

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, 2014a) 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:

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

with

1. PAD_{import} = amounts of imported goods,
2. PAD_{export} = amounts of exported goods and
3. PAD_{domestic} = amounts of goods 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:

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

Table 2: Amounts of dry, dusty bulk goods handled in Germany 2010-2018, in tonnes

Product / Good / Material	Mode of transport	2010	2011	2012	2013	2014	2015	2016	2017	2018
~ other herbal products	< inland vessel	> 5,523,633	> 5,711,645	> 6,541,031	> 6,529,161	> 38,829,323	> 39,189,603	> 38,498,874	> 34,508,319	> 30,305,094
<	< railways	> 1,242,916	> 1,242,916	> 170,158	> 807,829	> 17,868	> 470,000	> 547,545	> 532,253	> 445,547
<	< heavy-duty vehicle	> 20,847,400	> 30,967,600	> 29,445,800	> 28,094,800	> 34,166,200	> 34,166,200	> 22,918,493	> 24,118,587	> 35,511,100
<	< sea-going vessel	> 4,052,384	> 6,083,248	> 5,690,857	> 6,321,278	> 6,052,546	> 6,376,068	> 7,164,149	> 6,953,293	> 6,614,999
~ raw mineral chemicals	< inland vessel	> 6,794,922	> 11,213,581	> 11,750,342	> 12,044,542	> 2,556,501	> 2,366,579	> 2,573,770	> 2,696,029	> 11,798,872
<	< railways	> 9,827,059	> 9,827,059	> 10,158,766	> 9,139,348	> 10,472,017	> 9,273,000	> 9,627,577	> 9,885,631	> 10,634,917
<	< heavy-duty vehicle	> 78,928,400	> 89,219,400	> 83,315,200	> 84,937,600	> 82,363,000	> 82,363,000	> 10,043,513	> 11,351,314	> 63,713,624
<	< sea-going vessel	> 5,550,621	> 8,904,300	> 8,692,669	> 8,768,942	> 8,741,513	> 7,905,516	> 7,888,208	> 8,131,408	> 7,386,700
~ raw organic chemicals	< inland vessel	> 6,299,350	> 6,310,746	> 6,636,096	> 6,417,766	> 171,884	> 57,126	> 114,803	> 175,726	> 6,667,823
<	< railways	> 16,287,803	> 16,287,803	> 19,006,897	> 17,965,252	> 17,716,320	> 21,094,000	> 18,661,643	> 18,339,593	> 0
<	< heavy-duty vehicle	> 11,345,600	> 5,875,200	> 5,293,800	> 5,192,200	> 4,570,800	> 4,570,800	> 0	> 828,916	> 12,601,908
<	< sea-going vessel	> 3,638,264	> 2,630,859	> 2,502,315	> 2,690,538	> 3,182,266	> 2,478,579	> 2,341,016	> 2,413,459	> 2,463,615

