# Nitrogen emissions to the air in the Baltic Sea area

HELCOM Baltic Sea Environment Fact Sheet (BSEFS), 2021

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## Key Message

For all HELCOM Contracting Parties, *oxidized* nitrogen emissions were lower in 2019 than in 1995, with the largest reductions in Denmark (66%), followed by Finland (56%), Sweden (49%) and Germany (48%).

Concerning *reduced* nitrogen (ammonia), annual emissions were lower in 2019 than in 1995 in six out of the nine HELCOM Contracting Parties, with the largest reductions in Denmark (30%), followed by Poland (13%) and Sweden (13%). In Lithuania, Russia and Latvia ammonia emissions increased from 1995 to 2019 by 12%, 9% and 7%, respectively.

For all HELCOM Contracting Parties, *total* nitrogen emissions were lower in 2019 than in 1995, with the largest reductions in Denmark (48%), followed by Finland (43%) and Sweden (35%).

## Results and Assessment

### Relevance of the BSEFS for describing developments in the environment

This fact sheet presents the changes in annual emissions of nitrogen oxides (NO and $NO_2$) and ammonia ($NH_3$) from anthropogenic sources during the 1995 to 2019 period, which are the basis for the model calculations of the deposition on the Baltic Sea. The data include emissions from HELCOM Countries, Baltic and North Sea shipping and other sources outside the HELCOM area.

### Policy relevance and policy references

The HELCOM Copenhagen Ministerial Declaration of 2013 on taking further action to implement the Baltic Sea Action Plan reconfirmed the need of reaching good environmental status for a healthy Baltic Sea. The declaration includes nutrient reduction targets, and thus also concerns airborne nitrogen input to the Baltic Sea. The Declaration sets targets on Maximum Allowed Inputs (MAI) covering both water- and airborne inputs. These targets are maintained in the updated Baltic Sea Action Plan of 2021.

The relevant policy to the control of emissions of nitrogen oxides and ammonia to the atmosphere on a global scale is set in the framework of the UN ECE Convention on Long-Range Transboundary Air Pollution (CLRTAP). For EU member states the policy frame is set by the EU NEC and IED Directives. For the Russian Federation the corresponding policy frame is embraced by Federal Acts on Environment Protection and the Protection of Atmospheric Air. The Gothenburg Protocol (1999, and revised in 2012) requires that nitrogen oxides emissions in 2020 should be reduced by between 18% and 56% in 31 countries with respect to 2005 annual emissions, with the largest relative reductions in Denmark (56%), the United Kingdom (55%) and France (50%). Ammonia emissions should also be reduced, but by smaller percentages (1% to 24%). The largest relative reductions of ammonia emissions should be in Denmark (24%), Finland (20%) and Sweden (15%). In the European Union, the revised Gothenburg Protocol is implemented by the EU NEC Directive 2016/2284/EU, which sets 2020 and 2030 emission reduction commitments for five main air pollutants, including nitrogen oxides and ammonia. It is worth noting that in the case of ammonia, the commitments set for 2030 are much stricter than the Gothenburg Protocol reductions that were set for 2020. The Gothenburg Protocol currently undergoes a review process that will most likely result in a new revision.

## Assessment

In this fact sheet we present and discuss nitrogen emission data as used in the EMEP MSC-W model calculations performed for the 1995-2019 period. For all years, the gridded distributions of emissions have been provided by the EMEP Centre on Emission Inventories and Projections (CEIP) on 0.1° x 0.1° resolution. Details about the methods of gridding and gap-filling emission data done by CEIP can be found in the EMEP status report 1/2021 (EMEP, 2021, their section 3.5), which is publicly available on the web.

The gridded emission data used in the EMEP MSC-W model calculations are available on CEIP's WebDab at: https://www.ceip.at/webdab-emission-database/emissions-as-used-in-emep-models.

Time series of nitrogen oxides and ammonia annual emissions in the period 1995 – 2019, as used in the EMEP MSC-W model calculations, are shown for all HELCOM Contracting Parties in Figure 1. The figure also shows emissions from shipping in the North Sea and the Baltic Sea, as well as all other sources within the EMEP MSW-W model domain. For the first time this year, the coefficients for the best-fit linear trend are added, showing an increase or a decrease. "R-squared" is a measure of how much of the variability can be explained by the (linear trend) model. The R-squared values are written in bold font if the trend is statistically significant at the 5% level (Mann-Kendall test). Time series of nitrogen oxides, ammonia and total nitrogen annual emissions, expressed as percentage of 1995 emissions, are shown for the same period in Figure 2. Emissions from Russia are included only for the part of Russia that is included in the EMEP MSW-W model domain.

