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SWD(2021) 451 final

PART 2/3

COMMISSION STAFF WORKING DOCUMENT

**Sustainable carbon cycles for a 2050 climate-neutral EU
Technical Assessment**

Accompanying the

Communication from the Commission to the European Parliament and the Council

Sustainable Carbon Cycles

{COM(2021) 800 final} - {SWD(2021) 450 final}

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ANNEX: MAPPING OF NET LAND CARBON REMOVALS

This annex uses the latest EU Member States' Greenhouse Gas Inventory (GHGI) submission of 2021, reporting emissions and removals for the geographic scope of the EU-27 for years 1990 to 2019

¹. Sheets for land use categories show net carbon stock changes in carbon pools "Living biomass", "Dead organic matter" (for forest land uses split into "Deadwood" and "Litter"), "Mineral soils" and "Organic soils", as reported in Common Reporting Tables (CRT), for:

- Afforested land corresponding to sub-category "Land converted to forest land" in CRT 4.A (Forest Land)
- Managed forest land corresponding to sub-category "Forest land remaining forest land" in CRT 4.A (Forest Land)
- Cropland in CRT 4.B
- Grassland in CRT 4.C
- Wetland in CRT 4.D
- Settlement in CRT 4.E
- Other land in CRT 4.F
- Harvested wood products (HWP) in CRT 4.Gs1

The EU-27 profiles also depict additional land use category-specific emissions and removals², converted to CO₂-equivalents (CO₂e)³, for:

- Direct N₂O Emissions from N inputs to managed soils in CRT 4(I)
- Emissions and removals from drainage and rewetting and other management of organic and mineral soils in CRT 4(II)⁴
- Direct N₂O Emissions from N Mineralization/ Immobilization associated with loss/gain of soil organic matter resulting from change in the land use or management of mineral soils in CRT 4(III)
- Biomass Burning in CRT 4(V)
- Direct and Indirect N₂O emission from agricultural soils (cropland and grassland combined) in CRT 3.D⁵.

¹ GHGI submissions "FRK" for France and "DNM" for Denmark were used to ensure the EU reporting scope.

² Non-land use category specific emissions and removals such as CRT 4(IV) "Indirect N₂O emissions from managed soils" or CRT 4 under category H "Other" were not included.

³ C to CO₂: -44/12. CH₄ to CO₂e: 28, N₂O to CO₂e: 265.

⁴ Forest Land emissions and removals from CRT 4(II) were added to land category Managed forest land.

Four sheets were developed per land use category⁶:

- A. Map of net CO₂ density as the ratio of the net carbon stock change (total of all applicable carbon pools) and the total area of the category, expressed in tonnes CO₂ per hectare (t CO₂/ha) as average for the period 2015 to 2019. Source: CRT 4.A to 4.F.
- B. EU-27 profile as the total net carbon stock changes of all EU Member States, disaggregated by carbon pools from CRT 4.A to 4.F, their total, and the grand total including emissions from tables 4(I), 4(II), 4(III) and 4(V), expressed in Mega tonnes CO₂e (Mt CO₂e) for the period 1990 to 2019. For Cropland and Grassland their combined total of emissions from fertilizers is depicted separately.
- C. Map of area share as the ratio of the total area of each land use category and the total area of all land use categories, expressed in percent (%), as average for the period 2015 to 2019. Source: CRT 4.A to 4.F.
- D. Map of organic soil area share as the ratio of the organic soil area and the total area for each land use category, expressed in percent (%), as average for the period 2015 to 2019. Source: CRT 4.A to 4.F.

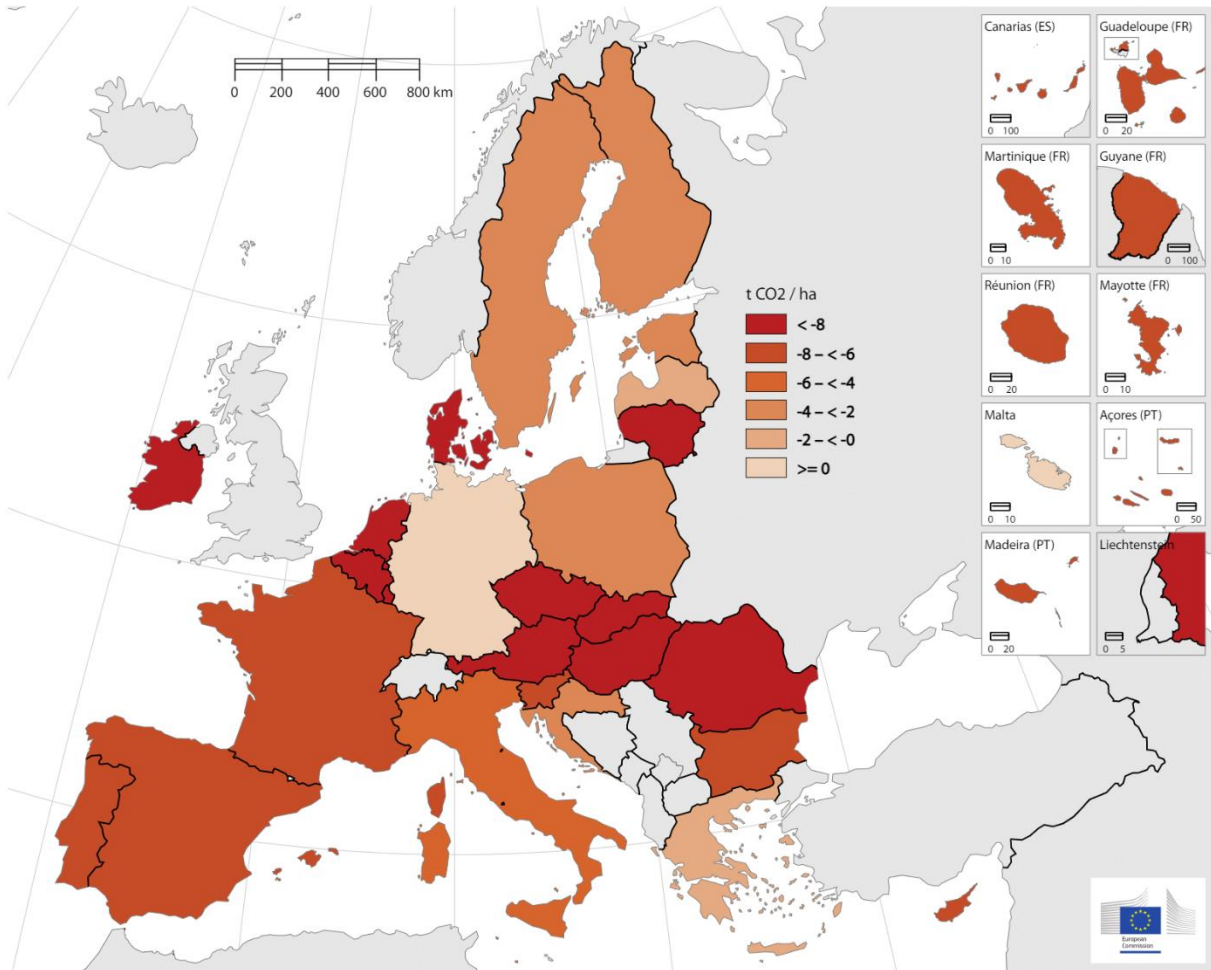
⁵ Fertilizer use was extracted from CRT 3.D matching CRT 4(I) (Inorganic N fertilizer, Organic N fertilizer), 4(II) (Cultivation of organic soils (i.e. histosols)) and 4(III) (Mineralization/immobilization associated with loss/gain of soil organic matter).