~ iron ore	< inland vessel	> 25,728,177	> 23,048,502	> 21,885,592	> 23,312,725	> 24,389,450	> 25,203,179	> 25,755,504	> 25,193,580	> 22,796,286
<	< railways	> 38,565,334	> 38,565,334	> 37,513,305	> 37,215,277	> 39,012,340	> 37,708,000	> 37,434,377	> 37,586,847	> 38,252,864
<	< heavy-duty vehicle	> 203,800	> 1,502,000	> 1,166,000	> NE	> NE	> NE	> 1,764,223	> 534,846	> 1,680,885
<	< sea-going vessel	> 13,922,885	> 12,702,983	> 13,397,347	> 14,028,077	> 14,444,514	> 13,967,430	> 13,365,447	> 14,810,135	> 14,761,129
~ crops	< inland vessel	> 9,816,233	> 9,348,956	> 9,693,828	> 11,180,006	> 11,452,177	> 11,243,918	> 10,046,500	> 9,546,963	> 7,715,977
<	< railways	> 2,982,548	> 2,982,548	> 2,446,615	> 1,994,499	> 2,688,008	> 4,583,000	> 3,545,040	> 3,759,205	> 2,985,786
<	< heavy-duty vehicle	> 65,464,800	> 65,723,600	> 63,027,200	> 63,948,600	> 70,614,200	> 70,614,200	> 58,304,413	> 61,639,154	> 58,957,570
<	< sea-going vessel	> 9,319,143	> 7,155,770	> 7,103,932	> 10,159,483	> 10,599,072	> 12,142,981	> 10,735,948	> 8,851,781	> 7,672,262
~ potatoes	< inland vessel	> 1,383	> 1,620	> 30	> 1,034	> NE	> 0	> 0	> 1,056	> 0
<	< railways	> 17,135	> 17,135	> 38,819	> 38,425	> 9,898	> 0	> 0	> 4,581,528	> 4,896,748
<	< heavy-duty vehicle	> 10,627,000	> 10,136,400	> 10,056,600	> 11,717,000	> 9,956,800	> 9,956,800	> 4,683,480	> 5,039,904	> 9,621,800
<	< sea-going vessel	> 29,296,456	> 26,293,129	> 29,732,990	> 23,583,567	> 23,943,784	> 21,170,067	> 20,406,870	> 22,490,149	> 20,701,636
~ coal products	< inland vessel	> 2,409,311	> 1,961,483	> 1,315,205	> 1,665,936	> 1,871,597	> 1,361,655	> 2,003,004	> 2,129,778	> 1,560,991
<	< railways	> 22,499,503	> 22,499,503	> 8,513,061	> 9,144,558	> 7,120,072	> 6,721,000	> 6,610,955	> 6,456,917	> 8,421,754
<	< heavy-duty vehicle	> 11,801,600	> 12,236,800	> 10,278,800	> 10,415,800	> 15,401,600	> 15,401,600	> 7,065,314	> 8,549,595	> 13,182,782
<	< sea-going vessel	> 802,164	> 398,570	> 59,335	> 53,695	> 72,473	> 48,778	> 43,760	> 135,197	> 25,450
~ proiducts from grinding and shelling mills	< inland vessel	> 1,782,712	> 2,567,049	> 3,086,180	> 2,871,889	> 3,200,833	> 4,133,053	> 5,180,094	> 5,368,877	> 5,275,005
<	< railways	> 2,852	> 2,852	> 328,857	> 350,368	> 362,180	> 0	> 465,039	> 381,098	> 349,419
<	< heavy-duty vehicle	> 97,539,400	> 106,391,800	> 104,354,000	> 101,813,400	> 99,568,200	> 99,568,200	> 75,685,582	> 69,634,714	> 99,763,916
<	< sea-going vessel	> 3,104,125	> 3,995,488	> 3,971,495	> 3,638,766	> 3,903,447	> 3,525,359	> 3,586,612	> 3,747,650	> 3,788,108
~ mineral fertilisers	< inland vessel	> 760,174	> 390,276	> 304,450	> 279,444	> 271,253	> 305,202	> 281,603	> 255,398	> 197,705
<	< railways	> 4,122,535	> 4,122,535	> 3,890,715	> 3,684,926	> 3,578,700	> 3,424,000	> 3,619,997	> 3,581,858	> 3,224,654
<	< heavy-duty vehicle	> 7,923,200	> 6,028,800	> 2,236,000	> 2,532,400	> 4,322,000	> 4,322,000	> 1,338,908	> 1,006,750	> 1,814,964
<	< sea-going vessel	> 117,224	> 563,030	> 348,447	> 395,809	> 507,459	> 409,515	> 256,924	> 323,622	> 311,822
~ natural sands, gravel and stones	< inland vessel	> 40,518,020	> 40,340,856	> 38,487,658	> 35,673,470	> 34,713,430	> 31,927,501	> 33,178,046	> 36,072,381	> 35,475,139
<	< railways	> 56,517,180	> 56,517,180	> 48,907,929	> 46,590,830	> 45,317,601	> 43,958,000	> 43,837,499	> 39,960,787	> 41,345,431
<	< heavy-duty vehicle	> 1,655,747,400	> 1,875,461,200	> 1,780,682,400	> 1,810,580,800	> 1,853,177,400	> 1,853,177,400	> 1,669,958,849	> 1,672,131,248	> 1,838,142,737
<	< sea-going vessel	> 8,739,096	> 11,121,374	> 11,421,774	> 9,822,506	> 9,947,768	> 9,739,769	> 10,353,589	> 13,515,063	> 12,463,686
~ non-iron ores	< inland vessel	> 1,512,246	> 2,991,850	> 3,399,513	> 2,909,452	> 3,186,877	> 2,964,925	> 2,827,648	> 3,199,797	> 3,043,062
<	< railways	> 29,742	> 29,742	> 15,232	> 6,651	> 7,972	> 8,000	> 6,642	> 16,877	> 61,486
<	< heavy-duty vehicle	> 705,600	> 788,600	> 2,480,600	> 1,321,000	> NE	> NE	> 0	> 827,676	> 512,051
<	< sea-going vessel	> 2,687,815	> 3,186,505	> 3,474,240	> 3,065,484	> 3,204,390	> 2,850,350	> 3,870,273	> 4,368,429	> 4,621,799