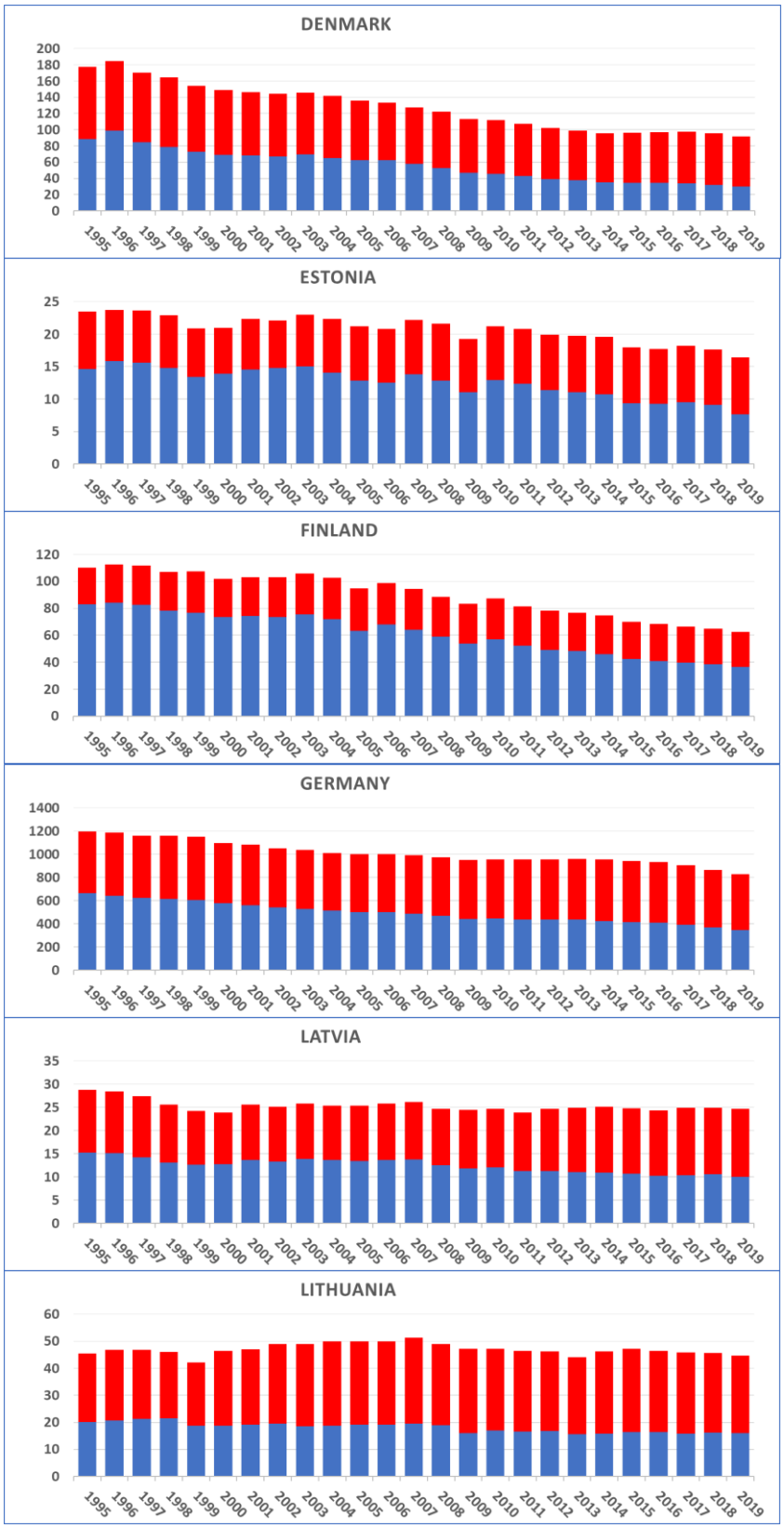
According to the work plan of the EMEP Programme, not all historical years of the considered period (starting in the 1990s) are gridded and gap-filled every year. Having to rely on data based on different data submissions is thus not unusual and, in most cases, does not lead to any major inconsistencies.

Nevertheless, it is important to note that the emission data for the years 1995 – 1999 are still based on the 2019 official data submissions to CEIP (as of February 2019), while the emission data for the period 2000 – 2019 have been updated this year, i.e. they are based on official data submissions to CEIP as of June 2021.

A special case are emissions from international shipping: These are not reported by the Parties to the UN ECE LRTAP Convention but taken from the CAMS global ship emission dataset (Granier et al., 2019), which starts in the year 2000 and was developed by the Finnish Meteorological Institute (FMI). Ship emissions for years before 2000 are estimated using CAMS global shipping emissions for 2000, adjusted with trends for global shipping from EDGAR v.4.3.2 (JRC/PBL 2016). Only the emission data for 2019 have been updated this year, and they include a larger number of small (non-IMO) vessels that have started to use AIS (Automatic Identification System) recently. The apparent increase in shipping emissions might thus partly be due to the increased use of AIS (which the emission data are based upon) and not reflect any real increase in ship emissions. Furthermore, reduced nitrogen emissions from ships do not occur in any significant amount and are thus not considered in the model or plotted in Figures 1 and 2.