⁶ For particularities of Harvested wood products see specific notes for those sheets.

Afforested Land

A. Afforested land net CO2 density

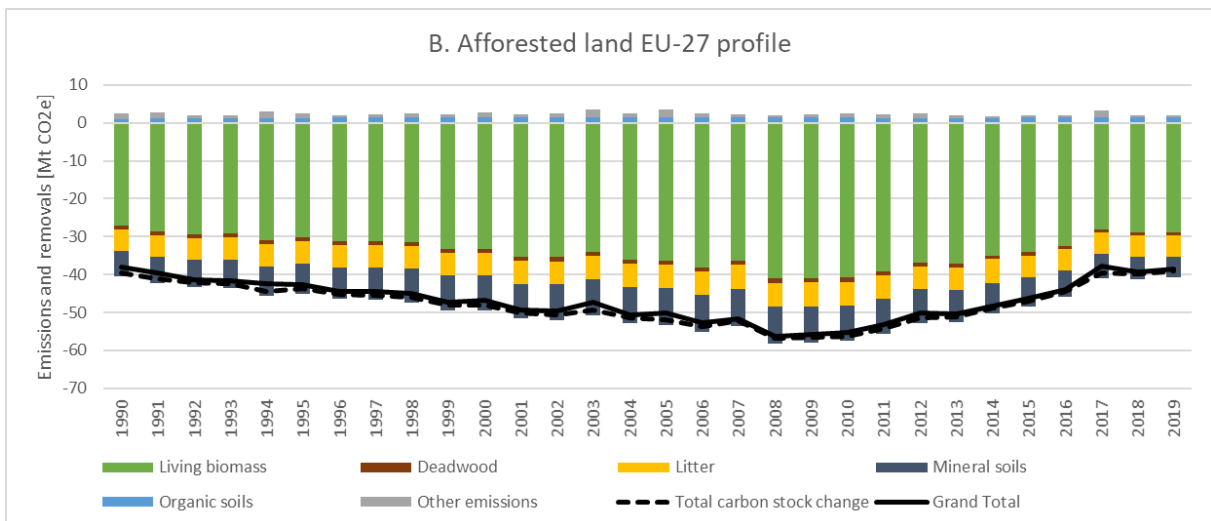
Net emissions and removals from "Land converted to Forest Land" by area



Total carbon stock changes of all applicable carbon pools for "Land converted to Forest Land" by total area of "Land converted to Forest Land", averaged for reported years 2015-2019. EU Member States GHG inventory submission of 2021

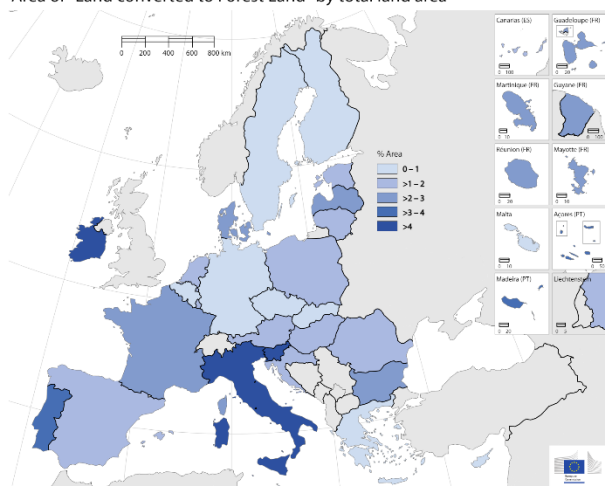
Administrative boundaries: © EuroGeographics © UN-FAO © Turkstat
Cartography: Eurostat – IMAGE, 11/2021

B. Afforested land EU-27 profile



C. Afforested land area share

Area of "Land converted to Forest Land" by total land area

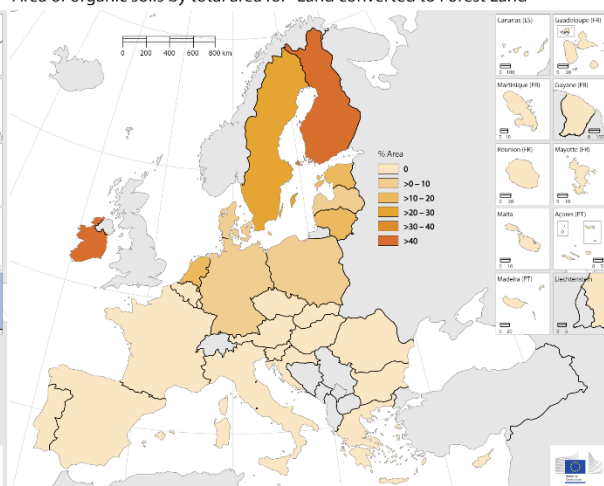


Total area of "Land converted to Forest Land" from carbon stock change by total land area, averaged for reported years 2013 - 2019. EU Member States GHG inventory submission of 2021

