Nitrogen emissions to the air in the Baltic Sea area

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Key Message

In all HELCOM Contracting Parties, oxidized nitrogen emissions were lower in 2016 than in 1995, with the most significant reductions in Denmark (60%), followed by Finland (48%), Sweden (47%) and Germany (44%). For all HELCOM Contracting Parties except Russia, reductions of *total* nitrogen emissions are reported for the period 1995 – 2016, ranging from 11% in Estonia to 46% in Denmark. Total nitrogen emissions from Russia increased only by 3% from 1995 to 2016. For ammonia (reduced nitrogen), annual emissions increased in only two out of nine HELCOM Contracting Parties in the period 1995-2016. These are: Russia (+21%) and Estonia (+1%). In the remaining countries a decline of ammonia emissions can be noticed, with the most significant declines in Denmark (32%) and Lithuania (28%).

Results and Assessment

Relevance of the BSEFS for describing 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 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 air-borne nitrogen input to the Baltic Sea. In particular, the Declaration welcomes the new targets on Maximum Allowed Inputs (based on revised harmonized eutrophication status targets) and agrees on revised Country Allocated Reduction Targets (CARTs), covering both pollution from land and airborne, which substitute the provisional country-wise nutrient reduction requirements of the Baltic Sea Action Plan.

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 by 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 also be reduced in the same 31 countries, but by smaller percentages, 1-24%. The largest relative reductions of ammonia emissions will be in Denmark (24%), Finland (20%) and Sweden (15%). In the European Union, the revised Gothenburg Protocol is implemented by the new EU NEC Directive 2016/2284/EU which sets 2020 and 2030 emission reduction commitments for five main air pollutants, including nitrogen oxides and ammonia.

Assessment

Here we show and discuss nitrogen emission data as used in the EMEP MSC-W model calculations performed in 2018 and presented to the Fourth Joint session of the Working Group on Effects and the Steering Body to EMEP which took place 10-14 September 2018 in Geneva. The emissions for 2016 have been derived from the 2018 official data submissions to UNECE CLRTAP as of May 2018. The gridded distributions of the 2016 emissions have been provided by the EMEP Centre on Emission Inventories and Projections (CEIP). The emission data reported in 2018 by all HELCOM Contracted Parties except Russia appeared 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 a gap-filling procedure was necessary (Tista et al., 2017). 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 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 – 2016 are shown for all HELCOM Contracting Parties in **Figure 1**. Time series of nitrogen oxides, ammonia and total nitrogen annual emissions, as percentage of 1995 emissions, are shown for the same period in **Figure 2**.

For most of the countries, a decline in nitrogen emissions can be seen in the period 1995 – 2016. An increase can only be noticed for ammonia emissions from Russia (+21%) and Estonia (+1%). The reduction of emissions from the Baltic Sea region in the years 1995 – 2016 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 second time this year, MSC-W has used data from the Finnish Meteorological Institute (FMI) in the model calculations. The data are valid for 2015, as emission data for 2016 were not available in time for the model calculations. For historical shipping emissions (2000-2014) the FMI data were scaled based on trends developed within the EU Horizon2020 project MACC-III (MACC-III, 2015) and the ICCT Report (Olmer et al. 2017). Ship emissions data for 1995-1999 have not been revised by CEIP recently, so these remained unchanged with respect to earlier HELCOM and EMEP status reports.

In all HELCOM Contracting Parties, nitrogen oxides emissions are 2-60% lower in 2016 than in 1995 with the most significant reductions in Denmark (60%) followed by Finland (48%), Sweden (47%), and Germany (44%). Large reductions, in the considered period, can also be noticed in Latvia (33%) and Poland (32%), Estonia (20%), Lithuania (13%) and Russia (10%)

For ammonia, emissions in seven out of nine HELCOM Contracting Parties are lower in 2016 than in 1995, with the largest reductions in Denmark (32%), followed by Lithuania (28%), Sweden (17%), Poland (16%), Finland (14%), Latvia (10%) and Germany (2%). Compared to 1995, ammonia emissions in 2016 are higher in Russia (21%) and slightly higher in Estonia (1%).