In most HELCOM Contracting Parties, emissions of total nitrogen have been decreasing during the period 1995 – 2019. The reduction of emissions from the Baltic Sea region in the years 1995 – 2019 is more significant for nitrogen oxides than for ammonia: In all HELCOM Contracting Parties, oxidized nitrogen emissions are by 10 to 66% lower in 2019 than in 1995, with the largest reductions in Denmark (66%), followed by Finland (56%), Sweden (49%), and Germany (48%). Reductions with respect to 1995 are also reported for all the other HELCOM Contracting parties: Estonia (48%), Poland (35%), Latvia (34%), Lithuania (20%), and Russia (10%).

For ammonia, the emissions from seven out of nine HELCOM Contracting Parties were lower in 2019 than in 1995, with the largest reductions in Denmark (30%), followed by Poland (13%), Sweden (13%), and Germany (10%). Reductions with respect to 1995 are also seen for Finland (4%) and Estonia (2%), while Lithuania, Russia and Latvia have increased their ammonia emissions since 1995 (by 12% and 9%, 7%, respectively).




NOx (blue):
y = -2.6 x + 91, **$R^2$ = 0.95**

$NH_3$ (red):
y = -1.2 x + 87, **$R^2$ = 0.92**

NOx (blue):
y = -0.29 x + 16, **$R^2$ = 0.87**

$NH_3$ (red):
y = 0.039 x + 7.8, $R^2$ = 0.37

NOx (blue):
y = -2.1 x + 89, **$R^2$ = 0.98**

$NH_3$ (red):
y = -0.083 x + 30, $R^2$ = 0.18

NOx (blue):
y = -12 x + 652, **$R^2$ = 0.97**

$NH_3$ (red):
y = -1.1 x + 531, **$R^2$ = 0.23**

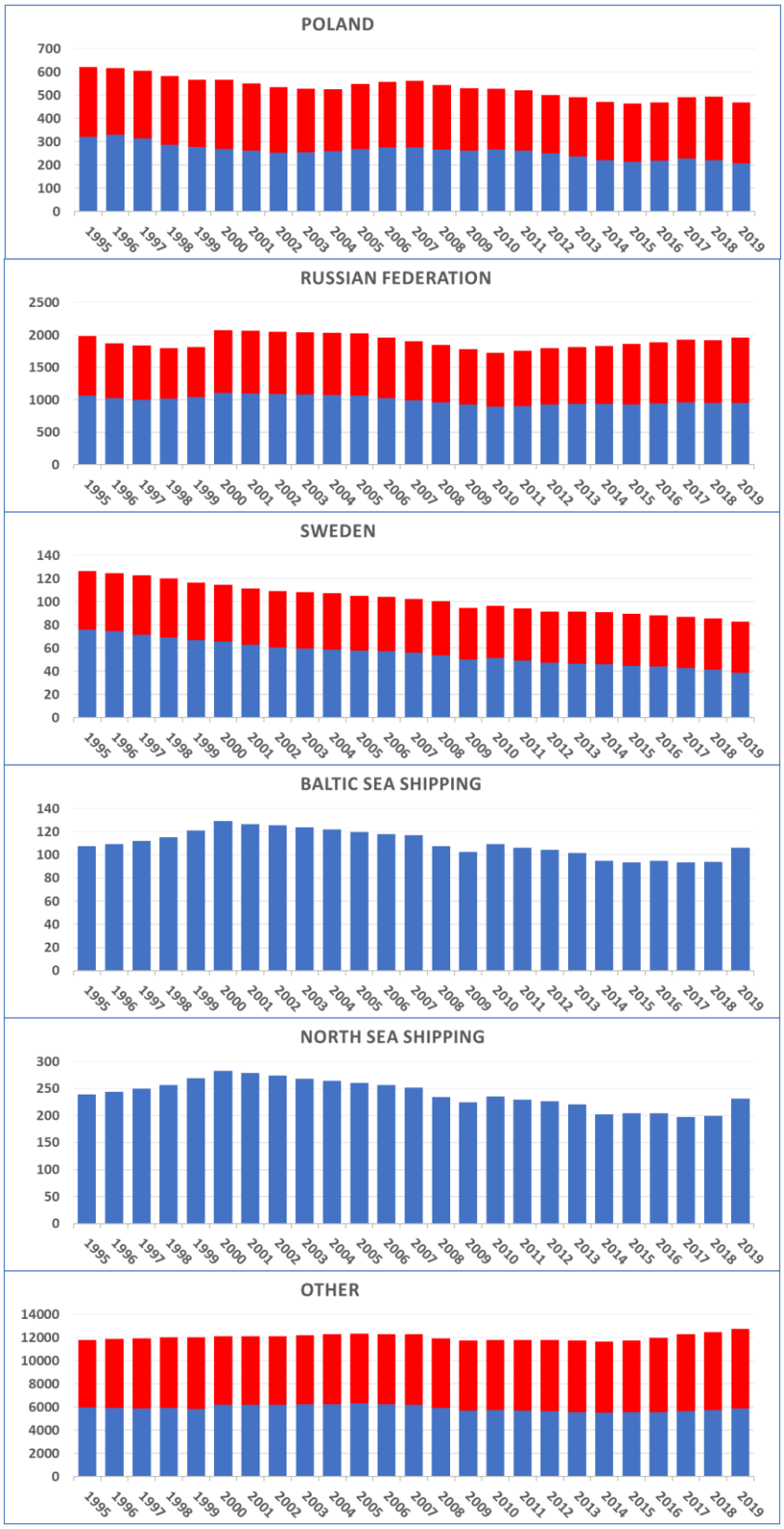
NOx (blue):
y = -0.19 x + 15, **$R^2$ = 0.84**