Administrative boundaries: © EuroGeographics © UN-GEOD | Turbotat Cartography | Source: -IMAG, 11/2021

D. Afforested land organic soil area share

Area of organic soils by total area for "Land converted to Forest Land"



Area of organic soils by total area for "Land converted to Forest Land" from carbon stock changes, averaged for reported years 2013 - 2019. EU Member States GHG inventory submission of 2021

Administrative boundaries: © EuroGeographics © UN-GEOD | Turbotat Cartography | Source: -IMAG, 11/2021

Notes

By default, emission and removals from afforested land are reported under sub-category "land converted to forest land" for the first 20 years after land conversion; after that period emission and removals on forested land are reported under "forest land remaining forest land". Generally, net carbon stock changes on afforested land are expected to depict net removals. As the only Member State, the 2021 GHG inventory submission of Germany reports carbon stock changes with net emission for afforested land on average for the last reported years; previous GHG inventory submissions reported very high net removals. Malta does not report carbon stock changes from afforested land.

The EU average of net carbon stock change density is $-5.9 \text{ t CO}_2/\text{ha}$. Estonia, Greece, Latvia Finland, and Sweden show low net carbon stock change densities between -1 and $-3 \text{ t CO}_2/\text{ha}$. Belgium, the Czech Republic, Ireland, Hungary, the Netherlands, Austria, Romania and Slovakia depict densities beyond $-10 \text{ t CO}_2/\text{ha}$, with an extreme value of $-21 \text{ t CO}_2/\text{ha}$ for Luxembourg. Germany reports a density of $+2.5 \text{ t CO}_2/\text{ha}$.

The EU profile ranges between -38 and $-56 \text{ Mt CO}_2\text{eq}$. The declining trend over the last decade is due to a decreasing areas share of "land converted to forest land" over the past 20 years⁷. Carbon pool living biomass is the main contributor to net removals (average: $-33 \text{ Mt CO}_2\text{eq}$), followed by mineral soils ($-8 \text{ Mt CO}_2\text{eq}$) and litter ($-6 \text{ Mt CO}_2\text{eq}$). Removals from deadwood ($-1 \text{ Mt CO}_2\text{eq}$) and emissions from organic soils and other emissions (each $1 \text{ Mt CO}_2\text{eq}$) hardly impact the profile.

The EU average area share of afforested land is 1.7%. Belgium, the Czech Republic, Germany, Greece, Cyprus, Slovakia, Finland and Sweden have afforested land area shares below 1%; Ireland, Italy and Slovenia report shares above 4%. Generally, Member States with high managed forest land area shares have lower afforested area shares; Slovenia is an exception.

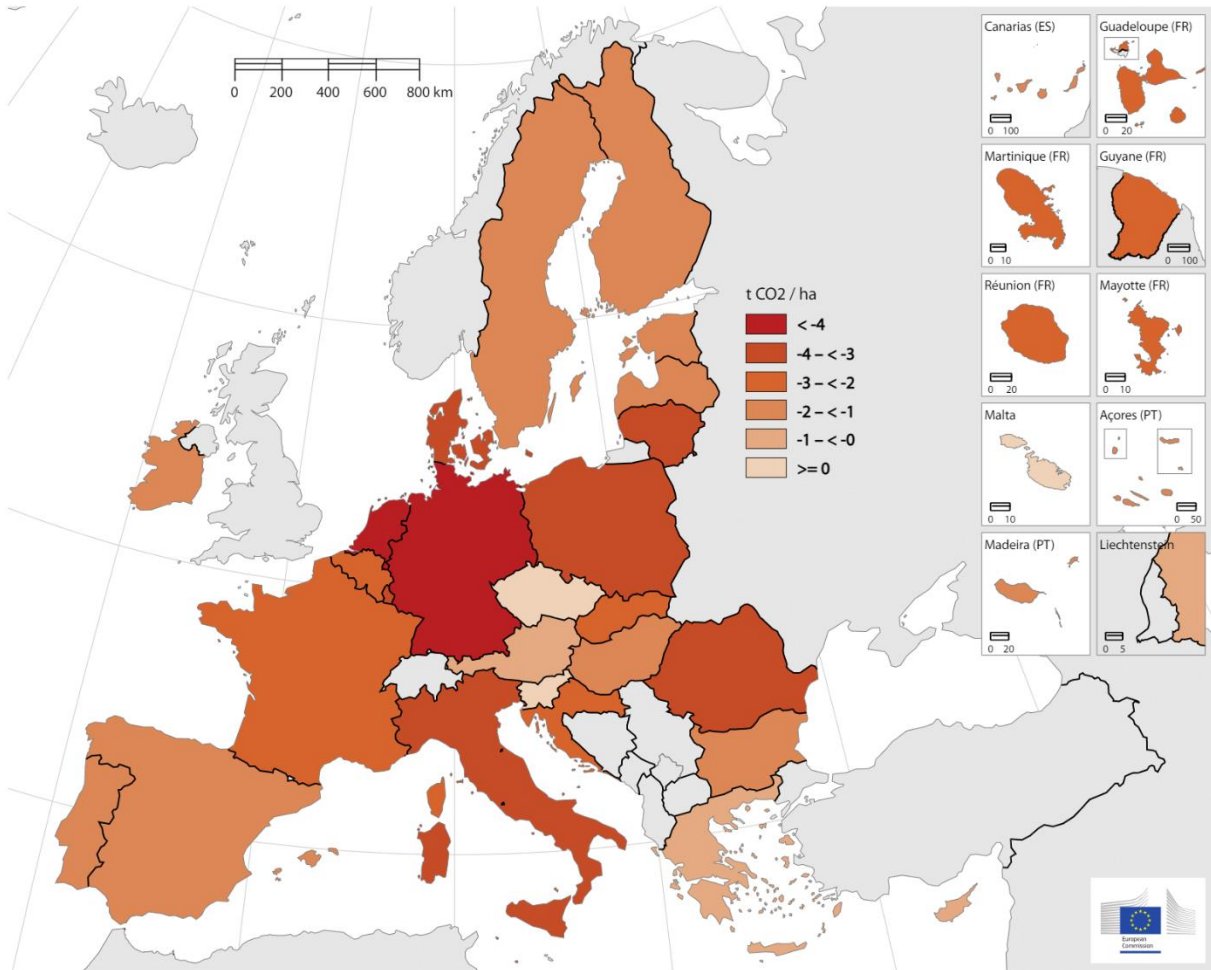
The EU average area share of afforested land on organic soils is 5.5%. All ten Member States with afforested land on organic soils are located in central and northern Europe, the Baltics and Ireland. Highest area shares are in Ireland (55.1%), Finland (41.1%) and Sweden (21.5%).