In all HELCOM Contracting Parties except Russia reductions of total nitrogen emissions are reported for the period 1995 – 2016, ranging from 10% in Estonia to 46% in Denmark. In Russia, emissions of total nitrogen increased by 3% between 1995 and 2016.

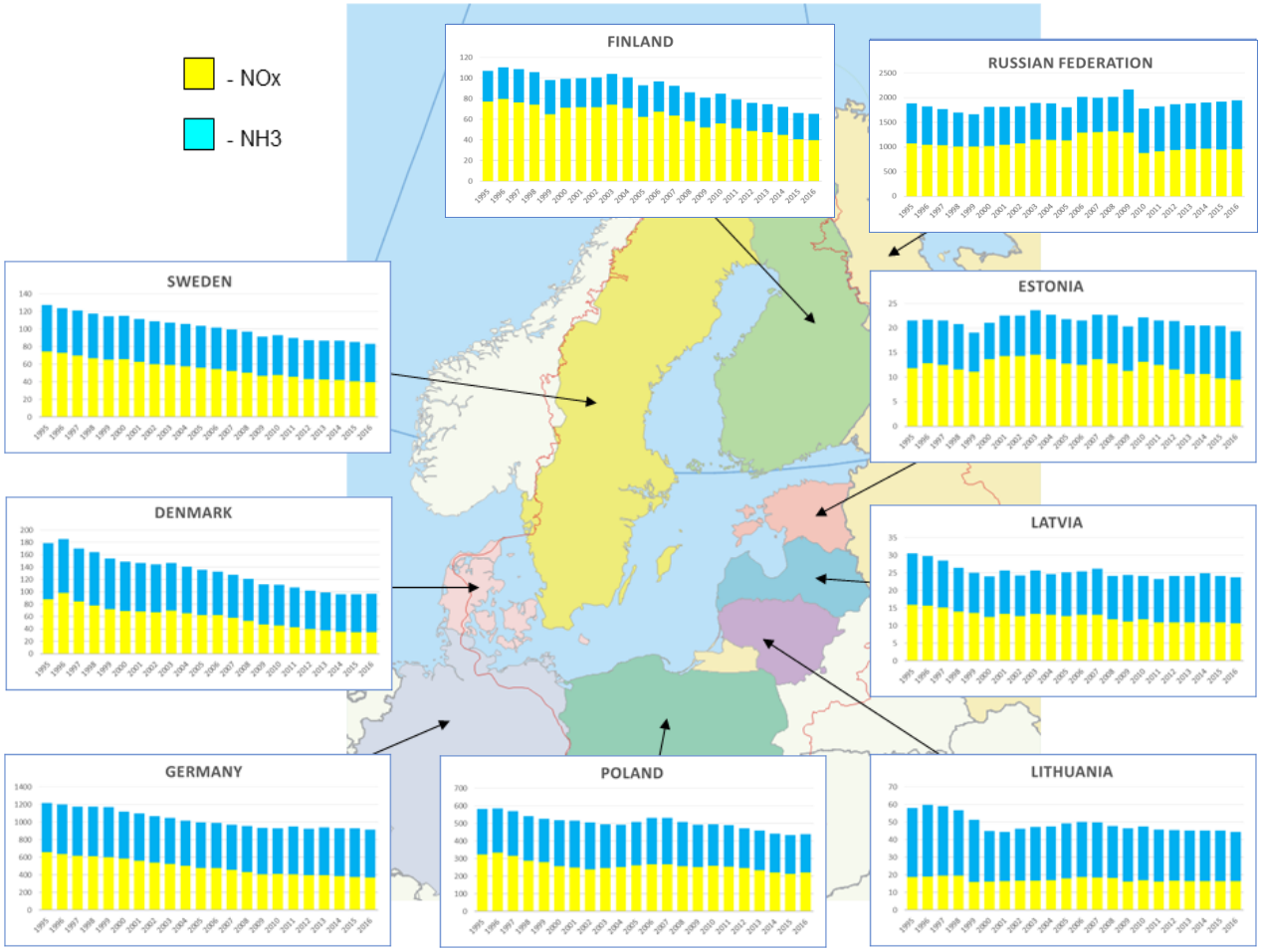

Figure 1. Map of annual atmospheric emissions of nitrogen oxides, ammonia and total nitrogen from individual HELCOM Contracting Parties in the period 1995 – 2016. Units: ktonnes N/yr. **Note**: Different scales have been used for the various countries. The data cover emissions from all countries, except 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 2018.

