

2.L(a) - Handling of Bulk Products

Short description

Under category 2.L(a) - *Handling of Bulk Products* dust emissions from bulk material handling (loading and unloading) including agricultural bulk materials offsite the fields are reported. Emissions from quarrying and mining of minerals and from point source emissions are excluded.

Methodology

For 1990 to 1996, only simplified estimates without a differentiation of handled materials and products exist. For all following years, emissions are calculated using a tier1 method taking into account detailed data on handled materials and products.

Activity data

Official statistics are of limited use in determining handling of bulk products. There are only transport statistics available providing the amounts of several transported materials.

During a research project carried out by (Müller-BBM) ¹⁾, activity data was derived from primary statistical data from the Federal Statistical Office for Germany (Statistisches Bundesamt, Destatis) and the Federal Motor Transport Authority (Kraftfahrt-Bundesamt, KBA). Here, data on goods transported by railways and ships is gathered by Destatis whereas data for road transport is collected by the KBA.

Here, for all years until 2009, the collection of data for transported goods followed the official **NST/R (1968) nomenclature and regulation** (Eurostat, 2015a) ²⁾.

As of 2010, statistical data following the newly implemented **NST-2007** ^{3), 4)} **nomenclature and regulation** from Destatis and KBA is applied instead.

Table 1: Overview of primary activity data sources over time

1990-1996	simplified estimates without differentiation of handled materials
1997-2009	statistical data following NST/R nomenclature
as of 2010	statistical data following NST-2007 nomenclature

Here, NST/R allowed the distribution of a broad variety of goods and materials (e.g. barley, corn, oats, rice, rye, and wheat), whereas NST-2007 provides only a very condensed list of classes of goods (e.g. 'crops').

Due to these methodological breaks, activity data and emissions show inconsistencies (especially on the level of specific goods and materials) that cannot be eliminated at the moment. Nonetheless, on a aggregate level, these breaks are balanced out more or less automatically as the total amount of transported dry materials does not change too much with changing statistical approaches.

For estimating the amount of moved bulk materials as well as emissions from the loading and unloading of bulk materials, these primary activity data (PAD, including the amounts of imported and exported goods as well as goods transported within Germany) have to be calculated from the amounts of transported goods:



$$PAD_{\text{material } i} = PAD_{\text{import}} + PAD_{\text{export}} + 2 * PAD_{\text{domestic handling}}$$

with

1. PAD_{import} = amount of imported good or material,
2. PAD_{export} = amount of exported good or material and
3. $PAD_{\text{domestic handling}}$ = amount of good or material transported only within Germany

As the basic statistics provide only total amounts of imported, exported and domestically transported dry goods without any distinction into bulk and packed goods, the shares of bulk goods had to be estimated via expert judgement during the workshop mentioned above.

During this workshop, experts, for comparable kinds of dry bulk material, discussed specific shares displaying which part of the total amount of dry material *i* loaded and/or unloaded within Germany might be transported as bulk material thus causing PM emissions.

So the activity data finally used for estimating specific particulate matter emissions for every bulk material is calculated as a specific share *s* of the amount of this material *i* loaded and/or unloaded within Germany:



$$AD_{\text{bulk material } i} = PAD_{\text{bulk material } i} * s_{\text{bulk share}}$$

Table 2: Amounts of dry, dusty bulk goods handled in Germany 2010-2019, in tonnes

