Atmospheric emissions of Cadmium in the Baltic Sea region

HELCOM Baltic Sea Environment Fact Sheet (BSEFS), 2022

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Key Message

Annual atmospheric cadmium emissions of the HELCOM Contracting Parties decreased by 66% from 1990 to 2020.

Results and Assessment

Relevance of the BSEFS for describing developments in the environment

This BSEFS shows the levels and trends in cadmium 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 cadmium on the Baltic Sea").

Policy relevance and policy reference

The updated 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.

Assessment

Annual anthropogenic emissions of cadmium to the atmosphere from the HELCOM Contracting Parties decreased by 66% from 1990 to 2020 (Figure 1). Spatial distributions of cadmium anthropogenic emission fluxes in 1990 and 2020 are shown in Figure 2. The largest emission fluxes are noted for the areas along the southern and western parts of the Baltic Sea.

Time-series of annual total cadmium emissions of the HELCOM Contracting Parties are shown in Figures 3. Among the HELCOM countries the largest drop of cadmium emissions is noted for Finland (90%), followed by Estonia (89%), and Sweden (79%). The smallest decrease of cadmium emissions is seen for Lithuania (13%).

In 2020 total annual anthropogenic cadmium emissions of the HELCOM Contracting Parties amounted to 61 t. The largest contributions to these emissions were made by Russia (61%) and Germany (18%).

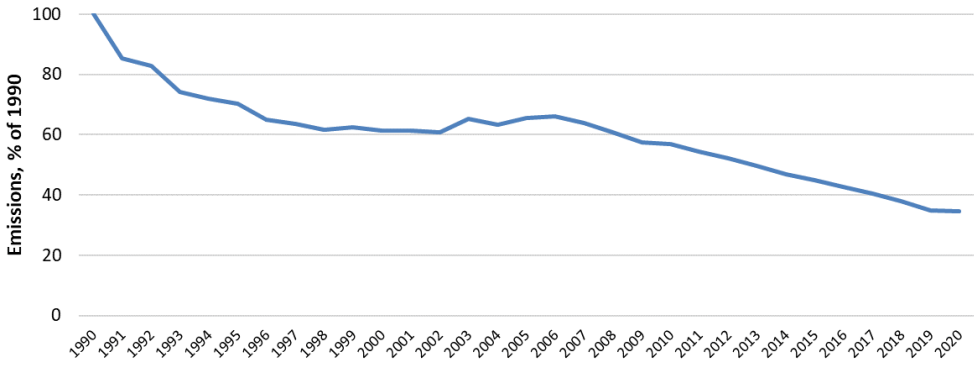

Figure 1. Relative changes of total annual emissions of cadmium to the atmosphere from the HELCOM Contracting Parties in period 1990-2020 (% of 1990).

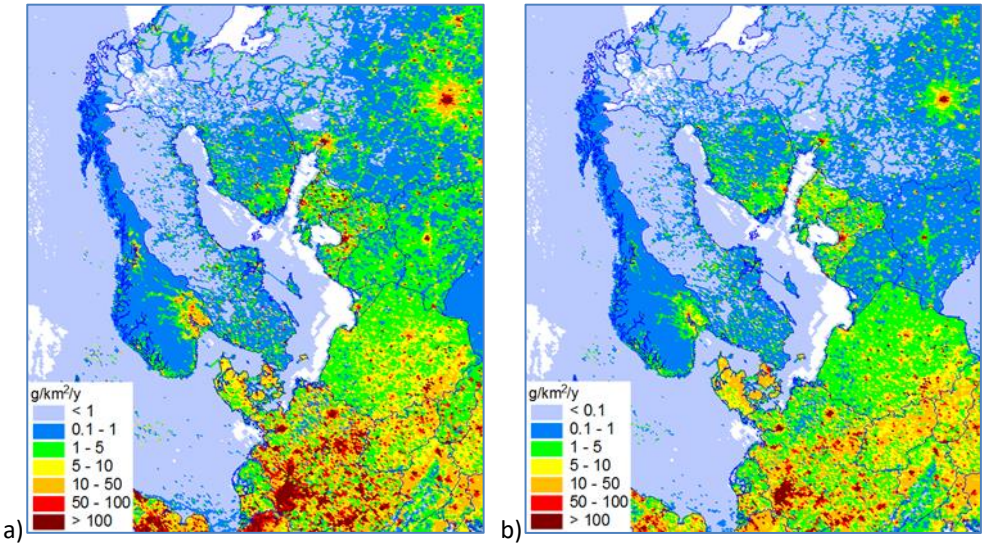

Figure 2. Spatial distribution of annual anthropogenic Cd emissions to the atmosphere in the Baltic Sea region in 1990 (a) and in 2020 (b), in g km^{-2} y^{-1}.