⁷ SWD(2021) 652 final. Stakeholder consultation and evidence base for the New EU Forest Strategy for 2030 ([link](#))

Managed forest land

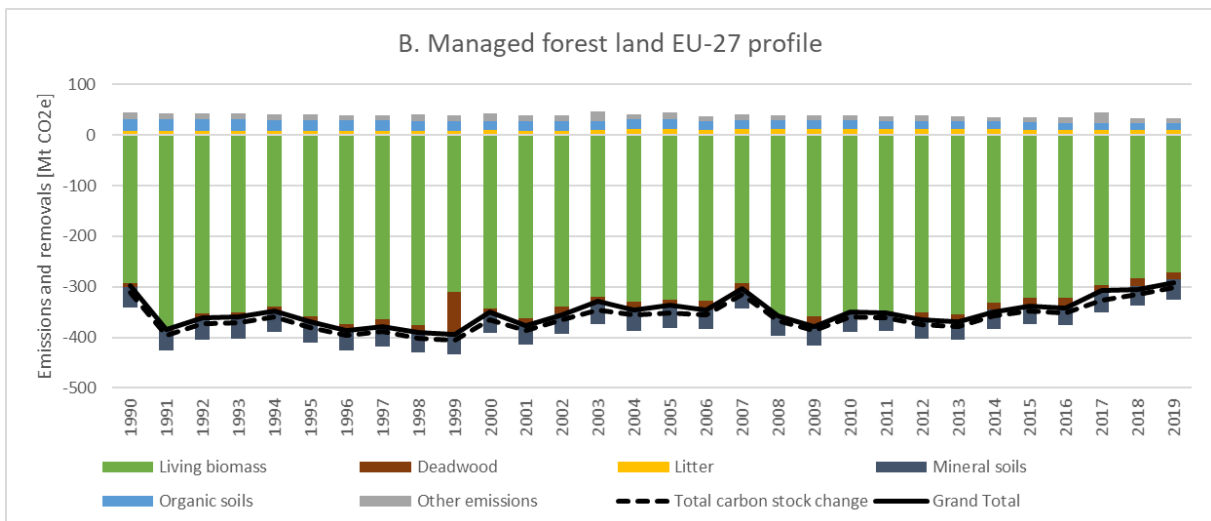
A. Managed forest land net CO2 density

Net emissions and removals from "Forest Land remaining Forest Land" by area



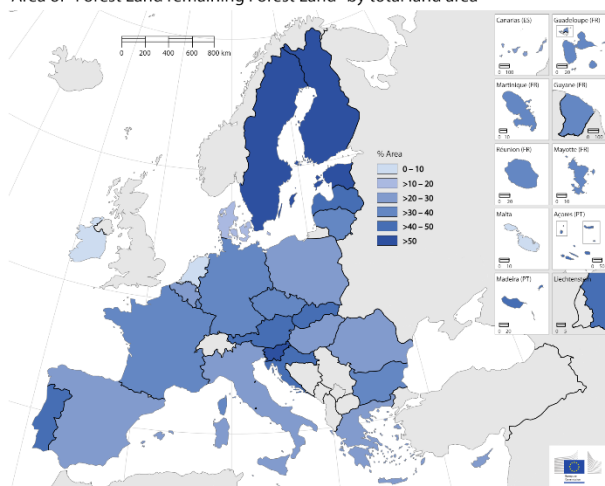
Total carbon stock changes of all applicable carbon pools for "Forest Land remaining Forest Land" by total area of "Forest Land remaining Forest Land", averaged for reported years 2015-2019. EU Member States GHG inventory submission of 2021

B. Managed forest land EU-27 profile



C. Managed forest land area share

Area of "Forest Land remaining Forest Land" by total land area

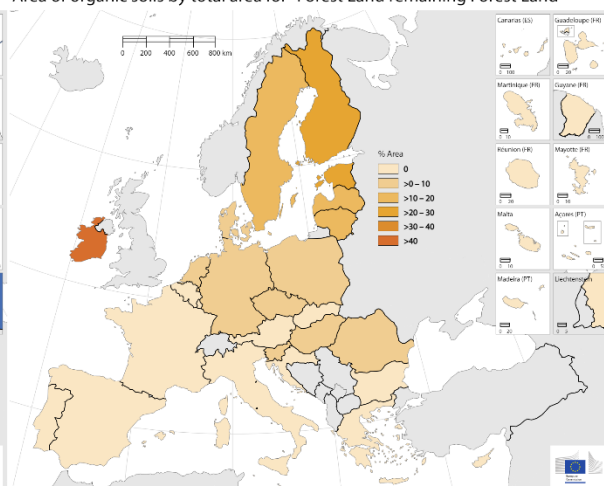


Total area of "Forest Land remaining Forest Land" from carbon stock changes by total land area, averaged for reported years 2013-2019. EU Member States GHG inventory submission of 2021

Administrative boundaries: © EuroGeographics © UN-GEOD | Turstat Cartography | Unesco - IMAGE, 11/2021

D. Managed forest land organic soil area share

Area of organic soils by total area for "Forest Land remaining Forest Land"



Area of organic soils by total area for "Forest Land remaining Forest Land" from carbon stock changes, averaged for reported years 2013-2019. EU Member States GHG inventory submission of 2021

Administrative boundaries: © EuroGeographics © UN-GEOD | Turstat Cartography | Unesco - IMAGE, 11/2021

Notes

Managed forest land corresponds to “forest land remaining forest land” and represent all forested land uses meeting the Member States’ forest definitions to the UNFCCC. It also includes forest land that is currently not stocked or where forest definitions for young trees are temporarily not met and, by default, “land converted to forest land” 20 years after land use conversion. On average for the last reported years, EU Member States report net carbon stock change removals from managed forest land with the exception of the Czech Republic and Slovenia. Both Member States suffered from severe natural disturbances that affected large areas. Malta does not report carbon stock changes from managed forest land.

