

Atmospheric emissions of Heavy Metals in the Baltic Sea region

HELCOM Baltic Sea Environment Fact Sheet (BSEFS), 2020

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Key Message

Annual atmospheric cadmium and mercury emissions of the HELCOM Contracting Parties have decreased by 49% and 62% during the period from 1990 to 2018, although the decreasing mainly occurred during the first half of the assessment period.

Results and Assessment

Relevance of the BSEFS for describing developments in the environment

This BSEFS shows the levels and trends in cadmium and mercury emissions from anthropogenic sources of the HELCOM Contracting Parties, and other sources in the calculations of the deposition on the Baltic Sea (cf. BSEFS “Atmospheric deposition of heavy metals on the Baltic Sea”).

Policy relevance and policy reference

The Baltic Sea Action Plan states the ecological objectives that concentrations of hazardous substances in the environment are to be close to background values for naturally occurring substances. HELCOM Recommendation 31E/1 identifies the list of regional priority substances for the Baltic Sea.

The relevant policy to the control of emissions of heavy metals to the atmosphere on European scale is set in the framework of UN ECE Convention on Long-Range Transboundary Air Pollution (CLRTAP). The CLRTAP Protocol on Heavy Metals (1998) targets three particularly harmful metals: cadmium, lead and mercury. According to one of the basic obligations emissions of these three metals must be reduced below the emission levels in 1990. The Protocol entered into force in 2003 and was signed and/or ratified by 41 countries. In addition, specific requirements and measures on reduction of mercury emissions are given in the UNEP 2013 Minamata Convention.

For EU member states the policy frame is set by the EU IED Directive, whereas for the Russian Federation the corresponding policy framework is embraced by the Russian Federal Act on the environmental protection and the Act on protection of atmospheric air.

Assessment

Annual emissions of heavy metals from the HELCOM Contracting Parties have decreased during the period 1990-2018 by 49% for cadmium and 62% for mercury (Figure 1). The most significant drop of cadmium emissions noted for Finland (87%), Estonia (82%) and Sweden (79%). Mercury emission most significantly declined in Denmark (91%), Germany (77%) and Sweden (74%).

The reduction in heavy metal emission to the atmosphere is a consequence of increased use of cleaner production technologies as well as of industrial restructuring in some of the HELCOM Contracting Parties in early 1990s.

In 2018 total annual emissions of the HELCOM Contracting Parties amounted to 92 and 31 tonnes of cadmium and mercury, respectively. The largest contributions to total annual cadmium and mercury emissions was made by Germany, Poland and Russia.

Time-series of annual total cadmium and mercury emissions of the HELCOM Contracting Parties are shown in Figures 2, 3. The diagrams also present the fractions of emissions deposited to the Baltic Sea. The largest fractions belong to Denmark and Sweden (about 20% for cadmium and 10% for mercury), while the lowest one to Russia (about 0.5%).

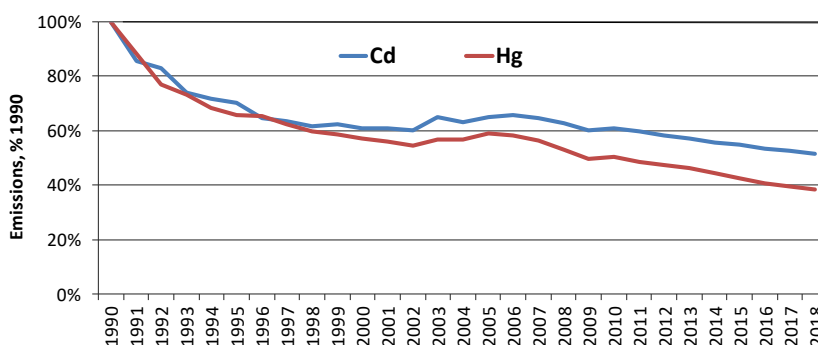


Figure 1. Relative changes of total annual emissions of cadmium and mercury to the atmosphere from HELCOM Contracting Parties in period 1990-2018 (% of 1990).

