B Complementary Greenhouse Gas Emissions Database

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B.1 Overview

The purpose of this Chapter is to document data sources and steps used to develop the complementary greenhouse gas (GHG) emissions database for the GTAP 11.[5] Emissions are reported for three types of non-CO_2 GHGs – methane (CH_4), nitrous oxide (N_2O) and the group of fluorinated gases (F-gases), and cover five reference years – 2004, 2007, 2011, 2014 and 2017. In addition, CO_2 emissions from non-fossil fuel combustion activities are reported in the database. FAOSTAT dataset is used for sourcing agricultural GHG emissions, while EDGAR database is used to source non-agricultural GHG emissions. Each emission flow is associated with one of the four sets of emission drivers: output by industries, endowment by industries, input use by industries and consumption by households. Selected categories of land use GHG emissions are reported separately without association with emission drivers.

B.2 Introduction

The core GTAP 11 Data Base (Aguiar et al. 2022) provides estimates of CO_2 emissions from fossil fuels combustion only. In 2022, over 28% of all GHGs were associated with non-CO_2 GHGs, including CH_4, N_2O and F-gases (Crippa et al. 2019).

Due to the important contribution of non-CO_2 GHG emissions to climate mitigation pathways, since GTAP Version 6, a special version of the GTAP non-CO_2 emissions dataset has been constructed. GTAP 6 non-CO_2 dataset (Rose and Lee 2009) with 2001 reference year was developed based on emission accounts provided in a detailed non-CO_2 and non-fossil fuel combustion CO_2 ("Other CO_2") greenhouse gas emissions database (Rose, Finn, et al. 2007).

For GTAP 7 and 8, non-CO_2 emission dataset was developed by an extrapolation of Rose, Finn, et al. 2007 data to match each of the reference years. In GTAP 7, CH_4 and N_2O emission growth rates were used from EPA 2006, while F-gases emission projections were based on output growth rates by regions from the GTAP database (Rose, Avetisyan, and Hertel 2010). For GTAP 8, however, applied emission growth rates are based on two other data sources: EDGAR Version 4.2 dataset (JRC/PBL 2011) for non-agricultural emissions and FAOSTAT for agricultural emissions (Ahmed et al. 2014).

Same data sources were used for the development of the GTAP 9 non-CO_2 GHG emissions dataset (Irfanoglu and Mensbrugghe 2016). Emissions were directly sourced from the two sources listed above (i.e., EDGAR and FAOSTAT) and mapped to three GTAP 9 reference years (2004, 2007 and 2011). As in EDGAR Version 4.2 the latest available data year is 2010, an emission

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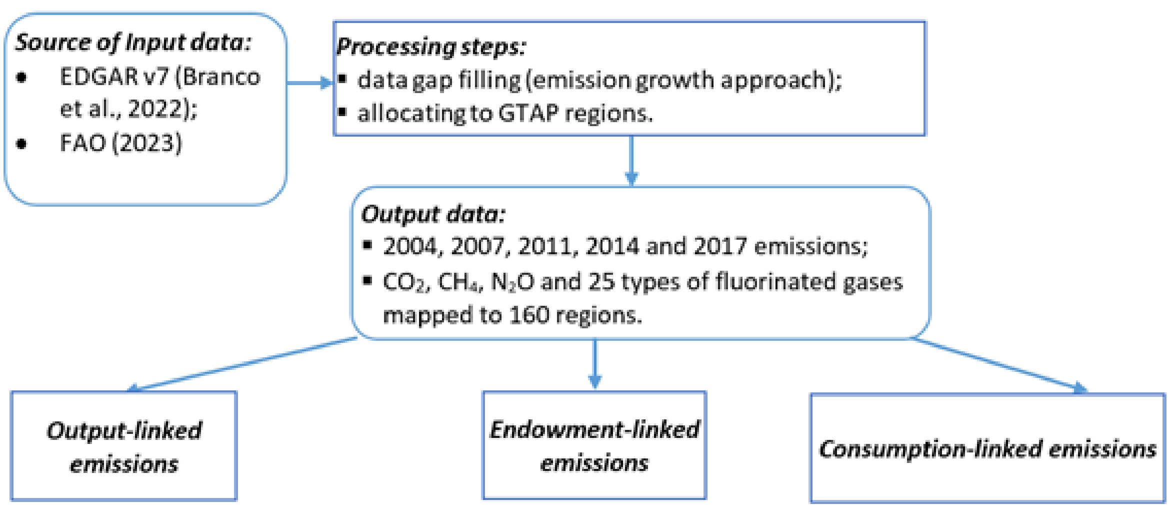
[5]This Chapter incorporates materials from Chepeliev 2020.

growth approach was used to project emissions from 2010 to 2011 levels, assuming that 2010-2011 emissions growth rate equals 2007-2010 emissions growth rate.