$NH_3$ (red):
y = 0.092 x + 12, $R^2$ = 0.42

NOx (blue):
y = -0.22 x + 21, **$R^2$ = 0.81**

$NH_3$ (red):
y = 0.19 x + 26, $R^2$ = 0.37

**Figure 1**. Annual atmospheric emissions of nitrogen oxides (NOx, blue) and ammonia ($NH_3$, red) from HELCOM Contracting Parties, international shipping (North Sea and Baltic Sea) and from other sources within the EMEP MSC-W model domain from 1995 to 2019. Unit: ktonnes(N)/year. Emission data for 1995 to 1999 are based on 2019 official submissions from EMEP countries, while emission data for 2000-2019 are updated according to this year's (2021) submissions. Break points seen at year 2000 are thus not necessarily real. Also, the ship emission data for 2019 take into account more small vessels than the years before. Coefficients of the linear trend model are added to the right. R-squared values in bold font mean that the indicated trend is significant at the 5% level. (Figure continues on next page)




NOx (blue):
y = -3.9 x + 310, **$R^2$ = 0.79**

$NH_3$ (red):
y = -1.9 x + 298, **$R^2$ = 0.71**

NOx (blue):
y = -6.6 x + 1081, **$R^2$ = 0.53**

$NH_3$ (red):
y = 2.8 x + 870, $R^2$ = 0.11

NOx (blue):
y = -1.5 x + 75, **$R^2$ = 0.98**

$NH_3$ (red):
y = -0.33 x + 51, **$R^2$ = 0.92**

NOx (blue):
y = -1.1 x + 124, **$R^2$ = 0.52**

NOx (blue):
y = -2.8 x + 276, **$R^2$ = 0.60**

NOx (blue):
y = -21 x + 6173, **$R^2$ = 0.35**

$NH_3$ (red):
y = 27 x + 5790, **$R^2$ = 0.58**

**Figure 1**. continued

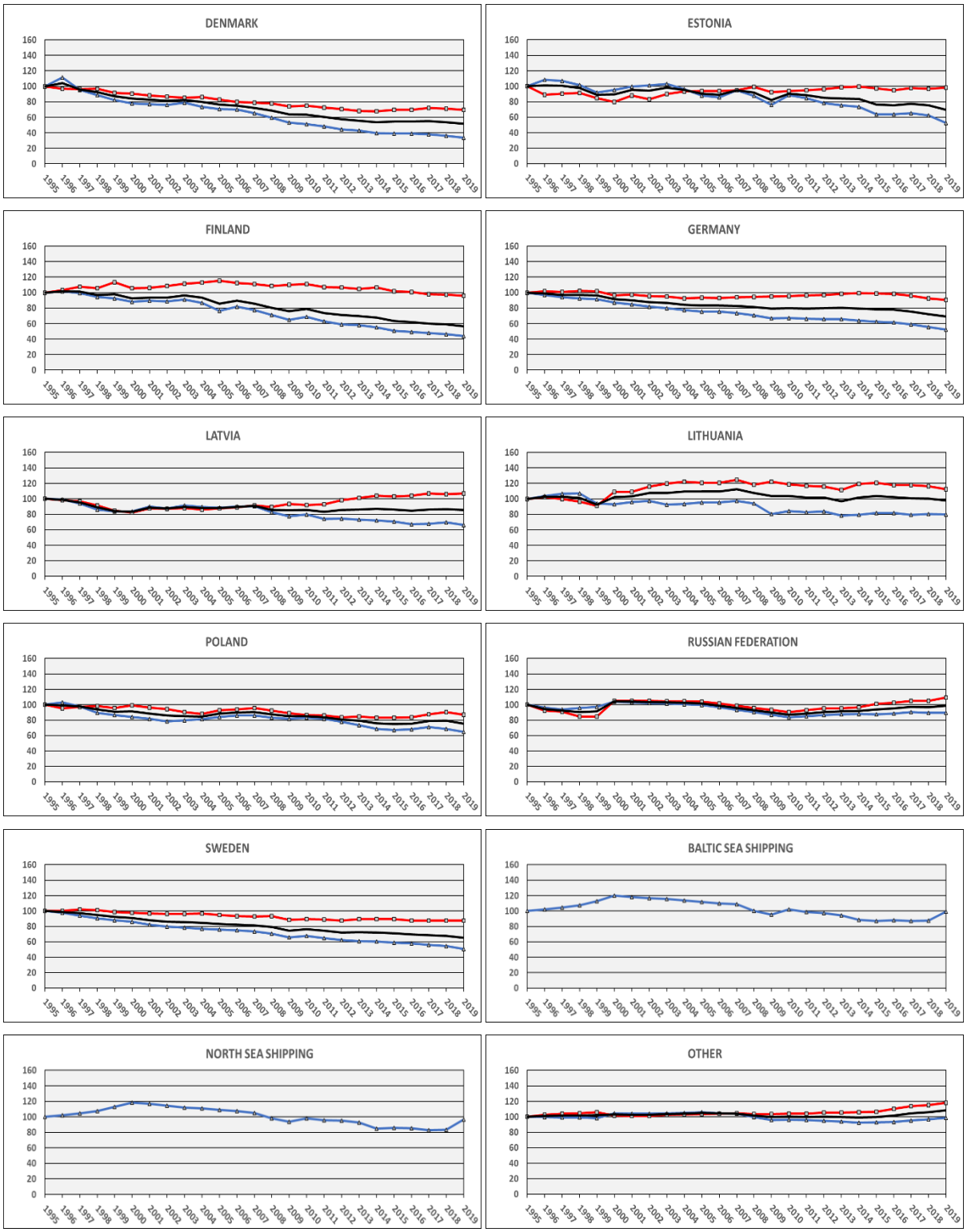



