

How has the forest-based carbon sink and stock evolved in the European Union?

Data and methods used

The following official and publicly accessible databases were used:

FRA (Forest Resource Assessment) is a process managed by UN FAO with regular data collection on the global forest resources. Results are presented via [FAOSTAT](#) and [FRA DATA](#) that provide free access to data for over 245 countries and territories from 1961 onwards.

[FOREST EUROPE](#) is the brand name of the Ministerial Conference on the Protection of Forests in Europe. It is the pan-European voluntary high-level political process for intergovernmental dialogue and cooperation on forest policies in Europe. FOREST EUROPE regularly collects data on European forest resources from its member countries, starting with 1990. Results are presented in reports.

The UNO provides data on greenhouse gas emissions and removals via several databases that can be accessed via <https://unfccc.int/process/transparency-and-reporting/greenhouse-gas-data/how-to-find-your-data>.

1.1 Development of annual CO₂ removals in the EU by forests and harvested wood products 1990-2020

EU 27 Development of the annual CO₂ removals by forests and harvested wood products 1990-2020: Data from the 2022 EU submission to the UNFCCC (document: European Union (Convention). 2022 Common Reporting Format (CRF) Table, 27 May 2022, <https://unfccc.int/documents/461929>, accessed 01.06.2022). From each annual submission file, from Table 4 (Sectoral report for land use, land-use change and forestry) the data on “Net CO₂ emissions/removals” for the categories “A. Forest land” and “G. Harvested wood products” were extracted. The same was done for the 2022 UK submission (document: United Kingdom. 2022 Convention Common Reporting Format (CRF) ,Table, 11 May 2022, accessed 01.06.2022). As the entity “EU-Convention” includes the UK, the UK data were subtracted from the EU-Convention data to calculate the EU 27 data.

1.2 Development of the annual CO₂ removals in the EU by forest land and harvested wood products 1951-2020

Carbon sink 1951-1999

Nabuurs et al. (2003) compiled a data series 1950-1999 for a group of 30 European countries, based on country data collected by Kuusela (1994) and Gold (2003). Gert-Jan Nabuurs gratefully made available these data for the elaboration of this report (EuFor-march 02 subm.xls, table “Tot”). Values for “net sink/source” (column N) were extracted in Pg C (Petagramm carbon). They were converted into million tonnes of CO₂ (Pg x 1000 x 3.666).

Nabuurs et al. (2003) include 22 EU member states: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden. In addition, they include the following other European countries: Albania, Bosnia and Herzegovina, Macedonia, Norway, Switzerland, Turkey, United Kingdom and Yugoslavia.

To scale the results on the annual sink from Nabuurs et al. (2003) to the entire EU 27, the growing stock 1990/2000 was used. From FAO FRA, growing stock data for all EU 27 member

states and for all the other countries included in Nabuurs were extracted. Data gaps were filled as follows:

- Belgium: 1990 and 2000-data from Forest Europe 2020 report.
- Ireland: 1990 and 2000-data from Forest Europe 2015 report.
- Montenegro: FAO FRA data are under “Naturally regenerated forests”.
- Portugal: 1990-data from Forest Europe 2015 report. 2000-data from Forest Europe 2020 report.

Nabuurs et al. (2003) included also former Yugoslavia that has no data in FAO FRA. Instead, the 1990 data for Bosnia-Herzegovina, Macedonia, Montenegro and Serbia were used, as well as those for Croatia and Slovenia that are included in the EU 27 data.

Nabuurs et al. (2003) used a carbon book-keeping model to estimate the temporal evolution of the forest sector net carbon sink from 1951 to 1999 for the entire group of the 30 European countries. This analysis includes trees, soil and wood products. Data on the sink for individual countries were not available in the data set used by Nabuurs et al. (2003). The results from this analysis for the entire group were scaled to annual values of the net sink for the entire EU 27 from 1951 until 1999, using the following approach: The share of the 22 EU countries on the growing stock of all Nabuurs countries was calculated for 1990/2000. The average for these two dates is 92%. This factor of 92% was used to scale the data on the annual net sink in Nabuurs et al. (2003) to the entire EU 27. The 22 EU countries cover 93.5% of the growing stock of all 27 EU countries in 1990 and 2000. Before 1990, there are no data on relevant forest characteristics available for both groups of countries. Another scaling approach using the share in forest area in 1992 results in a slightly lower sink in the EU 27 in the period 1951-1999 but does not change the general size and strong increase since 1951.

Carbon sink 1951-2020

The results of the scaling were combined with the data series 1990-2020 on annual CO₂ removals (data from the EU submissions to the UNFCCC) presented in Chapter 1.1 (sum of the values on “Forest land” and “Harvested wood products”).

Roundwood Production 1961-2020

For the period 1990-2020, data from FAOSTAT (Input-Forestry Production and Trade-Roundwood Total-Production Quantity, accessed 26.12.2021). Data gaps were filled as follows:

- Belgium: 1990-value includes Luxembourg.
- Czech Republic: 1990-value includes Slovakia (value for Czechoslovakia).
- Luxembourg: 1990-included in Belgium.
- Slovakia: 1990-included in Czech Republic (value for Czechoslovakia).

For 1990, data in FAOSTAT are incomplete as the three Baltic countries, Croatia and Slovenia are missing. The first complete data set in FAOSTAT is for 1992. The share of the five missing countries in 1992 was used to upscale the 1990 data to the entire EU 27. No individual country data were calculated for the five missing countries. The total 1990 for the EU 27 achieved by this approach is 0.63% bigger than a total 1990 resulting from the use of 1992 data for each of the five missing countries. The year 1990 seems to have had an extraordinarily high level of round wood production compared to the years before and after.