The GTAP 10 non-CO_2 emissions dataset construction followed the general approach outlined in Irfanoglu and Mensbrugghe 2016 with further updates and modifications (Chepeliev 2020). For the case of GTAP 11 we follow an overall approach developed in Chepeliev 2020, constructing emission accounts for the five GTAP 11 reference years – 2004, 2007, 2011, 2014 and 2017. Selected updates and modifications are implemented compared to Chepeliev 2020 as discussed in further detail below. FAOSTAT (FAO 2023) data is used to source agricultural non-CO_2 GHG emissions, while EDGAR v7.0 database (Branco et al. 2022) is used to source non-agricultural GHG emissions. Each emission flow is associated with one of the four sets of emission drivers: output by industries, endowment by industries, input use by industries and consumption by households. Emissions form the input use by industries are further split into emission from fossil fuel combustion and rest of emissions. The database also includes CO_2 emissions from industrial process, e.g. cement and fertilizer production. Figure 13.4 outlines general approach to the GTAP 11 complementary GHG emissions database construction. Selected categories of the land use GHG emissions are reported without associating them with emission drivers.

Figure 13.4: GTAP 11 complementary GHG database construction process



Note: In the final GTAP 11 complementary GHG database emissions are provided in million metric tonnes (mmt), while global warming potentials for converting to CO_2 eq. are reported in a separate header.
Source: Authors.

B.3 Treatment of the agricultural emissions from FAOSTAT

FAOSTAT data on emissions is used as a main source for agricultural non-CO_2 GHG emissions, excluding energy use emissions. Agricultural emissions in FAOSTAT are reported under 10 emission categories, which represent activities that produced such emissions. Table 13.4 provides a listing of such emission categories and their mapping to GHGs reported in the GTAP non-CO_2

database. FAOSTAT does not report agricultural emissions of fluorinated gases, but only N_2O and CH_4 emissions (Table 13.4, column 3). Three out of ten emission categories produce both GHGs, these include “Burning crop residues”, “Burning savanna” and “Manure management”, while seven remaining categories produce either N_2O or CH_4.

Table 13.4: FAO emission categories mapped to GHGs and emission drivers

No.	Emission category code	Emission category description	Reported GHGs	Emission driver
1	BCRS	Burning crop residues	N_2O, CH_4	Output
2	BSAV	Burning savanna	N_2O, CH_4	Land
3	CLOS	Cultivation of organic soils	N_2O	Land
4	CRES	Crop residues	N_2O	Output
5	MPAS	Manure left on pastures	N_2O	Capital
6	MASL	Manure applied to soils	N_2O	Capital
7	SNTF	Synthetic fertilizers	N_2O	Input use of chemical products (“chm”)
8	RICC	Rice cultivation	CH_4	Land
9	MMNG	Manure management	N_2O, CH_4	Capital
10	EFRM	Enteric fermentation	CH_4	Capital

Source: Developed by authors.

In addition, FAOSTAT reports data for 36 emission subcategories, which represent different agricultural commodities, types of land, etc. Their list is provided in the Table 13.5. 237 countries and territories reported by FAOSTAT are matched to the GTAP countries (FAO 2023). To map the FAOSTAT data to GTAP Data Base, we first map each emission category to their corresponding emission driver (Table 13.4, column 5). Then each emission subcategory is mapped to GTAP commodities (Table 13.5, column 4).

For instance, FAOSTAT (FAO, 2023) reports N_2O emissions from crop residues (“CRES” category in Table 13.4) for “Barley” by countries. Based on developed mappings, these emissions are associated with output of GTAP “Cereal grains nec” (“gro”) sector. In this case, we use direct mapping, as no redistribution of emissions between sectors is performed. An example where redistribution of emissions is implemented includes N_2O emissions from synthetic nitrogen fertilizer application (“SNTF” category in Table 13.4). These emissions are mapped to the eight GTAP agricultural sectors (listed in Table 13.5) and are associated with intermediate use of “Chemical products” (chm) by the corresponding sectors. We use the value of intermediate use of “chm” by these eight sectors to redistribute N_2O emissions. Such mapping approach is applied to all non-CO_2 GHG emission flows sourced from FAOSTAT.

Table 13.5: Emission subcategories reported in the FAOSTAT database and mapping to GTAP sectors

No.	Emission subcategory code	Emission subcategory description	GTAP sectors[a]
1	56	Maize	gro
2	27	Rice, paddy	pdr
3	156	Sugar cane	c_b
4	15	Wheat	wht
5	44	Barley	gro
6	79	Millet	gro
7	116	Potatoes	v_f
8	176	Beans, dry	v_f
9	75	Oats	gro
10	71	Rye	gro
11	236	Soybeans	osd
12	83	Sorghum	gro
13	6760	Savanna	ctl, oap, rmk
14	6789	Woody savanna	ctl, oap, rmk
15	6791	Closed shrubland	ctl, oap, rmk
16	6792	Open shrubland	ctl, oap, rmk
17	6794	Grassland	ctl, oap, rmk
18	6727	Cropland organic soils	pdr, wht, gro, v_f, osd, c_b, pfb, ocr
19	6728	Grassland organic soils	ctl, oap, rmk
20	1107	Asses	ctl
21	1126	Camels	ctl
22	960	Cattle, dairy	rmk, ctl
23	961	Cattle, non-dairy	ctl
24	1016	Goats	ctl
25	1096	Horses	ctl
26	1110	Mules	ctl
27	976	Sheep	ctl
28	946	Buffaloes	ctl
29	1051	Swine, breeding	oap
30	1049	Swine, market	oap
31	1177	Llamas	ctl
32	1053	Chickens, broilers	oap
33	1052	Chickens, layers	oap
34	1068	Ducks	oap
35	1079	Turkeys	oap
36	3107	Synthetic Nitrogen fertilizers	pdr, wht, gro, v_f, osd, c_b, pfb, ocr

Source: Developed by authors.