	transport mode	2010	2015	2016	2017	2018	2019	2020	2021
other herbal products	inland vessel	5.523.633	39,189,603	38,498,874	34,508,319	30,305,094	6,279,089	6,745,999	
	railways	1.242.916	470,000	547,545	532,253	445,547	613,000	588,000	
	heavy-duty vehicle	20.847.400	34,166,200	22,918,493	24,118,587	35,511,100	18,815,200	18,718,500	
	sea-going vessel	4.052.384	6,376,068	7,164,149	6,953,293	6,614,999	6,067,598	6,535,195	
raw mineral chemicals	inland vessel	6.794.922	2,366,579	2,573,770	2,696,029	11,798,872	11,909,168	11,706,333	
	railways	9.827.059	9,273,000	9,627,577	9,885,631	10,634,917	9,158,000	8,714,000	
	heavy-duty vehicle	78.928.400	82,363,000	10,043,513	11,351,314	63,713,624	11,315,500	9,742,600	
	sea-going vessel	5.550.621	7,905,516	7,888,208	8,131,408	7,386,700	4,839,421	5,150,665	
raw organic chemicals	inland vessel	6.299.350	57,126	114,803	175,726	6,667,823	6,528,823	6,025,705	
	railways	16.287.803	21,094,000	18,661,643	18,339,593	0	17,607,000	17,718,000	
	heavy-duty vehicle	11.345.600	4,570,800	0	828,916	12,601,908	0	0	
	sea-going vessel	3.638.264	2,478,579	2,341,016	2,413,459	2,463,615	2,623,994	2,370,156	
iron ore	inland vessel	25.728.177	25,203,179	25,755,504	25,193,580	22,796,286	21,531,669	18,676,735	
	railways	38.565.334	37,708,000	37,434,377	37,586,847	38,252,864	36,601,000	32,240,000	
	heavy-duty vehicle	203.800	0	1,764,223	534,846	1,680,885	731,400	0	
	sea-going vessel	13.922.885	13,967,430	13,365,447	14,810,135	14,761,129	14,521,110	12,666,336	
crops	inland vessel	9.816.233	11,243,918	10,046,500	9,546,963	7,715,977	8,128,252	9,593,182	
	railways	2.982.548	4,583,000	3,545,040	3,759,205	2,985,786	3,169,000	4,513,000	
	heavy-duty vehicle	65.464.800	70,614,200	58,304,413	61,639,154	58,957,570	56,315,100	55,307,700	
	sea-going vessel	9.319.143	12,142,981	10,735,948	8,851,781	7,672,262	7,985,888	9,630,445	
potatoes	inland vessel	1.383	0	0	1,056	0	49,119	46,427	
	railways	17.135	0	0	4,581,528	4,896,748	0	0	
	heavy-duty vehicle	10.627.000	9,956,800	4,683,480	5,039,904	9,621,800	4,789,300	5,227,200	
	sea-going vessel	29.296.456	21,170,067	20,406,870	22,490,149	20,701,636	25,168,423	22,127,609	