**Figure 2**. Changes in annual atmospheric emissions of nitrogen oxides (NOx, blue/triangles), ammonia ($NH_3$, red/squares) and total nitrogen (NOx+ $NH_3$, black solid) from HELCOM Contracting Parties, international shipping (North Sea and Baltic Sea) and from other sources within the EMEP MSC-W model domain from 1995 to 2019, plotted as percentage of the 1995 value. Unit: %. Emission data for 1995 to 1999 are based on 2019 official submissions from EMEP countries, while emission data for 2000-2019 are updated according to this year's (2021) submissions. Break points seen at year 2000 are thus not necessarily real. Also, the ship emission data for 2019 take into account more small vessels than the years before. See text for more details.

## References

EMEP, 2021: EMEP Status Report 1/2021. "Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components" Joint MSC-W & CCC & CEIP Report. Link for direct download: https://emep.int/publ/reports/2021/EMEP_Status_Report_1_2021.pdf

Granier, C., Darras, S., Denier van der Gon, H., Doubalova, J., Elguindi, N., Galle, B., Gauss, M., Guevara, M., Jalkanen, J.-P., Kuenen, J., Liousse, C., Quack, B., Simpson, D., and Sindelarova, K.: The Copernicus Atmosphere Monitoring Service global and regional emissions (April 2019 version), doi:10.24380/d0bn-kx16, Link for direct download: https://atmosphere.copernicus.eu/sites/default/files/201906/cams_emissions_general_document_apr2019_v7.pdf.

JRC/PBL: Emission Database for Global Atmospheric Research (EDGAR), Global Emissions EDGAR v4.3.1, European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL), URL http://edgar.jrc.ec.europa.eu, 2016.

## Data

**Table 1**. National total emissions of nitrogen oxides from HELCOM Contracting Parties, international shipping (NOS: North Sea, and BAS: Baltic Sea), and from other sources within the EMEP MSC-W model domain in the period 1995 – 2019, as used in the EMEP MSC-W model calculations of nitrogen deposition. Unit: ktonnes(N)/year.