[a]Description and codes of the GTAP 11 Data Base sectors are available at: `https://www.gtap.agecon.purdue.edu/databases/v11/v11_sectors.aspx`

B.4 Treatment of the non-agricultural emissions from EDGAR

Non-agricultural emissions and energy-related agricultural emissions are sourced from the EDGAR v7.0 databases (Branco et al. 2022). EDGAR reports emissions for 28 GHGs, including CO_2, CH_4, N_2O and 25 fluorinated gases. The database covers 208 countries, which are mapped to the GTAP countries, and reports emissions from international aviation and international shipping. These emissions are reported at the global level. We redistribute them by countries based on the value of exports reported in GTAP 11 for air transport (atp) and water transport (wtp) respectively, excluding exports of travelers' expenditures. It should be noted that the CO_2 emissions from fossil fuel combustion, including those from international aviation and navigation, are included to the standard GTAP Data Base, therefore emissions sourced from EDGAR are complementary to the fossil fuel combustion CO_2 emissions.

EDGAR reports emissions for 51 IPCC categories, which are mapped to emission drivers (Appendix Table 13.8). As agricultural emissions are covered by FAOSTAT, they are discarded from the EDGAR data processing steps to avoid double counting. Appendix Table 13.8 provides the mapping between IPCC categories reported in EDGAR, GTAP emission drivers and emission agents. These mappings are used to associate EDGAR emissions with GTAP-based emission drivers and agents that produce these emissions as described in Section B.2.

To provide the reallocation of emissions from combustion-related energy use (IPCC category 1A), we use volumes of combusted energy and emission factors. We estimate emission weights by multiplying combustion-related energy use by corresponding emission factors (Table 13.6). For other IPCC categories, not included into 1A, we use corresponding GTAP values to assist the redistribution. To redistribute emissions associated with non-energy products from fuels and solvent use across agents, we use the volume flow of white spirits, bitumen, lubricants and paraffin waxes reported in the detailed energy database.

Table 13.6: Emission factors for selected GHGs, g per mmBtu

Fuel type	GTAP sectors	CH_4 factor	N_2O factor
Coal and coke	coa	11	1.6
Natural gas	gas, gdt	1	0.1
Petroleum products	p_c, oil	3	0.6

Source: EPA 2018.

One distinctive features of the EDGAR v7.0 database is an explicit differentiation between fossil and bio emission sources. To take this into account, in selected cases, we modify the emission drivers for selected emission categories as indicated in the Appendix Table 13.8. In the final GTAP database emissions from fossil and bio sources are aggregated, however, the distinction across drivers remains captured in the database.

The resulting database reports GHG emissions in million metric tonnes (mmt) and 100-year global warming potentials (GWPs) from the IPCC's Second, Fourth and Fifth Assessment Reports (AR2, AR4 and AR5 respectively). GTAP 9 non-CO_2 GHG emissions dataset was using

GWPs from the IPCC's AR2 (Irfanoglu and Mensbrugghe 2016), while GTAP 10 Data Base, as a default, was using GWPs from AR4 (Chepeliev, 2020). In GTAP 11, we provide users an opportunity to perform conversion to CO_2-eq. on their own using either one of the provided GWP conversion factors or alternative approaches. GWP values from the AR5, reported in the database files, do not include climate-carbon feedbacks (IPCC 2014). In those cases when GTAP regions do not emit any F-gases, global weighted average GWPs for F-gases are reported.

B.5 Land use GHG emissions

Since the standard GTAP database does not have detailed representation of the land use accounts, GTAP 9 non-CO_2 GHG emissions dataset did not report land use emissions (Irfanoglu and Mensbrugghe 2016). GTAP 10 GHG emissions data included land use-related emissions as a separate account (without an explicit association with emission drivers) (Chepeliev 2020). A number of previous efforts have been linking land use change emissions with the GTAP Land Use and Land Cover Data Base, which provides detailed accounting of the land use activities (e.g. Hertel et al. 2010). At the same time, accounting for all GHG emission sources is important for the proper tracking of the mitigation efforts and global warming estimates, for instance, in the case of linking of the GTAP simulations with the climate model.

In the current effort, we provide estimates of the land use GHG emissions by GTAP 11 Data Base regions based on the FAOSTAT database (FAO 2023). Unlike in the GTAP 10 Data Base, some subcategories of the land use emissions are redistributed across GTAP activities. In particular, Emissions from drying pastureland and cropland are mapped to primary crops and livestock respectively based on the mappings provided in Table 13.5.

Land use emissions from burning biomass are represented across land types (FAOSTAT emission categories) and are not mapped to drivers and agents. Treatment of the land use emission changes for the latter category is left up to the modelers, as different alternative assumptions could be implemented taking into account features of the applied model and specifics of the policy simulation. For instance, one can impose exogenous trends on land use emissions based on the additional data sources, e.g. using SSP database (IIASA 2016), assume these emissions stay at the reference year level (e.g. within the static model runs) or link to the land use activities if such representation is available in the model.