	transport mode	2010	2015	2016	2017	2018	2019	2020	2021
coal products	inland vessel	2,409,311	1,361,655	2,003,004	2,129,778	1,560,991	1,870,568	1,635,431	
	railways	22,499,503	6,721,000	6,610,955	6,456,917	8,421,754	6,743,000	4,712,000	
	heavy-duty vehicle	11,801,600	15,401,600	7,065,314	8,549,595	13,182,782	6,653,300	3,878,200	
	sea-going vessel	802,164	48,778	43,760	135,197	25,450	21,898	18,396	
products from grinding & shelling mills	inland vessel	1,782,712	4,133,053	5,180,094	5,368,877	5,275,005	5,506,351	5,509,211	
	railways	2,852	0	465,039	381,098	349,419	645,000	506,000	
	heavy-duty vehicle	97,539,400	99,568,200	75,685,582	69,634,714	99,763,916	69,628,300	74,421,000	
	sea-going vessel	3,104,125	3,525,359	3,586,612	3,747,650	3,788,108	4,001,310	4,365,473	
mineral fertilisers	inland vessel	760,174	305,202	281,603	255,398	197,705	202,054	138,138	
	railways	4,122,535	3,424,000	3,619,997	3,581,858	3,224,654	2,756,000	3,000,000	
	heavy-duty vehicle	7,923,200	4,322,000	1,338,908	1,006,750	1,814,964	1,423,800	2,364,000	
	sea-going vessel	117,224	409,515	256,924	323,622	311,822	392,516	406,221	
natural sands, gravel & stones	inland vessel	40,518,020	31,927,501	33,178,046	36,072,381	35,475,139	38,522,204	36,093,810	
	railways	56,517,180	43,958,000	43,837,499	39,960,787	41,345,431	43,057,000	44,816,000	
	heavy-duty vehicle	1,655,747,400	1,853,177,400	1,669,958,849	1,672,131,248	1,838,142,737	1,639,276,500	1,609,497,100	
	sea-going vessel	8,739,096	9,739,769	10,353,589	13,515,063	12,463,686	13,506,136	12,271,288	
non-iron ores	inland vessel	1,512,246	2,964,925	2,827,648	3,199,797	3,043,062	2,749,584	3,389,500	
	railways	29,742	8,000	6,642	16,877	61,486	22,000	250,000	
	heavy-duty vehicle	705,600	0	0	827,676	512,051	0	675,600	
	sea-going vessel	2,687,815	2,850,350	3,870,273	4,368,429	4,621,799	3,488,596	4,680,063	
raw coals	inland vessel	36,652,759	0	0	0	19,571	26,136,332	18,399,530	
	railways	58,433,815	67,749,000	61,034,978	51,142,196	48,277,288	41,538,000	32,449,000	
	heavy-duty vehicle	10,561,400	13,275,800	11,858,051	16,057,484	12,593,015	12,603,300	6,404,100	
	sea-going vessel	13,299,295	16,476,145	14,401,269	15,919,606	16,187,881	12,695,386	7,439,063	
secondary raw materials	inland vessel	15,691,876	11,521,886	11,212,165	12,089,358	15,101,718	16,441,457	16,504,345	
	railways	25,614,264	22,113,000	21,261,312	22,147,649	20,565,387	17,627,000	14,626,000	
	heavy-duty vehicle	422,570,000	490,299,000	161,493,436	171,462,235	502,448,809	175,973,100	164,093,200	
	sea-going vessel	5,047,097	5,810,444	5,057,435	4,173,386	3,427,249	3,502,952	3,465,765	
rock & saline salt	inland vessel	2,769,356	3,939,437	3,651,498	4,115,651	3,977,618	4,621,784	4,370,103	
	railways	3,067,187	2,575,000	2,362,886	2,603,115	3,017,352	2,673,000	2,078,000	
	heavy-duty vehicle	21,579,000	7,887,600	7,238,776	10,591,977	11,820,822	8,527,200	5,613,400	
	sea-going vessel	567,059	919,251	888,593	812,124	1,116,411	961,803	624,742	
nitrogen fertilisers	inland vessel	5,737,386	5,104,076	4,930,755	4,742,988	4,466,442	4,975,009	4,881,285	
	railways	15,708,472	14,091,000	13,614,102	14,066,445	12,318,493	11,774,000	11,651,000	
	heavy-duty vehicle	37,454,600	71,366,600	28,434,989	30,619,530	68,151,044	29,142,700	28,658,700	
	sea-going vessel	5,309,443	6,509,499	7,011,855	7,392,865	7,239,705	7,385,920	7,868,139	

	transport mode	2010	2015	2016	2017	2018	2019	2020	2021
white cement, lime, cement	inland vessel	3.273.975	2,479,720	2,532,347	2,776,593	2,978,726	2,896,408	3,398,570	
	railways	17.849.146	21,867,000	19,270,679	18,928,775	18,679,111	17,758,000	14,257,000	
	heavy-duty vehicle	69.407.200	86,441,400	76,251,684	77,289,169	99,899,785	82,985,300	82,091,500	
	sea-going vessel	1.544.488	2,757,516	2,470,814	2,552,567	2,172,344	1,972,384	1,483,783	
sugar beet	inland vessel	0	6,366,439	6,426,328	6,396,070	5,912,659	0	4,265	
	railways	123.598	24,000	64,094	37,555	0	2,000	2,000	
	heavy-duty vehicle	26.946.200	36,601,000	22,159,060	32,853,554	31,023,482	32,540,800	31,424,000	
	sea-going vessel	17	2,872	3,125	9,676	3,277	0	3,257	

sources: annual data deliveries DESTATIS & KBA (for heavy-duty vehicles) to the inventory compiler

Emission factors

Emission factors are based on the methodology according VDI guidelines 3790. The values used here originate from a research project by (Müller-BBM, 2011) ⁵⁾ taking into account information of an expert panel of industry and administration. For details see the [<https://www.umweltbundesamt.de/publikationen/konsistenzpruefung-verbesserungspotenzial> project report] (German version only).

