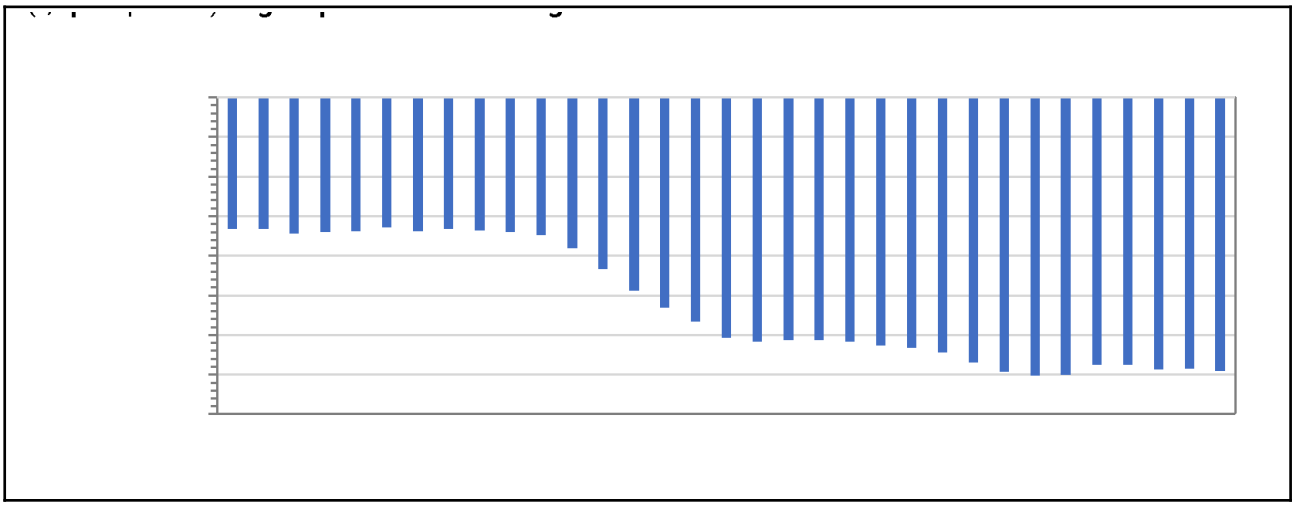

Figure 6-2 GHG emissions and removals in Cropland remaining cropland

The GHG emissions from IPCC category 4.B Cropland is amounted to -661.74 kt CO_2 equivalent, -1,233.24 kt CO_2 equivalent in 2010 and -1,378.68 kt CO_2 equivalent in 2022.

In the period 1990-2022 the GHG removals increased by 108.3 % and in the period 2010-2022 the CO_2 removals increased by 11.8 % and by 0.8 % in the period 2021-2022. This significant increase of removals may be attributed to the expansion of perennial cropland , which is a result of

- The NADP, launched in 2000, marked the beginning of a vast reform of the Algerian agricultural sector, which was extended to the rural sector in 2002.
- The diversification of the agricultural sector that is significant for its economy and food security
- The production of dates, olives, apricot, plum and figs represent an important economic factor; Algeria is a large exporter of these fruits.

Table 6-10 Annual increase in biomass carbon stocks due to biomass growth for IPCC category 4.B.1 Cropland remaining cropland

GHG emissions	4.B Cropland				4.A.2
	4.B.1 Cropland remaining Cropland				Land converted to Cropland
	TOTAL GHG	CO_2	CH_4	N_2O	
	kt CO_2 equivalent				kt CO_2 equivalent
1990	-661.74	-661.74	IE	IE	NE

GHG emissions	4.B Cropland				4.A.2
	4.B.1 Cropland remaining Cropland				Land converted to Cropland
	TOTAL GHG	CO_2	CH_4	N_2O	
	kt CO_2 equivalent				kt CO_2 equivalent
1991	-661.74	-661.74	IE	IE	NE
1992	-684.52	-684.52	IE	IE	NE
1993	-677.45	-677.45	IE	IE	NE
1994	-675.75	-675.75	IE	IE	NE
1995	-656.70	-656.70	IE	IE	NE
1996	-675.77	-675.77	IE	IE	NE
1997	-663.50	-663.50	IE	IE	NE
1998	-669.61	-669.61	IE	IE	NE
1999	-677.59	-677.59	IE	IE	NE
2000	-693.62	-693.62	IE	IE	NE
2001	-759.54	-759.54	IE	IE	NE
2002	-864.71	-864.71	IE	IE	NE
2003	-974.81	-974.81	IE	IE	NE
2004	-1,061.03	-1,061.03	IE	IE	NE
2005	-1,130.48	-1,130.48	IE	IE	NE
2006	-1,211.83	-1,211.83	IE	IE	NE
2007	-1,234.29	-1,234.29	IE	IE	NE
2008	-1,226.77	-1,226.77	IE	IE	NE
2009	-1,224.78	-1,224.78	IE	IE	NE
2010	-1,233.24	-1,233.24	IE	IE	NE
2011	-1,252.51	-1,252.51	IE	IE	NE
2012	-1,263.72	-1,263.72	IE	IE	NE
2013	-1,288.61	-1,288.61	IE	IE	NE
2014	-1,337.34	-1,337.34	IE	IE	NE
2015	-1,384.43	-1,384.43	IE	IE	NE
2016	-1,405.21	-1,405.21	IE	IE	NE
2017	-1,399.39	-1,399.39	IE	IE	NE
2018	-1,349.03	-1,349.03	IE	IE	NE
2019	-1,351.32	-1,351.32	IE	IE	NE
2020	-1,372.35	-1,372.35	IE	IE	NE
2021	-1,367.50	-1,367.50	IE	IE	NE
2022	-1,378.68	-1,378.68	IE	IE	NE
Trend					
1990 - 2022	108.34%	108.34%	NA	NA	NA
2010 - 2022	11.79%	11.79%	NA	NA	NA
2021 - 2022	0.82%	0.82%	NA	NA	NA

6.3.1 Cropland remaining Cropland (IPCC category 4.B.1)

It's to mentioned that only emissions and removals were estimated from living biomass. Dead wood is assumed to be not occurring on croplands remaining croplands. Litter and soil litter is assumed to be not occurring on croplands remaining croplands. Due to the lack of data on changes in management practices, changes in soil carbon stocks of croplands remaining croplands are not estimated.

This section outlines the methodology for calculating CO_2 emissions and removals from IPCC category 4.B.1 Cropland remaining cropland.

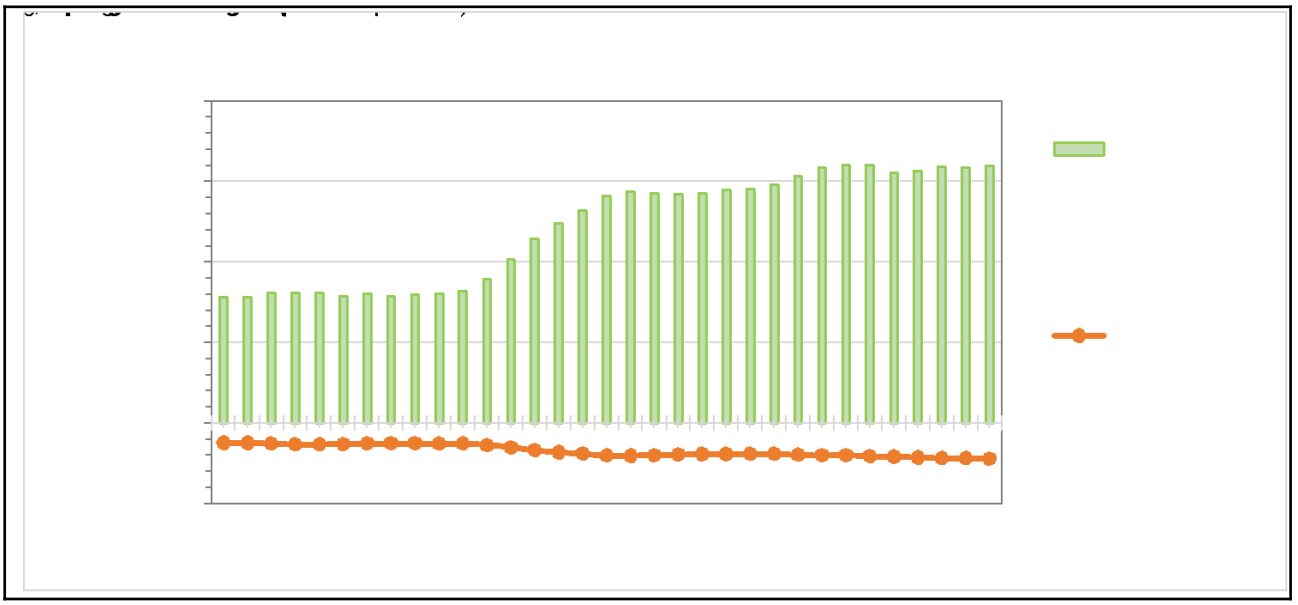

Figure 6-3 Cropland remaining cropland – carbon stock gains and losses

The graph demonstrates the annual variability in gain and losses within IPCC category cropland remaining cropland between 1990 and 2022. A significant increase in gains is observed starting from 2000, which can be attributed to the expansion of perennial crop areas.

6.3.1.1 Category description

This section describes the estimation of emissions and removals resulting from cropland as described in the 2006 IPCC Guidelines (Volume 5, chapter 5). Emissions and removals of CO_2 within the LULUCF Sector are generally estimated based on changes in ecosystem carbon stocks.

In the period 1990-2020 the CO_2 removals increased by 41% and in the period 2005-2020 the CO_2 emissions increased by 94%. Instead of the period of 2021-2022 were removals decreased by -1%. this may be due to fires which in increase for the five last years.