Based on the FAO land use change GHG emissions data (FAO 2023), we identify two emission categories and four subcategories of emissions that are not mapped to GTAP-based drivers (Table 13.7). We map land use GHG emissions reported by countries in the FAO database to the 160 GTAP 11 regions.

In terms of land use emission sources, in 2017 forest conversion contributed over 90% of all emission increases – 2945 $MtCO_2$-eq. – CO_2 emissions only (Figure 13.5). These emissions have been almost fully outweighed by CO_2 removals by forest land – negative emissions of 2637 $MtCO_2$-eq. Humid tropical forests and other forests together contributed 207 $MtCO_2$-eq. emissions, split almost equally between N_2O and CH_4 (Figure 13.5). When estimated on the net basis, CO_2 accounted for 61.2% of all land use GHG emissions, followed by CH_4 with the share

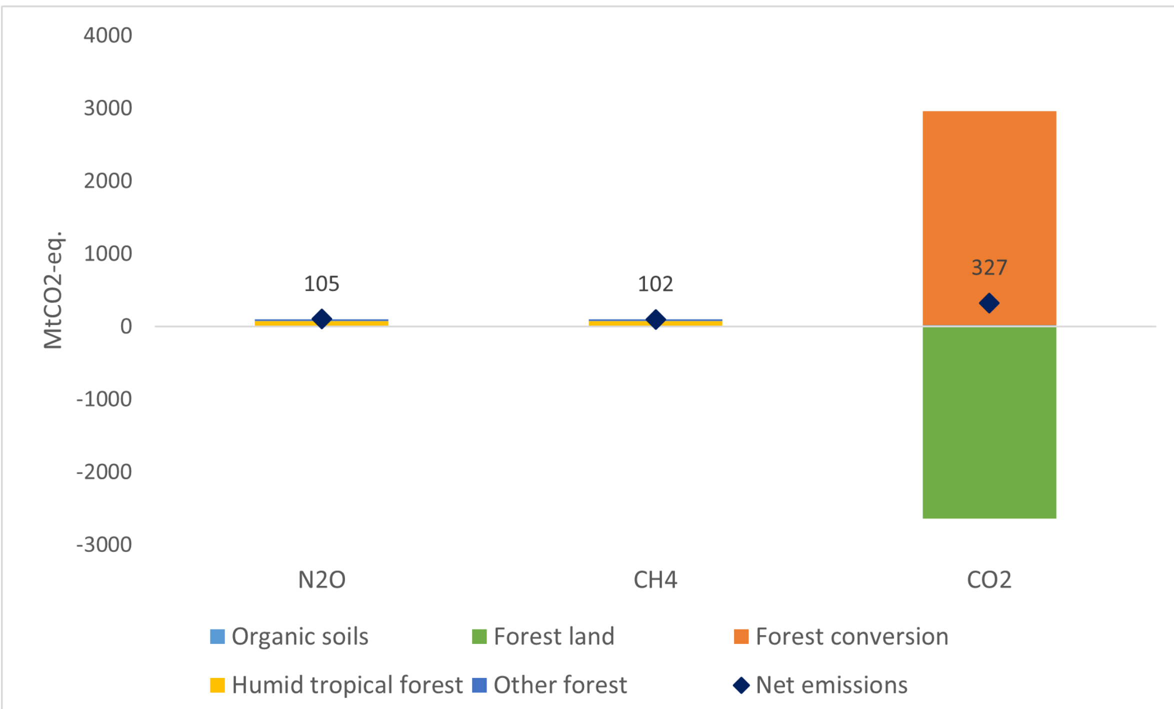
Table 13.7: Land use GHG emission categories reported in the FAOSTAT database

No.	Emission category (code)	Emission subcategory (code)	Reported GHGs
1.	Forest land (FrsLand)	Forest land (FrsLand)	CO_2
2.	Forest land (FrsLand)	Forest conversion (FrsConv)	CO_2
3.	Burning – biomass (BrnBiom)	Humid tropical forest (TropFrs)	N_2O, CH_4
4.	Burning – biomass (BrnBiom)	Other forest (OthFrs)	N_2O, CH_4
5.	Burning – biomass (BrnBiom)	Organic soils (OrgSoil)	CO_2, CH_4

Source: FAO 2023.

of 19.7%.

Figure 13.5: Distribution of global land use net GHG emissions in 2017 by gases and categories