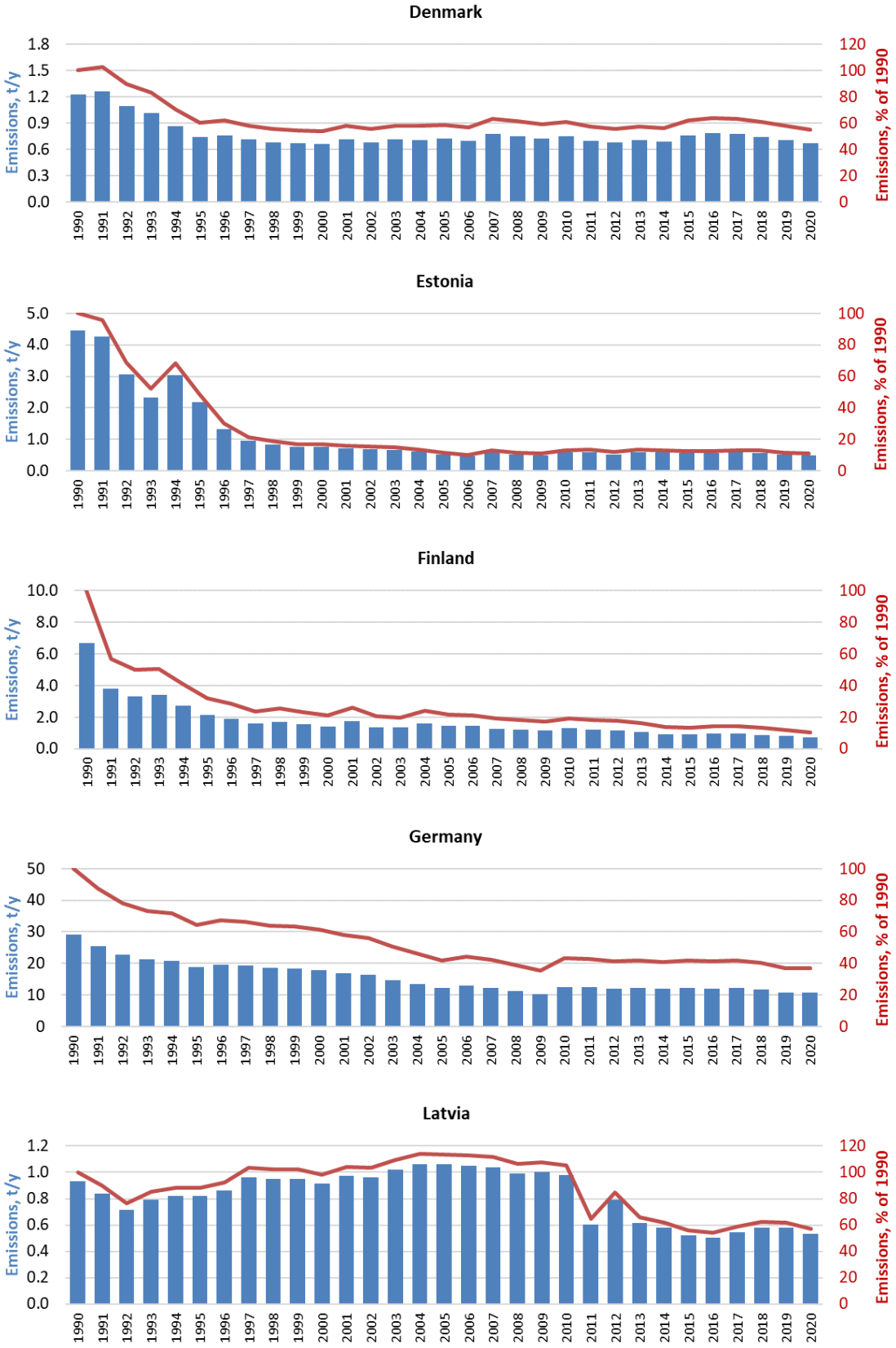

Figure 3. Cadmium emissions of the HELCOM Contracting Parties (CP) to the atmosphere for the period 1990-2020 in t y^{-1} (blue bars) and in % of 1990 (red line). The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

