11 - Natural Sources

11.B - Forest Fires

Short Description

In Germany's forests prescribed burning is not applied. Therefore, all forest fires are categorized as wildfires (include emissions from forest fires occurring naturally or caused by humans). - Note that emissions reported here are not accounted for the national totals.

Method	AD	EF	Key Category
CS, T2, T1	CS	D	*not included in key category analysis*

Legend T = key source by Trend / L = key source by Level

Methods D: Default RA: Reference Approach T1: Tier 1 / Simple Methodology * T2: Tier 2* T3: Tier 3 / Detailed Methodology * C: CORINAIR CS: Country Specific M: Model as described in the EMEP/CORINAIR Emission Inventory Guidebook - 2019, in the group specific chapters.

AD:- Data Source for Activity Data NS: National Statistics RS: Regional Statistics IS: International Statistics PS: Plant Specific data AS: Associations, business organisations Q: specific questionnaires, surveys

EF - Emission Factors D: Default (EMEP Guidebook) C: Confidential CS: Country Specific PS: Plant Specific data

Methodology

For calculating the emissions of wildfires a country specific Tier2 approach was used. The mass of carbon emitted M(C) was calculated using the adapted equation follows the methodology of Seiler and Crutzen (1980) [1].

$M(C) = 0.45 * A * B * \beta$

where:

0.45 = average fraction of carbon in fuel wood;

A = forest area burnt in [m²];

B = mean above-ground biomass of fuel material per unit area in [kg/m²];

β = burning efficiency (fraction burnt) of the above-ground biomass.

The data on forest areas burnt for the period 1990 to 2021 have been taken from the German forest fire statistic (BLE, 2022)[2)] managed by the Federal Agency for Agriculture and Food. The mean above-ground biomass of fuel material was determined from the pools above ground biomass, dead wood and litter. The mean above-ground biomass and dead wood biomass was derived for each year by linear extrapolation and interpolation between the

- German National Forest Inventories of 1987, 2002, 2012 (Bundeswaldinventuren 1987, 2002, 2012),
- the inventory study 2008 and,
- the carbon inventory 2017.

Biomass of Litter was derived for each year by linear interpolation between 1990 and 2006 and extrapolation from 2007 based on the both Forest soil inventories (BZE I Wald (1990)[3)] and BZE II Wald (2006)[4)]).

Pursuant to König (2007) [5)], 80% of the forest fires in Germany are surface fires and 20% crown fires. In accordance to the IPCC Good Practice Guidance for LULUCF (2003) a burning efficiency of 0.15 was used for surface fires and an efficiency of 0.45 was used for crown fires.

The emissions for the pollutants were calculated by multiplying the mass of carbon with the respective emission factors from table 3-3 (EMEP/EEA, 2019)[6)].

For the calculation of particulate emissions (TSP, PM_{10} and $PM_{2.5}$) the burnt biomass was multiplied with the respective emission factors from table 3-5 (EMEP/EEA, 2019). Those particulate emission factors have been estimated by averaging the emission factors from the US Environmental Protection Agency (USEPA, 1996) [7)] methodology, since no better information is available. Those emission factors are assumed to be the same for all types of forest.

The Guidebook does not indicate whether EFs have considered the condensable component (with or without).

Activity data

The data on forest areas burnt for the period 1990 to 2021 are based on the German forest fire statistic (BLE, 2021) managed by the Federal Agency for Agriculture and Food.

Table 1: Area of forest burnt from 1990 until the latest reporting year, in [ha]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Area of forest burnt	1606	920	4908	1493	1114	592	1381	599	397	415	581
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Area of forest burnt	122	122	1315	274	183	482	256	539	757	522	214
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	
Area of forest burnt	269	199	120	526	283	395	2349	2711	368	148	

Emission factors

For the year 2021 the estimated emission factors from table 2 were applied.

Table 2: Emission factors applied for 2021

Pollutant	EF_{2021}
NO_x	155.19
CO	5,535.19
NMVOC	488.86
SO_x	37.25

Pollutant	EF_{2021}
NH_3	41.9
TSP	879.42
PM_{10}	569.04
$PM_{2.5}$	465.58
BC	41.90

In addition, a large-scale fire, which occurred in September 2018, is reported under 11.B. A detailed description can be found in the NIR 2020 in Chapter 6.8.2.5 [8], because a large amount of CO_2 emissions were released.

The burned area of the drained moor, which is used as a military facility, covered 1,221 ha. This fire was extensively investigated and documented by the Federal Office for Infrastructure, Environmental Protection and Services of the German Armed Forces. The emissions are calculated according to IPCC GL (2006), chapter 2, form 2.27 [9].

The product MB×Cf is set to 336 t dm ha^{-1} according to Table 2.6 and formula 2.7, 2013 IPCC Wetlands Supplement [10], i.e. it is assumed that the moor was completely drained during the fire.

For the calculation of CO emissions the EF according to Table 2.7, 2013 IPCC Wetlands Supplement 207 g $(kg\ dm)^{-1}$, is taken into account. This results in 85 kt CO. For other emissions from land fires on drained organic soils no Tier-1 emission factors exist and are therefore not reported (NO).

Recalculations

Recalculations were made for the complete time series due to the methodology changes (the inclusion of the burning biomass of dead wood and litter, which has not been considered until now). No recalculation was made for the large-scale fire in 2018.