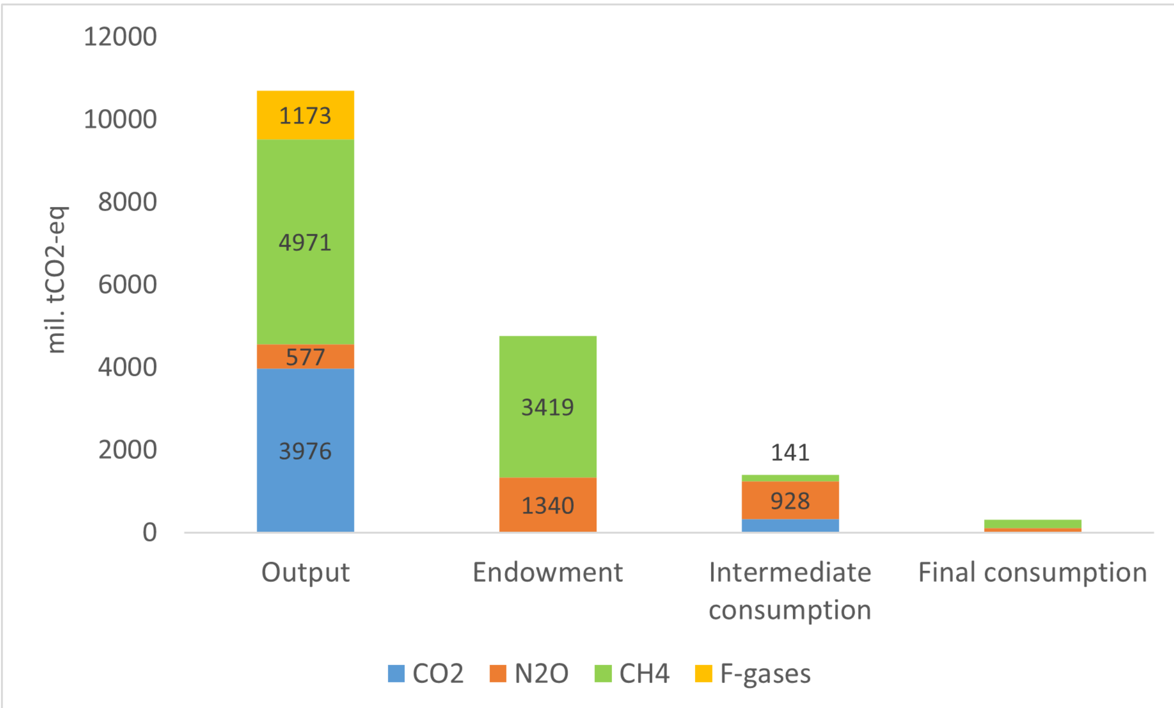


Notes: GWPs from AR4 are used for the conversion to CO_2 eq. Only land emissions that are not distributed across GTAP drivers are reported on the figure.
Source: FAO 2023.

B.6 Overview of the constructed database

In 2017, of 17.2 billion tCO_2-eq. of complementary GHG emissions, over 62% are linked to output (Figure 13.6).[6] CH_4 accounts for around 51% of global complementary GHG emissions, followed by CO_2 (from non-combustion energy use, including fugitive emissions) – 25.2%, N_2O for around 17.1%, with the rest contributed by F-gases (6.8%).

Figure 13.6: Distribution of the global complementary GHG emissions in 2017 by gases and drivers

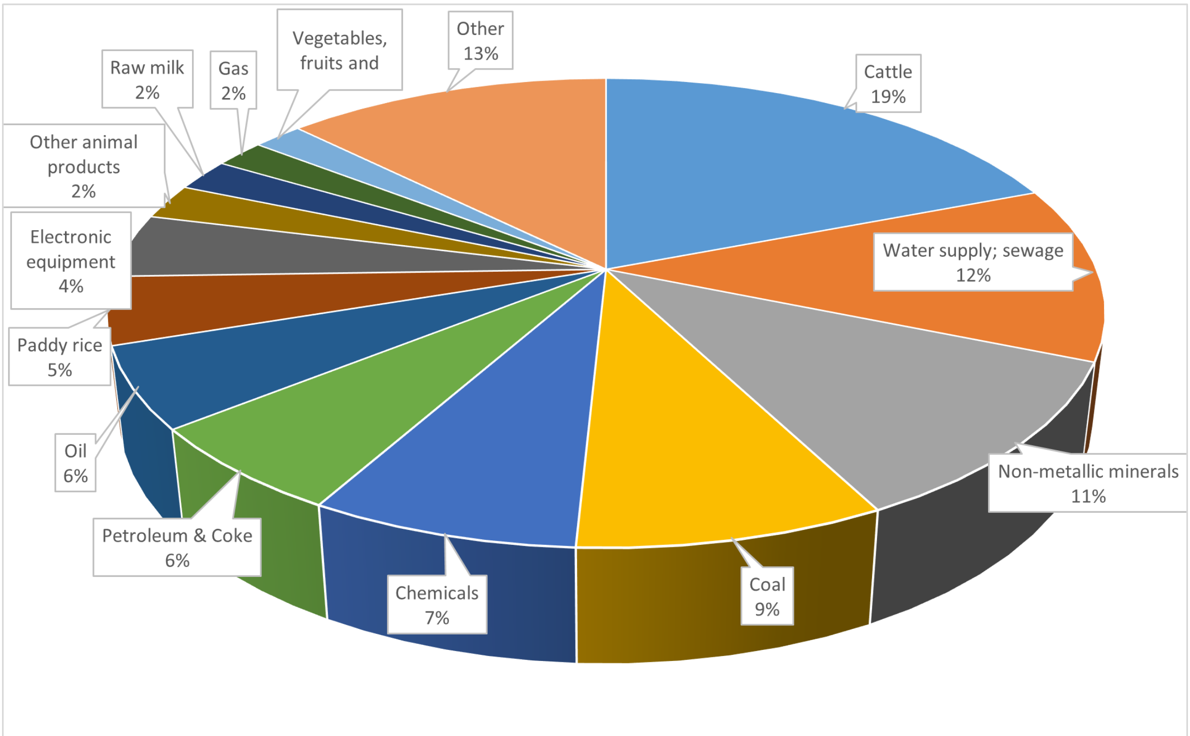


Source: Estimated by authors based on GTAP 11 complementary GHG emissions database.