| Year | DK | EE | FI | DE | LV | LT | PL | RU | SE | Sum HELCOM | Shipping | | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | BAS | NOS | |
| 1995 | 88.5 | 14.6 | 83.0 | 664 | 15.2 | 20.0 | 321 | 1064 | 76.2 | 2346 | 107 | 239 | 5953 |
| 1996 | 98.9 | 15.8 | 84.3 | 642 | 15.1 | 20.7 | 330 | 1023 | 74.5 | 2304 | 109 | 244 | 5927 |
| 1997 | 84.6 | 15.6 | 82.5 | 623 | 14.3 | 21.3 | 314 | 1000 | 71.6 | 2226 | 112 | 250 | 5890 |
| 1998 | 78.5 | 14.8 | 78.2 | 615 | 13.1 | 21.5 | 287 | 1018 | 69.1 | 2196 | 115 | 257 | 5903 |
| 1999 | 72.9 | 13.4 | 76.8 | 608 | 12.7 | 18.8 | 278 | 1037 | 66.9 | 2184 | 121 | 269 | 5844 |
| 2000 | 68.9 | 13.9 | 73.4 | 580 | 12.7 | 18.7 | 269 | 1105 | 65.6 | 2207 | 129 | 283 | 6210 |
| 2001 | 68.1 | 14.5 | 74.4 | 562 | 13.6 | 19.2 | 262 | 1096 | 62.8 | 2173 | 126 | 279 | 6204 |
| 2002 | 67.2 | 14.8 | 73.7 | 544 | 13.3 | 19.5 | 252 | 1088 | 60.7 | 2132 | 125 | 273 | 6191 |
| 2003 | 69.9 | 15.0 | 75.7 | 530 | 13.9 | 18.5 | 255 | 1079 | 59.6 | 2117 | 124 | 268 | 6217 |
| 2004 | 65.0 | 14.0 | 72.2 | 515 | 13.6 | 18.7 | 261 | 1071 | 58.5 | 2089 | 122 | 264 | 6255 |
| 2005 | 62.5 | 12.9 | 63.3 | 500 | 13.4 | 19.1 | 270 | 1062 | 57.7 | 2061 | 120 | 260 | 6310 |
| 2006 | 62.3 | 12.5 | 68.1 | 503 | 13.7 | 19.1 | 276 | 1028 | 57.2 | 2040 | 118 | 256 | 6225 |
| 2007 | 57.8 | 13.8 | 64.2 | 489 | 13.7 | 19.5 | 275 | 994 | 55.8 | 1984 | 117 | 251 | 6186 |
| 2008 | 52.9 | 12.8 | 58.9 | 470 | 12.6 | 18.8 | 267 | 960 | 53.6 | 1907 | 107 | 234 | 5921 |
| 2009 | 47.1 | 11.1 | 53.7 | 443 | 11.8 | 16.1 | 262 | 926 | 49.9 | 1821 | 102 | 224 | 5690 |
| 2010 | 45.6 | 12.9 | 57.0 | 448 | 12.1 | 16.9 | 267 | 892 | 51.4 | 1803 | 109 | 235 | 5728 |
| 2011 | 42.7 | 12.4 | 52.1 | 440 | 11.3 | 16.6 | 261 | 905 | 49.3 | 1791 | 106 | 229 | 5692 |
| 2012 | 39.4 | 11.4 | 49.2 | 437 | 11.3 | 16.8 | 249 | 924 | 47.4 | 1786 | 104 | 227 | 5651 |
| 2013 | 38.0 | 11.0 | 48.2 | 437 | 11.1 | 15.7 | 236 | 933 | 46.5 | 1777 | 101 | 221 | 5577 |
| 2014 | 35.1 | 10.7 | 45.9 | 424 | 11.0 | 15.9 | 220 | 936 | 46.0 | 1744 | 95 | 202 | 5488 |
| 2015 | 34.7 | 9.3 | 42.2 | 415 | 10.7 | 16.4 | 215 | 930 | 44.8 | 1718 | 93 | 204 | 5540 |
| 2016 | 34.7 | 9.3 | 41.0 | 408 | 10.2 | 16.4 | 218 | 944 | 44.1 | 1725 | 95 | 204 | 5551 |
| 2017 | 33.7 | 9.5 | 39.6 | 393 | 10.3 | 15.9 | 228 | 960 | 42.6 | 1733 | 93 | 198 | 5662 |
| 2018 | 32.1 | 9.1 | 38.6 | 368 | 10.5 | 16.1 | 221 | 953 | 41.6 | 1691 | 94 | 199 | 5752 |
| 2019 | 30.0 | 7.7 | 36.5 | 346 | 10.1 | 16.0 | 207 | 953 | 38.7 | 1646 | 106 | 231 | 5870 |

**Table 2**. National total emissions of ammonia from HELCOM Contracting Parties and from other sources within the EMEP MSC-W model domain in the period 1995 – 2019, as used in the EMEP MSC-W model calculations of nitrogen deposition. Unit: ktonnes(N)/year.