~ raw coals	< inland vessel	> 36,652,759	> 36,960,623	> 37,127,495	> 39,825,584	> 39,049	> 0	> 0	> 0	> 19,571
<	< railways	> 58,433,815	> 58,433,815	> 69,687,308	> 73,653,317	> 69,222,607	> 67,749,000	> 61,034,978	> 51,142,196	> 48,277,288
<	< heavy-duty vehicle	> 10,561,400	> 9,592,600	> 10,288,800	> 14,056,000	> 13,275,800	> 13,275,800	> 11,858,051	> 16,057,484	> 12,593,015
<	< sea-going vessel	> 13,299,295	> 14,640,469	> 13,878,763	> 14,194,693	> 14,065,658	> 16,476,145	> 14,401,269	> 15,919,606	> 16,187,881
~ secondary raw materials	< inland vessel	> 15,691,876	> 15,455,505	> 15,346,780	> 15,565,961	> 12,209,667	> 11,521,886	> 11,212,165	> 12,089,358	> 15,101,718
<	< railways	> 25,614,264	> 25,614,264	> 24,816,767	> 24,034,064	> 23,099,944	> 22,113,000	> 21,261,312	> 22,147,649	> 20,565,387
<	< heavy-duty vehicle	> 422,570,000	> 465,981,000	> 452,569,000	> 464,878,800	> 490,299,000	> 490,299,000	> 161,493,436	> 171,462,235	> 502,448,809
<	< sea-going vessel	> 5,047,097	> 5,440,262	> 6,098,151	> 5,739,258	> 6,094,992	> 5,810,444	> 5,057,435	> 4,173,386	> 3,427,249
~ rock & saline salt	< inland vessel	> 2,769,356	> 5,367,045	> 4,297,737	> 4,588,453	> 3,959,354	> 3,939,437	> 3,651,498	> 4,115,651	> 3,977,618
<	< railways	> 3,067,187	> 3,067,187	> 2,413,134	> 2,963,318	> 2,258,785	> 2,575,000	> 2,362,886	> 2,603,115	> 3,017,352
<	< heavy-duty vehicle	> 21,579,000	> 18,284,800	> 11,550,200	> 13,746,800	> 7,887,600	> 7,887,600	> 7,238,776	> 10,591,977	> 11,820,822
<	< sea-going vessel	> 567,059	> 1,340,830	> 1,062,136	> 912,141	> 761,849	> 919,251	> 888,593	> 812,124	> 1,116,411
~ noitrogen fertilisers	< inland vessel	> 5,737,386	> 5,636,147	> 5,616,853	> 5,321,196	> 5,267,318	> 5,104,076	> 4,930,755	> 4,742,988	> 4,466,442
<	< railways	> 15,708,472	> 15,708,472	> 15,592,709	> 15,550,134	> 14,971,021	> 14,091,000	> 13,614,102	> 14,066,445	> 12,318,493
<	< heavy-duty vehicle	> 37,454,600	> 44,977,200	> 61,230,200	> 64,460,400	> 71,366,600	> 71,366,600	> 28,434,989	> 30,619,530	> 68,151,044
<	< sea-going vessel	> 5,309,443	> 5,821,309	> 5,953,434	> 6,489,522	> 6,378,323	> 6,509,499	> 7,011,855	> 7,392,865	> 7,239,705
~ white cement, lime, cement	< inland vessel	> 3,273,975	> 3,324,316	> 3,120,120	> 3,046,615	> 2,408,113	> 2,479,720	> 2,532,347	> 2,776,593	> 2,978,726
<	< railways	> 17,849,146	> 17,849,146	> 17,115,456	> 18,418,916	> 19,947,465	> 21,867,000	> 19,270,679	> 18,928,775	> 18,679,111
<	< heavy-duty vehicle	> 69,407,200	> 81,743,800	> 71,895,800	> 76,202,600	> 86,441,400	> 86,441,400	> 76,251,684	> 77,289,169	> 99,899,785
<	< sea-going vessel	> 1,544,488	> 2,130,253	> 2,171,491	> 1,954,095	> 2,699,787	> 2,757,516	> 2,470,814	> 2,552,567	> 2,172,344
~ sugar beet	< inland vessel	> 0	> 5,003	> 0	> 1,035	> 6,362,106	> 6,366,439	> 6,426,328	> 6,396,070	> 5,912,659
<	< railways	> 123,598	> 123,598	> 96,747	> 29,869	> 46,870	> 24,000	> 64,094	> 37,555	> 0
<	< heavy-duty vehicle	> 26,946,200	> 27,903,200	> 31,496,200	> 20,903,200	> 36,601,000	> 36,601,000	> 22,159,060	> 32,853,554	> 31,023,482
<	< sea-going vessel	> 17	> 142	> 1,843	> 1,154	> 4,086	> 2,872	> 3,125	> 9,676	> 3,277

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

= vehicle type	= TSP	= PM ₁₀	= PM _{2.5}
= 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
< 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]

= Product / Good / Material			= Heavy-duty vehicles			= Railways			= Inland vessels			= Sea-going 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: * TSP = 100%, * 50% of TSP are ≤ 10 µm. Therefore, the EF(PM₁₀) are assumed as 1/2 of the corresponding EF(TSP), and * 10% of TSP are ≤ 2.5 µm. Therefore, the EF(PM_{2.5}) are assumed as 1/10 of the corresponding EF(TSP).

[image PM-ratios.PNG](#)

The ratios of TSP, PM₁₀, and 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.

Discussion of emission trends

NFR 2.L(a) is key category for **PM_{2.5}**, **PM₁₀**, and **TSP**.

In general, diffuse particulate matter emissions depend strongly on the amounts of dry bulk goods handled and transported. In addition, due to efforts to prevent such particle emissions, the time series of the emission factors applied for all three fractions of particulate matter show a falling trend.

Recalculations

With both **activity data** and **emission factors** remaining unrevised, no recalculations have been carried out.

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.

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¹⁾ (bibcite 1)

²⁾ (bibcite 2)

³⁾ (bibcite 3)

⁴⁾ (bibcite 4)

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