With respect to the sectoral distribution, cattle sector accounts for almost one-fifth of all complementary GHG emissions at the global level, followed by water supply and sewage (12%) and non-metallic minerals (11%) in 2017 (Figure 13.7). Top eight sectors contribute over 74% of all complementary GHGs at the global level (Figure 13.7). As discussed earlier, apart from the non-CO_2 GHG emissions, the current version of the emissions database also includes CO_2 emissions from non-combustion energy use activities. In the case of 2017 reference year, CO_2 emissions from cement production represent around one third of this category, fugitive emissions (including flaring emissions) represent over 22%, emissions from chemical industry contribute around 16.3%, lime production and industrial processes and product use in metal industry each contributes over 7% to the total. Appendix Table 13.8 identifies IPCC categories that report CO_2 emissions from non-combustion energy use. These emissions complement the CO_2 emission accounts from fossil fuel combustion activities reported in the core GTAP Data Base.

[6]In this section we consider only GHG emissions distributed across GTAP-based drivers.

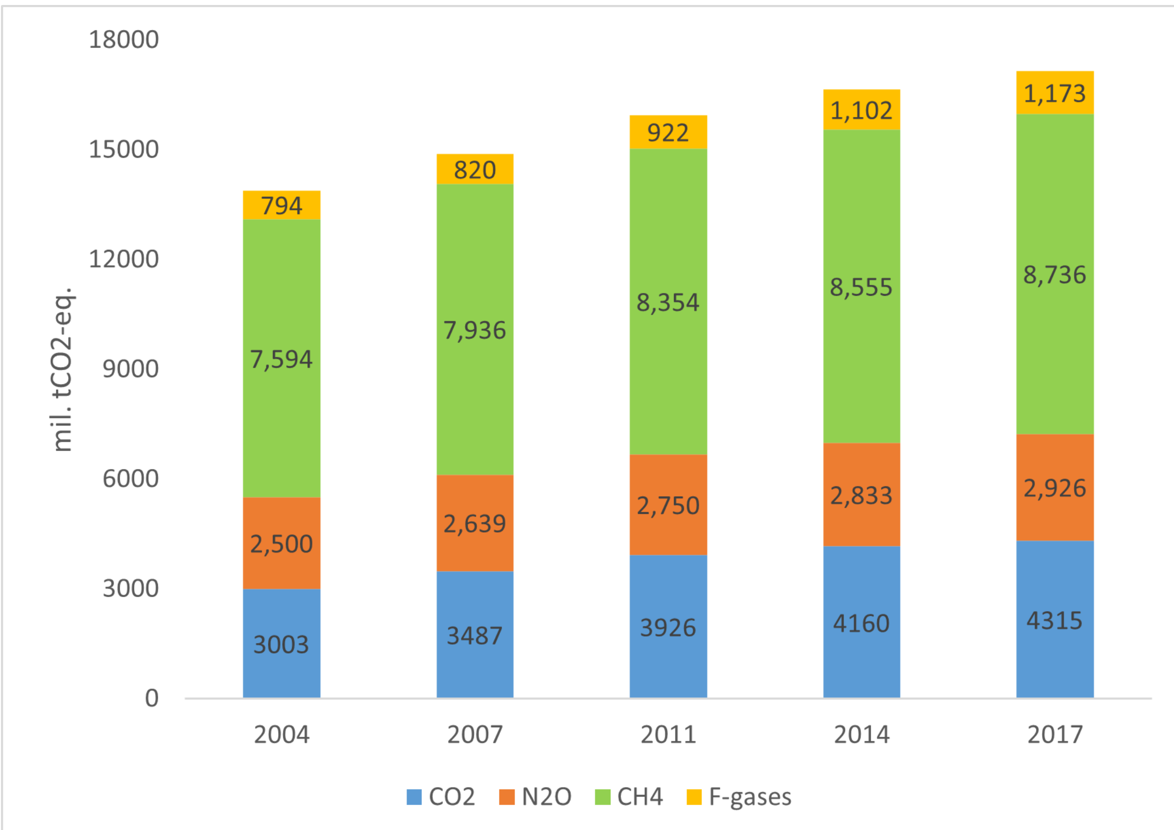
Figure 13.7: Distribution of the global complementary GHG emissions by GTAP sectors in 2017, %



Source: Estimated by authors based on GTAP 11 complementary GHG emissions database.

Over time, GHG emissions reported in the GTAP complementary GHG accounts show constant increase over time – from 13.9 billion tCO_2-eq. in 2004 to 17.2 billion tCO_2-eq. in 2017, with an annual average growth rate of around 1.6% (Figure 13.8). The most substantial growth during this period has been observed for the case of F-gases – on average 3% per year, followed by CO_2 emissions (from non-combustion energy use) – a 2.8% annual growth rate. N_2O and CH_4 emissions have been growing at a substantially lower pace between 2004 and 2017 – 1.2% and 1.1% respective.

Figure 13.8: Global complementary GHG emissions by GTAP 11 reference years and gases



Source: Estimated by authors based on GTAP 11 complementary GHG emissions database.