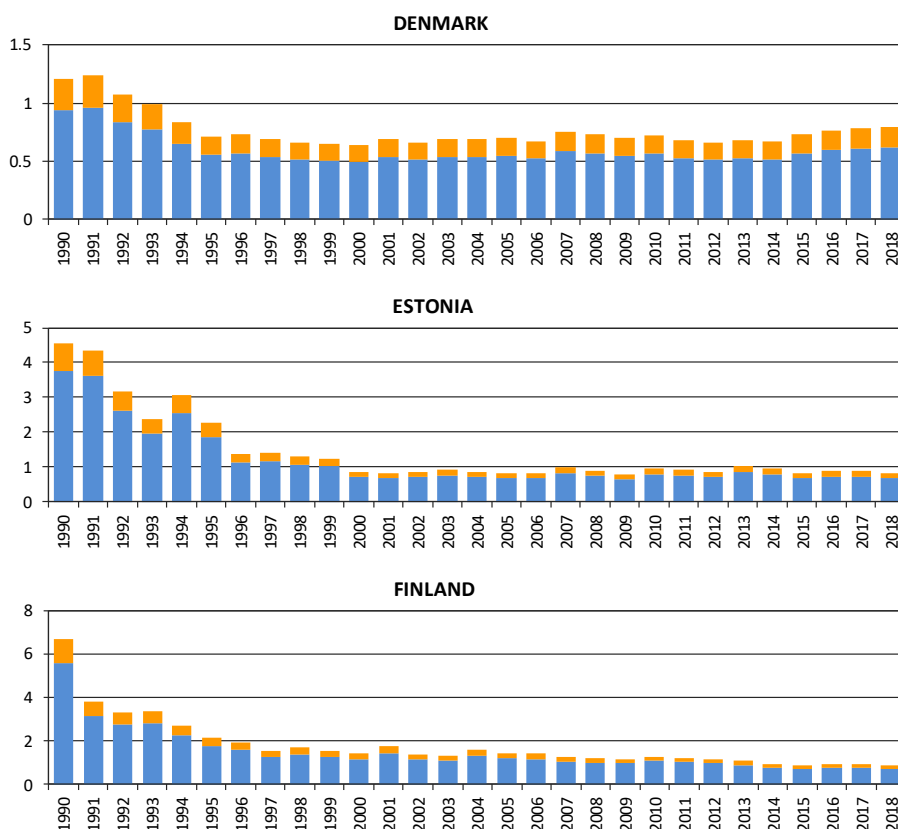


Figure 2. Cadmium emissions of HELCOM Contracting Parties (CP) to air as totals in tonnes/year for the period 1990-2018. Orange sections of the bars identify the fraction of emission deposited to the Baltic Sea. Green bars indicate expert estimates. The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

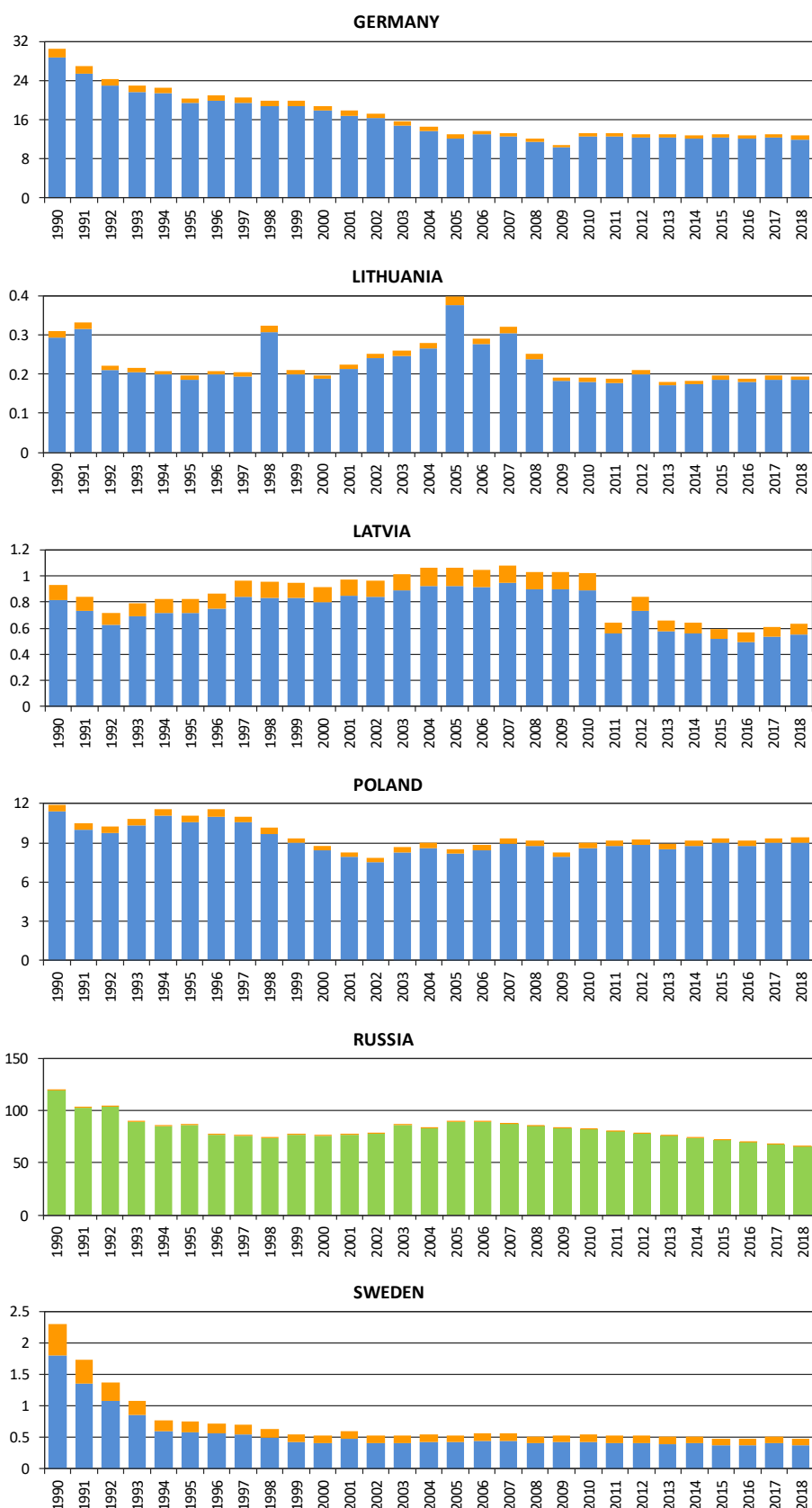


Figure 2. (continued) Cadmium emissions of HELCOM Contracting Parties (CP) to air as totals in tonnes/year for the period 1990-2018. Orange sections of the bars identify the fraction of emission deposited to the Baltic Sea. Green bars indicate expert estimates. The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