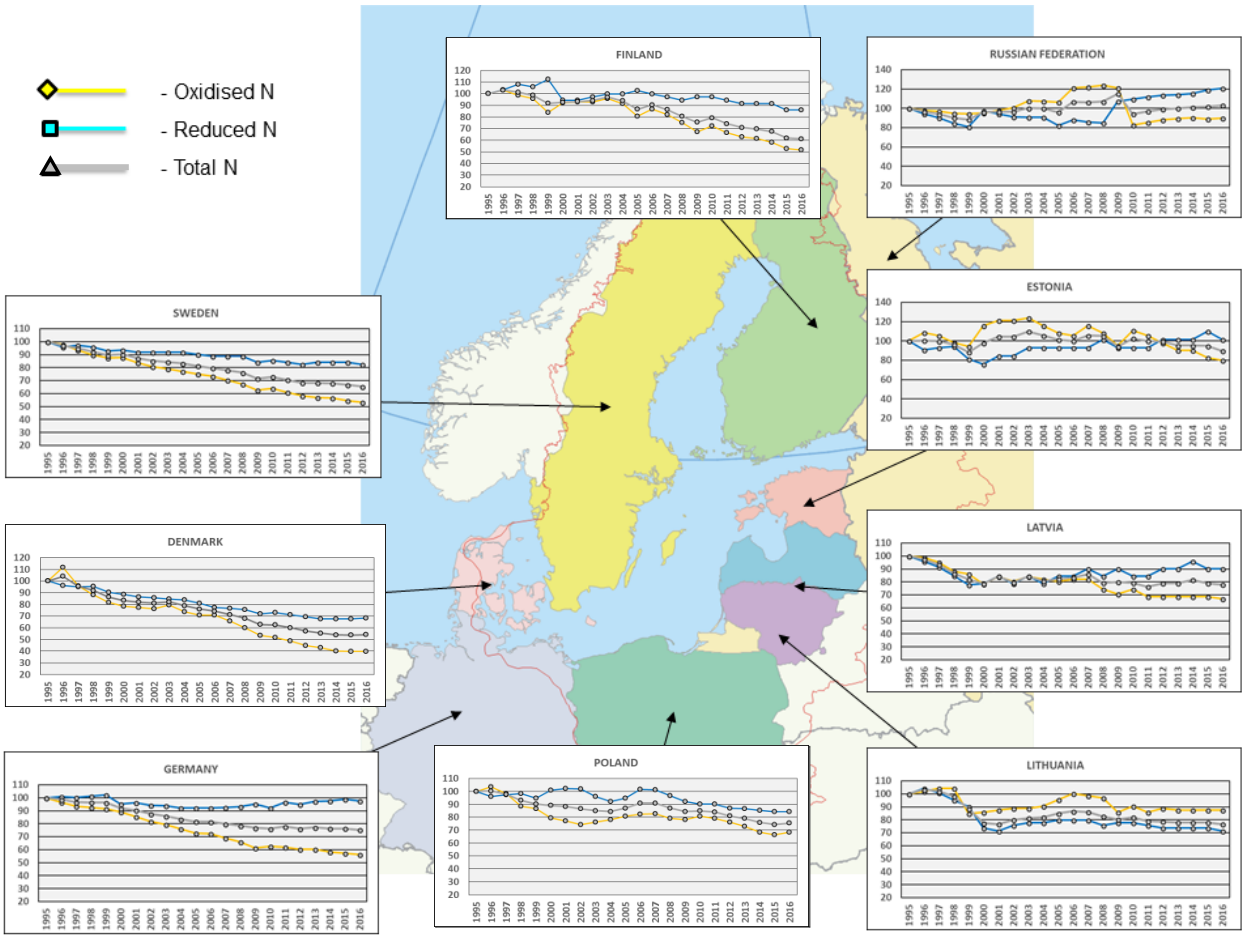

Figure 2. Map of annual atmospheric emissions of nitrogen oxides, ammonia and total nitrogen from individual HELCOM Contracting Parties in the period 1995 – 2016, as percentage of 1995 emissions. **Note**: The data cover emissions from all countries, except for Russia, where only emissions from the area covered by EMEP are included. These emission data have been used in the EMEP MSC-W model calculations performed in 2018.

References

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Data

Table 1. National total emissions of nitrogen oxides from individual HELCOM Contracting Parties (and international shipping) in the period 1995 – 2016. Units: ktonnes N/yr. Emission data as used in the EMEP MSC-W model calculations performed in 2018. "Shipping" means emissions from International Shipping on the Baltic Sea.

Year	DK	EE	FI	DE	LV	LT	PL	RU	SE	HELCOM	Shipping
1995	88.1	11.8	77.4	660	15.9	18.8	324	1069	74.7	2375	79
1996	98.6	12.8	79.7	638	15.7	19.2	335	1049	73.1	2357	80
1997	84.5	12.5	76.5	618	15.2	19.6	318	1036	69.8	2284	82
1998	77.8	11.6	74.1	610	14.1	19.7	287	1014	67.1	2208	84
1999	72.1	11.1	64.8	603	13.7	15.9	280	1009	65.4	2166	85