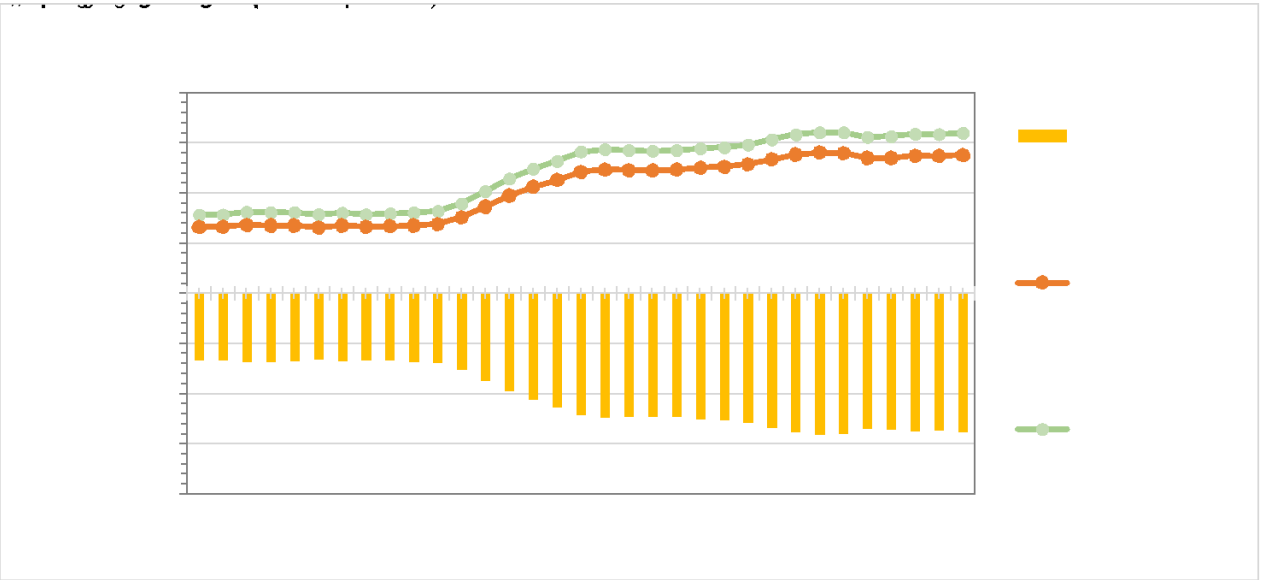

Figure 6-4 Cropland remaining cropland annual change in carbon stocks in biomass

6.3.1.2 Methodological issues

The **biomass gain-loss method** is applied. According to the 2006 IPCC Guidelines, the biomass gain-loss method is applicable for all tiers estimating **Gains** include total (above-ground and below-ground) biomass growth.

This is the Tier 1 method that, when combined with default biomass growth rates, allows for any country to calculate the annual increase in biomass, using estimates of area and mean annual biomass increment, for each land-use type and stratum (e.g., climatic zone, ecological zone, vegetation type) (Equation 2.9).

Step 1: Enter the subcategories of Cropland for the reporting year

Typically, there are various types of Croplands with woody perennial cover in a country with varying biomass stocks and increments. Examples of these are: fruit orchards (e.g., mango, citrus), agricultural plantations (e.g., coconut, rubber) and agroforestry farms.

Step 2: For each sub-category, enter the annual area of Cropland with perennial woody biomass

The area (A) in hectares of each sub-category of Cropland can usually be obtained from national land-use agencies, Ministry of Agriculture, and Ministry of Natural Resources. Possible sources of data include: satellite images, aerial photography and land-based surveys, and FAO database.

Step 3: For each sub-category, enter the mean annual carbon stocks in the biomass accumulation of perennial woody biomass

The annual growth rates (ΔC_G) for each sub-category of Cropland, from the biomass accumulation rates G in Table 5.1, are entered in the appropriate column of worksheets.

Step 4: For each sub-category, enter the annual carbon stocks in biomass losses

If there is harvesting, the amount of carbon stocks from the biomass harvested (ΔC_L) is entered in the appropriate column.

This can be estimated by multiplying the default above woody above ground biomass for various croplands in Table 5.3 by the default carbon density of 0.5 tonne C/tonne biomass.

Step 5: Calculate the annual change of carbon stocks in biomass for each sub-category

The annual change of carbon stocks in biomass (ΔC_B) is calculated using Equation 2.7 in Chapter 2.

Step 6: Calculate the total change in carbon stocks (ΔC_B) by adding up all the values of the subcategory

6.3.1.2.1 Annual biomass gain in Cropland Remaining Cropland

The annual biomass gain increased by 103.49% in the period 1990-2022. Then increased by 12.02% in the period 2010-2022 and by 0.86% in the period 2021-2022. It's due mainly to the increase of crop land area over the years for the reasons mentioned in chapter 6.6 Cropland.

Table 6-11 Annual increase in biomass carbon stocks due to biomass growth for IPCC category 4.B.1 Cropland remaining cropland

	Annual increase in biomass carbon stocks due to biomass growth					
	Total	Vine wine and grapes	Olivier	Date palms	Citrus	Fig trees
	kt CO_2 equivalent					
1990	-785.46	-58.01	-277.49	-310.87	-69.14	-69.96
1991	-785.46	-58.01	-277.49	-310.87	-69.14	-69.96
1992	-811.20	-85.37	-277.10	-312.95	-70.82	-64.96
1993	-810.13	-82.01	-272.19	-314.72	-74.94	-66.27
1994	-808.63	-80.93	-271.99	-314.55	-75.10	-66.06
1995	-787.61	-65.06	-271.18	-314.06	-74.07	-63.24
1996	-802.04	-64.45	-278.37	-330.67	-70.59	-57.96
1997	-789.09	-58.98	-274.66	-328.37	-70.35	-56.73
1998	-795.87	-58.01	-278.74	-332.66	-70.67	-55.80
1999	-804.61	-58.74	-279.31	-339.22	-71.01	-56.33
2000	-821.26	-61.38	-288.67	-344.13	-71.11	-55.97
2001	-896.22	-71.54	-317.75	-371.90	-75.84	-59.19
2002	-1,017.28	-83.72	-364.74	-419.21	-84.35	-65.26
2003	-1,143.24	-98.18	-413.95	-467.28	-92.73	-71.10
2004	-1,241.96	-102.08	-457.66	-507.50	-99.30	-75.41
2005	-1,320.55	-104.42	-494.83	-539.13	-103.98	-78.18
2006	-1,413.70	-100.83	-541.27	-579.51	-110.14	-81.95
2007	-1,437.35	-95.18	-560.58	-589.88	-110.43	-81.27
2008	-1,425.66	-89.71	-565.17	-584.61	-107.77	-78.41
2009	-1,420.35	-84.95	-572.12	-581.83	-105.57	-75.89
2010	-1,426.92	-82.57	-583.17	-583.17	-104.12	-73.89
2011	-1,446.06	-79.80	-600.01	-590.07	-103.62	-72.55
2012	-1,455.83	-76.32	-613.23	-593.18	-102.41	-70.69
2013	-1,481.02	-75.39	-632.38	-601.74	-102.09	-69.42
2014	-1,533.82	-72.74	-665.15	-622.71	-103.78	-69.44
2015	-1,584.11	-72.55	-696.22	-641.36	-104.94	-69.04
2016	-1,604.17	-70.48	-714.61	-647.84	-104.02	-67.20
2017	-1,604.58	-71.50	-730.26	-629.98	-108.29	-64.54
2018	-1,558.17	-71.23	-726.97	-585.97	-111.95	-62.06
2019	-1,566.55	-70.48	-727.81	-590.13	-115.94	-62.18
2020	-1,590.98	-71.17	-739.36	-599.50	-117.78	-63.17
2021	-1,585.32	-71.17	-736.61	-597.27	-117.34	-62.93
2022	-1,598.37	-71.17	-742.96	-602.41	-118.35	-63.48
Trend						
1990 - 2022	103.49%	22.69%	167.74%	93.78%	71.19%	-9.26%
2010 - 2022	12.02%	-13.81%	27.40%	3.30%	13.67%	-14.09%
2021 - 2022	0.86%	0.86%	0.86%	0.86%	0.86%	0.86%

6.3.1.2.1.1 Choice of method

The change in biomass is only estimated for perennial woody crops. For annual crops, increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year - thus there is no net accumulation of biomass carbon stocks.

Changes in carbon in cropland biomass (ΔC_{CCB}) may be estimated from annual rates of biomass gain and loss.

Tier 1

The default method is to multiply the area of perennial woody cropland by a net estimate of biomass accumulation from growth and subtract losses associated with harvest or gathering or disturbance (according to Equation 2.7 in Chapter 2). Losses are estimated by multiplying a carbon stock value by the area of cropland on which perennial woody crops are harvested.

Default Tier 1 assumptions are: all carbon in perennial woody biomass removed (e.g., biomass cleared and replanted with a different crop) is emitted in the year of removal; and perennial woody crops accumulate carbon for an amount of time equal to a nominal harvest/maturity cycle. The latter assumption implies that perennial woody crops accumulate biomass for a finite period until they are removed through harvest or reach a steady state where there is no net accumulation of carbon in biomass because growth rates have slowed and incremental gains from growth are offset by losses from natural mortality, pruning or other losses.

For estimation of **annual biomass gain** (ΔC_G) in *Cropland Remaining Cropland* using estimates of area and biomass growth, for in the country available using Equations 2.9 and 2.10 in Chapter 2 of Volume 4 of the 2006 IPCC GL[6].