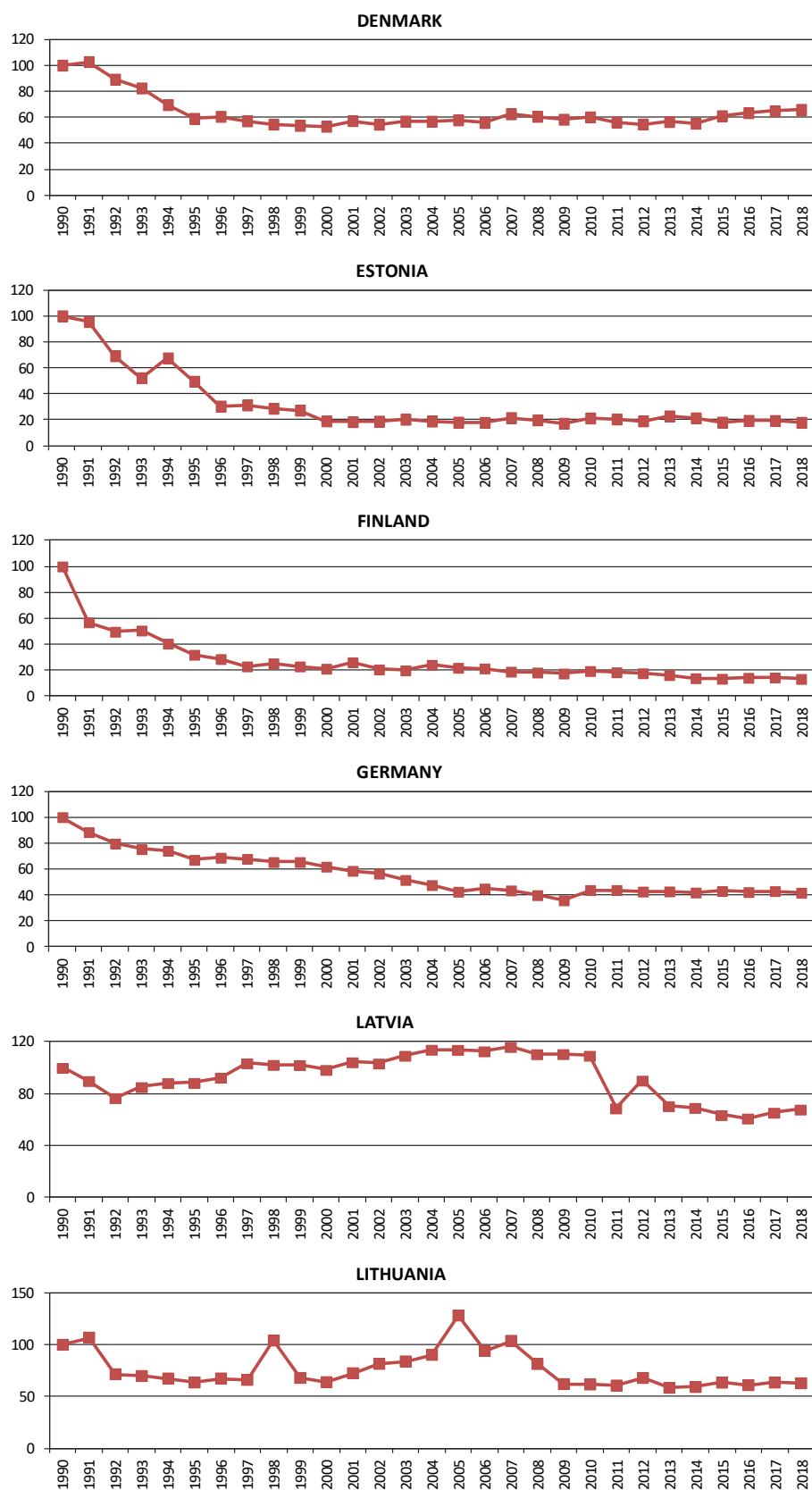


Figure 3. Trends in annual atmospheric emissions of cadmium from HELCOM Contracting Parties from 1990 to 2018, plotted as percentage of the 1990 value. Unit: %. The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