References

Aguiar, Angel et al. (Dec. 2022). "The Global Trade Analysis Project (GTAP) Data Base: Version 11". In: *Journal of Global Economic Analysis* 7.2. URL: https://jgea.org/ojs/index.php/jgea/article/view/181.

Ahmed, S. Amer et al. (2014). *DEVELOPMENT OF THE VERSION 8 NON-CO2 GHG EMISSIONS DATASET*. Department of Agricultural Economics, Purdue University, West Lafayette, IN: Global Trade Analysis Project (GTAP). URL: https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=4343.

Branco, Alfredo et al. (2022). *EDGAR v7.0 Greenhouse Gas Emissions*. European Commission, Joint Research Centre (JRC) [Dataset]. URL: http://data.europa.eu/89h/fdb5aff4-66e5-4938-92a5-159ff872afd3.

Chepeliev, Maksym (2020). *Development of the Non-*CO_2 *GHG Emissions Database for the GTAP Data Base Version 10A*. GTAP Research Memorandum 32. Department of Agricultural Economics, Purdue University, West Lafayette, IN: Global Trade Analysis Project (GTAP). URL: https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=5993.

Crippa, M. et al. (2019). *GHG emissions of all world countries*. Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/953322, JRC134504.

EPA, US (2006). *Global Emissions of Non-CO2 Greenhouse Gases: 1990-2020*. United States Environmental Protection Agency (US-EPA), Washington, D.C., EPA Report 430-R-06-003.

— (2018). *Emission Factors for Greenhouse Gas Inventories*. United States Environmental Protection Agency (US-EPA). URL: https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf.

FAO (2023). *FAOSTAT*. https://www.fao.org/faostat/. Food and Agriculture Organization (FAO) of the United Nations.

Hertel, Thomas W. et al. (2010). "Effects of US Maize Ethanol on Global Land Use and Greenhouse Gas Emissions: Estimating Market-mediated Responses". In: *BioScience* 60.3, pp. 223–231. DOI: 10.1525/bio.2010.60.3.8. URL: https://doi.org/10.1525/bio.2010.60.3.8.

IIASA (2016). *SSP Database (Shared Socioeconomic Pathways) – Version 1.1*. URL: https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=about.

IPCC (2008). *2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories*. URL: https://www.ipcc-nggip.iges.or.jp/support/Primer_2006GLs.pdf.

— (2014). *AR5 Climate Change 2014: Mitigation of Climate Change*. Intergovernmental Panel on Climate Change (IPCC). URL: https://www.ipcc.ch/report/ar5/wg3/.

IPCC/OECD/IEA (1997). *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. Paris: Intergovernmental Panel on Climate Change (IPCC), Organization for Economic Co-operation and Development (OECD), International Energy Agency (IEA). URL: http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ri.pdf.

Irfanoglu, Zeynep Burcu and Dominique van der Mensbrugghe (2016). *Non-CO2 documentation V9*. Department of Agricultural Economics, Purdue University, West Lafayette, IN: Global

Trade Analysis Project (GTAP). URL: https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=4868.

JRC/PBL (2011). *Emission Dataset for Global Atmospheric Research (EDGAR), release Version 4.2*. European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). URL: http://edgar.jrc.ec.europa.eu/overview.php?v=42FT2010.

Rose, S., S. Finn, et al. (2007). *Detailed greenhouse gas emissions data for global economic modeling*. United States Environmental Protection Agency, Washington, DC.

Rose, S. and H.L Lee (2009). "Non-CO2 Greenhouse Gas Emissions Data for Climate Change Economic Analysis". In: *Economic Analysis of Land Use in Global Climate Change Policy*. Ed. by Thomas W. Hertel, Steven Rose, and Richard Tol. Routledge Publishing: New York, NY., p. 373.

Rose, Steven, Misak Avetisyan, and Thomas Hertel (2010). *Development of the Preliminary Version 7 Non-CO2 GHG Emissions Dataset*. GTAP Research Memorandum 17. Department of Agricultural Economics, Purdue University, West Lafayette, IN: Global Trade Analysis Project (GTAP). URL: https://doi.org/10.21642/GTAP.RM17.

Appendix

Table 13.8: Mapping between EDGAR emission categories and GTAP emission drivers

No.	IPCC 2006 category code	IPCC 1996 category code	Category description	GTAP emission drivers (for the case of bio emissions, if different)	GTAP emission agents
1	1A1A		Fuel Combustion Activities: Main Activity Electricity and Heat Production	coa, oil, gas, p_c, gdt	ely
2	1A1BC		Fuel Combustion Activities: Petroleum Refining; Manufacture of Solid Fuels and Other Energy Industries	coa, oil, gas, p_c, gdt	coa, oil, gas, p_c, gdt
3	1A2		Fuel Combustion Activities: Manufacturing Industries and Construction	coa, oil, gas, p_c, gdt	oxt, cmt, omt, vol, mil, pcr, sgr, ofd, b_t, tex, wap, lea, lum, ppp, chm, bph, rpp, nmm, i_s, nfm, fmp, ele, eeq, ome, mvh, otn, omf, cns
4	1A3A		Fuel Combustion Activities: Civil Aviation	coa, oil, gas, p_c, gdt (p_c)	atp
5	1A3B		Fuel Combustion Activities: Road Transportation	coa, oil, gas, p_c, gdt (p_c)	otp, HHs[7]
6	1A3C		Fuel Combustion Activities: Railways	coa, oil, gas, p_c, gdt (p_c)	otp
7	1A3D		Fuel Combustion Activities: Water-borne Navigation	coa, oil, gas, p_c, gdt (p_c)	wtp
8	1A3E		Fuel Combustion Activities: Other Transportation	coa, oil, gas, p_c, gdt (p_c)	otp
9	1A4		Fuel Combustion Activities: Other Sectors	coa, oil, gas, p_c, gdt (p_c)	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol, frs, fsh, wtr, trd, afs, whs, cmn, ofi, ins, rsa, obs, ros, osg, edu, hht, dwe, HHs[8]
10	1A5		Fuel Combustion Activities: Non-Specified	coa, oil, gas, p_c, gdt (p_c)	trd, afs, whs, cmn, ofi, ins, rsa, obs, ros, osg, edu, hht, dwe
11	1B1*		Fugitive Emissions from Fuels: Solid Fuels	Output	coa[9]