Within the study, PM emission factors are estimated for each material or good that might be transported as dry and unpacked bulk. These very specific EF are then assigned to the classes of materials/goods available from the different different statistics (NST/R, NST-2007) to form implied EF for these class of bulk material.

As NST/R provided a wide variety of goods and materials, whereas NST-2007 provides only a very condensed list of classes of goods, the very specific EF derived during the study and the joint expert workshop have been aggregated in order to match the classes of goods following NST-2007.

Table 2: specific EF for PM emissions from NST/R crop products, in [kg/t], as used for 2009 estimates

	TSP	PM10	PM2.5
for barley			
inland ship	0.038	0.019	0.004
railway	0.038	0.019	0.004
maritime ship	0.038	0.019	0.0038
heavy-duty vehicle	0.038	0.019	0.004
for oats			
inland ship	0.018	0.009	0.002
railway	0.018	0.009	0.002
maritime ship	0.018	0.009	0.00179
heavy-duty vehicle	0.018	0.009	0.002
for corn			
inland ship	0.029	0.014	0.003
railway	0.029	0.014	0.003
maritime ship	0.029	0.014	0.00287
heavy-duty vehicle	0.029	0.014	0.003
for rice			
inland ship	0.015	0.008	0.002
railway	0.015	0.008	0.002
maritime ship	0.015	0.008	0.00151
heavy-duty vehicle	0.015	0.008	0.002
for rye			
inland ship	0.038	0.019	0.004
railway	0.038	0.019	0.004

	TSP	PM10	PM2.5
maritime ship	0.038	0.019	0.0038
heavy-duty vehicle	0.038	0.019	0.004
for wheat			
inland ship	0.038	0.019	0.004
railway	0.038	0.019	0.004
maritime ship	0.038	0.019	0.0038
heavy-duty vehicle	0.038	0.019	0.004

Here, in order to match the new NST-2007 classes for goods and materials, the very specific emission factors used in former submissions were converted to aggregated implied emission factors.

Table 3: IEFs used for emission estimates as of 2010, in [kg/t]

	Heavy-duty vehicles			Railways			Inland vessels			Sea vessels		
	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}	TSP	PM ₁₀	PM _{2.5}
Other herbal products	0.032000	0.016000	0.003200	0.024000	0.012000	0.002400	0.022000	0.011000	0.002200	0.028000	0.014000	0.002800
Chemische Grundstoffe, mineralisch	0.041000	0.020500	0.004100	0.031000	0.015500	0.003100	0.029000	0.014500	0.002900	0.036000	0.018000	0.003600
Raw organic chemicals	0.024000	0.012000	0.002400	0.018000	0.009000	0.001800	0.017000	0.008500	0.001700	0.021000	0.010500	0.002100
Iron ore	0.057000	0.028500	0.005700	0.042000	0.021000	0.004200	0.040000	0.020000	0.004000	0.050000	0.025000	0.005000
Crops	0.045000	0.022500	0.004500	0.034000	0.017000	0.003400	0.031000	0.015500	0.003100	0.039000	0.019500	0.003900
Potatoes	0.007000	0.003500	0.000700	0.005000	0.002500	0.000500	0.005000	0.002500	0.000500	0.006000	0.003000	0.000600
Coal products	0.019000	0.009500	0.001900	0.014000	0.007000	0.001400	0.013000	0.006500	0.001300	0.017000	0.008500	0.001700
Products from grinding and shelling mills	0.003000	0.001500	0.000300	0.003000	0.001500	0.000300	0.003000	0.001500	0.000300	0.003000	0.001500	0.000300
Mineral fertilisers	0.024000	0.012000	0.002400	0.018000	0.009000	0.001800	0.017000	0.008500	0.001700	0.021000	0.010500	0.002100
Natural sands, gravel, and stones	0.027000	0.013500	0.002700	0.020000	0.010000	0.002000	0.019000	0.009500	0.001900	0.023000	0.011500	0.002300
Non-iron ores	0.066000	0.033000	0.006600	0.049000	0.024500	0.004900	0.046000	0.023000	0.004600	0.058000	0.029000	0.005800
Raw coals	0.016000	0.008000	0.001600	0.016000	0.008000	0.001600	0.020000	0.010000	0.002000	0.028000	0.014000	0.002800
Secondary raw materials	0.027000	0.013500	0.002700	0.020000	0.010000	0.002000	0.019000	0.009500	0.001900	0.023000	0.011500	0.002300
Rock & saline salt	0.068000	0.034000	0.006800	0.051000	0.025500	0.005100	0.047000	0.023500	0.004700	0.059000	0.029500	0.005900
Nitrogen fertilisers	0.024000	0.012000	0.002400	0.018000	0.009000	0.001800	0.017000	0.008500	0.001700	0.021000	0.010500	0.002100
White cement, lime, cement	0.005000	0.002500	0.000500	0.004000	0.002000	0.000400	0.003000	0.001500	0.000300	0.004000	0.002000	0.000400
Sugar beet	0.000240	0.000120	0.000024	0.000180	0.000090	0.000018	0.000170	0.000085	0.000017	0.000210	0.000105	0.000021