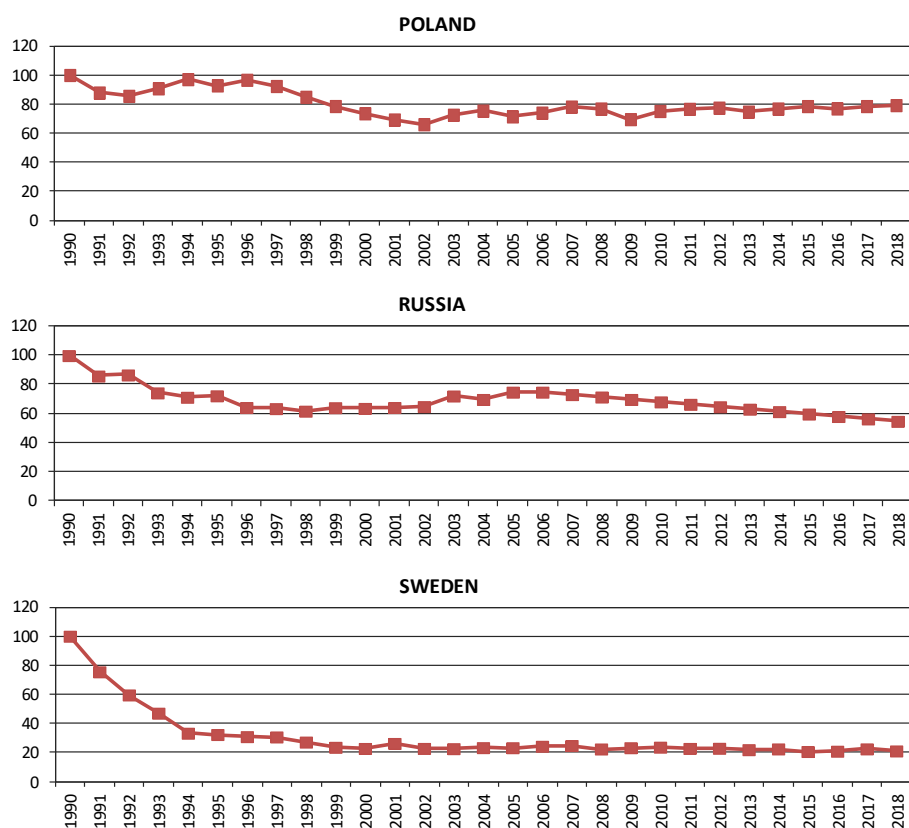


Figure 3. (continued) Trends in annual atmospheric emissions of cadmium from HELCOM Contracting Parties from 1990 to 2018, plotted as percentage of the 1990 value. Unit: %. The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

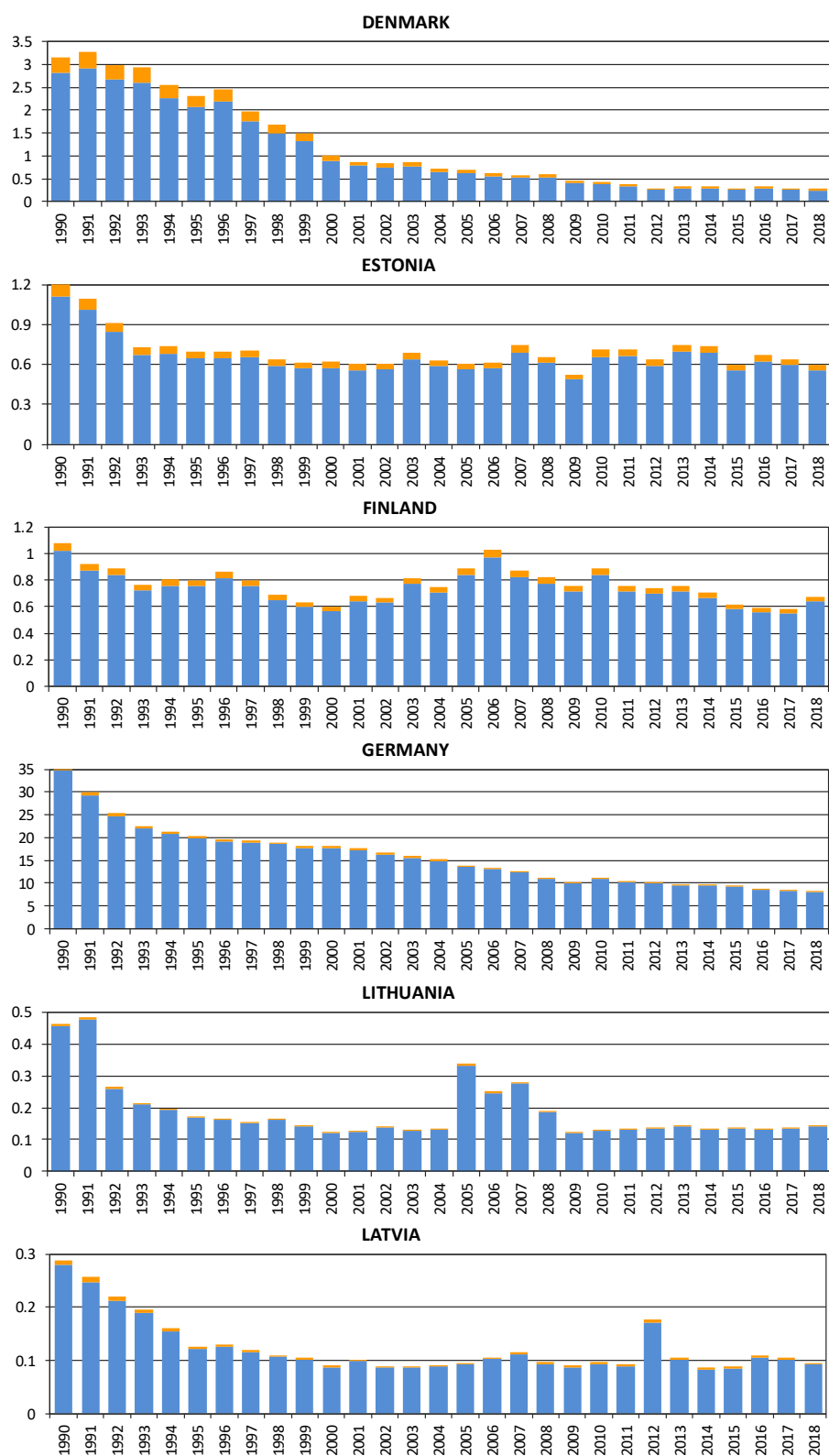


Figure 4. Mercury emissions of HELCOM Contracting Parties (CP) to air as totals in tonnes/year for the period 1990-2018. Orange sections of the bars identify the fraction of emission deposited to the Baltic Sea. Green bars indicate expert estimates. The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