2000	69.1	13.7	71.2	587	12.5	16.1	258	1019	65.7	2141	107
2001	68.2	14.3	71.8	563	13.4	16.4	250	1048	62.7	2138	109
2002	67.3	14.3	71.8	540	12.8	16.7	240	1076	60.3	2129	111
2003	70.0	14.6	74.3	523	13.4	16.7	246	1152	59.0	2200	113
2004	65.1	13.7	70.9	503	13.1	17.0	253	1147	57.5	2170	115
2005	62.4	12.8	62.4	480	12.8	18.0	261	1136	56.0	2130	117
2006	62.4	12.5	67.3	477	13.1	18.9	267	1297	54.8	2299	114
2007	58.1	13.7	63.6	456	13.1	18.6	267	1305	52.7	2278	106
2008	53.0	12.8	58.1	434	11.9	18.3	256	1323	50.2	2245	103
2009	47.2	11.3	52.0	405	11.3	16.1	253	1295	46.9	2163	101
2010	45.7	13.1	56.0	413	11.9	17.0	261	882	47.8	1774	101
2011	42.9	12.5	51.4	408	11.0	16.1	256	913	45.7	1782	103
2012	39.6	11.6	48.7	397	11.0	16.7	247	942	43.5	1781	96
2013	38.0	10.7	47.5	397	11.0	16.4	236	958	42.6	1781	93
2014	35.3	10.7	45.0	385	11.0	16.4	221	964	42.3	1756	93
2015	35.0	9.74	40.8	378	11.0	16.4	215	951	40.8	1722	78
2016	35.0	9.43	39.9	371	10.7	16.4	221	960	39.9	1727	78

Table 2. National total emissions of ammonia from individual HELCOM Contracting Parties in the period 1995 – 2016. Units: ktonnes N/yr. Emission data as used in the EMEP MSC-W model calculations performed in 2018.