The EU average of net carbon stock change density is $-2.1 \text{ t CO}_2/\text{ha}$. Greece and Cyprus report net carbon stock change density removals of less than $-1 \text{ t CO}_2/\text{ha}$; Germany ($-5.7 \text{ t CO}_2/\text{ha}$) and the Netherlands ($-4.4 \text{ t CO}_2/\text{ha}$) show net carbon stock change densities well above average. Net carbon stock change density emissions are reported in the Czech Republic ($+0.6 \text{ t CO}_2/\text{ha}$) and Slovenia ($+1.3 \text{ t CO}_2/\text{ha}$).

The EU profile ranges between -290 and $-395 \text{ Mt CO}_2\text{eq}$. The declining trend over the last decade is driven by a mix of factors, including an increase in wood demand, an increasing share of forests reaching maturity in terms of production management, and an increase in natural disturbances. The living biomass carbon pool (average: $-336 \text{ Mt CO}_2\text{eq}$) is the main contributor to net removals. Removals from deadwood ($-14 \text{ Mt CO}_2\text{eq}$) balance emissions from litter ($10 \text{ Mt CO}_2\text{eq}$). As a result of a major natural disturbance, mainly in France, deadwood removals reach $-80 \text{ Mt CO}_2\text{eq}$ in 2009. Removals from mineral soils ($-40 \text{ Mt CO}_2\text{eq}$) are higher than emissions from organic soils (13 to $22 \text{ Mt CO}_2\text{eq}$). Other emissions, including drainage and rewetting for forest land, are, on average, $10 \text{ Mt CO}_2\text{eq}$ but may vary due to emission by fires (e.g. 2017: $20 \text{ Mt CO}_2\text{eq}$).

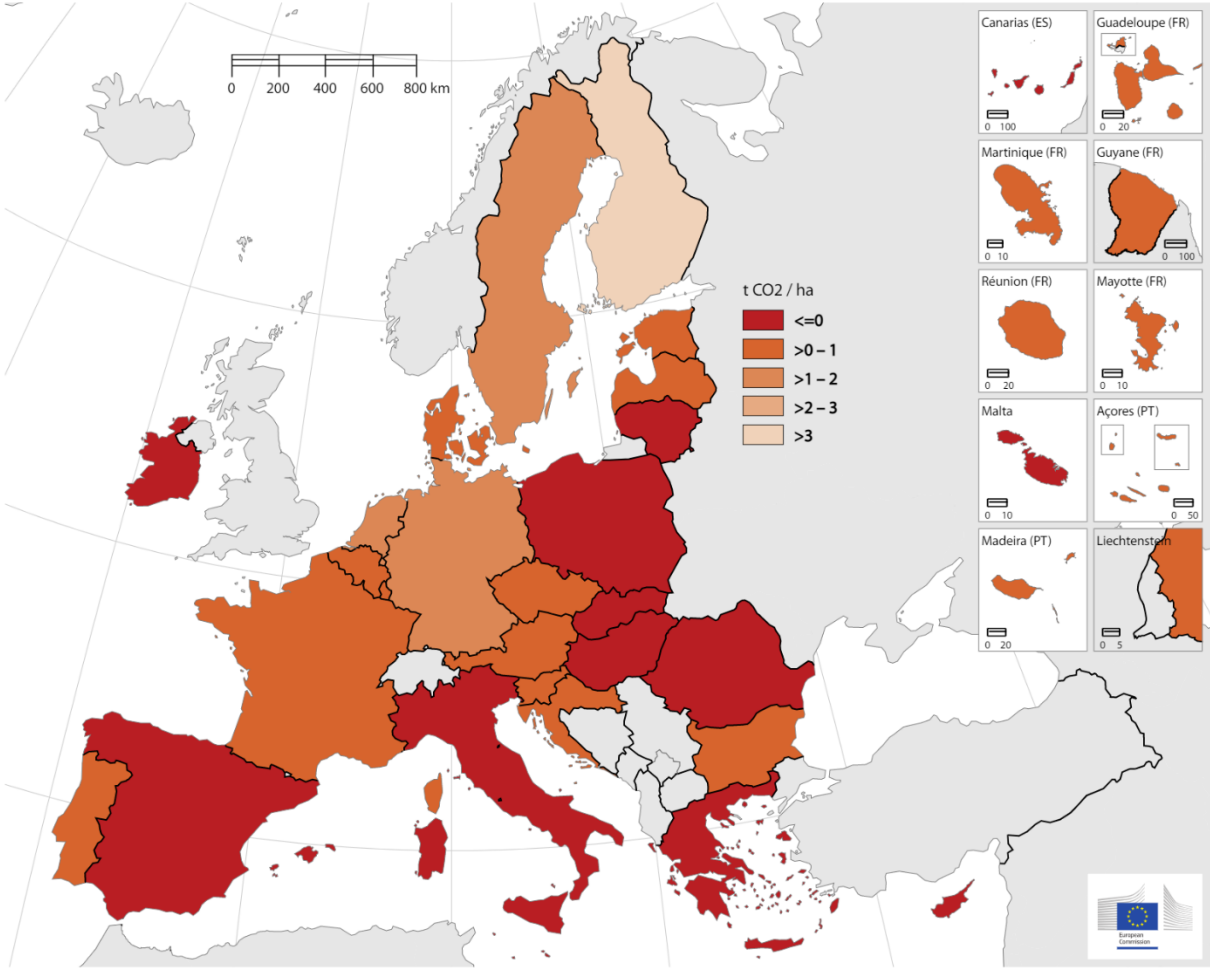
The EU average area share of managed forest land is 36.8%. Ireland, Malta and the Netherlands have managed forest land area shares below 10%; Estonia, Slovenia, Finland and Sweden report shares above 50%.

The EU average area share of managed forest land on organic soils is 7.7%. All 14 Member States with managed forest land on organic soils are located in central, northern and central-eastern Europe, the Baltics and Ireland. Highest area shares are in Estonia (23.7%), Ireland (60.6%) and Finland (27.2%).