Table 3: Recalculation of air pollutant emisssions from 1990 until the latest reported year, in kg and %

Pollutant	Submission	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Black Carbon	Sub 2023	kt	0,061	0,022	0,022	0,007	0,020	0,021	0,011	0,016	0,096	0,112	0,015
Black Carbon	Sub 2022	kt	0,047	0,017	0,017	0,005	0,016	0,017	0,009	0,013	0,078	0,091	0,013
Black Carbon	Difference	kt	0,014	0,005	0,005	0,001	0,004	0,004	0,002	0,003	0,018	0,020	0,003
Black Carbon	Difference	%	30,5%	29,1%	27,8%	26,3%	24,2%	22,8%	22,7%	22,6%	22,5%	22,3%	22,2%
CO	Sub 2023	kt	8,043	2,949	2,879	0,911	2,641	2,771	1,506	2,114	12,684	14,762	2,019
CO	Sub 2022	kt	6,165	2,284	2,253	0,722	2,125	2,257	1,228	1,724	10,357	12,067	1,652
CO	Difference	kt	1,878	0,665	0,627	0,189	0,515	0,515	0,278	0,390	2,327	2,695	0,367
CO	Difference	%	30,5%	29,1%	27,8%	26,3%	24,2%	22,8%	22,7%	22,6%	22,5%	22,3%	22,2%
NH3	Sub 2023	kt	0,061	0,022	0,022	0,007	0,020	0,021	0,012	0,016	0,098	0,112	0,015
NH3	Sub 2022	kt	0,047	0,017	0,017	0,005	0,016	0,017	0,009	0,013	0,078	0,091	0,013
NH3	Difference	kt	0,014	0,005	0,005	0,001	0,004	0,004	0,002	0,003	0,020	0,020	0,003
NH3	Difference	%	30,0%	28,7%	27,7%	26,8%	27,2%	25,8%	25,5%	25,7%	25,5%	22,3%	22,2%
NMVOC	Sub 2023	kt	0,710	0,260	0,254	0,080	0,233	0,245	0,133	0,187	1,120	1,304	0,178
NMVOC	Sub 2022	kt	0,545	0,202	0,199	0,064	0,188	0,199	0,108	0,152	0,915	1,066	0,146
NMVOC	Difference	kt	0,166	0,059	0,055	0,017	0,046	0,045	0,025	0,034	0,205	0,238	0,032
NMVOC	Difference	%	30,5%	29,1%	27,8%	26,3%	24,2%	22,8%	22,7%	22,6%	22,5%	22,3%	22,2%
NOx	Sub 2023	kt	0,226	0,083	0,081	0,026	0,074	0,078	0,042	0,059	0,356	0,414	0,057
NOx	Sub 2022	kt	0,173	0,064	0,063	0,020	0,060	0,063	0,034	0,048	0,290	0,338	0,046
NOx	Difference	kt	0,053	0,019	0,018	0,005	0,014	0,014	0,008	0,011	0,065	0,076	0,010
NOx	Difference	%	30,5%	29,1%	27,8%	26,3%	24,2%	22,8%	22,7%	22,6%	22,5%	22,3%	22,2%
PM 10	Sub 2023	kt	0,827	0,303	0,296	0,094	0,271	0,285	0,155	0,217	1,304	1,518	0,208
PM 10	Sub 2022	kt	0,634	0,235	0,232	0,074	0,218	0,232	0,126	0,177	1,065	1,241	0,170
PM 10	Difference	kt	0,193	0,068	0,064	0,019	0,053	0,053	0,029	0,040	0,239	0,277	0,038
PM 10	Difference	%	30,5%	29,1%	27,8%	26,3%	24,2%	22,8%	22,7%	22,6%	22,5%	22,3%	22,2%
PM 2.5	Sub 2023	kt	0,677	0,248	0,242	0,077	0,222	0,233	0,127	0,178	1,067	1,242	0,170
PM 2.5	Sub 2022	kt	0,519	0,192	0,189	0,061	0,179	0,190	0,103	0,145	0,871	1,015	0,139
PM 2.5	Difference	kt	0,158	0,056	0,053	0,016	0,043	0,043	0,023	0,033	0,196	0,227	0,031

Pollutant	Submission	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
PM 2.5	Difference	%	30,5%	29,1%	27,8%	26,3%	24,2%	22,8%	22,7%	22,6%	22,5%	22,3%	22,2%
SO2	Sub 2023	kt	0,054	0,020	0,019	0,006	0,018	0,019	0,010	0,014	0,085	0,099	0,014
SO2	Sub 2022	kt	0,041	0,015	0,015	0,005	0,014	0,015	0,008	0,012	0,070	0,081	0,011
SO2	Difference	kt	0,013	0,004	0,004	0,001	0,003	0,003	0,002	0,003	0,016	0,018	0,002
SO2	Difference	%	30,5%	29,1%	27,8%	26,3%	24,2%	22,8%	22,7%	22,6%	22,5%	22,3%	22,2%
TSP	Sub 2023	kt	1,278	0,469	0,457	0,145	0,420	0,440	0,239	0,336	2,015	2,345	0,321
TSP	Sub 2022	kt	0,980	0,363	0,358	0,115	0,338	0,359	0,195	0,274	1,646	1,917	0,262
TSP	Difference	kt	0,298	0,106	0,100	0,030	0,082	0,082	0,044	0,062	0,370	0,428	0,058
TSP	Difference	%	30,5%	29,1%	27,8%	26,3%	24,2%	22,8%	22,7%	22,6%	22,5%	22,3%	22,2%

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