

Thünen à la carte

Germany's LULUCF Inventory *2017*

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The German emissions inventory for land use, land use change and forestry (LULUCF) covers the release and uptake of greenhouse gases in different land use categories, as well as carbon sequestration in harvested wood products. The land sector in Germany has been acting as an overall greenhouse gas sink since the first inventory in 1990, meaning that the uptake of carbon exceeds the emissions to the atmosphere. Here we present the results of the LULUCF inventory 2017 (data for 2015). In 2015, the net sink function amounted to approx. 14.6 million tons CO₂-equivalents, mainly due to carbon sequestered in forest biomass and in wood products. This carbon uptake reduces Germany's total emissions by 1.6 %.

BACKGROUND

Climatic change is one of the greatest environmental challenges of our time. In response, the international community has established a range of multinational treaties, including the UN Framework Convention on Climate Change (UNFCCC), the Kyoto-Protocol and the Paris Agreement. Germany, as member state to these agreements, has committed to substantially reducing its emissions of harmful greenhouse gases (GHG).

For the design, implementation and evaluation of effective emission reduction measures it is essential to assess and fully understand the national emissions landscape. To that end, the UNFCCC member states have established an annual reporting system, with National GHG Inventories documenting the development of emissions over time, also capturing key emitting sectors and identifying GHG sources and sinks. In Germany, the annual National Inventory Report is developed and coordinated by the Federal Ministry of the Environment (Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit). The responsibility for the reporting sectors "Agriculture" and "Land use, Land Use Change and Forestry" (LULUCF) lies with the Federal Ministry of Food and Agriculture (Bundesministerium für Ernährung und Landwirtschaft), which has retained the Thünen Institutes of Forest Ecosystems, of Climate-Smart Agriculture and of Wood Research to develop the annual inventory reports.

METHODS

The German GHG Inventory is conducted in line with the most recent guidelines of the Intergovernmental Panel on Climate Change (IPCC). The LULUCF inventory takes stock of emissions and removals of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) in the land use categories Forest Land, Cropland, Grassland, Wetlands and Settlements. The LULUCF inventory only covers greenhouse gases from land use and land use change, whereas agricultural emissions from e.g., livestock and fertilizer management are captured in the "Agriculture" inventory. The inventories of "Energy" and "Industry" cover substitution effects of wood

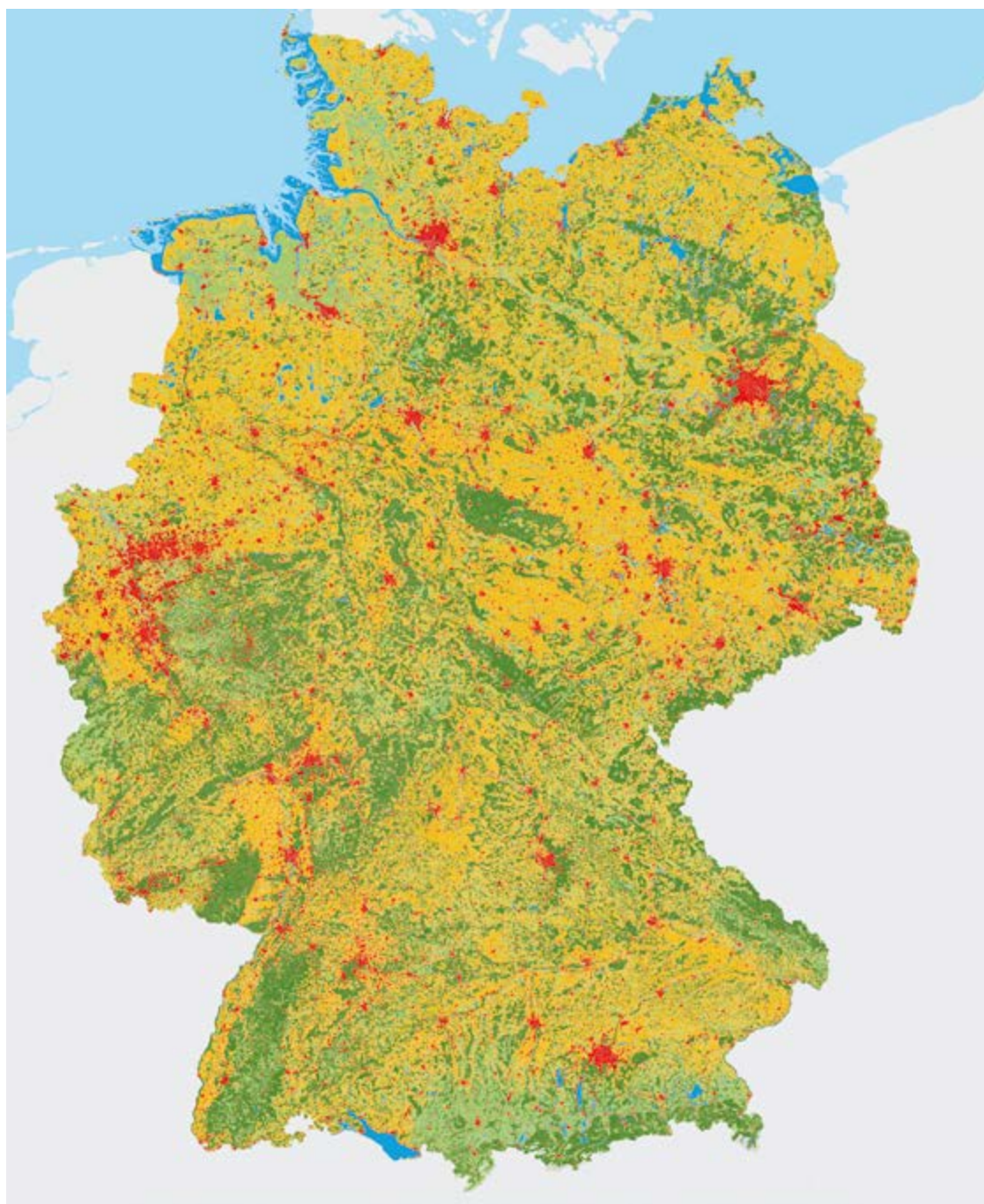
What is considered?