Cropland

A. Cropland net CO2 density

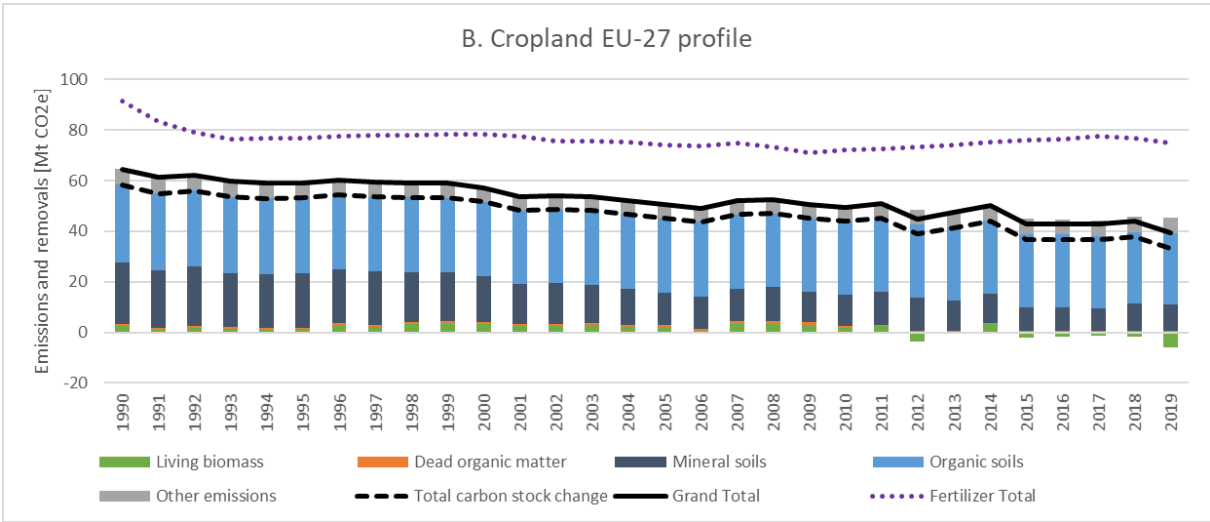
Net emissions and removals from "Total Cropland" by area



Total carbon stock changes of all applicable carbon pools for "Total Cropland" by total area of "Total Cropland", averaged for reported years 2015-2019. EU Member States GHG inventory submission of 2021

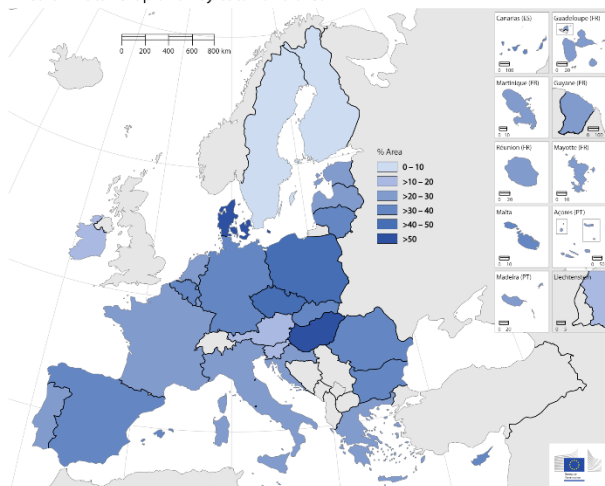
Administrative boundaries: © EuroGeographics © UN-FAO © Turkstat
Cartography: Eurostat – IMAGE, 11/2021

B. Cropland EU-27 profile



C. Cropland area share

Area of "Total Cropland" by total land area

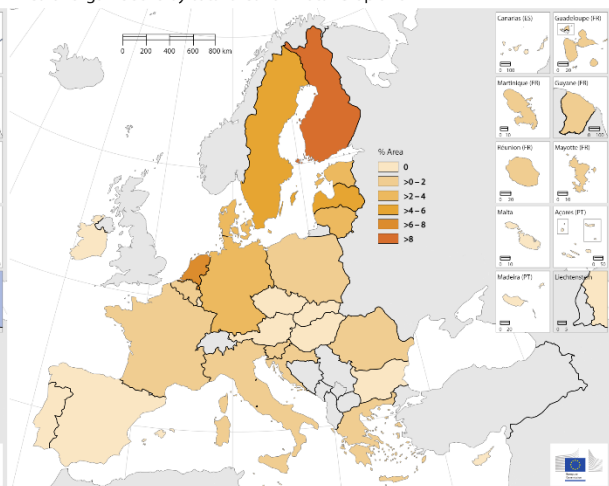


Total area of "Total Cropland" from carbon stock changes by total land area, averaged for reported years 2015-2019. EU Member States GHG inventory submission of 2021

Administrative boundaries: © EuroGeographics © UN-GEOD | Turbotat Cartography | Unswest - IMAGE, 11/2021

D. Cropland organic soil area share

Area of organic soils by total area for "Total Cropland"



Area of organic soils by total area for "Total Cropland" from carbon stock changes, averaged for reported years 2015-2019. EU Member States GHG inventory submission of 2021

Administrative boundaries: © EuroGeographics © UN-GEOD | Turbotat Cartography | Unswest - IMAGE, 11/2021

Notes

Cropland includes land that remains under cropland land use and land uses that were converted to cropland. While on average cropland reports net carbon stock change emissions at the level of the EU, the following eleven EU Member States report net carbon stock change removals for the last reported years: Ireland, Greece, Spain, Italy, Cyprus, Lithuania, Hungary, Malta, Poland, Romania, and Slovakia.

The EU average of net carbon stock change density is $+0.3 \text{ t CO}_2/\text{ha}$. Cyprus, Romania and Slovakia report net carbon stock change densities below $-0.5 \text{ t CO}_2/\text{ha}$; all other Member States with net removals have densities of greater than $-0.2 \text{ t CO}_2/\text{ha}$. Germany, the Netherlands and Sweden have net carbon stock change density emissions greater than $1 \text{ t CO}_2/\text{ha}$ and Finland $+3.1 \text{ t CO}_2/\text{ha}$.