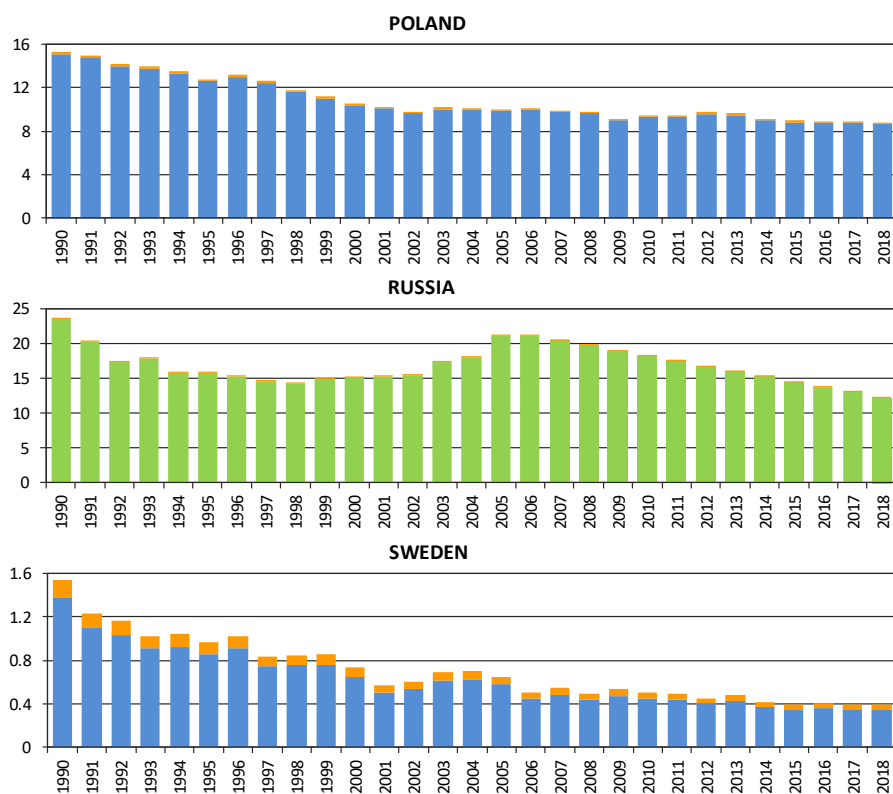


Figure 4. (continued) Mercury emissions of HELCOM Contracting Parties (CP) to air as totals in tonnes/year for the period 1990-2018. Orange sections of the bars identify the fraction of emission deposited to the Baltic Sea. Green bars indicate expert estimates. The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