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	HELCOM
1995	90.4	9.75	29.7	559	14.6	39.1	261	817	52.9	1872
1996	86.9	8.85	30.7	564	14.0	40.8	251	772	50.8	1818
1997	85.9	9.05	32.0	560	13.4	39.5	253	736	51.4	1780
1998	86.1	9.20	31.4	566	12.4	37.2	256	688	50.7	1737
1999	81.8	7.93	33.4	571	11.3	35.3	247	660	49.0	1696
2000	79.9	7.41	28.0	533	11.5	28.8	263	796	49.4	1796
2001	78.2	8.24	28.0	538	12.4	28.0	266	770	48.6	1777
2002	77.4	8.24	28.8	527	11.5	29.6	265	745	48.6	1741
2003	76.6	9.06	29.6	525	12.4	30.5	250	740	48.6	1721
2004	75.8	9.06	29.6	516	11.5	30.5	241	741	48.6	1702
2005	73.3	9.06	30.5	515	12.4	31.3	247	673	47.8	1639
2006	70.0	9.06	29.6	516	12.4	31.3	264	718	46.9	1697
2007	69.2	9.06	28.8	517	13.2	31.3	264	699	46.9	1678
2008	68.4	9.88	28.0	521	12.4	29.6	252	693	46.9	1661
2009	65.1	9.06	28.8	532	13.2	30.5	241	878	44.5	1841
2010	65.9	9.06	28.8	516	12.4	30.5	235	896	45.3	1838
2011	64.2	9.06	28.0	540	12.4	29.6	235	913	44.5	1875
2012	62.6	9.88	27.2	530	13.2	28.8	227	928	43.6	1870
2013	60.9	9.88	27.2	544	13.2	28.8	226	931	44.5	1884
2014	60.9	9.88	27.2	545	14.0	28.8	222	943	44.5	1896
2015	60.9	10.7	25.5	552	13.2	28.8	220	970	44.5	1925
2016	61.8	9.88	25.5	546	13.2	28.0	220	985	43.6	1933

Table 3. National total emissions of total nitrogen from individual HELCOM Contracting Parties in the period 1995 – 2016. Units: ktonnes N/yr. Emission data as used in the EMEP MSC-W model calculations performed in 2018.

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	HELCOM
1995	179	21.6	107	1218	30.5	58.0	584	1886	128	4248
1996	186	21.7	111	1202	29.8	60.0	586	1821	124	4175
1997	170	21.5	109	1178	28.6	59.1	571	1772	121	4065
1998	164	20.8	106	1176	26.4	56.9	543	1702	118	3945
1999	154	19.1	98.1	1174	25.0	51.3	527	1668	114	3862
2000	149	21.1	99.2	1120	24.0	45.0	520	1814	115	3937
2001	146	22.5	99.8	1101	25.7	44.4	516	1818	111	3915
2002	145	22.5	101	1067	24.3	46.4	506	1821	109	3870
2003	147	23.7	104	1048	25.7	47.2	497	1892	108	3921
2004	141	22.8	101	1018	24.6	47.5	493	1888	106	3872
2005	136	21.8	92.9	995	25.1	49.3	509	1808	104	3769
2006	132	21.5	96.9	993	25.4	50.2	531	2015	102	3997
2007	127	22.8	92.4	973	26.3	49.9	531	2004	99.6	3957
2008	121	22.7	86.1	956	24.2	47.9	508	2016	97.2	3906
2009	112	20.3	80.9	937	24.4	46.6	493	2173	91.3	4004
2010	112	22.1	84.8	929	24.2	47.5	496	1778	93.1	3613
2011	107	21.5	79.4	949	23.3	45.8	491	1825	90.1	3657
2012	102	21.4	75.9	927	24.1	45.6	473	1870	87.2	3651
2013	99.0	20.5	74.7	940	24.1	45.3	461	1888	87.1	3665
2014	96.2	20.5	72.2	930	25.0	45.3	443	1907	86.8	3651
2015	95.9	20.4	66.3	930	24.1	45.3	434	1921	85.3	3648
2016	96.8	19.3	65.4	917	23.8	44.4	441	1945	83.5	3660

Metadata

Technical information

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

2. Description of data: The gridded distributions of the 2016 emissions have been provided by the EMEP Centre on Emission Inventories and Projections (CEIP). The emissions for 2016 have been derived from the 2018 official data submissions to UNECE CLRTAP as of May 2018.

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 - 2016.

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 stored in 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 database; Weakness: 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. 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.