The EU profile ranges between 40 and 65 Mt CO_2eq with a moderately declining trend over the 30-year period. All carbon pools show net emissions with the exception of living biomass in some years. Organic soils (average: 29 Mt CO_2eq) and mineral soils (between 9 and 24 Mt CO_2eq) are the main contributors. Living biomass turned from a net emission of 3 Mt CO_2eq to a net removal of $-2 \text{ Mt CO}_2\text{eq}$ ($-6 \text{ Mt CO}_2\text{eq}$ in 2019). Net emissions from dead organic matter are 1 Mt CO_2eq and other emissions 6 Mt CO_2eq . In contrast to other land use categories, N_2O emissions from fertilizer use on cropland and grassland (76 Mt CO_2eq for both land use categories) are reported under the agriculture sector.

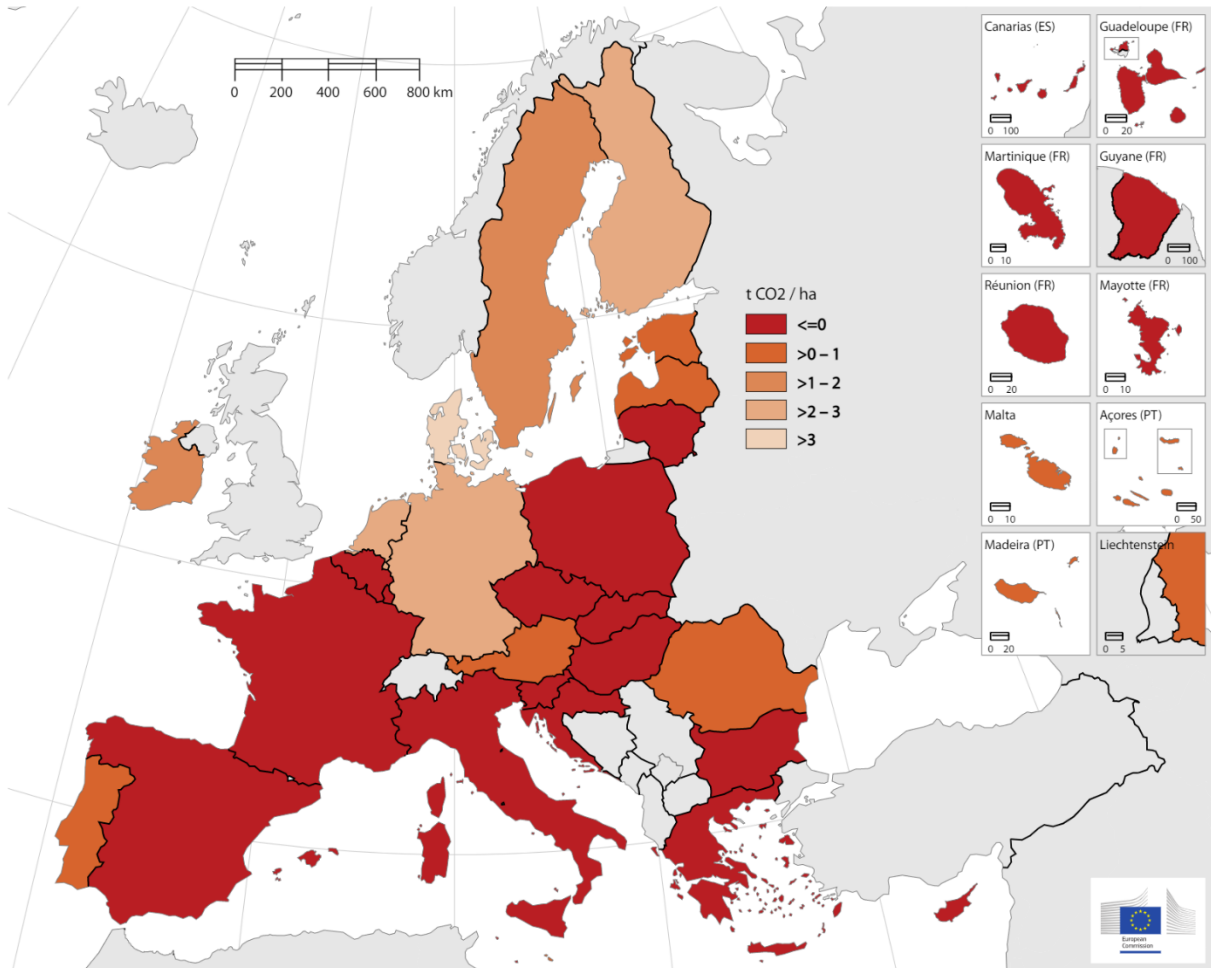
The EU average area share of cropland is 28.4%. Finland and Sweden have cropland area shares below 10%; Denmark and Hungary report shares above 50%.

The EU average area share of cropland on organic soils is 1.1%. All eleven Member States with no cropland on organic soils are located on the Iberian Peninsula, in central-eastern Europe and Bulgaria, Ireland, Cyprus, Luxembourg, and Malta. Highest area shares are in Denmark (3.4%), Latvia (5.3%), Lithuania (3.0%), the Netherlands (7.4%) and Sweden (4.9%).