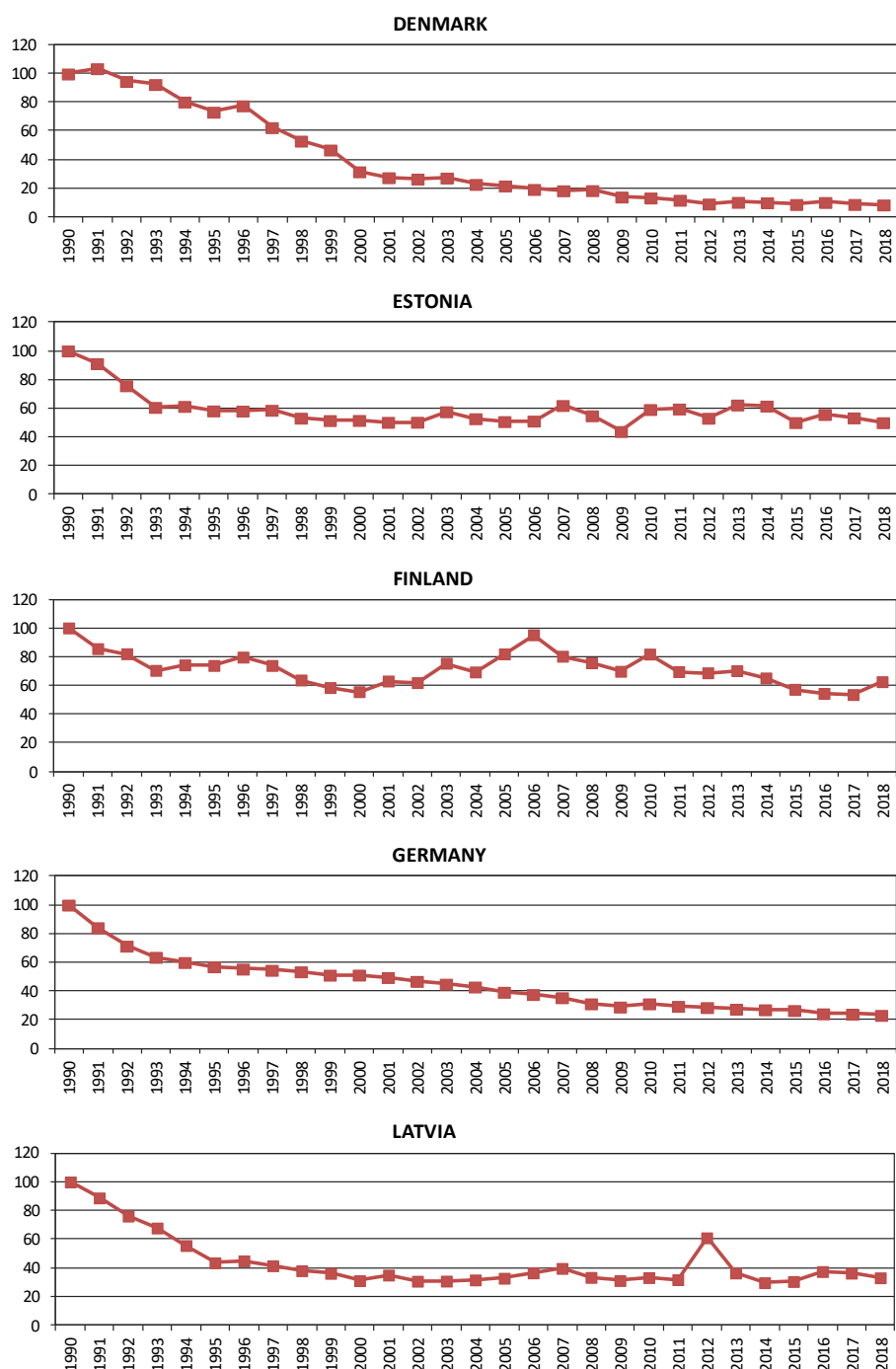


Figure 5. Trends in annual atmospheric emissions of cadmium from HELCOM Contracting Parties from 1990 to 2018, plotted as percentage of the 1990 value. Unit: %. The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

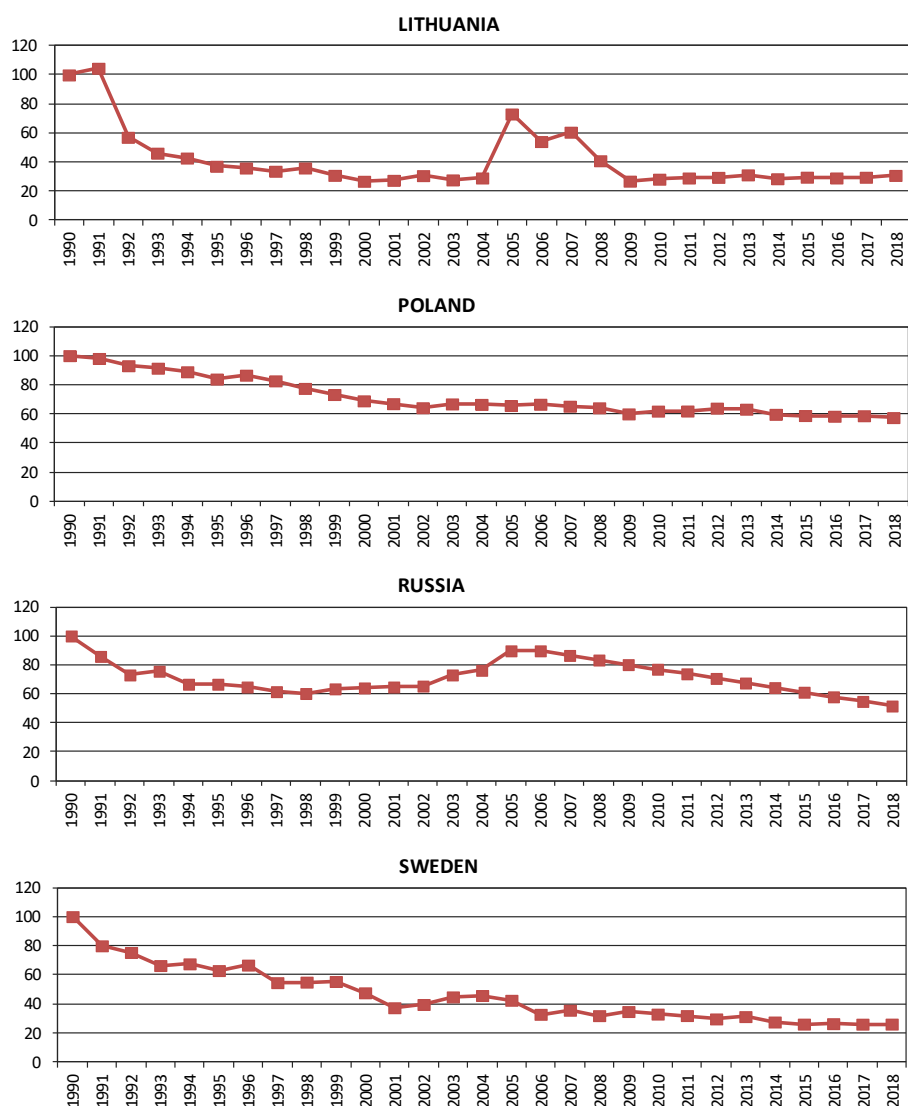


Figure 5. (continued) Trends in annual atmospheric emissions of cadmium from HELCOM Contracting Parties from 1990 to 2018, plotted as percentage of the 1990 value. Unit: %. The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

Data

Numerical data on HM anthropogenic emissions of HELCOM Contracting Parties are given in the following tables.

