Nitrogen emissions to the air in the Baltic Sea area

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Key message

In all HELCOM Contracting Parties, nitrogen oxides emissions are lower in 2015 than in 1995 with the most significant drop of nitrogen oxides emissions in Denmark (60%) followed by Sweden (47%) and then Germany and Finland both (45%). For all HELCOM Contracting Parties except Russia, reductions of total nitrogen emissions can be observed in the period 1995 – 2015, ranging from 12% in Estonia to 47% in Denmark. Total nitrogen emissions from Russia increased by 12% from 1995 to 2015. For ammonia, annual emissions increased in three out of nine HELCOM Contracting Parties in the period 1995-2015. These are: Russia (+31%), Germany (+12%) and Latvia (+6%). In the remaining countries a decline of ammonia emissions can be noticed, with the most significant declines in Lithuania (39%) and Denmark (34%).

Results and Assessment

Relevance of the indicator for describing the developments in the environment

This indicator shows the levels and trends of annual nitrogen oxides and ammonia emissions from anthropogenic sources in HELCOM Contracting Parties into the air. The emissions of nitrogen oxides and ammonia represent the pressure of emission sources on the atmosphere above the Baltic Sea basin and catchment.

Policy relevance and policy reference

The HELCOM Ministerial Declaration of 1988 called for a 50% reduction in discharges of nutrients to air and water by 1995 with 1987 as a base year. The 1992 Helsinki Convention and the 1998 Ministerial Declaration reaffirmed the need to further reduce discharges; leading to the adoption of several relevant Recommendations concerning measures to reduce emissions from point sources and diffuse sources. In 1990 HELCOM adopted its first Recommendation on Monitoring of Airborne Pollution Load (HELCOM Recommendation 11/1), which was later superseded by the Recommendations 14/1 and 24/1.

On the European level the relevant policy to the control of emissions of nitrogen oxides and ammonia to the atmosphere is being taken in the framework of UN ECE Convention on Long-Range Transboundary Air Pollution (CLRTAP) and in the EU NEC Directive. The Executive Body of CLRTAP adopted the Protocol to Abate Acidification, Eutrophication and Ground Level Ozone in Gothenburg (Sweden) on 30 November 1999. The 1999 Protocol set emission ceilings for 2010 for four pollutants: sulphur oxides, nitrogen oxides, ammonia and Volatile Organic Compounds (VOCs). These ceilings were negotiated on the basis of scientific assessments of pollution effects and abatement options. Parties whose emissions had a more severe environmental or health impact and whose emissions were relatively cheap to reduce had to make the biggest cuts. The original 1999 Protocol was amended in 2012 to include national emission reduction commitments to be achieved in 2020 and beyond. Following the revised Gothenburg Protocol, nitrogen oxides emissions in 2020 will be reduced between 18% and 56% in 31 countries, compared to 2005 annual emissions. The largest relative reductions will be in Denmark (56%), United Kingdom (55%) and France (50%). Ammonia emissions will be also reduced in the same 31 countries, but in the lower range 1-24%. The largest relative reductions of ammonia emissions will be in Denmark (24%), Finland (20%) and Sweden (15%).

Assessment

Here we show and discuss nitrogen emission data as used in the EMEP MSC-W model calculations performed in 2017 and presented to the Third Joint session of the Working Group on Effects and the Steering Body to EMEP which took place 11-15 September 2017 in Geneva. The emissions for 2015 have been derived from the 2017 official data submissions to UNECE CLRTAP as of May 2017 The gridded distributions of the 2015 emissions have been provided by the EMEP Centre on Emission Inventories and Projections (CEIP). The emission data reported in 2017 by all HELCOM Contracted Parties except Russia seemed to be complete and plausible. Therefore no gap-filling was performed for these countries. In the case of Russia, the most recent reported data includes only the year 2013 and the gap-filling procedure was necessary

(Tista et al., 2017c). For NOx emissions, national total data was calculated by the extrapolation of TNO data (Kuenen et al. 2014). National totals of ammonia emissions were calculated by extrapolation of reported data. The gridded emission data used in the model calculations this year are available on WebDab at:
http://www.ceip.at/webdab_emepdatabase/emissions_emepmodels

Time series of nitrogen oxides, ammonia and total nitrogen annual emissions in the period 1995 – 2015 are shown, for all HELCOM Contracting Parties, in **Figure 1**. Time series of nitrogen oxides, ammonia and total nitrogen annual emissions for the same period, in percent of 1995 emissions, are shown in **Figure 2**.