Equation 2.9: Annual increase in biomass carbon stock due to biomass increment in land remaining in Forestland remaining land forest (2006 IPCC Guidelines, Volume 4, Chapter 2)

$$\Delta C_G = \sum_{i,j} (A_{i,j} * G_{TOTAL_{i,j}} * CF_{i,j})$$

Where:

- ΔC_G = annual increase in biomass carbon stocks due to biomass growth in land remaining in the same land-use category by vegetation type and climatic zone, tons C yr^{-1}
- A = area of land remaining in the same land-use category, ha
- G_{TOTAL} = mean annual biomass growth, tons d. m. ha^{-1} yr^{-1}
- *i* = ecological zone (*i* = 1 to *n*)
- *j* = climate domain (*j* = 1 to *m)*
- C_F = carbon fraction of dry matter, ton C (ton d.m.)$^{-1}$

G_{TOTAL} is the total biomass growth expanded from the above-ground biomass growth (Gw) to include below ground biomass growth. Following a Tier 1 method, this may be achieved directly by using default values of GW for naturally regenerated trees or broad categories of plantations together with R, the ratio of below-ground biomass to above-ground biomass differentiated by woody vegetation type.

[6] 2006 IPCC Guidelines, Volume 4, Chapter 2, 2.3 Generic methods for CO_2 emissions and removals

6.3.1.2.1.2 Choice of activity data

Activity data consist of areas of Cropland Remaining Cropland summarized by major cropland are shown in table 6-36 in chapter 6.6 Cropland (IPCC category 4.B) .

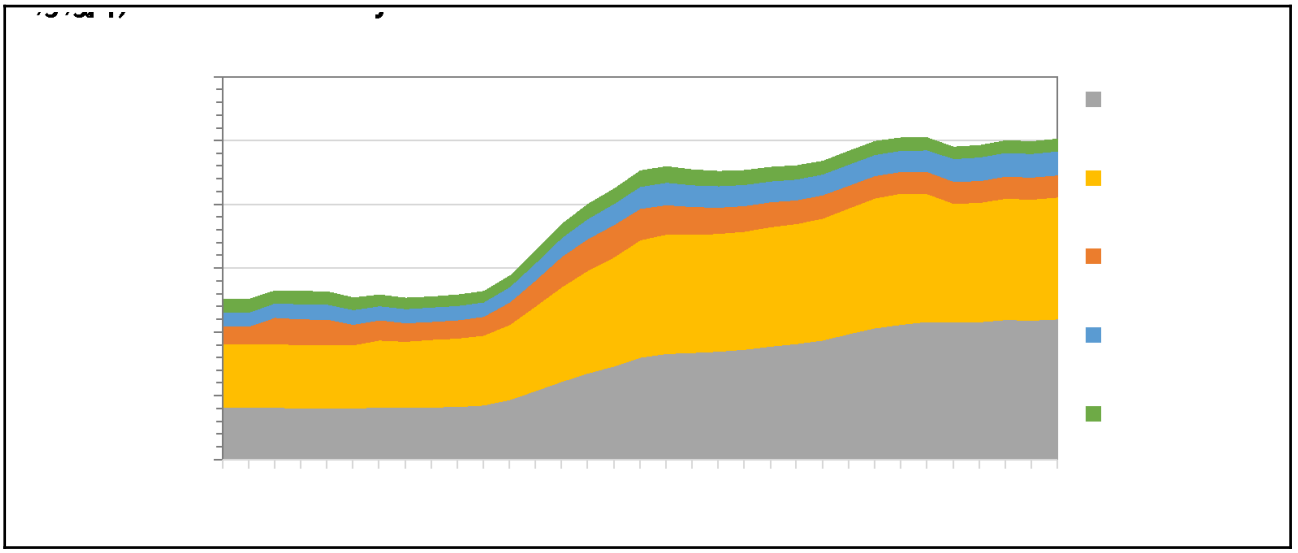

Figure 6-5 Area in 4.B.1 Cropland remaining cropland

The following table shows that the areas of Cropland increased by 10.1 % in the period 1990-2022, and by 1.6% in the period 2010-2022. It should be mentioned that the cropland area in 2021 and 2022 remained consistent with the 2020 figure, according to national methodologies.

The increase of perennial cultures is a result of

- Further diversification of the agricultural sector that is significant for its economy and food security
- production of dates, olives, apricot, plum and figs represent an important economic factor; Algeria is a large exporter of these fruits.

However, it's important to note that the national definition of cropland may differ from that outlined in the IPCC guidelines.

Table 6-12 Activity data for IPCC category 4.B Cropland

Year	Cropland	Vines wine and trees	Olive trees	Date palms	Citrus	Figs	Source
		Ha					
1990	7,766,110	56,500	164,520	197,170	43,850	44,370	As 1991
1991	7,766,110	56,500	164,520	197,170	43,850	44,370	MADR data
1992	8,093,990	83,150	164,290	198,490	44,920	41,200	
1993	8,062,960	79,880	161,380	199,610	47,530	42,030	
1994	8,005,670	78,830	161,260	199,500	47,630	41,900	
1995	8,029,520	63,370	160,780	199,190	46,980	40,110	
1996	8,040,560	62,780	165,040	209,730	44,770	36,760	
1997	8,159,330	57,450	162,840	208,270	44,620	35,980	
1998	8,173,670	56,500	165,260	210,990	44,820	35,390	
1999	8,191,690	57,210	165,600	215,150	45,040	35,730	
2000	8,192,210	59,790	171,146	218,263	45,104	35,496	
2001	8,162,840	69,680	188,387	235,876	48,104	37,542	
2002	8,205,050	81,550	216,250	265,885	53,497	41,390	
2003	8,244,980	95,630	245,426	296,374	58,815	45,092	
2004	8,296,246	99,432	271,339	321,881	62,983	47,830	MADR data
2005	8,363,570	101,710	293,380	341,942	65,951	49,588	
2006	8,378,022	98,214	320,911	367,553	69,854	51,977	
2007	8,389,208	92,708	332,358	374,134	70,041	51,548	
2008	8,400,463	87,375	335,081	370,787	68,352	49,729	
2009	8,398,790	82,743	339,200	369,023	66,960	48,130	
2010	8,410,278	80,423	345,755	369,874	66,038	46,865	
2011	8,420,670	77,730	355,737	374,253	65,721	46,016	
2012	8,430,295	74,338	363,575	376,222	64,954	44,835	
2013	8,435,254	73,430	374,928	381,656	64,754	44,028	
2014	8,439,263	70,852	394,356	394,952	65,822	44,043	
2015	8,462,386	70,664	412,780	406,783	66,560	43,787	
2016	8,468,875	68,652	423,683	410,894	65,977	42,624	
2017	8,434,182	69,645	432,962	399,567	68,680	40,935	
2018	8,519,200	69,378	431,010	371,650	71,003	39,360	
2019	8,509,554	68,652	431,508	374,290	73,535	39,439	
2020	8,547,493	69,319	438,357	380,231	74,702	40,065	
2021	8,547,493	69,319	436,726	378,816	74,424	39,916	
2022	8,547,493	69,319	440,489	382,080	75,065	40,260	
Trend							
1990 - 2022	10.1%	22.7%	167.7%	93.8%	71.2%	-9.3%	
2010- 2022	1.6%	-13.8%	27.4%	3.3%	13.7%	-14.1%	
2021 - 2022	0.0%	0.0%	0.9%	0.9%	0.9%	0.9%	

6.3.1.2.1.3 Choice of emission factors

The default value for Above-ground woody biomass growth rate and mean biomass carbon stock (G) were taken from Table 5.3 of 2019 refinement to the 2006 IPCC Guidelines.

Table 6-13 Above-ground woody biomass growth rate

Domain	Cropping system	Above- ground biomass accumulatio n rate (G) (tonnes C ha- 1 yr-1)
Temperate	Olive	0.46 ± 27%
	Orchard e.g. apple	0.43 ± 46%
	Vine e.g. grape	0.28 ± 26%
	Short Rotation Coppice	3.2 ± 40%
Sources: Table 5.3, 2019 refinement to 2006 IPCC Guidelines, default value for Above-ground woody biomass growth rate and mean biomass carbon stock Volume5, Chapter 5		

Table 6-14 Annual increase in biomass carbon stocks due to biomass growth

4.B.1 Cropland remaining cropland						
	Parameter	**Unit**	**Formula**	**Source**	**Comment**	**2022**
A	Area of Cropland Remaining Cropland	ha		MADR_LandUse	VIGNES VIN ET RAISIN	69,319
G_{vin}	Mean biomass carbon stock (Lmean)	tons C ha^{-1}	-	TABLE 5.3 ; Refinements		0.28
ΔC_L	"Annual losses of perennial					19,409
ΔC_L	tons C yr^{-1}	A * L mean	Equation 2.14, Chap 2, Vol. 4, 2006 IPCC GL		Conversion of C stock changes to CO_2 emissions/removals	-71,168
ΔC_L	CO_2 emission and removals	tons CO_2 yr^{-1}	ΔC_G * 44/12			-71.17

6.3.1.2.2 Annual losses in biomass from removal in Cropland Remaining Cropland

The annual loss in biomass due to removals increased by 77.56% in the period 1990-2022,.then increased by 13.43% in the period 2010-2022 and by 0.86% in the period 2021-2022.

Annual losses were calculated by estimating the harvested area for each perennial culture type, based on expert assessments.