Ratio TSP : PM₁₀ : PM_{2.5}

The shares of PM₁₀ and PM_{2.5} of the entire amounts of emitted TSP have been set to fixed values used for the entire time series.

Assumptions:

1. TSP = 100%,
2. 50% of TSP are =< 10 µm. Therefore, the EF(PM₁₀) are assumed as 1/2 of the corresponding EF(TSP), and

3. 10% of TSP are $\leq 2.5 \mu\text{m}$. Therefore, the $\text{EF}(\text{PM}_{2.5})$ are assumed as 1/10 of the corresponding $\text{EF}(\text{TSP})$.

The ratios of TSP, PM_{10} , and $\text{PM}_{2.5}$ were also discussed in the research project mentioned above, but without generating any new data. Nonetheless, the ratios might be too low at the moment and will be checked furthermore.

Recalculations

As for submission 2021 activity data for 2019 could not be derived from national statistics, amounts of goods transported for 2018 were applied for 2019, too. With the current submission, these data are replaced with original 2019 activity data, resulting in correspondingly revised emission estimates.

table: Revised amounts of bulk goods transported in 2019, in tonnes

	Submission 2021	Submission 2022	absolute change	relative change
other herbal products	30,305,094	6,279,089	-24,026,005	-79%
	445,547	613,000	167,453	38%
	35,511,100	18,815,200	-16,695,900	-47%
	6,614,999	6,067,598	-547,401	-8%
raw mineral chemicals	11,798,872	11,909,168	110,296	1%
	10,634,917	9,158,000	-1,476,917	-14%
	63,713,624	11,315,500	-52,398,124	-82%
	7,386,700	4,839,421	-2,547,279	-34%
raw organic chemicals	6,667,823	6,528,823	-139,000	-2%
	0	17,607,000	17,607,000	
	12,601,908	0	-12,601,908	-100%
	2,463,615	2,623,994	160,379	7%
iron ore	22,796,286	21,531,669	-1,264,617	-6%
	38,252,864	36,601,000	-1,651,864	-4%
	1,680,885	731,400	-949,485	-56%
	14,761,129	14,521,110	-240,019	-2%
crops	7,715,977	8,128,252	412,275	5%
	2,985,786	3,169,000	183,214	6%
	58,957,570	56,315,100	-2,642,470	-4%
	7,672,262	7,985,888	313,626	4%
potatoes	0	49,119	49,119	
	4,896,748	0	-4,896,748	-100%
	9,621,800	4,789,300	-4,832,500	-50%
	20,701,636	25,168,423	4,466,787	22%
coal products	1,560,991	1,870,568	309,577	20%
	8,421,754	6,743,000	-1,678,754	-20%
	13,182,782	6,653,300	-6,529,482	-50%
	25,450	21,898	-3,552	-14%
products from grinding and shelling mills	5,275,005	5,506,351	231,347	4%
	349,419	645,000	295,581	85%
	99,763,916	69,628,300	-30,135,616	-30%
	3,788,108	4,001,310	213,202	6%
mineral fertilisers	197,705	202,054	4,349	2%
	3,224,654	2,756,000	-468,654	-15%
	1,814,964	1,423,800	-391,164	-22%
	311,822	392,516	80,694	26%
natural sands, gravel and stones	35,475,139	38,522,204	3,047,065	9%
	41,345,431	43,057,000	1,711,569	4%
	1,838,142,737	1,639,276,500	-198,866,237	-11%
	12,463,686	13,506,136	1,042,450	8%