Table 1. Cadmium emissions from anthropogenic sources of HELCOM Contracting Parties from 1990 to 2018.
Units: tonnes/year.

	DK	EE	FI	DE	LV	LT	PL	RU	SE	HELCOM	Other
1990	1.206	4.561	6.670	30.42	0.931	0.310	11.93	120.3	2.307	178.6	229.8
1991	1.240	4.359	3.796	26.89	0.837	0.331	10.49	103.3	1.741	153.0	220.0
1992	1.076	3.156	3.311	24.21	0.714	0.222	10.22	104.2	1.374	148.5	208.8
1993	0.994	2.382	3.372	22.91	0.793	0.216	10.83	89.4	1.084	132.0	186.6
1994	0.839	3.079	2.700	22.52	0.822	0.209	11.58	85.8	0.766	128.3	179.4
1995	0.712	2.258	2.125	20.41	0.823	0.197	11.07	87.0	0.746	125.3	174.4
1996	0.730	1.386	1.905	20.90	0.861	0.209	11.53	77.3	0.712	115.5	170.3
1997	0.689	1.425	1.528	20.62	0.964	0.205	11.02	76.4	0.707	113.5	163.4
1998	0.658	1.305	1.688	19.88	0.952	0.323	10.14	74.2	0.626	109.8	154.4
1999	0.646	1.241	1.526	19.89	0.951	0.211	9.377	77.1	0.542	111.5	143.7
2000	0.638	0.864	1.408	18.80	0.916	0.198	8.778	76.5	0.524	108.6	132.0
2001	0.690	0.837	1.739	17.82	0.971	0.225	8.271	77.3	0.604	108.4	124.3
2002	0.657	0.855	1.371	17.17	0.962	0.253	7.879	78.0	0.525	107.7	113.2
2003	0.686	0.921	1.322	15.68	1.018	0.260	8.664	86.8	0.521	115.9	134.4
2004	0.685	0.856	1.608	14.48	1.061	0.280	9.001	83.9	0.537	112.4	107.4
2005	0.697	0.820	1.456	12.92	1.060	0.397	8.525	90.0	0.536	116.4	107.9
2006	0.673	0.809	1.422	13.67	1.050	0.291	8.837	90.0	0.559	117.3	103.6
2007	0.754	0.980	1.257	13.22	1.081	0.322	9.332	88.0	0.571	115.5	103.8
2008	0.730	0.900	1.212	12.11	1.029	0.252	9.174	86.0	0.516	111.9	103.0
2009	0.703	0.780	1.160	10.90	1.030	0.192	8.300	84.0	0.536	107.6	91.6
2010	0.725	0.966	1.290	13.31	1.018	0.191	8.970	81.9	0.545	109.0	88.9
2011	0.678	0.930	1.225	13.31	0.641	0.188	9.147	79.9	0.525	106.6	87.7
2012	0.659	0.865	1.174	12.96	0.840	0.211	9.246	77.9	0.527	104.4	84.8
2013	0.682	1.038	1.079	13.00	0.657	0.181	8.919	75.9	0.505	101.9	81.8
2014	0.666	0.970	0.919	12.74	0.644	0.184	9.174	73.9	0.517	99.7	80.9
2015	0.736	0.819	0.890	13.08	0.593	0.197	9.374	71.9	0.476	98.0	78.8
2016	0.764	0.882	0.941	12.84	0.568	0.189	9.177	69.8	0.481	95.7	80.7
2017	0.782	0.877	0.956	13.07	0.610	0.197	9.374	67.8	0.517	94.2	81.5
2018	0.795	0.813	0.883	12.69	0.632	0.195	9.451	65.8	0.485	91.8	82.9

Table 2. Mercury emissions from anthropogenic sources of HELCOM Contracting Parties from 1990 to 2018. Units: tonnes/year.