Table 6-15 Annual losses in biomass from removals

Year	Total	Annual losses in biomass from removal				
		Vine wine and grapes	Olivier	Date palms	Citrus	Fig trees
		Kt CO_2 equivalent				
1990	-123.72	-1.160	-8.32	-9.25	-102.90	-2.08
1991	-123.72	-1.160	-8.32	-9.25	-102.90	-2.08
1992	-126.68	-1.707	-8.31	-9.32	-105.41	-1.93
1993	-132.68	-1.640	-8.17	-9.37	-111.54	-1.97
1994	-132.88	-1.619	-8.16	-9.36	-111.77	-1.97
1995	-130.91	-1.301	-8.14	-9.35	-110.25	-1.88
1996	-126.27	-1.289	-8.35	-9.84	-105.06	-1.73
1997	-125.59	-1.180	-8.24	-9.77	-104.71	-1.69
1998	-126.26	-1.160	-8.36	-9.90	-105.18	-1.66
1999	-127.02	-1.175	-8.38	-10.10	-105.69	-1.68
2000	-127.64	-1.228	-8.66	-10.24	-105.84	-1.67
2001	-136.68	-1.431	-9.53	-11.07	-112.88	-1.76
2002	-152.58	-1.674	-10.94	-12.48	-125.54	-1.94
2003	-168.43	-1.964	-12.42	-13.91	-138.02	-2.12
2004	-180.92	-2.042	-13.73	-15.11	-147.80	-2.24
2005	-190.07	-2.088	-14.85	-16.05	-154.76	-2.33
2006	-201.87	-2.017	-16.24	-17.25	-163.92	-2.44
2007	-203.06	-1.904	-16.82	-17.56	-164.36	-2.42
2008	-198.88	-1.794	-16.96	-17.40	-160.40	-2.33
2009	-195.57	-1.699	-17.16	-17.32	-157.13	-2.26
2010	-193.67	-1.651	-17.50	-17.36	-154.97	-2.20
2011	-193.55	-1.596	-18.00	-17.56	-154.23	-2.16
2012	-192.11	-1.526	-18.40	-17.66	-152.43	-2.10
2013	-192.41	-1.508	-18.97	-17.91	-151.95	-2.07
2014	-196.47	-1.455	-19.95	-18.54	-154.46	-2.07
2015	-199.68	-1.451	-20.89	-19.09	-156.19	-2.06
2016	-198.96	-1.410	-21.44	-19.28	-154.83	-2.00
2017	-205.18	-1.430	-21.91	-18.75	-161.17	-1.92
2018	-209.14	-1.425	-21.81	-17.44	-166.62	-1.85
2019	-215.22	-1.410	-21.83	-17.57	-172.56	-1.85
2020	-218.63	-1.423	-22.18	-17.85	-175.30	-1.88
2021	-217.82	-1.423	-22.10	-17.78	-174.65	-1.87
2022	-219.69	-1.423	-22.29	-17.93	-176.15	-1.89
Trend						
1990-2022	77.56%	22.69%	167.74%	93.78%	71.19%	-9.26%
2010-2022	13.43%	-13.81%	27.40%	3.30%	13.67%	-14.09%
2021-2022	0.86%	0.00%	0.86%	0.86%	0.86%	0.86%

6.3.1.2.2.1 Choice of method

Loss estimates are needed for calculating biomass carbon stock change using the Gain-Loss Method. For this, the annual biomass loss ΔC_L was estimated using equation 2.9 which was described in chapter 6.6.1.2.1.1 **Choice of method.**

6.3.1.2.2.2 Choice of activity data

The annual harvested area was estimated using the area of perennial crops and expert judgment for the share of the area harvested for each year.

Table 6-16 harvested area of perennial crops

perennial crops	Share	Source
Wine vine and grapes	0.2%	expert judgment
Olivier	0.2%	
Date palms	0.2%	
Citrus	10.0%	
Fig trees	0.2%	

6.3.1.2.2.3 Choice of factors

The default value for Mean biomass carbon stock (L_{mean}) was taken from Table 5.3 of 2019 refinement to the 2006 IPCC Guidelines.

Table 6-17 Mean biomass carbon stock

Domain	**Part of tree**	**Mean biomass carbon stock (L_{mean}) [tonne C (tonne d.m.)$^{-1}$]**
Default value	Olive	6.9 ± 25%
	Orchard e.g. apple	6.4 ± 25%
	Vine e.g. grape	2.8 ± 25%
	Short Rotation Coppice	6.35 ± 40%
Sources: Table 5.3, 2019 refinement to 2006 IPCC Guidelines, default value for Above-ground woody biomass growth rate and mean biomass carbon stock Volume5, Chapter 5		

Table 6-18 Annual losses in biomass from removal

4.B.1 Cropland remaining cropland						
	Parameter	**Unit**	**Formula**	**Source**	**Comment**	**2022**
A	Area of Cropland Remaining Cropland	ha		MADR_LandUse	VIGNES VIN ET RAISIN	139
L_{mean} vin	Mean biomass carbon stock (L_{mean})	tons C ha^{-1}	-	TABLE 5.3 ; Refinements		2.8
ΔC_L	"Annual losses of perennial					388
ΔC_L	tonnes C yr^{-1}	A * L mean	Equation 2.14, Chap 2, Vol. 4, 2006 IPCC GL		Conversion of C stock changes to CO_2 emissions/removals	-1,423

ΔC_L	CO_2 emission and removals	tons CO_2 yr^{-1}	ΔC_G * 44/12			-1.42

6.3.1.2.3 Uncertainty assessment and time-series consistency

No uncertainties provided for IPCC category 4.B.1 Cropland remaining Cropland due to lack of detailed information of background data of activity data.

6.3.1.2.4 Source-specific QA/QC and verification

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- Time series consistency (plausibility checks of dips and jumps).

6.3.1.2.5 Category-specific recalculations including explanatory information and justifications

The following table presents the main revisions and recalculations made since the last two submissions to the UNFCCC and relevant to IPCC category 4.B.1 Cropland remaining Cropland.

Table 6-19 Recalculations in IPCC sub-category 4.B Cropland

source category	Revisions of data	Type of revision	Type of improvement
4.B.1	Application of 2006 IPCC Guidelines methodology and 2019 Refinements IPCC 2006 guidelines.	method	Accuracy Comparability
4.B.1	Application of guidance on methodology, parameter (AD) and emission factors provided by the 2006 IPCC guidelines and 2019 Refinements IPCC 2006 guidelines.	EF	Accuracy Comparability

6.3.1.2.6 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

Due to a lack of national expertise in utilizing FAO data satellite data, it was not possible to estimate changes in crop soil carbon stocks using available data from FAO or national sources. Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in crop soils.

Table 6-20 Planned improvements for IPCC category 4.B.1 Cropland remaining Cropland

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.B.1	Survey and/or research with consideration of (a) regional and district diversity, (b) characterization by climate and/or soil type and/or (c) ecological regions (i.e., strata) • estimates of land areas remaining cropland or converted to Cropland • information on Cropland o arable and tillable land, rice fields, and agroforestry systems o annual and perennial crops as well as temporary fallow land o crop-pasture rotation (mixed system) o land areas of growing stock and harvested land with perennial woody crops including information of Broad subcategories (i.e. fruit orchards, plantation crops, agroforestry system) and related Specific subcategories Survey and/or research with consideration of (a) regional and district diversity, (b) characterization by climate and/or soil type and/or (c) ecological regions (i.e., strata) • estimates of land areas remaining cropland or converted to cropland • share of land-use categories: Steppe/tundra/prairie grassland, Semi-arid grassland, Sub-tropical/ tropical grassland, Woodland/Savannah, Shrubland • information on use/management systems • area under managed organic soils	AD	Accuracy Transparency Comparability Completeness Consistency	High
4.B.2	Estimates of land converted to Cropland			High
4	An uncertainty analysis of the LULUCF sector will be carried out.			Medium

6.3.2 Land converted to Cropland (IPCC category 4.B.2)

GHG emissions from this sector comprise emissions from the following categories that are described in the following table.

Table 6-21 status of the estimates made in IPCC category 4.B.2 land converted to cropland

IPCC categories	Description	Status for		
		CO_2	CH_4	N_2O
4.A	**Cropland**			
4.B.2	Land converted to cropland			
4.B.2.a	Forestland converted to cropland	NE	NA	NE
4.B.2.b	Grassland converted to cropland	NE	NA	NE
4.B.2.c	Wetland converted to cropland	NE	NA	NA
4.B.2.d	Settlements converted to cropland	NE	NA	NA
4.B.2.e	Other land converted to cropland	NE	NA	NA

This category was not estimated due to lack of data.

6.3.2.1 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

Table 6-22 Planned improvements for IPCC category 4.B.2 Land converted to Cropland

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.B.2	Estimates of Land converted to Cropland Application of methodology of 2006 IPCC Guidelines and guidance of 2019 refinements to the 2006 IPCC Guidelines.	EMI	Accuracy Transparency Comparability Completeness Consistency	High
4.B.2	Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in crop soils.	AD	Completeness	High
4.B.2	Preparation of land transition matrix	AD	Completeness	High
4.B.2	Collection of country specific parameter : ○ country specific stock changes factors by crop type ○ biomass accumulation rates and biomass loses for perennial crops ○ AGB by crop type e.g. irrigated (sugarcane) and subsistence crops (Maize).	EF	Completeness	High

6.4 Grassland (IPCC category 4.C)

GHG emissions from this sector comprise emissions from the following categories that are described in the following table.

Table 6-23 status of the estimates made in IPCC category 4.C Grassland remaining grassland

IPCC categories	Description	CO_2	Key category	CH_4	Key category	N_2O	Key category
4.C	**Grassland**						
4.C.1	Grassland remaining grassland	NO	-	IE	-	IE	-
4.C.2	Land converted to grassland[7]	NE	-	NE	-	NE	-
4.C.1: CH_4 and N_2O emissions are included in 4.A.1.							

6.4.1 Grassland remaining grassland (IPCC category 4.C.1)

6.4.1.1 Category description

This section describes the estimation of emissions and removals resulting from IPCC category 4.C Grassland as described in the 2006 IPCC Guidelines (Volume 5, chapter 6). Emissions and removals of CO_2 within the LULUCF Sector are generally estimated based on changes in ecosystem carbon stocks.

In the following are presented information and description of methodologies used for estimating GHG emissions as well as references to activity data reported under IPCC category 4.C.1 Grassland remaining grassland.

6.4.1.2 Methodological issues

6.4.1.2.1 Choice of method

The **biomass gain-loss method** is applied. According to the 2006 IPCC Guidelines, the biomass gain-loss method is applicable for all tiers estimating **Gains** include total (above-ground and below-ground) biomass growth.

A Tier 1 approach assumes no **change in biomass** in *Grassland Remaining Grassland*.