	Submission 2021	Submission 2022	absolute change	relative change
non-iron ores	3,043,062	2,749,584	-293,478	-10%
	61,486	22,000	-39,486	-64%
	512,051	0	-512,051	-100%
	4,621,799	3,488,596	-1,133,203	-25%
raw coals	19,571	26,136,332	26,116,761	133446%
	48,277,288	41,538,000	-6,739,288	-14%
	12,593,015	12,603,300	10,285	0%
	16,187,881	12,695,386	-3,492,495	-22%
secondary raw materials	15,101,718	16,441,457	1,339,739	9%
	20,565,387	17,627,000	-2,938,387	-14%
	502,448,809	175,973,100	-326,475,709	-65%
	3,427,249	3,502,952	75,703	2%
rock & saline salt	3,977,618	4,621,784	644,167	16%
	3,017,352	2,673,000	-344,352	-11%
	11,820,822	8,527,200	-3,293,622	-28%
	1,116,411	961,803	-154,608	-14%
nitrogen fertilisers	4,466,442	4,975,009	508,567	11%
	12,318,493	11,774,000	-544,493	-4%
	68,151,044	29,142,700	-39,008,344	-57%
	7,239,705	7,385,920	146,215	2%
white cement, lime, cement	2,978,726	2,896,408	-82,318	-3%
	18,679,111	17,758,000	-921,111	-5%
	99,899,785	82,985,300	-16,914,485	-17%
	2,172,344	1,972,384	-199,960	-9%
sugar beet	5,912,659	0	-5,912,659	-100%
	0	2,000	2,000	
	31,023,482	32,540,800	1,517,318	5%
	3,277	0	-3,277	-100%

table: Revised particulate matter emissions from of bulk goods transported in 2019, in kilotonnes

	PM _{2.5}	PM ₁₀	TSP
current submission	6,62	33,1	66,2
previous submission	8,52	42,6	85,2
absolute change	-1,90	-9,52	-19,0
relative change	-22,3%	-22,3%	-22,3%

Planned improvements

Although no specific improvement is planned, additional effort will be necessary to further minimise the inconsistencies in the activity data time series resulting from the different approaches applied.

^{1), 5)} Müller-BBM, 2011: Dr. Matthias Bender, Ludger Gronewäller, Detlef Langer: Konsistenzprüfung und Verbesserungspotenzial der Schüttgutemissionsberechnung - Umweltforschungsplan des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit, Förderkennzeichen 3708 49 107 2 - FB 00 1453 UBA; Müller- BBM GmbH, Im Auftrag des Umweltbundesamtes, Planegg/Dessau-Roßlau, Februar 2011 - URL:

<https://www.umweltbundesamt.de/publikationen/konsistenzpruefung-verbesserungspotenzial>

²⁾ Eurostat, 2015a: Standard Goods Classification for Transport Statistics/Revised (1967) NST/R - URL

³⁾ Eurostat, 2015b: Standard Goods Classification for Transport Statistics, 2007 - URL:

https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=NST_2007&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC

⁴⁾ Destatis, 2013: Statistisches Bundesamt, Verkehr, NST-2007: Einheitliches Güterverzeichnis für die Verkehrsstistik - 2007 - URL:

<https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Transport-Verkehr/Gueterverkehr/Tabellen/nsz-2007.html>