	DK	EE	FI	DE	LV	LT	PL	RU	SE	HELCOM	Other
1990	3.163	1.201	1.084	35.45	0.289	0.463	15.24	23.6	1.545	82.1	234.8
1991	3.280	1.094	0.927	29.87	0.257	0.485	14.95	20.3	1.234	72.4	229.4
1992	2.998	0.909	0.888	25.33	0.220	0.264	14.19	17.3	1.163	63.2	220.7
1993	2.930	0.728	0.763	22.56	0.196	0.213	13.93	17.9	1.023	60.2	196.2
1994	2.544	0.736	0.804	21.28	0.161	0.198	13.55	15.8	1.041	56.1	193.0
1995	2.320	0.698	0.800	20.23	0.126	0.172	12.79	15.8	0.970	53.9	191.4
1996	2.460	0.697	0.863	19.66	0.130	0.166	13.19	15.3	1.028	53.5	180.4
1997	1.978	0.704	0.800	19.36	0.120	0.156	12.60	14.5	0.841	51.1	170.6
1998	1.681	0.638	0.690	18.99	0.110	0.166	11.81	14.2	0.846	49.2	164.0
1999	1.485	0.617	0.633	18.16	0.105	0.143	11.17	15.0	0.853	48.2	157.6
2000	1.004	0.619	0.602	18.18	0.090	0.124	10.50	15.2	0.732	47.0	155.3
2001	0.873	0.603	0.682	17.58	0.101	0.127	10.21	15.3	0.573	46.0	150.5
2002	0.844	0.603	0.670	16.63	0.089	0.142	9.778	15.5	0.608	44.8	130.9
2003	0.866	0.691	0.817	15.95	0.089	0.128	10.18	17.3	0.689	46.7	153.6
2004	0.726	0.633	0.751	15.24	0.092	0.134	10.13	18.0	0.704	46.4	126.8
2005	0.691	0.609	0.887	13.95	0.095	0.339	10.01	21.2	0.653	48.4	124.5
2006	0.615	0.613	1.032	13.39	0.106	0.251	10.14	21.2	0.503	47.9	133.9
2007	0.585	0.744	0.870	12.60	0.115	0.280	9.937	20.5	0.546	46.1	123.4
2008	0.588	0.657	0.820	11.10	0.097	0.189	9.769	19.7	0.489	43.4	120.4
2009	0.447	0.526	0.756	10.30	0.090	0.124	9.131	19.0	0.533	40.9	107.7
2010	0.426	0.710	0.886	11.09	0.096	0.130	9.424	18.2	0.505	41.5	109.7
2011	0.376	0.714	0.753	10.47	0.092	0.134	9.433	17.5	0.490	39.9	110.5
2012	0.293	0.637	0.744	10.17	0.176	0.136	9.736	16.7	0.454	39.1	109.2
2013	0.330	0.748	0.760	9.776	0.106	0.144	9.624	16.0	0.479	37.9	106.3
2014	0.321	0.739	0.705	9.629	0.086	0.132	9.085	15.2	0.421	36.3	104.7
2015	0.282	0.601	0.620	9.445	0.088	0.137	8.959	14.5	0.399	35.0	101.5
2016	0.327	0.668	0.589	8.632	0.109	0.134	8.884	13.7	0.403	33.4	100.0
2017	0.284	0.640	0.580	8.549	0.105	0.137	8.938	13.0	0.398	32.6	101.5
2018	0.272	0.599	0.677	8.248	0.096	0.142	8.744	12.2	0.399	31.4	107.3

Meta data

Technical information:

1. Source:

Meteorological Synthesizing Centre East (MSC-E) of EMEP, Centre on Emission Inventories and Projections (CEIP) of EMEP.

2. Description of data:

Annual total emissions of cadmium and mercury were officially reported to the UN ECE Secretariat by HELCOM Contracting Parties. These data are available from the EMEP Centre on Emission Inventories and Projections (CEIP) (<http://www.ceip.at/>).

3. Geographical coverage:

EMEP region

4. Temporal coverage:

Data on cadmium and mercury annual emission totals are available for the period 1990 – 2018 for all HELCOM Contracting Parties but Russia. The Russian Federation did not submit the information for 2001 and 2007-2018. Values of HM emissions from Russia for 2007-2018 were estimated by CEIP [*Poupa and Wankmueller, 2020*].

5. Methodology and frequency of data collection:

National data on HM emissions are annually submitted by countries Parties to LRTAP Convention to the UN ECE Secretariat. The methodology is based on combination of measurements of releases to the atmosphere and estimation of emission based on activity data and emission factors. Submitted emission data are processed using quality assurance and quality control procedure and stored in the UN ECE/EMEP emission database at EMEP/CEIP Centre.

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, uncertainties in national emissions, lack of gridded emissions, and incompleteness

7. Uncertainty:

Among the HELCOM countries the level of uncertainty of official data on HM emission was reported by Denmark, Estonia, Finland, Latvia, Poland, and Sweden. From other EMEP countries the information on uncertainties of HM official emissions is available for Austria, Belarus, Belgium, Croatia, Cyprus, France, Republic of Moldova, Switzerland and the United Kingdom. The

uncertainty of reported data on HM emissions expressed as percentage relative to mean value of emission is as follows:

Denmark:	Cd	409%
	Hg	124%
Estonia:	Cd	122%
	Hg	161%
Finland:	Cd	±28%
	Hg	±19%
Latvia:	Cd	29%
	Hg	20%
Poland:	Cd	53%
	Hg	59%
Sweden:	Cd	35%
	Hg	66%
Austria:	Cd	41%
	Hg	31%
Belarus:	Cd	266%
	Hg	111%
Belgium:	Cd	103%
	Hg	50%
Croatia:	Cd	284%
	Hg	85%
Cyprus:	Cd	24%
	Hg	24%
France:	Cd	45%
	Hg	32%
Republic of Moldova:	Cd	207%
	Hg	138%
Switzerland:	Cd	20% to 50%
	Hg	20% to 50%
UK:	Cd	-30% to >50%
	Hg	-30% to >50%

8. Further work required:

Further work of national experts on emissions of heavy metals is required to fill the gaps in the emission time-series and to reduce their uncertainties.

References

Poupa S. and R.Wankmueller [2020] Methodologies applied to the CEIP GNFR gap-filling 2020. Part II: Heavy Metals (Pb, Cd, Hg). Technical report CEIP 02/2020. (<https://www.ceip.at/ceip-reports>).