For the period 1961-1991, data in FAOSTAT are incomplete as the three Baltic countries, Croatia and Slovenia are missing. The first complete data set in FAOSTAT is for 1992. The share

of the five missing countries in 1992 was used to upscale the data 1961-1991 to the entire EU 27. The volume of annually produced roundwood in m³ was converted to tonnes of CO₂ by using the factors from Nabuurs et al. (2003) for wood density (0.45) and carbon content (0.59) and multiplied by 3.666 to calculate the CO₂ content in tonnes.

1.3 Development of the volume of carbon stored in living biomass in forests and of round wood production in the EU 1950-2020

Carbon stored in forests 1950-2020

Year 1950:

Nabuurs et al. (2003) found a tree carbon stock of 5.3 PgC in 1950 for all 30 European countries included in their analysis. The factor of 92% (see above “Carbon sink 1951-2020”) was used to scale this to a 1950 value for the entire EU 27 (4.876 PgC).

Period 1990-2020:

EU 27 Carbon stock in Forests: Data from FAOSTAT (Input-Land use-Carbon stock in living biomass-Forest land, accessed 17.01.2022 and 25.01.2022). For 2020, data from FAO FRA 2020 were used, accessed 20220413. Data gaps were filled as follows:

- Belgium: 1990-value includes Luxembourg.
- Croatia: 1990-no data in FAOSTAT, value for 1992.
- Czech Republic: 1990-value includes Slovakia (value for Czechoslovakia).
- Estonia: 1990-no data in FAOSTAT, value for 1992.
- Latvia: 1990-no data in FAOSTAT, value for 1992.
- Lithuania: 1990-no data in FAOSTAT, value for 1992.
- Luxembourg: 1990-included in Belgium.
- Slovakia: 1990-included in Czech Republic (value for Czechoslovakia).
- Slovenia: 1990-no data in FAOSTAT, value for 1992.

Both data sets were combined to calculate the increase for the years 1990, 2000, 2010 and 2020.

Roundwood production 1950-2020

Data from FAOSTAT that provides data from 1961 on, accessed 20.12.2021. Data for 1950 from Kuusela (1994) for 20 EU countries were upscaled to the EU 27 by their share on the EU 27 roundwood production in the first complete data set in FAOSTAT for 1992.

Carbon stock time series based on growing stock development 1950-2020

Carbon stock in living biomass in forests 1950-2010 for 20 EU member states: Verkerk (2015) compiled data series 1950-2010 on growing stock, based on country data collected by Kuusela (1994) and Gold (2003). For the period 1990-2010, data from Forest Europe (2011) and Vilen et al., (2012) were used. Pieter Johannes Verkerk gratefully made available these data for the elaboration of this report. Growing stock data used by Verkerk (2015) were extracted for 20 EU member states (Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Poland, Portugal, Romania, Slovakia, Spain and Sweden). They were converted to carbon volumes using the carbon and expansion factors from Nabuurs et al. (2003) (basic wood density: 0.45, carbon content: 0.5, Stock BEF: 1.81818) and summed up a total value for this group of countries. The 20 countries included in Verkerk (2015) represented in 1990 ca. 93% of the forest area, ca. 91% of the growing stock and ca. 97% of the roundwood production from forests in all EU 27

countries. Their development since 1950 can be therefore considered as highly representative for the overall evolution of the forest carbon stock in the EU 27 in this period.

Carbon stock in living biomass in forests 1990-2020 for 20 EU member states

Data on growing stock from FAO FRA, <https://fra-data.fao.org/EU27/fra2020/growingStock/> accessed 20211217, were compiled for the same 20 countries as in Verkerk (2015). This database provides only data for the years 1990, 2000, 2010, 2015-2020. Data gaps were filled as follows:

- Belgium: 1990-2000-2010-2020-data from Forest Europe 2020 report. 2015-data from FAO FRA (Sum of “Planted forests” and “Naturally regenerating forests”). 2016-2017-2018-2019-value for 2015.
- Ireland: 1990-2000-data from Forest Europe 2015 report.
- Portugal: 1990-data from Forest Europe 2015 report. 2000-data from Forest Europe 2020 report. 2016-2017-2018-2019-2020-value for 2015.

The growing stock data were converted to carbon volumes using the carbon and expansion factors from Nabuurs, 2003. The two carbon stock series 1950-2000 and 1990-2020 were combined. For 1990, the value from Verkerk was used that is about 5% smaller than the FAO FRA value. From 1991 on, only FAO FRA data were included in the combined series. In the text, only the ratio between the 1950 and 2020 data is addressed.

Roundwood production 1950-2020 for 20 EU member states

Data from FAOSTAT that provides data from 1961 on, accessed 20.12.2021. Data were extracted for the same 20 EU countries of the growing stock time series. They represented in 1990 ca. 93% of the forest area, ca. 90% of the growing stock and ca. 96% of the roundwood production from forests in all EU 27 countries. For the same 20 countries, data on annual removals for 1950 and 1960 from Kuusela (1994) were included to complete the time series.

2 Relevance of the forest carbon sink and stock development for EU climate policy

Annual CO₂ emissions in the EU 27: Our World in Data, based on the Global Carbon Project. Information on Annual CO₂ emissions-Carbon dioxide (CO₂) emissions from fossil fuels and industry. Land use change is not included. <https://ourworldindata.org/explorers/co2?time=earliest..latest&facet=none&country=EU-27~EU~EU~EU&Gas=CO%E2%82%82&Accounting=Production-based&Fuel=Total&Count=Per+country&Relative+to+world+total=false>, accessed 15.10.2022. Data downloaded on CO₂, Production based, all fuels, per country (EU 27).

Please note that the annual values in the Global Carbon Project differ from those submitted by the EU to the UNFCCC. The later include also other GHG gases and other emission sources. The UNFCCC databases start from 1990 only.