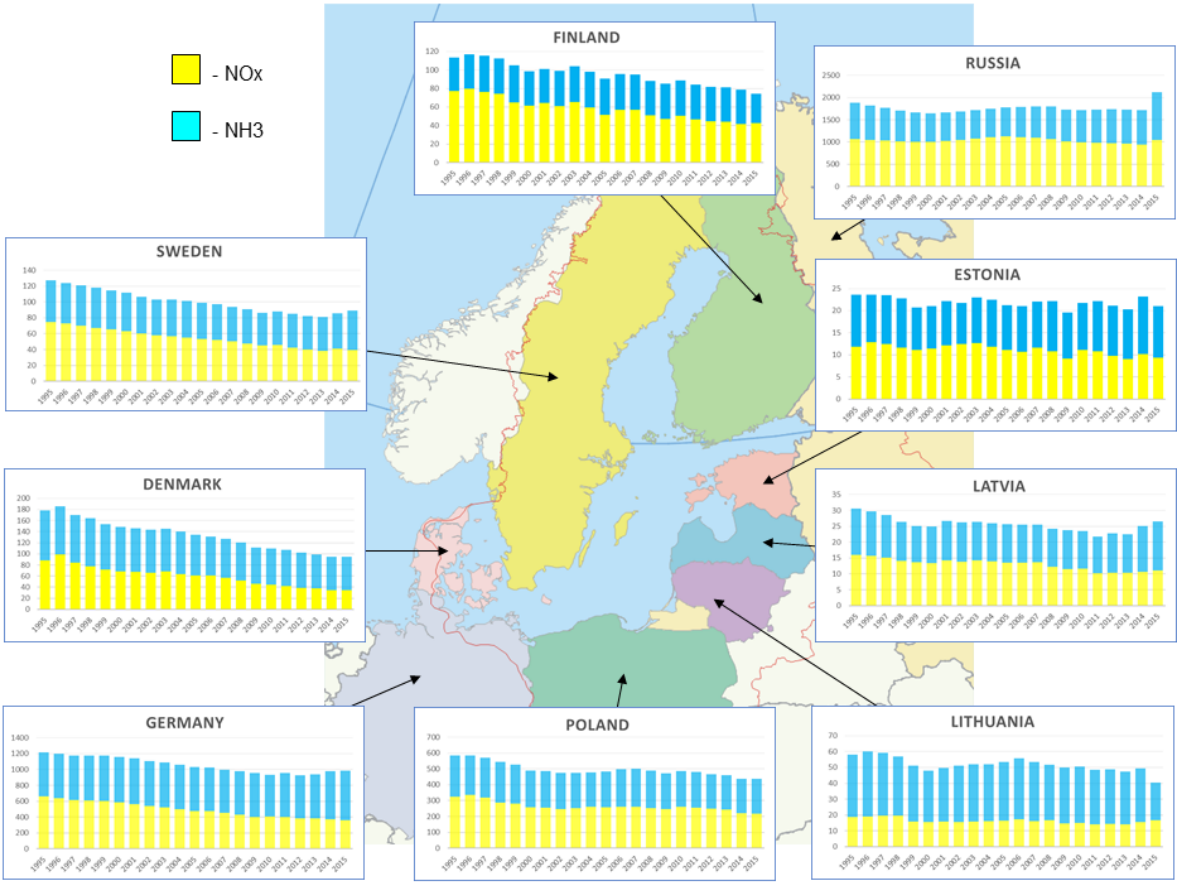

Figure 1. Map of annual atmospheric emissions of nitrogen oxides, ammonia and total nitrogen from individual HELCOM Contracting Parties in the period 1995 – 2015. Units: ktonnes N/yr. **Note**: Different scales have been used for the various countries. The data cover emissions from all countries, except for Russia, where only emissions from the area covered by EMEP are included. These emission data have been used in the EMEP MSC-W model calculations performed in 2017.