Continued ...

[7]In the case of households, 1A3B emissions are linked to the "p_c" use only.
[8]In the case of households, 1A4 emissions are linked to the use of "coa", "oil", "gas" and "gdt".
[9]In the cases when mapping of "1B1" emissions to "coa" only results in the emission intensities much higher than the world/region average, these emissions are additionally redistributed between "oil", "gas" , "p_c", "gdt" and "ely" activities. This impacts mostly small fossil fuel producers in Africa.

…Continued

No.	IPCC 2006 category code	IPCC 1996 category code	Category description	GTAP emission drivers (for the case of bio emissions, if different)	GTAP emission agents
12	1B2*		Fugitive Emissions from Fuels: Oil and Natural Gas	Output	oil, gas, p_c, gdt
13	2A1*		Industrial processes and product use: Cement Production	Output	nmm
14	2A2*		Industrial processes and product use: Lime Production	Output	nmm
15	2A3*		Industrial processes and product use: Glass Production	Output	nmm
16	2A4*		Industrial processes and product use: Other Process Uses of Carbonates	Output	nmm
17	2B*		Industrial processes and product use: Chemical Industry	Output	chm
18	2C*		Industrial processes and product use: Metal Industry	Output	i_s, nfm
19	2D*		Non-Energy Products from Fuels and Solvent Use	p_c (white spirit, bitumen, lubricants paraffin waxes)	All sectors, HHs
20		2E	Byproduct emissions of production of halocarbons and sulphur hexafluoride	Output	chm
21		2F1A	Consumption of halocarbons and sulphur hexafluoride: refrigerator and air conditioning	Output	ele
22		2F1B	Commerical refrigeration	Output	ele
23		2F1C	Domestic refrigeration	Output	ele
24		2F1D	Industrial refrigeration	Output	ele
25		2F1E	Transport refrigeration	Output	ele
26		2F1F	Mobile Air Conditioning	Output	ele
27		2F2A	Stationary Air Conditioning	Output	chm
28		2F2B	Closed cell foam		
29		2F3	Open cell foam	Output	chm
30		2F4	Fire Extinguishers	Output	chm
31		2F5	Aerosols	Output	ele
32		2F6	Solvents	Output	ele
33		2F7	F-gas as Solvent	Output	ele
34		2F8	Other ODS	Output	eeq
35		2F9	Semiconductor/Electronics Manufacture	Output	ele, eeq, ome
36	2G		Other Product Manufacture and Use	chm, bph	ofd, hht

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No.	IPCC 2006 category code	IPCC 1996 category code	Category description	GTAP emission drivers (for the case of bio emissions, if different)	GTAP emission agents
37	3A1		Enteric Fermentation	NA	NA
38	3A2		Manure Management	NA	NA
39	3C1		Emissions from biomass burning	NA	NA
40	3C2*		Liming	nmm	pdr, wht, gro, v_f, osd, c_b, pfb, ocr
41	3C3*		Urea application	chm	pdr, wht, gro, v_f, osd, c_b, pfb, ocr
42	3C4		Direct N2O Emissions from managed soils	NA	NA
43	3C5		Indirect N2O Emissions from managed soils	NA	NA
44	3C6		Indirect N2O Emissions from manure management	NA	NA
45	3C7		Rice cultivations	NA	NA
46	4A		Solid Waste Disposal	Output	wtr
47	4B		Biological Treatment of Solid Waste	Output	wtr
48	4C*		Incineration and Open Burning of Waste	Output	coa, oil, gas, oxt, cmt, omt, vol, mil, pcr, sgr, ofd, b_t, tex, wap, lea, lum, ppp, p_c, chm, bph, rpp, nmm, i_s, nfm, fmp, ele, eeq, ome, mvh, otn, omf, wtr
49	4D		Wastewater Treatment and Discharge	Output	wtr
50	5A		Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NA	NA
51	5B*		Other	Output	coa, oil

Notes: “NA” corresponds to agricultural emission categories. These emissions are sourced from FAOSTAT dataset (FAO 2023), therefore we do not process these emission categories from EDGAR dataset. “*” identifies IPCC categories that report CO_2 emissions from non-combustion energy use.
Source: Developed by authors based on IPCC/OECD/IEA 1997; IPCC 2008; Branco et al. 2022.