CO₂ emissions and removals	• in above-ground and below-ground biomass, deadwood and litter, mineral and organic soils • in harvested wood products • from industrial peat extraction
N₂O emissions	• from organic soils in forests, wetlands and settlements • from industrial peat extraction and forest fires • from humus mineralisation processes in mineral soils, through land management or land use change
CH₄ emissions	• from organic soils, ditches in organic soils, industrial peat extraction and forest fires

Map 1:
Land use in Germany
according to IPCC
categories

- Cropland
- Forest Land
- Grassland
- Settlements
- Wetlands

Source:
Umweltbundesamt,
CORINE Land Cover
2006



use, e.g., when wood as construction material replaces cement or steel, which results in the avoidance of emissions arising from their production.

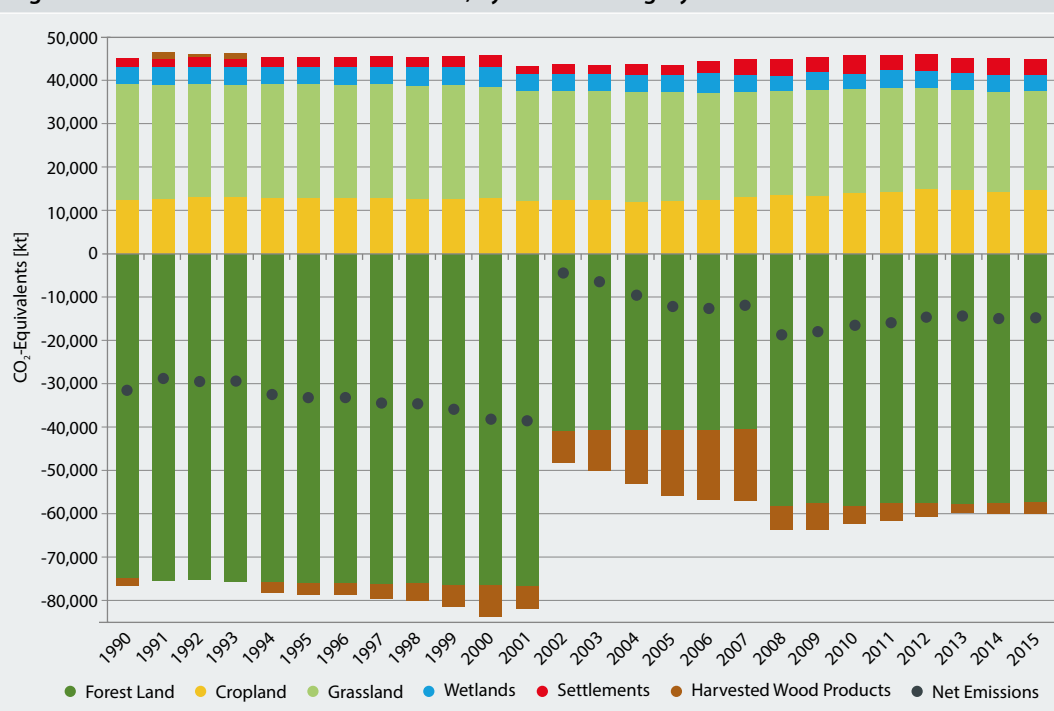
The calculation approach of the LULUCF inventory divides the entire surface of Germany into the land use categories Forest, Cropland, Grassland, Wetlands and Settlements, and determines their respective areas (Map 1). These categories are then further stratified according to the soil composition, into mineral and organic soils. The resulting areas as well as the transitions between the land use categories are consolidated into a land use matrix, which is based on geographically explicit cartographic data (among