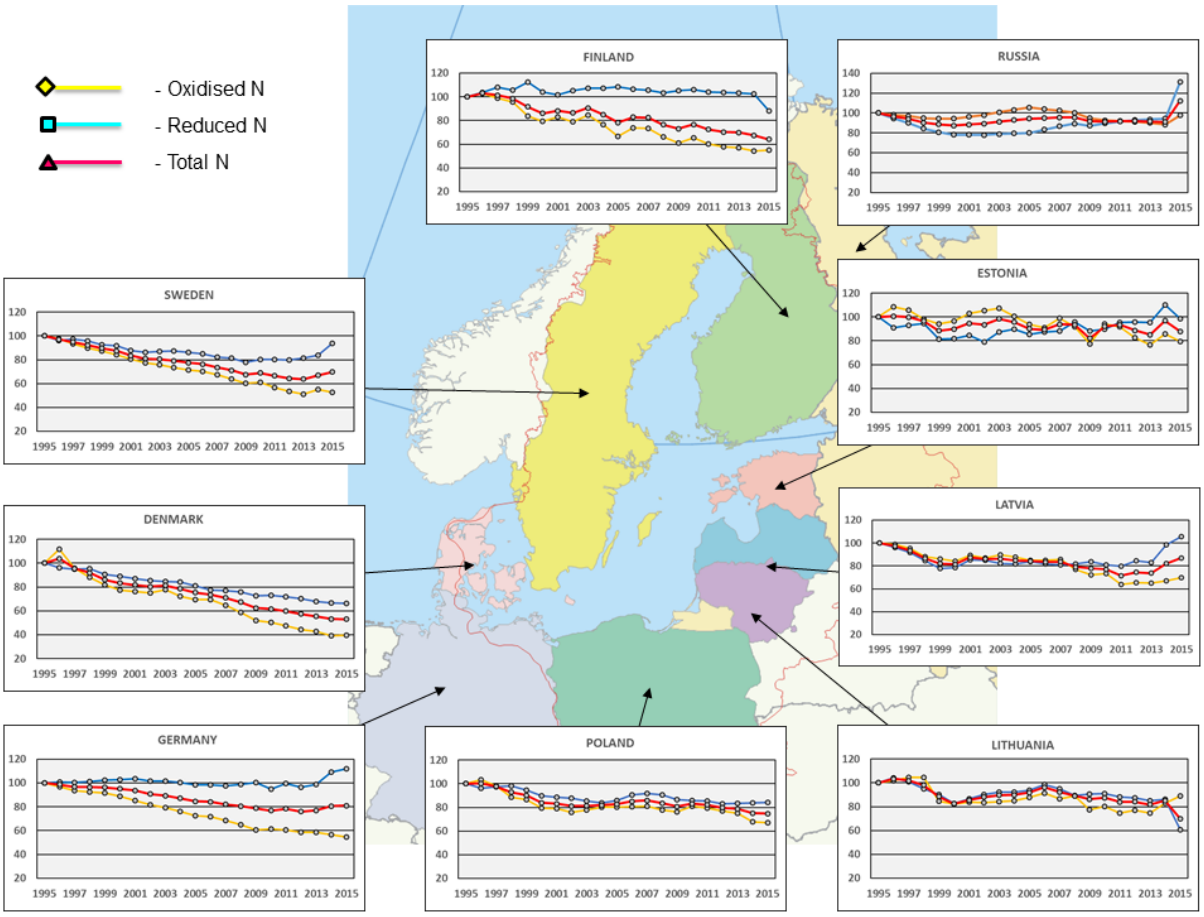

Figure 2. Map of annual atmospheric emissions of nitrogen oxides, ammonia and total nitrogen from individual HELCOM Contracting Parties in the period 1995 – 2015, in percent of 1995 emissions. **Note**: The data cover emissions from all countries, except for Russia, where only emissions from the area covered by EMEP are included. These emission data have been used in the EMEP MSC-W model calculations performed in 2017.