> *In grassland where there is no change in either type or intensity of management, biomass will be in an approximate steady-state (i.e., carbon accumulation through plant growth is roughly balanced by losses through grazing, decomposition and fire). In grassland where management changes are occurring over time (e.g., through introduction of silvopastoral systems, tree/brush removal for grazing management, improved pasture management or other practices), the carbon stock changes can be significant*.[8]

The Tier 1 method assumes that the **dead wood and litter stocks** are at equilibrium, so there is no need to estimate the carbon stock changes for these pools.

> *Countries experiencing significant changes in grassland types or disturbance or management regimes in their grasslands are encouraged to develop domestic data to quantify this impact and report it under Tier 2 or 3 methodologies*.[9]

[7] 4.C.2.a Forest land converted to grassland, 4.C.2.b Cropland converted to grassland, 4.C.2.c Wetland converted to grassland, 4.C.2.d Settlements converted to grassland, 4.C.2.e Other land converted to grassland.

[8] 2006 IPCC Guidelines, Volume 4, Chapter 6: Grassland, page 6.6

[9] 2006 IPCC Guidelines, Volume 4, Chapter 6: Grassland, page 6.11

Mineral soils - Tier 1: For mineral soils, the estimation method is based on changes in **soil organic C stocks** over a finite period following changes in management that impact soil organic C storage. After a finite transition period, one can assume a steady state for this stock.

Organic soils - Tier 1: Equation 2.26 of Chapter 2 is used to estimate **C stock change** in managed grassland on organic soils (e.g., peat derived, Histosols).

The methodology is to stratify managed organic soils by climate region and assign a climate-specific annual emission rate. Land areas are multiplied by the emission factor and then summed to derive annual C emissions. Natural grasslands that may be used for seasonal grazing but have not been artificially drained should not be included in this category.[10]

6.4.1.2.2 Choice of activity data

Activity data consist of areas of *Grassland Remaining Grassland* summarized in graph and table below.

Grassland according to national approaches include natural meadows and pastures and rangelands with alfa grass.

The area of grassland was generated using data from Serie B agriculture statistics and DGF data to complete the times series. The graph shows a general upward trend in the area of grassland from 1990 to 2022. This indicates that the grassland area has been increasing over time.

This increase might due to:

- changes in land use from other categories to grass land
- Increase of degraded land area that is considered as grassland
- Changes in climate patterns,

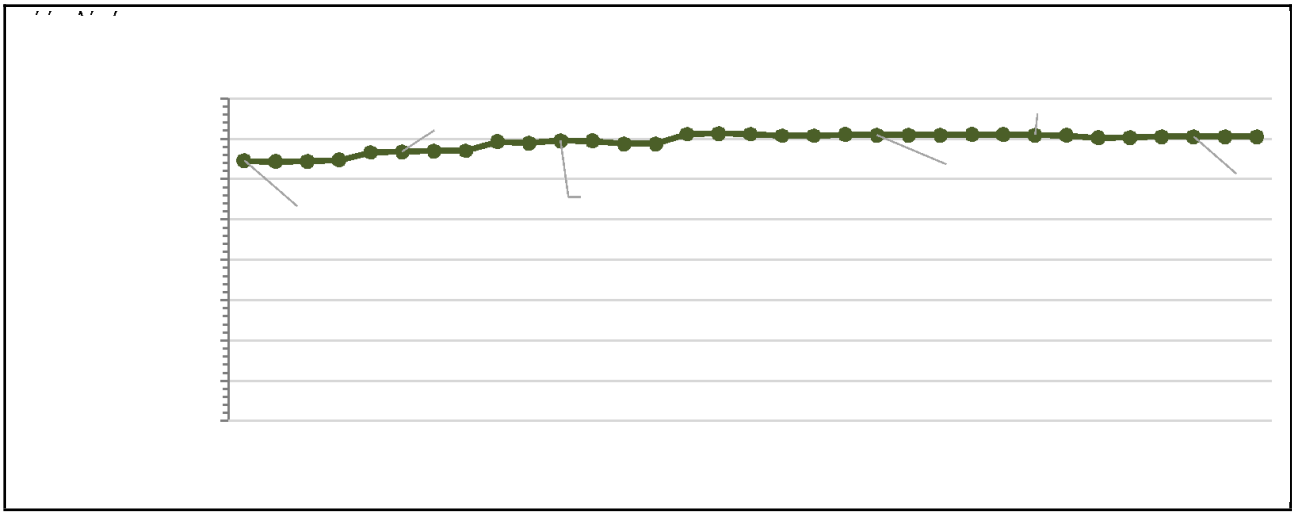

Figure 6-6 Grassland in ha (1990-2022)

6.4.1.3 Uncertainty assessment and time-series consistency

No uncertainties provided for IPCC category 4.C.1 Grassland remaining grassland due to lack of detailed information

6.4.1.4 Source-specific QA/QC and verification

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
    - documented sources,

[10] 2006 IPCC Guidelines, Volume 4, Chapter 6: Grassland, page 6.15

- use of units,
- unique use of formulas, special cases are documented/highlighted,
- quick-control checks for data consistency through all steps of calculation.

- Time series consistency (plausibility checks of dips and jumps).

6.4.1.5 Category-specific recalculations including explanatory information and justifications

The following table presents the main revisions and recalculations made since the last two submissions to the UNFCCC and relevant to IPCC category 4.C Grassland.

Table 6-24 Recalculations in IPCC sub-category 4.C.1 Grassland remaining grassland

source category	Revisions of data	Type of revision	Type of improvement
4.C.1	No revisions were performed		

6.4.1.6 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in the following table will be explored.

Table 6-25 Planned improvements for IPCC category 4.C.1 Grassland remaining grassland

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.C	Estimates of Land converted to Grassland Application of higher TIER methodology of 2006 IPCC Guidelines and guidance of 2019 refinements to the 2006 IPCC Guidelines.	AD	Accuracy Transparency Comparability Completeness Consistency	High
4.C.1	Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in crop soils.	AD	Completeness	High
4.C.1	Preparation of land transition matrix	AD	Completeness	High
4.C	Collection of activity data and country specific parameter.	EF		High

6.4.2 Land converted to Grassland (IPCC category 4.C.2)

GHG emissions from this sector comprise emissions from the following categories that are described in the following table.

Table 6-26 status of the estimates made in IPCC category 4.C.2 land converted to Grassland .

IPCC categories	Description	Status for		
		CO_2	CH_4	N_2O
4.A	**Grassland**			
4.C.2	Land converted to grassland			
4.C.2.a	Forestland converted to grassland	NE	NA	NE
4.C.2.b	Cropland converted to grassland	NE	NA	NE
4.C.2.c	Wetland converted to grassland	NE	NA	NA
4.C.2.d	Settlements converted to grassland	NE	NA	NA
4.C.2.e	Other land converted to grassland	NE	NA	NA

This category was not estimated due to lack of data.

6.4.2.1 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

Table 6-27 Planned improvements for IPCC category 4.B.2 Land converted to Cropland

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.C.2	Estimates of Land converted to Cropland Application of methodology of 2006 IPCC Guidelines and guidance of 2019 refinements to the 2006 IPCC Guidelines.	EMI	Accuracy Transparency Comparability Completeness Consistency	High
4.C.2	Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in crop soils.	AD	Completeness	High
4.C.2	Preparation of land transition matrix	AD	Completeness	High
4.C.2	Collection of country specific parameter	EF	Completeness	High

6.5 Wetlands (IPCC category 4.D)

Table 6-28 status of the estimates made in IPCC category 4.D wetlands

IPCC categories	Description	CO_2	Key category	CH_4	Key category	N_2O	Key category
4.D	**Wetlands**						
4.D.1	Wetlands remaining wetlands	NE		NE		NE	
4.D.2	Lands converted to wetlands	NO		NO		NO	

This chapter provides guidance on estimating and reporting greenhouse gas (GHG) emissions from managed wetlands. As described in 2006 IPCC Guidelines, wetlands include any land that is covered or saturated by water for all or part of the year, and that does not fall into the Forest Land, Cropland, or Grassland categories. Managed wetlands will be restricted to wetlands where the water table is artificially changed (e.g., drained or raised) or those created through human activity (e.g., damming a river). Emissions from unmanaged wetlands are not estimated.

In the following table, Ramsar classes of human-made wetlands and the corresponding wetlands sub-categories in the IPCC terminology are provided.

Table 6-29 Ramsar classes of human-made wetlands

RAMSAR class	Corresponding wetlands sub-categories in the IPCC terminology	Methodological guidance
Aquaculture	Flooded Land	No [1]
Ponds	Flooded Land	No [1]
Irrigated land (if cultivated)	Cropland	No [2]
Seasonally flooded agricultural land	Rice Cultivation	Yes
Salt exploitation sites	---	No [1]
Water storage areas	Flooded Land	Yes
Excavations (partly)	Peatlands managed for peat extraction	Yes
Wastewater treatment areas	"Constructed wetlands" or Waste Sector	No [3]
Canals and drainage channels, ditches.	--	No [3]

NOTES:

[1] No suitable default methodologies are available for these sources.

[2] The Cropland Chapter includes this source.

[3] Emissions of CH_4 and N_2O from wastewater discharges to canals, rivers, lakes, seas, and drainage channels or ditches, as well as wastewater treatment areas, are covered in Volume 5, Chapter 3 though any additional emissions from new wetlands are not. Emissions of N_2O from leachate of nitrogenous fertilizers are covered in Volume 4, Chapter 11.

Source: Ramsar, 1996

Source; Table 7.3 Ramsar classes of human-made wetlands, Chapter 7, Volume 4, 2006 IPCC Guidelines

Greenhouse gas emissions and removals from wetlands

As described in 2006 IPCC Guidelines, wetlands are ecosystems where the biological and geochemical processes, and resulting greenhouse gas emissions and removals, are controlled by the degree of water saturation as well as climate and nutrient availability.