| Year | DK | EE | FI | DE | LV | LT | PL | RU | SE | Sum HELCOM | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1995 | 88.7 | 8.87 | 27.2 | 535 | 13.6 | 25.5 | 301 | 920 | 50.3 | 1969 | 5830 |
| 1996 | 85.9 | 7.90 | 28.0 | 543 | 13.4 | 26.1 | 287 | 849 | 50.4 | 1892 | 5970 |
| 1997 | 85.6 | 8.01 | 29.3 | 538 | 13.2 | 25.5 | 292 | 837 | 51.4 | 1880 | 6053 |
| 1998 | 85.8 | 8.09 | 28.7 | 545 | 12.5 | 24.6 | 295 | 779 | 50.9 | 1831 | 6090 |
| 1999 | 81.4 | 7.50 | 30.8 | 545 | 11.5 | 23.2 | 288 | 779 | 49.7 | 1816 | 6183 |
| 2000 | 80.2 | 7.08 | 28.7 | 516 | 11.2 | 27.8 | 298 | 967 | 49.2 | 1985 | 5908 |
| 2001 | 78.3 | 7.78 | 28.8 | 520 | 11.9 | 27.8 | 289 | 965 | 48.7 | 1978 | 5885 |
| 2002 | 76.9 | 7.38 | 29.5 | 510 | 11.9 | 29.5 | 284 | 963 | 48.5 | 1961 | 5895 |
| 2003 | 75.6 | 7.96 | 30.3 | 507 | 12.0 | 30.5 | 272 | 961 | 48.6 | 1946 | 5968 |
| 2004 | 76.5 | 8.28 | 30.7 | 495 | 11.7 | 31.2 | 264 | 959 | 48.8 | 1925 | 6014 |
| 2005 | 73.5 | 8.31 | 31.3 | 500 | 11.9 | 30.8 | 279 | 958 | 47.6 | 1940 | 6036 |
| 2006 | 70.8 | 8.32 | 30.5 | 496 | 12.1 | 30.8 | 282 | 933 | 47.0 | 1911 | 6067 |
| 2007 | 69.9 | 8.41 | 30.1 | 503 | 12.4 | 31.7 | 287 | 908 | 46.8 | 1897 | 6095 |
| 2008 | 69.2 | 8.79 | 29.4 | 506 | 12.2 | 30.2 | 277 | 883 | 46.9 | 1862 | 6022 |
| 2009 | 65.8 | 8.18 | 29.9 | 508 | 12.7 | 31.2 | 267 | 858 | 44.6 | 1825 | 6032 |
| 2010 | 66.5 | 8.31 | 30.1 | 510 | 12.5 | 30.3 | 261 | 833 | 45.0 | 1796 | 6064 |
| 2011 | 64.4 | 8.41 | 29.1 | 515 | 12.6 | 29.7 | 259 | 852 | 44.7 | 1815 | 6072 |
| 2012 | 62.8 | 8.54 | 29.0 | 519 | 13.4 | 29.5 | 251 | 875 | 44.0 | 1832 | 6133 |
| 2013 | 60.7 | 8.74 | 28.5 | 525 | 13.8 | 28.4 | 255 | 878 | 44.9 | 1842 | 6161 |
| 2014 | 60.3 | 8.84 | 28.9 | 531 | 14.2 | 30.4 | 251 | 892 | 44.9 | 1861 | 6181 |
| 2015 | 61.8 | 8.61 | 27.6 | 528 | 14.0 | 30.7 | 250 | 929 | 44.9 | 1894 | 6215 |
| 2016 | 61.9 | 8.40 | 27.3 | 526 | 14.2 | 30.0 | 251 | 943 | 44.0 | 1905 | 6417 |
| 2017 | 64.1 | 8.67 | 26.6 | 514 | 14.6 | 30.1 | 263 | 964 | 44.1 | 1929 | 6630 |
| 2018 | 63.3 | 8.59 | 26.5 | 495 | 14.4 | 29.6 | 272 | 964 | 44.2 | 1917 | 6723 |
| 2019 | 62.0 | 8.72 | 26.0 | 483 | 14.6 | 28.6 | 261 | 1004 | 44.0 | 1932 | 6872 |

**Table 3**. National total emissions of total nitrogen from HELCOM Contracting Parties, international shipping (NOS: North Sea, and BAS: Baltic Sea), and from other sources within the EMEP MSC-W model domain in the period 1995 – 2019, as used in the EMEP MSC-W model calculations of nitrogen deposition. Units: ktonnes(N)/year.