others, of the official German topographic-cartographic information system ATKIS) and sample plot data from nationwide surveys such as the National Forest Inventory (Bundeswaldinventur).

In the land use categories, the carbon pools above-ground and below-ground biomass, deadwood and litter, mineral and organic soils function as sinks and sources of greenhouse gases. In addition, harvested wood products are considered.

The development of carbon stocks in these pools is determined with the help of emission factors. These are based on data from the Federal Statistical Office (Statistisches Bundesamt), on recent

Fig. 1: German LULUCF emissions since 1990, by land use category



research findings, and on national surveys such as the Agricultural and Forest Soil Inventories (BZE Landwirtschaft und Wald), and the National Forest Inventory.

If the net balance of all GHG emissions is negative, i.e., the uptake is greater than the release, the land use system is considered an emissions sink, whereas a positive balance represents an emissions source. The overall emissions balance is derived by converting all greenhouse gases (CO_2 , N_2O , CH_4) into CO_2 -equivalents (CO_{2e}).

CLIMATE IMPACT OF THE LAND USE SECTOR: DEVELOPMENT SINCE 1990

The time series since 1990 (Fig. 1) shows that land use is both a cause and a remedy in the climate change context – on one hand it enhances global warming with annual emissions of about 40-50 million tons CO_2 -equivalents (MtCO_{2e}), on the other hand climate change is mitigated through an annual uptake of about 45-85 MtCO_{2e} . Net emissions (=uptake minus emissions) have been constantly negative since 1990, meaning that the land use sector has acted as a reliable emissions sink over time.

The major part of the carbon uptake occurs in the land use category Forest Land (97%). Main sinks are mineral soils and biomass, due to increasing timber stocks and sustainable forest management. Harvested wood products constitute additional removals, albeit of varying magnitude over time. Note that the jump bet-

ween the years 2001 and 2002 has methodological reasons, as the development of forest biomass stocks is not determined annually but periodically.

Agricultural areas by contrast are dominant emissions sources. The land use categories Cropland and Grassland represent a constant emissions source over the years, contributing around 80% of Germany's land use emissions. This is mainly due to drained organic soils and grassland conversion. Wetlands comprise around 9% of land use emissions, primarily through industrial peat extraction. The emissions share of Settlements has steadily increased over the years, from 4.4% in 1990 to 8% in 2015.