As in other ecosystems, a net carbon flux to or from the atmosphere is a result from the balance between carbon uptake from the atmosphere by photosynthesis and its release as a result of decomposition. Both the rates of C uptake and decay losses are influenced by climate, nutrient availability, water saturation or oxygen availability.

In aerobic conditions (abundant oxygen), which are prevalent in most upland ecosystems, decomposition releases CO_2; while CH_4 emissions prevail in anaerobic conditions. The undecayed material sinks to the bottom of the water body and accumulates on top of previously deposited material.

Under saturated conditions 1 or in flooded environments, the activity of aerobic bacteria and other decay organisms is limited by oxygen availability. Anoxic (oxygen-depleted) conditions commonly found at the bottom of water bodies prevent further organic matter decomposition by these organisms. Other bacteria, methanogens, sulfurgens and others, are able to decompose at least part of the organic matter, which results in

emissions of CH_4 and other gases. If the methane diffuses up through the water column or top layer of aerated soil, still another group of bacteria, methanotrophs, partially oxidize the methane into CO_2, before it escapes.

Generally, wetlands are a natural source of CH_4, with estimated emissions of 55-150 Tg CH_4 yr-1.

Generally, N_2O emissions from saturated ecosystems are very low, unless there is a sustained supply of exogenous nitrogen. When wetlands, especially peatlands, are drained, N_2O emission rates are largely controlled by the provision of nitrogen by mineralization, hence by soil fertility. In minerotrophic (nutrient-rich) conditions, other controls such as pH, temperature and water level will regulate the nitrification of mineral nitrogen, and its subsequent reduction into N_2O (Klemedtsson *et al.*, 2005; Martikainen *et al.*, 1995).

In summary, wetland drainage results in a reduction of CH_4 emissions, an increase in CO_2 emissions due to increased oxidation of soil organic material, and an increase in N_2O emissions in minerotrophic wetlands.

Conversely, the creation of wetlands through flooding alters the pattern of greenhouse gas emissions towards greater CH_4 emissions and less CO_2 emissions. Depending on climate and reservoir characteristics, both CO_2 and CH_4 can be emitted from the decay of submerged biomass, and the decomposition of inundated soil organic matter and other dissolved organic matter particles.

6.5.1 Wetlands remaining Wetlands (IPCC category 4.D.1)

GHG emissions from this sector comprise emissions from the following categories that are described in the following table.

Table 6-30 status of the estimates made in IPCC category 4.D.1 wetlands remaining wetlands

IPCC categories	Description	Status for		
		CO_2	CH_4	N_2O
4.D	**Wetlands**			
4.D.1	Wetlands remaining wetlands			
4.D.1.a	Peat extraction remaining peat extraction	NE	NA	NA
4.D.1.b	Flooded land remaining flooded land	NE	NA	NA
4.D.1.c	Other wetlands remaining other wetlands	NE	NA	NA

This category was not estimated due to lack of data.

6.5.1.1 Choice of activity data

Activity data consists of areas of *Wetland Remaining Wetland* summarized in graph and table below.

The graph shows a consistent wetland area over time, reflecting the data from the Ramsar Convention, where no new wetland sites have been added to the list since 2011.

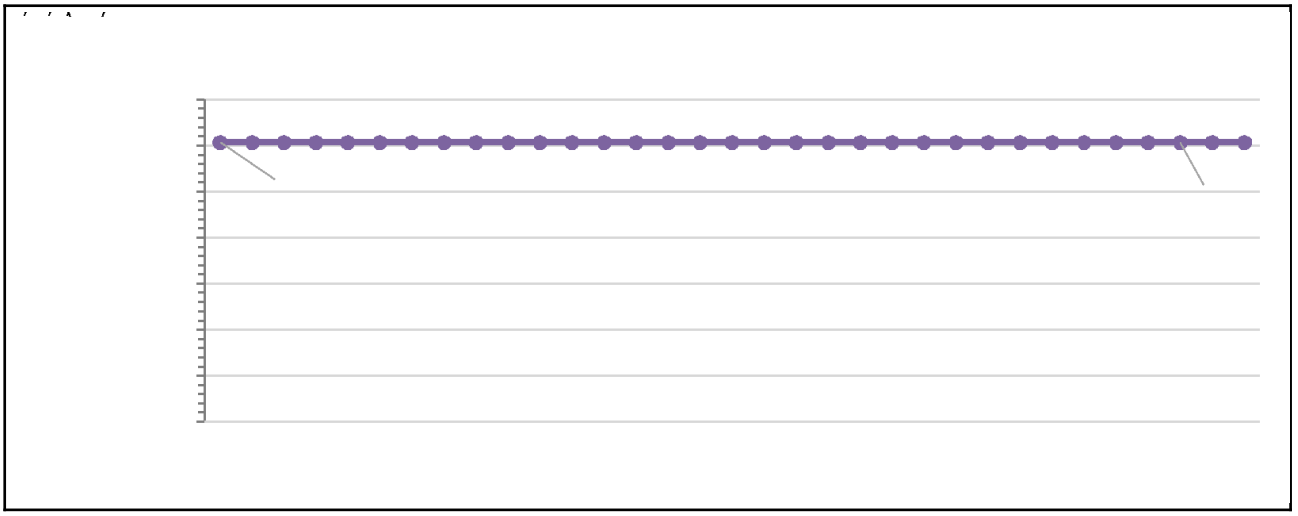

Figure 6-7 Wetland in ha (1990-2022)

6.5.1.2 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in the following table will be explored.

Table 6-31 Planned improvements for IPCC category 4.D Wetland.

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.D.1	Estimates of Land converted to Wetland Application of methodology of 2006 IPCC Guidelines and guidance of 2019 refinements to the 2006 IPCC Guidelines.	EMI	Accuracy Transparency Comparability Completeness Consistency	High
4.D.1	Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in crop soils.	AD	Completeness	High
4.D.1	Preparation of land transition matrix	AD	Completeness	High
4.D.1	Collection of country specific parameter	EF	Completeness	High

6.5.2 Land converted to Wetlands (IPCC category 4.D.2)

GHG emissions from this sector comprise emissions from the following categories that are described in the following table.

Table 6-32 Status of the estimates made in IPCC category 4.D.2 land converted to wetlands

IPCC categories	Description	Status for		
		CO_2	CH_4	N_2O
4.A	**Wetland**			
4.D.2	Lands converted to wetlands			
4.D.2.a	Forestland converted to wetlands	NE	NA	NE
4.D.2.b	Cropland converted to wetlands	NE	NA	NE
4.D.2.c	Grassland converted to wetlands	NE	NA	NE
4.D.2.d	Settlements converted to wetlands	NE	NA	NE
4.D.2.e	Other land converted to wetlands	NE	NA	NE

This category was not estimated due to lack of data.

6.5.2.1 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

Table 6-33 Planned improvements for IPCC category 4.D.2 Land converted to Wetland

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.D.2	Estimates of Land converted to Forestland Application of methodology of 2006 IPCC Guidelines and guidance of 2019 refinements to the 2006 IPCC Guidelines.	EMI	Accuracy Transparency Comparability Completeness Consistency	High
4.D.2	Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in crop soils.	AD	Completeness	High
4.D.2	Preparation of land transition matrix	AD	Completeness	High
4.D.2	Collection of country specific parameter	EF	Completeness	High

6.6 Settlements (IPCC category 4.E)

Table 6-34 status of the estimates made in IPCC category 4.E settlements remaining settlements

IPCC categories	Description	CO_2	Key category	CH_4	Key category	N_2O	Key category
4.E	**Settlements**						
4.E.1	Settlements remaining settlements	NO		NE		NE	
4.E.2	Lands converted to settlements	NE		NE		NE	

As described in the 2006 IPCC Guidelines, Settlements are defined in Chapter 3 (Volume 4, 2006 IPCC Guidelines) as including all developed land -- i.e., residential, transportation, commercial, and production (commercial, manufacturing) infrastructure of any size, unless it is already included under other land-use categories. The land-use category Settlements includes soils, herbaceous perennial vegetation such as turf grass and garden plants, trees in rural settlements, homestead gardens and urban areas. Examples of settlements include land along streets, in residential (rural and urban) and commercial lawns, in public and private gardens, in golf courses and athletic fields, and in parks, provided such land is functionally or administratively associated with particular cities, villages or other settlement types and is not accounted for in another land-use category.

Vegetation management in settlements may result in gains, losses, or transfers of carbon amongst the relevant pools. For example, branches removed during pruning or turfgrass clippings (biomass losses) may be left on site (transfer to litter), disposed of as solid waste (transfer to waste), or burned (emitted). Emissions of the relevant greenhouse gases accounted for in the appropriate sections of the present guidance. Biomass removed as fuelwood from trees in settlements and used as fuel is accounted for in the Energy Sector. The net effect of conversion or management leading to increment, on the one hand, or to loss (such as from burning and decay), on the other, determines the overall C balance in settlements.

6.6.1 Settlements remaining settlements (IPCC category 4.E.1)

GHG emissions from this sector comprise emissions from the following categories that are described in the following table.

Status of the estimates made in IPCC category 4.E .1 Settlements remaining settlements and 4.D.2 land converted to settlements

IPCC categories	Description	Status for		
		CO_2	CH_4	N_2O
4.E	**Settlements**			
4.E.1	Settlements remaining settlements	NO	NE	NE
4.E.2	Lands converted to settlements			
4.E.2.a	Forestland converted to settlements	NE	NA	NE
4.E.2.b	Cropland converted to settlements	NE	NA	NE
4.E.2.c	Grassland converted to settlements	NE	NA	NE
4.E.2.d	Wetlands converted to settlements	NE	NA	NE
4.E.2.e	Other land converted to settlements	NE	NA	NE

6.6.1.1 Methodological issues

6.6.1.1.1 Choice of method

Tier 1 assumes no change in carbon stocks in live biomass in *Settlements Remaining Settlements*, in other words, that the growth and loss terms balance. .[11]

Tier 1 assumes that the **dead wood and litter stocks** are at equilibrium, and so there is no need to estimate the carbon stock changes for these pools. [12]

Mineral soils: It is assumed in the Tier 1 method that inputs equal outputs so that settlement **soil C stocks** do not change in *Settlements Remaining Settlements*.