Grassland

A. Grassland net CO2 density

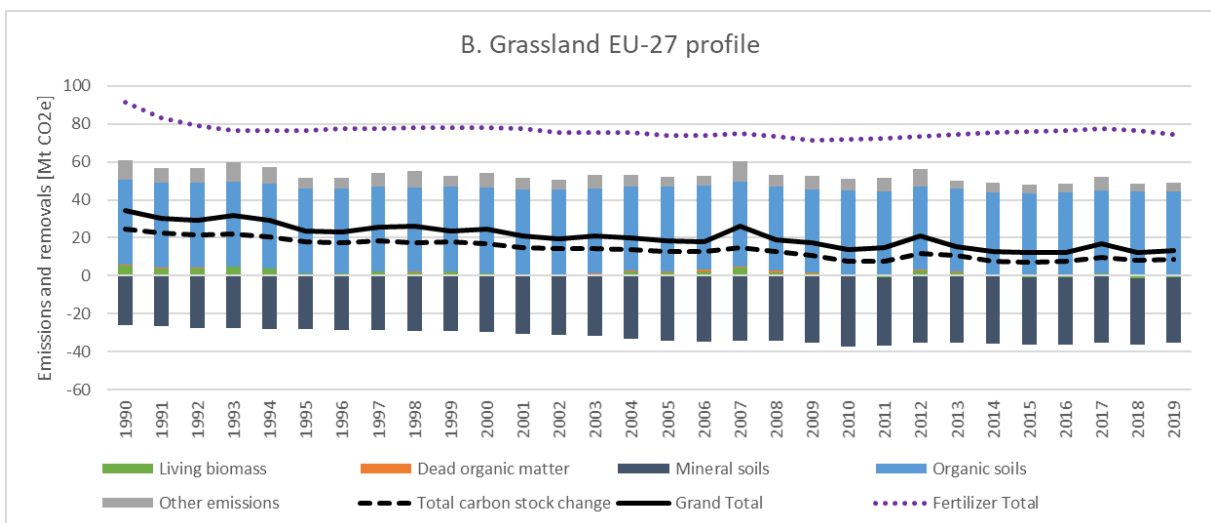
Net emissions and removals from "Total Grassland" by area



Total carbon stock changes of all applicable carbon pools for "Total Grassland" by total area of "Total Grassland", averaged for reported years 2015-2019. EU Member States GHG inventory submission of 2021

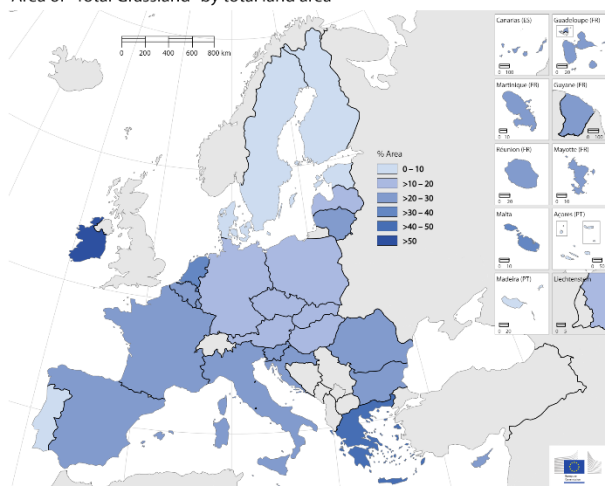
Administrative boundaries: © EuroGeographics © UN-FAO © Turkstat
Cartography: Eurostat – IMAGE, 11/2021

B. Grassland EU-27 profile



C. Grassland area share

Area of "Total Grassland" by total land area

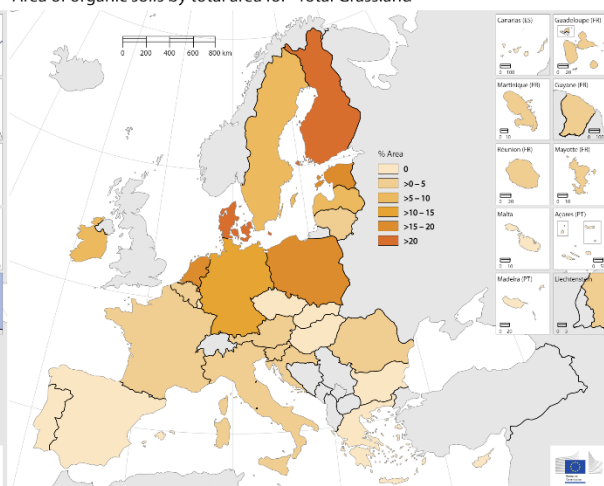


Total area of "Total Grassland" from carbon stock changes by total land area, averaged for reported years 2013-2019. EU Member States GHG inventory submission of 2021

Administrative boundaries: © EuroGeographics © UN-FAO | Turbotat Cartography | Source: - IMAGE, 11/2021

D. Grassland organic soil area share

Area of organic soils by total area for "Total Grassland"



Area of organic soils by total area for "Total Grassland" from carbon stock changes, averaged for reported years 2013-2019. EU Member States GHG inventory submission of 2021

Administrative boundaries: © EuroGeographics © UN-FAO | Turbotat Cartography | Source: - IMAGE, 11/2021

Notes

Grassland includes land that remains under grassland land use and land uses that were converted to grassland. While on average grassland reports net carbon stock change emissions at the level of the EU, the following 15 EU Member States report net carbon stock change removals for the last reported years: Belgium, Bulgaria, the Czech Republic, Greece, Spain, France, Croatia, Italy, Cyprus, Lithuania, Luxembourg, Hungary, Poland, Slovenia and Slovakia.

The EU average of net carbon stock change density is +0.1 t CO₂/ha. Belgium, France, Italy, Cyprus, Lithuania, Luxembourg and Slovenia report net carbon stock change densities below -0.5 t CO₂/ha. Germany, the Netherlands and Finland have net carbon stock change density emissions greater than 2 t CO₂/ha and Denmark +11.5 t CO₂/ha.

The EU profile ranges between 12 and 34 Mt CO₂eq with a declining trend over the 30-year period. Carbon pools organic soils shows net emissions (average: 44 Mt CO₂eq); mineral soils show net removals increasing from -26 Mt CO₂eq to -35 Mt CO₂eq. Living biomass emissions decreased from 5 Mt CO₂eq zero or even small net removals (-1.3 Mt CO₂eq) in some years. Dead organic matter has emissions of 0.4 Mt CO₂eq; other emissions of, on average, 7 Mt CO₂eq show larger variations. In contrast to other land use categories, N₂O emissions from fertilizer use on cropland and grassland (76 Mt CO₂eq for both land use categories) are reported under the agriculture sector.

The EU average area share of grassland is 17.8%. Denmark, Estonia, Portugal, Finland and Sweden have grassland area shares below 10%; Ireland and Greece report shares above 40%.

The EU average area share of grassland on organic soils is 3.7%. All ten Member States with no grassland on organic soils are located on the Iberian Peninsula, in central-eastern and south-eastern Europe and Luxembourg and Malta. Highest area shares are in Denmark (45.2%), Estonia (18.1%), the Netherlands (19.2%), Poland (18.2%) and Finland (27.5%).