Fig. 2: German LULUCF emissions 2015

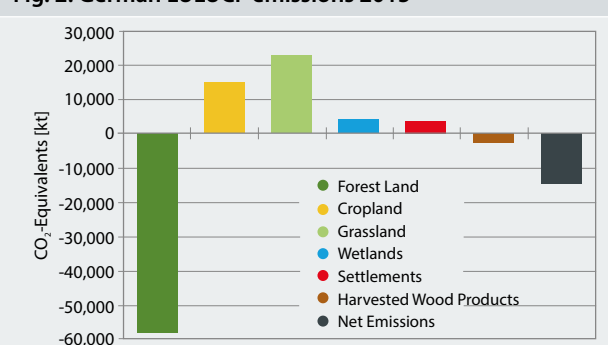
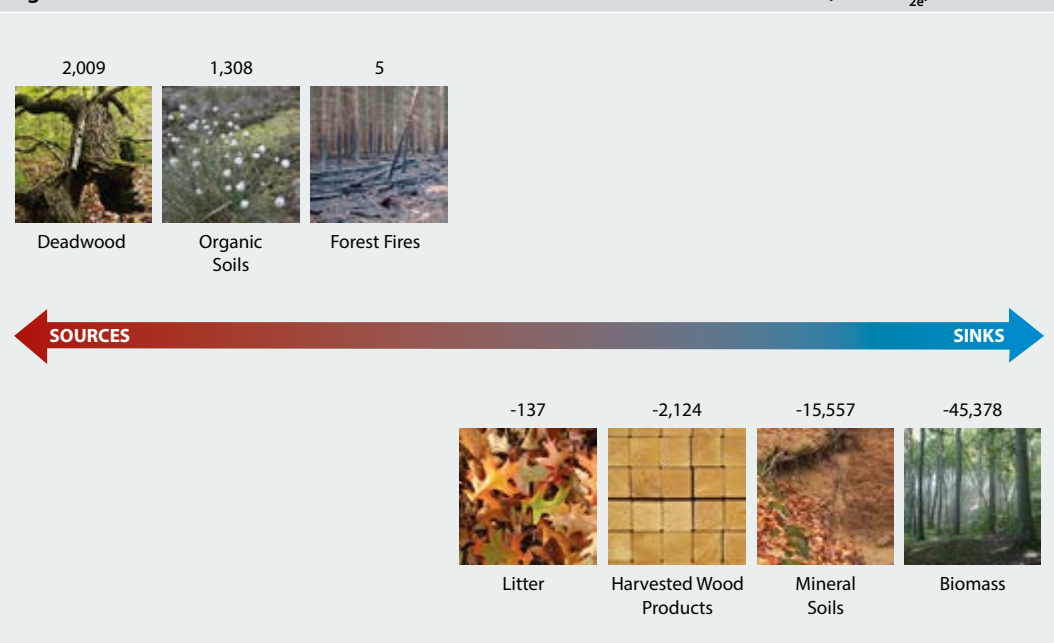


Fig. 3: Emission sources and sinks in Forest and Harvested Wood Products 2015 (in ktCO_{2e})

Overall, carbon dioxide is the dominating greenhouse gas, with substantially lower methane and nitrous oxide emissions.

LATEST EMISSIONS BALANCE

The latest German GHG Inventory 2017 describes a negative LULUCF emissions balance for the year 2015, showing that the land use sector continues to act as an emissions sink. A total uptake of 59.9 MtCO_{2e} in 2015 was counteracted by emissions of 45.3 MtCO_{2e}, resulting in an overall sink of 14.6 MtCO_{2e} (Fig. 2). For comparison: Germany's total GHG emissions in 2015 amounted to approx. 902 MtCO_{2e}. The consideration of the land sink reduces this figure by 1.6% to 887 MtCO_{2e}.

With a total uptake of 63.2 MtCO_{2e}, the categories Forest Land and Harvested Wood Products constituted the major part of this sink, thus emphasizing their climate change mitigation potential. Subtracting emissions of 3.3 MtCO_{2e} from deadwood, organic soils and forest fires results in a net land sink of 59.9 MtCO_{2e} for 2015 (Fig. 3).

OUTLOOK

Germany has committed to reducing its GHG emissions by 55% until 2030, compared to the base year 1990. Although land use is not currently being counted towards the German climate protection targets, it will be integrated into European climate change legislation more strongly after 2020. In addition, land use is an important element of the Paris Agreement, which explicitly calls for the protection and enhancement of biological carbon sinks

and reservoirs, and encourages all member states to make use of ecosystem-based mitigation options. The LULUCF Inventory offers some insights as to how to optimize the contribution of the land use sector to Germany's mitigation efforts:

- Peatland protection through conservation of high water tables, and climate-smart 'wet' management of organic soils
- Avoidance of further grassland conversion
- Maintenance and enhancement of forest sinks
- Wood use with preference for long-lasting uses.

FURTHER READING

Climate Change, 14/2017: Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol 2017. National Inventory Report for the German Greenhouse Gas Inventory 1990 – 2015. Dessau: German Environment Agency, ISSN 1862-4359, 1034.

Schmitz F, Polley H, Hennig P, Kroihner F, Marks A, Riedel T, Schmidt U, Schwitzgebel F, Stauber T (2014) Der Wald in Deutschland: ausgewählte Ergebnisse der dritten Bundeswaldinventur. Bonn: Bundesministerium für Ernährung und Landwirtschaft, 52 p.

The National GHG Inventory 2017 was developed according to the following methodological guidelines: 2006 IPCC Guidelines; 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (IPCC 2014a); 2013 Supplement to the IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (IPCC 2014b).

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