For most of the countries, a decline in nitrogen emissions can be seen in the period 1995 – 2015. An increase can only be noticed for ammonia emissions from Russia, Germany and Latvia. The reduction of emissions from the Baltic Sea region in the years 1995 – 2015 is more significant for nitrogen oxides than for ammonia. Concerning nitrogen oxides emissions from international shipping on the Baltic Sea (not shown here), for the first time this year, MSC-W has used data from the Finnish Meteorological Institute (FMI) in the model calculations. Compared to 2014 emissions, they are 20% higher in 2015, and compared to 1995, ship emissions in 2015 are 24% higher.

In all HELCOM Contracting Parties, nitrogen oxides emissions are 2-60% lower in 2015 than in 1995 with the most significant drop of nitrogen oxides emissions in Denmark (60%) followed by Sweden (47%) and then Germany and Finland (both 45%). Large reductions, in the considered period, can also be noticed in Poland (33%) and Latvia (30%), smaller in Estonia (21%) and Lithuania (11%). In Russia nitrogen oxides emissions are 2% lower in 2015 than in 1995.

For ammonia, emissions in six out of nine HELCOM Contracting Parties are lower in 2015 than in 1995, with the largest reduction in Lithuania (39%), followed by Denmark (34%), Poland (16%), Finland (12%), Sweden (6%) and Estonia (2%). Compared to 1995, ammonia emissions in 2015 are higher in Russia (31%), Germany (12%) and Latvia (6%).

In all HELCOM Contracting Parties except Russia the reductions of total nitrogen emissions can be observed in the period 1995 – 2015, ranging from 12% in Estonia to 47% in Denmark. In Russia emissions of total nitrogen increased by 12% between 1995 and 2015.

Data

Table 1. National total emissions of nitrogen oxides from individual HELCOM Contracting Parties in the period 1995 – 2015. Units: kt N/yr. Emission data as used in the EMEP MSC-W model calculations performed in 2017.

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	HELCOM
1995	88.1	11.8	77.4	659.5	15.9	18.8	323.6	1069.1	74.7	2339.0
1996	98.6	12.8	79.7	637.7	15.7	19.2	335.0	1048.9	73.1	2320.7
1997	84.5	12.5	76.5	617.6	15.2	19.6	317.6	1036.4	69.8	2249.6
1998	77.8	11.6	74.1	610.4	14.1	19.7	287.0	1014.1	67.1	2175.9
1999	72.1	11.1	64.8	603.0	13.7	15.9	280.2	1008.6	65.4	2134.8
2000	68.3	11.4	61.3	586.0	13.4	15.4	256.9	1009.1	63.1	2084.8
2001	67.3	12.1	64.3	562.4	14.2	15.8	255.3	1028.3	60.1	2079.9
2002	66.1	12.4	61.2	538.7	13.8	15.7	245.4	1047.4	57.8	2058.5
2003	68.7	12.7	65.3	522.0	14.3	15.8	252.1	1078.2	56.7	2085.8
2004	63.9	11.9	59.3	501.7	14.0	16.0	260.1	1103.1	54.8	2084.7
2005	61.3	11.1	51.6	478.8	13.5	16.5	259.0	1127.3	53.4	2072.6
2006	61.2	10.7	57.1	473.9	13.5	17.2	260.4	1109.5	52.4	2056.0
2007	57.0	11.7	56.8	451.5	13.7	16.3	261.9	1094.0	50.4	2013.3
2008	51.8	10.8	51.1	429.4	12.2	16.8	252.4	1071.8	47.8	1944.0
2009	45.8	9.1	47.1	398.7	11.5	14.6	246.2	1014.6	45.0	1832.6
2010	44.2	11.1	50.7	405.9	11.7	15.1	261.9	990.1	45.5	1836.3
2011	42.0	10.8	46.7	398.9	10.2	14.0	256.4	983.5	42.4	1805.0
2012	39.0	9.8	44.6	386.6	10.4	14.5	249.3	975.1	40.0	1769.2
2013	37.7	9.0	44.1	386.3	10.4	14.1	242.9	961.0	38.3	1743.8
2014	34.5	10.1	41.8	372.6	10.7	15.6	220.1	945.0	41.1	1691.6
2015	34.8	9.4	42.5	361.4	11.1	16.7	217.2	1045.2	39.4	1777.9