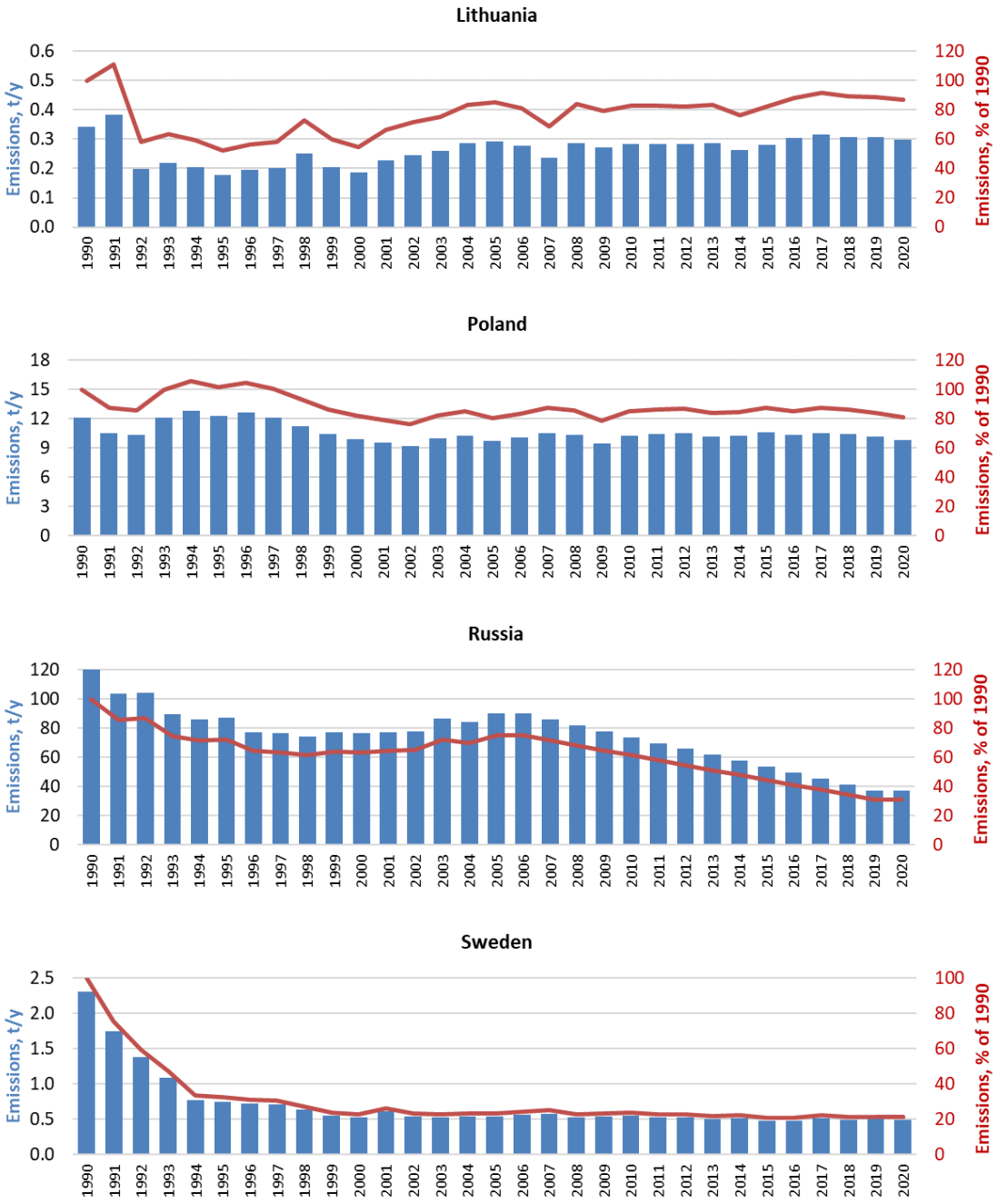

Figure 3 (continued). Cadmium emissions of the HELCOM Contracting Parties (CP) to the atmosphere for the period 1990-2020 in t y^{-1} (blue bars) and in % of 1990 (red line). The emission data of the CP refer to the total area of the CPs except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

Data

Numerical data on anthropogenic cadmium emissions of the HELCOM Contracting Parties are given in the following table.

Table 1. Cadmium emissions from anthropogenic sources of the HELCOM Contracting Parties from 1990 to 2020. Units: t y^{-1}.