Organic soils: Settlements are unlikely to be built on deep organic soils.

6.6.1.1.2 Choice of activity data

Activity data consist of areas of *Settlements Remaining Settlements* summarized in graph and table below.
The area of settlements shown in the graph increased over the years due to the increase of population and the industrial development that encourages urban growth.
The time series was generated by interpolating and extrapolating World Bank data on settlement shares.

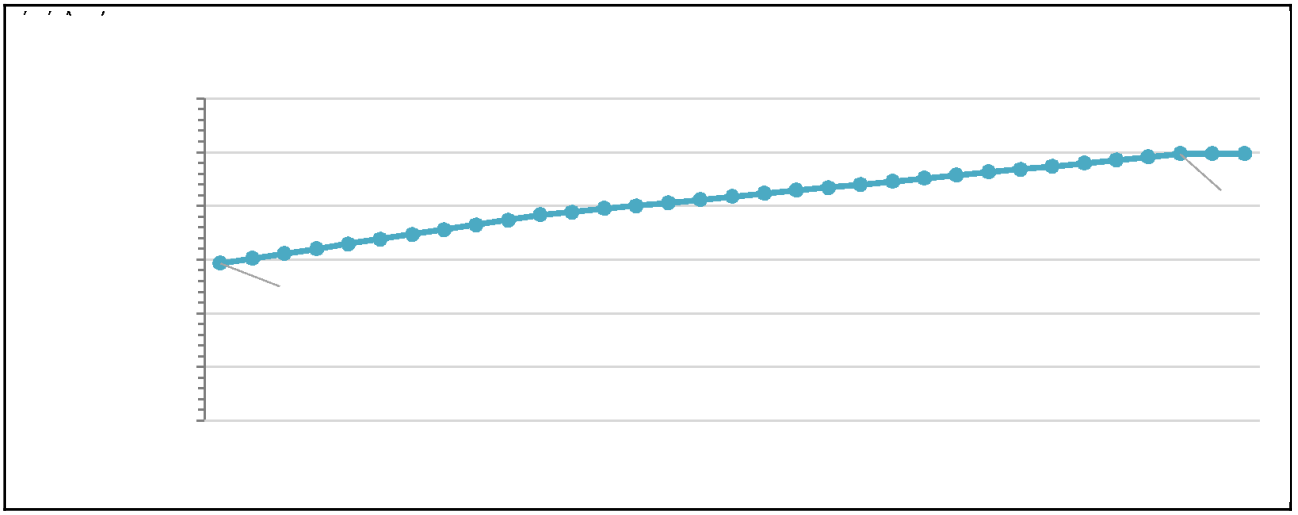

Figure 6-8 Settlement in ha (1990-2022)

6.6.1.1.3 Choice of emission/removal factors

Tier 1

This method assumes, probably conservatively, that changes in biomass carbon stocks due to growth in biomass are fully offset by decreases in carbon stocks due to removals (i.e., by harvest, pruning, clipping) from both living and from dead biomass (e.g., fuelwood, broken branches, etc.). Therefore, in a Tier 1 approach $\Delta C_G = \Delta C_L$ and for all plant components, and $\Delta C_B = 0$ in Equation 2.7. [13]

6.6.1.2 Uncertainty assessment and time-series consistency

No uncertainties provided for IPCC category 4.E.1 *Settlements Remaining Settlements* due to lack of detailed information.

[11] 2006 IPCC Guidelines, Volume 4, Chapter 6: Settlments, page 8.7

[12] Countries experiencing significant changes in tree cover in settlements are encouraged to develop national data to quantify this change and report it under Tier 2 or 3 methodologies.

[13] 2006 IPCC Guidelines, Volume 4, Chapter 6: Settlments, page 8.8

6.6.1.3 Source-specific QA/QC and verification

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- Time series consistency (plausibility checks of dips and jumps).

6.6.1.4 Category-specific recalculations including explanatory information and justifications

The following table presents the main revisions and recalculations made since the last two submissions to the UNFCCC and relevant to IPCC category 4.E.1 *Settlements Remaining Settlements*.

Table 6-35 Recalculations in IPCC sub-category 4.E.1 *Settlements Remaining Settlements*

source category	Revisions of data	Type of revision	Type of improvement
4.E.1	No revisions were performed		

6.6.1.5 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in the following table will be explored.

Table 6-36 Planned improvements for IPCC category 4.E.1 *Settlements Remaining Settlements*.

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.E.1	Estimates of Land converted to Settlements Application of methodology of 2006 IPCC Guidelines and guidance of 2019 refinements to the 2006 IPCC Guidelines.	EMI	Accuracy Transparency Comparability Completeness Consistency	High
4.E.1	Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in crop soils.	AD	Completeness	High
4.E.1	Preparation of land transition matrix	AD	Completeness	High
4.E.1	Collection of country specific parameter	EF	Completeness	High

6.6.2 Land converted to Settlements (IPCC category 4.E.2)

GHG emissions from this sector comprise emissions from the following categories that are described in the following table.

Table 6-37 Status of the estimates made in IPCC category 4.E.2 land converted to settlements

IPCC categories	Description	Status for		
		CO_2	CH_4	N_2O
4.E	**Settlements**			
4.E.2	Lands converted to settlements			
4.E.2.a	Forestland converted to settlements	NE	NA	NE
4.E.2.b	Cropland converted to settlements	NE	NA	NE
4.E.2.c	Grassland converted to settlements	NE	NA	NE
4.E.2.d	Wetlands converted to settlements	NE	NA	NE
4.E.2.e	Other land converted to settlements	NE	NA	NE

This category was not estimated due to lack of data.

6.6.2.1 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

Table 6-38 Planned improvements for IPCC category 4.E.2 Land converted to Settlements

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.E.2	Estimates of Land converted to Settlements Application of methodology of 2006 IPCC Guidelines and guidance of 2019 refinements to the 2006 IPCC Guidelines.	EMI	Accuracy Transparency Comparability Completeness Consistency	High
4.E.2	Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in crop soils.	AD	Completeness	High
4.E.2	Preparation of land transition matrix	AD	Completeness	High
4.E.2	Collection of country specific parameter	EF	Completeness	High

6.7 Other land (IPCC category 4.F)

Table 6-39 status of the estimates made in IPCC category 4.F Other land

IPCC categories	Description	CO_2	Key category	CH_4	Key category	N_2O	Key category
4.E	**Wetlands**						
4.E.1	Wetlands remaining wetlands	NE		NE		NE	
4.E.2	Lands converted to wetlands	NO		NO		NO	

As described in the 2006 IPCC guidelines, Other Land includes bare soil, rock, ice, and all land areas that do not fall into any of the other five land-use categories. Other Land is often unmanaged, and in that case changes in carbon stocks and non-CO_2 emissions and removals are not estimated.

6.7.1 Other land remaining other land (IPCC category 4.F.1)

GHG emissions from this sector comprise emissions from the following categories that are described in the following table.

Table 6-40 Status of the estimates made in IPCC category 4.F.1 other land remaining other land.

IPCC categories	Description	Status for		
		CO_2	CH_4	N_2O
4.F	**Other Land**			
4.F.1	Other land remaining other land	NE	NA	NA

This category was not estimated due to lack of data.

6.7.1.1 Choice of activity data

Activity data consist of areas of *Other land remaining other land* summarized in graph and table below.

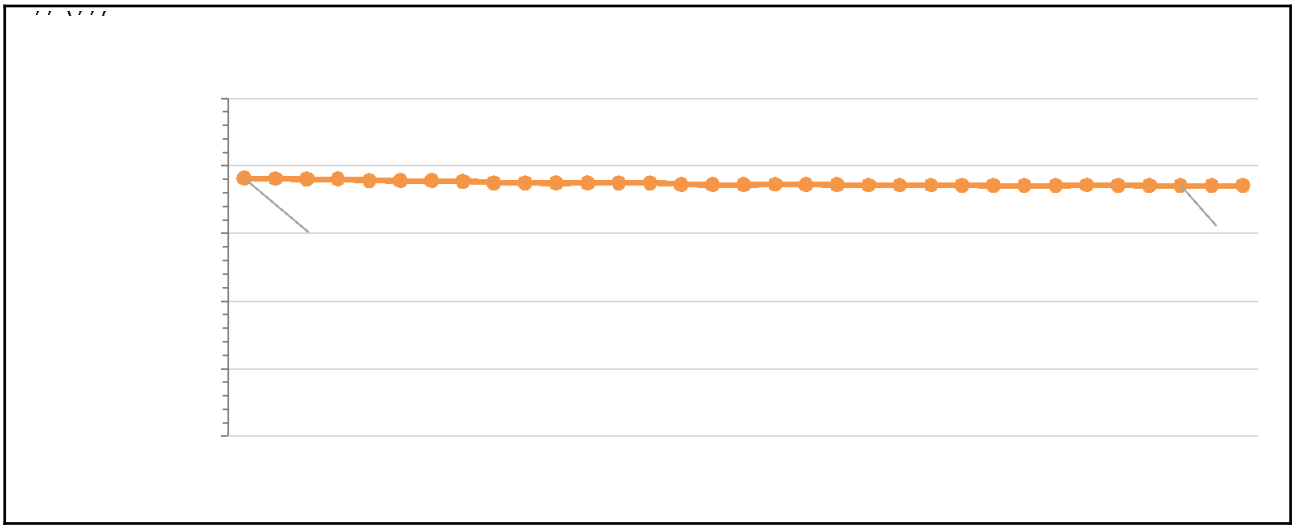

Figure 6-9 Other Land in ha (1990-2022)

6.7.1.2 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in the following table will be explored.