Table 2. National total emissions of ammonia from individual HELCOM Contracting Parties in the period 1995 – 2015. Units: kt N/yr. Emission data as used in the EMEP MSC-W model calculations performed in 2017.

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	HELCOM
1995	90.4	9.8	29.7	558.7	14.6	39.1	260.6	816.6	52.9	1872.3
1996	86.9	8.9	30.7	563.8	14.0	40.8	250.7	771.9	50.8	1818.5
1997	85.9	9.1	32.0	560.1	13.4	39.5	253.3	735.6	51.4	1780.3
1998	86.1	9.2	31.4	565.7	12.4	37.2	255.9	688.2	50.7	1736.9
1999	81.8	7.9	33.4	570.8	11.3	35.3	246.9	659.7	49.0	1696.1
2000	80.5	8.0	30.9	573.1	11.5	32.4	233.6	637.8	48.5	1656.2
2001	78.6	8.2	30.2	579.3	12.5	33.8	230.7	637.1	46.5	1656.9
2002	77.2	7.7	31.3	566.7	12.4	35.4	228.5	636.3	45.5	1641.0
2003	76.5	8.5	31.8	566.8	12.0	36.2	223.1	642.6	46.1	1643.7
2004	76.3	8.8	31.8	559.9	12.0	36.1	218.6	648.3	46.2	1637.9
2005	73.1	8.3	32.2	550.0	12.2	36.8	223.7	653.2	45.6	1635.2
2006	70.0	8.5	31.6	550.4	12.0	38.6	236.3	679.5	45.0	1671.9
2007	69.7	8.6	31.4	546.0	11.8	37.2	239.5	708.5	43.5	1696.3
2008	68.7	9.3	30.7	550.9	11.9	34.9	235.8	729.9	43.0	1715.1
2009	65.7	8.6	31.2	560.1	12.3	35.5	225.7	712.2	41.3	1692.5
2010	65.9	8.8	31.5	529.2	11.9	35.6	223.6	731.1	42.5	1679.9
2011	64.9	9.3	30.8	555.7	11.6	34.6	222.8	745.8	42.5	1718.2
2012	63.5	9.3	30.7	539.4	12.3	34.2	216.2	758.6	42.2	1706.4
2013	61.2	9.3	30.7	552.5	12.1	33.3	216.9	765.0	43.0	1724.0
2014	60.4	10.7	30.4	609.2	14.4	33.7	218.3	769.3	44.4	1790.9
2015	59.9	9.6	26.2	625.3	15.4	23.8	220.0	1070.4	49.7	2100.2

Table 3. National total emissions of total nitrogen from individual HELCOM Contracting Parties in the period 1995 – 2015. Units: kt N/yr. Emission data as used in the EMEP MSC-W model calculations performed in 2017.