	DK	EE	FI	DE	LV	LT	PL	RU	SE	HELCOM	Other
1990	1.23	4.45	6.69	29.1	0.93	0.34	12.1	120	2.31	177	225
1991	1.26	4.26	3.81	25.4	0.84	0.38	10.6	103	1.75	152	215
1992	1.10	3.06	3.33	22.7	0.71	0.20	10.4	104	1.38	147	203
1993	1.02	2.33	3.39	21.3	0.79	0.22	12.1	89.4	1.09	132	180
1994	0.86	3.04	2.72	20.8	0.82	0.20	12.8	85.8	0.77	128	173
1995	0.74	2.18	2.13	18.8	0.82	0.18	12.3	87.0	0.75	125	167
1996	0.76	1.34	1.91	19.5	0.86	0.19	12.6	77.3	0.72	115	163
1997	0.71	0.95	1.59	19.3	0.96	0.20	12.1	76.4	0.71	113	156
1998	0.68	0.83	1.69	18.6	0.95	0.25	11.3	74.2	0.63	109	147
1999	0.67	0.77	1.53	18.4	0.95	0.21	10.5	77.1	0.54	111	137
2000	0.66	0.76	1.41	17.8	0.92	0.19	9.93	76.5	0.53	109	123
2001	0.71	0.72	1.75	16.8	0.97	0.23	9.57	77.3	0.61	109	114
2002	0.68	0.69	1.37	16.3	0.96	0.25	9.23	78.0	0.53	108	106
2003	0.71	0.66	1.33	14.7	1.02	0.26	10.0	86.8	0.53	116	127
2004	0.71	0.60	1.62	13.5	1.06	0.29	10.3	83.9	0.54	113	100
2005	0.72	0.52	1.45	12.2	1.06	0.29	9.73	90.0	0.54	117	102
2006	0.70	0.46	1.43	12.9	1.05	0.28	10.1	90.0	0.56	117	97
2007	0.78	0.58	1.27	12.3	1.04	0.24	10.6	86.0	0.58	113	96
2008	0.75	0.52	1.21	11.4	0.99	0.29	10.4	81.9	0.52	108	93
2009	0.73	0.50	1.15	10.3	1.00	0.27	9.48	77.9	0.54	102	82
2010	0.75	0.58	1.28	12.6	0.98	0.28	10.3	73.8	0.55	101	79
2011	0.70	0.60	1.22	12.5	0.60	0.28	10.5	69.8	0.53	97	78
2012	0.68	0.53	1.17	12.1	0.79	0.28	10.5	65.7	0.53	92	73
2013	0.70	0.60	1.08	12.2	0.62	0.29	10.2	61.7	0.50	88	71
2014	0.69	0.58	0.92	11.9	0.58	0.26	10.2	57.7	0.52	83	69
2015	0.76	0.55	0.89	12.2	0.52	0.28	10.6	53.6	0.47	80	68
2016	0.79	0.56	0.94	12.0	0.50	0.30	10.3	49.6	0.48	76	68
2017	0.77	0.59	0.95	12.2	0.55	0.31	10.6	45.5	0.52	72	69
2018	0.74	0.58	0.88	11.8	0.58	0.31	10.5	41.5	0.48	67	68
2019	0.71	0.52	0.79	10.7	0.58	0.31	10.2	37.5	0.49	62	72
2020	0.67	0.50	0.70	10.7	0.53	0.30	9.80	37.5	0.49	61	66

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 were officially reported by the HELCOM Contracting Parties to the UN ECE Secretariat in 2022. 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 annual emission totals are available for the period 1990 – 2020 for all HELCOM Contracting Parties with the exception of Russia. For Russia, expert estimates of emissions were elaborated on the basis of methodology developed by CEIP [*Poupa*, 2021].

5. Methodology and frequency of data collection:

National data on cadmium emissions are annually submitted by countries Parties to LRTAP Convention to the UN ECE Secretariat. The methodology is based on the 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 of sectoral distribution.

7. Uncertainty:

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

Kingdom. The uncertainty of reported data on Cd emissions expressed as percentage relative to the mean value of emission is as follows:

Denmark:	360%
Estonia:	133%
Finland:	33%
Latvia:	29%
Poland:	17%
Sweden:	35%
Austria:	49%
Belarus:	179%
Belgium:	110%
Croatia:	292%
Cyprus:	25%
France:	39%
Monaco:	25%
Republic of Moldova:	255%
Slovakia:	103%
Switzerland:	50-100%
UK:	-30 to +50%

Evaluation of emission uncertainties is made by the experts of the HELCOM contracting parties on the base of methodology presented in EMEP/EEA guidebook [*EEA*, 2019]. The methodology considers uncertainties of the activity data and the emission factors applied for each emission sector. It is important to note that the uncertainties of emission factors are much higher than those for the activity data. For heavy metals the default value of emission factor uncertainty suggested by the guidebook exceeds 100%. Besides, the estimates of the uncertainties as a rule do not account for possible lack of completeness of the emission data.

8. Further work required:

Further work to refine national inventories of cadmium emissions is required to reduce their uncertainties, to fill the gaps in sector distribution and improve spatial distribution of emissions. Besides, further studies to evaluate cadmium releases to the atmosphere from natural and secondary emission sources are of importance for the assessment of cadmium pollution levels.

References

EEA [2019]. EMEP/EEA air pollutant emission inventory guidebook 2019. Technical guidance to prepare national emission inventories. EEA Report No 13/2019.

Poupa S. [2021] Methodologies applied to the CEIP GNFR gap-filling 2021. Part II: Heavy Metals (Cd, Hg, Pb) and Persistent Organic Pollutants (Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total polycyclic aromatic hydrocarbons, Dioxin and Furan, Hexachlorobenzene, Polychlorinated biphenyls). Technical Report CEIP 06/2021 (https://www.ceip.at/ceip-reports).