Table 6-41 Planned improvements for IPCC category 4.F.1 Other land remaining other land.

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.F.1	Estimates of Land converted to Other land remaining other land Application of methodology of 2006 IPCC Guidelines and guidance of 2019 refinements to the 2006 IPCC Guidelines.	EMI	Accuracy Transparency Comparability Completeness Consistency	High
4.F.1	Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in crop soils.	AD	Completeness	High
4.F.1	Preparation of land transition matrix	AD	Completeness	High
4.F.1	Collection of country specific parameter	EF	Completeness	High

6.7.2 Lands converted to other land (IPCC category 4.F.2)

GHG emissions from this sector comprise emissions from the following categories that are described in the following table.

Table 6-42 Status of the estimates made in IPCC category 4.F.2 lands converted to other land

IPCC categories	Description	Status for		
		CO_2	CH_4	N_2O
4.F	**Other Land**			
4.F.2	Lands converted to other land			
4.F.2.a	Forestland converted to other land	NE	NA	NA
4.F.2.b	Cropland converted to other land	NE	NA	NA
4.F.2.c	Grassland converted to other land	NE	NA	NA
4.F.2.d	Wetlands converted to other land	NE	NA	NA

This category was not estimated due to lack of data.

6.7.2.1 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

Table 6-43 Planned improvements for IPCC category 4.F.2 Lands converted to other land

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.F.2	Estimates of Lands converted to other land Application of methodology of 2006 IPCC Guidelines and guidance of 2019 refinements to the 2006 IPCC Guidelines.	EMI	Accuracy Transparency Comparability Completeness Consistency	High
4.F.2	Capacity building is planned to enable national experts to utilize tools and methods for data exploitation and estimate carbon stock changes in crop soils.	AD	Completeness	High
4.F.2	Preparation of land transition matrix	AD	Completeness	High
4.F.2	Collection of country specific parameter	EF	Completeness	High

6.8 Harvested wood products (HWP) (IPCC category 4.G)

GHG emissions from this sector comprise emissions from the following categories that are described in the following table.

Table 6-44 Status of the estimates made in IPCC category 4.G harvested wood products

IPCC categories	Description	Status for		
		CO_2	CH_4	N_2O
4.G	**TOTAL HWP consumed domestically (ΔC HWPdom IU DC)**			
4.G.1	Solid wood[14]			
4.G.1.a	Sawn wood	NE	NA	NA
4.G.1.b	Wood panels	NE	NA	NA
4.G.1.c	Other solid wood products	NE	NA	NA
4.G.2	Paper and paper board	NE	NA	NA
4.G.3	Other	NE	NA	NA

This category was not estimated due to lack of resources.

[14] If data are available, Parties are encouraged to report at the disaggregated data using the pre-defined drop-down menu. Furthermore, Parties are encouraged, to the extent possible, to use the pre-defined category definitions rather than create similar categories, in order to ensure the highest possible degree of comparability of the reporting. If detailed data are not available, Parties should include all emissions from solid wood under other solid wood products.

6.8.1 Choice of activity data

The production data for Sawnwood were taken from DGF statistics, whereas the import and export data were taken from FAO statistics. The data for Wood panels and Paper and paperboard were also taken from FAO statistics.

Table 6-45 Activity data for IPCC category 4.G harvested wood products.

	Sawnwood			Wood panels			Paper and paperboard		
	Production	Imports	Exports	Production	Imports	Exports	Production	Imports	Exports
year	(1000 m^3)			(1000 m^3)			(kt)		
1961	58.00	160.00	NO	NO	22.00	NO	14.70	25.50	18.70
1962	58.00	165.00	NO	NO	10.00	NO	5.20	25.50	18.70
1963	16.50	95.00	NO	NO	9.00	NO	6.30	25.50	18.70
1964	16.50	122.00	NO	NO	10.60	NO	6.30	14.60	17.80
1965	16.50	150.50	NO	NO	9.80	NO	6.30	14.60	17.80
1966	25.00	147.60	NO	NO	8.15	NO	6.30	14.60	17.20
1967	25.00	177.60	NO	NO	12.55	NO	11.10	14.60	17.20
1968	23.00	198.70	NO	NO	8.32	NO	11.00	24.70	15.60
1969	23.70	277.30	NO	21.40	11.32	NO	11.00	38.10	13.30
1970	22.80	485.90	NO	25.30	16.73	NO	13.00	44.30	13.90
1971	22.80	454.30	NO	25.30	37.03	NO	12.00	41.80	10.10
1972	22.80	254.00	NO	25.30	12.93	NO	12.00	39.00	8.30
1973	17.80	232.70	NO	25.30	28.70	NO	13.00	56.80	4.30
1974	17.80	606.70	NO	25.30	55.56	NO	12.00	57.10	4.30
1975	12.80	442.10	NO	25.30	28.35	NO	12.00	43.90	4.30
1976	12.80	312.80	NO	25.30	23.00	NO	12.00	27.80	4.30
1977	12.80	648.20	NO	25.30	49.90	NO	12.00	50.90	4.30
1978	12.80	313.00	NO	25.30	23.00	NO	12.00	93.50	NO
1979	12.80	461.80	NO	25.30	42.00	NO	127.00	95.60	NO
1980	12.80	450.30	NO	25.30	42.00	NO	156.40	95.60	NO
1981	12.80	857.00	NO	25.30	50.30	NO	177.60	90.10	NO
1982	12.80	854.10	NO	25.30	36.50	NO	179.60	96.10	NO
1983	12.80	1,284.20	NO	25.30	90.40	NO	194.10	75.50	NO
1984	12.80	1,123.50	NO	25.30	90.40	NO	216.10	76.30	NO
1985	12.80	818.50	NO	25.30	90.40	NO	222.10	65.00	NO
1986	12.80	827.00	NO	25.30	42.70	NO	230.10	193.90	NO
1987	12.80	451.10	NO	25.30	25.40	NO	214.10	186.60	NO
1988	12.80	661.90	NO	25.30	39.50	NO	218.10	180.60	NO
1989	12.80	1,043.30	NO	25.30	70.60	NO	236.10	135.00	NO
1990	12.80	803.00	NO	25.30	60.70	NO	208.00	84.00	NO
1991	12.80	1,302.50	NO	25.30	60.70	NO	177.00	95.60	NO
1992	12.80	263.94	0.19	25.30	47.85	0.84	173.00	109.85	0.06
1993	12.80	626.50	NO	25.30	77.27	0.40	204.20	103.00	NO
1994	12.80	714.80	NO	25.30	100.86	NO	188.60	113.00	0.20

	Sawnwood			Wood panels			Paper and paperboard		
	Production	Imports	Exports	Production	Imports	Exports	Production	Imports	Exports
year	(1000 m^3)			(1000 m^3)			(kt)		
1995	12.80	667.90	NO	25.30	55.80	NO	151.00	113.00	0.20
1996	12.80	490.00	NO	25.30	44.60	NO	100.30	80.00	NO
1997	12.80	652.60	NO	25.30	80.90	NO	102.00	67.00	NO
1998	12.80	667.00	NO	25.30	57.70	NO	109.00	125.00	NO
1999	12.80	777.20	NO	25.30	80.70	NO	35.80	136.40	NO
2000	12.80	777.00	NO	25.30	91.50	NO	37.50	115.70	NO
2001	12.80	962.70	NO	25.30	93.90	NO	36.90	106.70	NO
2002	12.80	935.30	NO	25.30	129.80	NO	26.70	110.40	NO
2003	12.80	1,116.43	0.45	25.30	367.58	NO	30.90	172.12	0.13
2004	12.80	1,201.00	0.56	25.30	94.89	0.15	35.20	259.27	0.12
2005	12.80	1,170.50	0.56	25.30	118.45	0.15	33.50	259.27	0.12
2006	12.80	1,124.49	0.14	25.30	101.93	0.15	33.50	136.30	0.10
2007	12.80	1,314.27	0.14	25.30	86.07	0.15	33.50	179.97	2.40
2008	12.80	1,298.58	0.16	25.30	72.73	0.18	33.50	160.61	2.11
2009	12.80	1,519.78	0.07	25.30	160.30	0.19	33.50	198.87	6.79
2010	20.00	1,686.92	0.06	25.30	228.75	0.77	33.50	238.96	6.05
2011	24.40	1,586.99	0.21	25.30	234.69	0.77	33.50	255.16	6.12
2012	25.40	2,171.09	0.29	25.30	257.67	0.44	33.50	243.77	2.45
2013	12.80	2,241.67	0.23	25.30	259.71	0.44	33.50	283.68	2.32
2014	12.80	2,424.65	1.07	25.30	289.62	0.44	33.50	304.89	0.82
2015	12.80	2,185.04	0.13	25.00	220.11	0.00	33.50	419.45	0.85
2016	12.80	1,824.80	0.03	25.00	463.86	0.00	33.50	487.56	2.83
2017	12.80	1,863.63	NO	25.00	280.53	NO	33.50	406.02	5.40
2018	12.80	1,948.80	NO	25.00	420.42	NO	33.50	419.10	NO
2019	12.80	1,205.00	0.46	25.00	473.49	0.28	33.50	403.27	NO
2020	12.80	716.98	0.00	25.00	410.08	NO	40.50	NO	NO
2021	12.80	816.43	0.01	25.00	392.68	NO	40.50	NO	NO
2022	12.80	747.25	NO	25.00	442.25	1.12	50.50	NO	NO

6.8.2 Category-specific planned improvements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in the following table will be explored.

Table 6-46 Planned improvements for IPCC category 4.F.1 Other land remaining other land.

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.G.1	Estimates of emission from Harvested wood products Application of methodology of 2006 IPCC Guidelines and guidance of 2019 refinements to the 2006 IPCC Guidelines.	EMI	Accuracy Transparency Comparability Completeness Consistency	High

GHG source & sink category	Planned improvement	Type of improvement		Priority
4.G.1	Collection of country specific parameter	EF	Completeness	High

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