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	HELCOM
1995	178.5	21.6	107.1	1218.2	30.5	58.0	584.2	1885.7	127.6	4211.3
1996	185.5	21.7	110.5	1201.5	29.8	60.0	585.7	1820.8	123.9	4139.2
1997	170.4	21.5	108.5	1177.7	28.6	59.1	570.9	1772.0	121.2	4029.9
1998	163.9	20.8	105.5	1176.1	26.4	56.9	542.9	1702.3	117.8	3912.7
1999	153.9	19.1	98.1	1173.7	25.0	51.3	527.1	1668.3	114.4	3830.9
2000	148.8	19.4	92.2	1159.1	24.9	47.8	490.5	1646.8	111.6	3741.0
2001	145.9	20.4	94.5	1141.7	26.7	49.6	486.0	1665.4	106.6	3736.8
2002	143.3	20.1	92.4	1105.4	26.3	51.1	473.9	1683.6	103.3	3699.5
2003	145.3	21.2	97.1	1088.8	26.3	52.0	475.2	1720.9	102.8	3729.5
2004	140.1	20.6	91.1	1061.6	25.9	52.1	478.8	1751.4	101.0	3722.7
2005	134.5	19.4	83.8	1028.8	25.7	53.3	482.7	1780.5	99.1	3707.8
2006	131.3	19.2	88.7	1024.3	25.5	55.8	496.7	1789.0	97.4	3727.9
2007	126.7	20.2	88.2	997.5	25.5	53.5	501.5	1802.5	93.9	3709.6
2008	120.4	20.1	81.8	980.3	24.2	51.7	488.2	1801.7	90.7	3659.1
2009	111.5	17.7	78.3	958.8	23.8	50.1	471.9	1726.8	86.2	3525.1
2010	110.1	19.9	82.2	935.1	23.5	50.7	485.5	1721.2	88.1	3516.2
2011	106.9	20.1	77.6	954.7	21.8	48.6	479.2	1729.3	84.9	3523.2
2012	102.5	19.1	75.3	925.9	22.7	48.7	465.5	1733.7	82.2	3475.7
2013	98.9	18.4	74.8	938.7	22.5	47.3	459.9	1726.0	81.3	3467.7
2014	94.9	20.9	72.2	981.8	25.0	49.4	438.4	1714.3	85.5	3482.4
2015	94.8	18.9	68.7	986.7	26.6	40.5	437.2	2115.6	89.1	3878.1

Meta data

Technical information

1. Source: EMEP Centre on Emission Inventories and Projections (CEIP).

2. Description of data: The gridded distributions of the 2015 emissions have been provided by CEIP. The emissions for 2015 have been derived from the 2017 official data submissions to UNECE CLRTAP as of May 2017. The gridded distributions of the 2015 emissions have been provided by the EMEP Centre on Emission Inventories and Projections (CEIP).

3. Geographical coverage: EMEP domain covering Europe, a part of Asia and a part of Atlantic Ocean.

4. Temporal coverage: Data on nitrogen oxides and ammonia emissions are presented here for the period 1995 - 2015.

5. Methodology and frequency of data collection: National data on emissions are annually submitted by countries Parties to CLRTAP Convention to the UN ECE Secretariat; the methodology is based on combination of emission measurements and emission estimates based on activity data and emission factors. Submitted data are passing through QA/QC procedure and stored in the the EMEP Centre for Emission inventories and Projections CEIP in Vienna, Austria.

Quality information

6. Strength and weakness: Strength: data on emissions are annually submitted, checked and stored in the database; Weakness: gaps in time series of national emissions which have to be corrected by experts. Delays 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, however in general the emission data calculated in the gap-filling procedure are less certain than those submitted by the countries.

8. Further work required: Further work on emission uncertainty is required.

References

Kuenen J.J.P., Visschedijk A.J.H., Jozwicka M., Denier van der Gon H.A.C. 2014: TNO-MACC_II emission inventory; A multi-year (2003-2009) consistent high-resolution European emission inventory for air quality modelling. Supplementary material. Atmos. Chem. Phys. 14, 1096310976. http://www.atmos-chem-phys.net/14/10963/2014/

Tista, M., Wankmueller, R., and K. Mareckova (2017c) Methodologies applied to the CEIP GNFR gap-filling 2017. Part III: Main pollutants and Particulate Matter (NOx, NMVOCs, SOx, NH3, CO, PM2.5, PM10, PMcoarse). Technical report CEIP 03-3/2017.

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