| Year | DK | EE | FI | DE | LV | LT | PL | RU | SE | Sum HELCOM | Shipping | | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | BAS | NOS | |
| 1995 | 177 | 23.5 | 110 | 1199 | 28.8 | 45.5 | 621 | 1984 | 127 | 4316 | 107 | 239 | 11783 |
| 1996 | 185 | 23.7 | 112 | 1186 | 28.4 | 46.8 | 617 | 1872 | 125 | 4196 | 109 | 244 | 11897 |
| 1997 | 170 | 23.6 | 112 | 1161 | 27.4 | 46.8 | 606 | 1837 | 123 | 4106 | 112 | 250 | 11943 |
| 1998 | 164 | 22.9 | 107 | 1161 | 25.6 | 46.0 | 582 | 1798 | 120 | 4026 | 115 | 257 | 11993 |
| 1999 | 154 | 20.9 | 108 | 1153 | 24.2 | 42.1 | 566 | 1816 | 117 | 4000 | 121 | 269 | 12027 |
| 2000 | 149 | 21.0 | 102 | 1096 | 23.9 | 46.4 | 567 | 2072 | 115 | 4192 | 129 | 283 | 12119 |
| 2001 | 146 | 22.3 | 103 | 1082 | 25.6 | 47.0 | 551 | 2062 | 112 | 4151 | 126 | 279 | 12089 |
| 2002 | 144 | 22.1 | 103 | 1053 | 25.2 | 49.0 | 536 | 2051 | 109 | 4093 | 125 | 273 | 12087 |
| 2003 | 146 | 23.0 | 106 | 1037 | 25.8 | 48.9 | 528 | 2041 | 108 | 4063 | 124 | 268 | 12185 |
| 2004 | 142 | 22.3 | 103 | 1010 | 25.3 | 49.9 | 525 | 2030 | 107 | 4014 | 122 | 264 | 12269 |
| 2005 | 136 | 21.2 | 94.6 | 1000 | 25.4 | 49.9 | 548 | 2020 | 105 | 4000 | 120 | 260 | 12346 |
| 2006 | 133 | 20.8 | 98.6 | 999 | 25.8 | 49.9 | 558 | 1961 | 104 | 3951 | 118 | 256 | 12292 |
| 2007 | 128 | 22.2 | 94.3 | 992 | 26.2 | 51.2 | 563 | 1902 | 103 | 3881 | 117 | 251 | 12281 |
| 2008 | 122 | 21.6 | 88.3 | 976 | 24.7 | 49.0 | 544 | 1843 | 101 | 3769 | 107 | 234 | 11943 |
| 2009 | 113 | 19.2 | 83.6 | 951 | 24.5 | 47.2 | 529 | 1784 | 94.5 | 3646 | 102 | 224 | 11723 |
| 2010 | 112 | 21.2 | 87.1 | 957 | 24.6 | 47.2 | 528 | 1725 | 96.4 | 3598 | 109 | 235 | 11791 |
| 2011 | 107 | 20.8 | 81.2 | 954 | 23.9 | 46.3 | 521 | 1757 | 94.0 | 3605 | 106 | 229 | 11764 |
| 2012 | 102 | 20.0 | 78.2 | 956 | 24.7 | 46.3 | 501 | 1798 | 91.4 | 3618 | 104 | 227 | 11785 |
| 2013 | 98.6 | 19.8 | 76.7 | 962 | 24.9 | 44.1 | 491 | 1811 | 91.4 | 3619 | 101 | 221 | 11738 |
| 2014 | 95.4 | 19.6 | 74.8 | 954 | 25.1 | 46.3 | 471 | 1827 | 90.9 | 3605 | 94.9 | 202 | 11670 |
| 2015 | 96.5 | 17.9 | 69.9 | 943 | 24.8 | 47.1 | 465 | 1858 | 89.8 | 3612 | 93.2 | 204 | 11754 |
| 2016 | 96.6 | 17.7 | 68.3 | 934 | 24.4 | 46.4 | 469 | 1887 | 88.1 | 3631 | 94.6 | 204 | 11968 |
| 2017 | 97.9 | 18.2 | 66.3 | 907 | 24.9 | 45.9 | 491 | 1924 | 86.7 | 3662 | 93.3 | 198 | 12293 |
| 2018 | 95.4 | 17.7 | 65.0 | 864 | 24.9 | 45.7 | 493 | 1917 | 85.8 | 3608 | 93.9 | 199 | 12475 |
| 2019 | 92.0 | 16.4 | 62.5 | 829 | 24.7 | 44.6 | 469 | 1957 | 82.7 | 3578 | 106 | 231 | 12742 |

# Metadata

## Technical information

1. Source: EMEP Centre on Emission Inventories and Projections (CEIP).
2. Description of data: The gridded distributions of emissions have been provided by the EMEP Centre on Emission Inventories and Projections (CEIP). The emissions for the 1995-1999 period are derived from the 2019 official data submissions to UNECE CLRTAP as of February 2019, while emissions for 2000-2019 are derived from the 2021 official data submissions to UNECE CLRTAP as of June 2021.
3. Geographical coverage: EMEP domain covering Europe, parts of Asia and a part of the Atlantic Ocean.
4. Temporal coverage: Data on emissions of nitrogen oxides and ammonia are presented here for the period 1995 - 2019.
5. Methodology and frequency of data collection: National data on emissions are annually submitted by the Parties to the CLRTAP Convention to the UN ECE Secretariat. The methodology is based on a combination of emission measurements and emission estimates, based on activity data and emission factors. Submitted data undergo a QA/QC procedure and are stored in the WebDab database of the EMEP Centre for Emission inventories and Projections (CEIP) in Vienna, Austria.

## Quality information

6. Strengths and weaknesses: Strength: data on emissions are annually submitted, checked and stored in the CEIP database; Weaknesses: there are gaps in time series of national emissions, which have to be corrected by experts. Delays occur in updating historical emission data submitted by the EMEP Contracting Parties.
7. Uncertainty. No official information about the uncertainty of provided nitrogen emission data is available from CEIP.
8. Further work required: Further work on emission uncertainty is required.