Atmospheric emissions of cadmium in the Baltic Sea region

Baltic Marine Environment Protection Commission

Hazardous substances

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HELCOM Baltic Sea Environment Fact Sheet (BSEFS), 2024

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Key Message

Annual atmospheric emissions of cadmium in the HELCOM Contracting Parties decreased by 65% between 1990 and 2022.

Results and Assessment

Relevance of the BSEFS for describing developments in the environment

This Fact Sheet presents the levels, spatial distribution, and temporal trends of cadmium emissions from anthropogenic sources in the HELCOM Contracting Parties, which are used in modelling cadmium deposition to the Baltic Sea (cf. BSEFS "Atmospheric deposition of cadmium to the Baltic Sea").

Policy relevance and policy references

The updated Baltic Sea Action Plan outlines the ecological objective that concentrations of hazardous substances in the environment should be close to background levels for naturally occurring substances. HELCOM Recommendation 31E/1 identifies a list of regional priority substances for the Baltic Sea.

At the European level, the relevant policy for controlling heavy metal emissions to the atmosphere is set under the framework of the 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. One of the core obligations of the Protocol is to reduce emissions of these metals to levels below those recorded in 1990. The Protocol entered into force in 2003 and has been signed and/or ratified by 41 countries.

Assessment

Annual anthropogenic cadmium emissions to the atmosphere from the HELCOM Contracting Parties decreased by 65% between 1990 and 2022 (Figure 1). The spatial distribution of cadmium emission fluxes for 1990 and 2022 is shown in Figure 2, with the highest fluxes observed along the southern and eastern coasts of the Baltic Sea.

The time series of annual cadmium emissions from the HELCOM Contracting Parties is presented in Figure 3. Among these countries, Estonia experienced the largest reduction in emissions (90%), followed by Finland (88%) and Sweden (78%). Poland had the smallest decrease, with only a 14% reduction.

In 2022, total anthropogenic cadmium emissions from the HELCOM Contracting Parties amounted to 61 tonnes. The largest contributors were Russia (61%), Germany (17%), and Poland (17%).

Given the generally high uncertainties in emission estimates and fragmented reported data for the Russian Federation (see Metadata), the uncertainty in the total cadmium emissions estimate for the HELCOM countries remains relatively high.

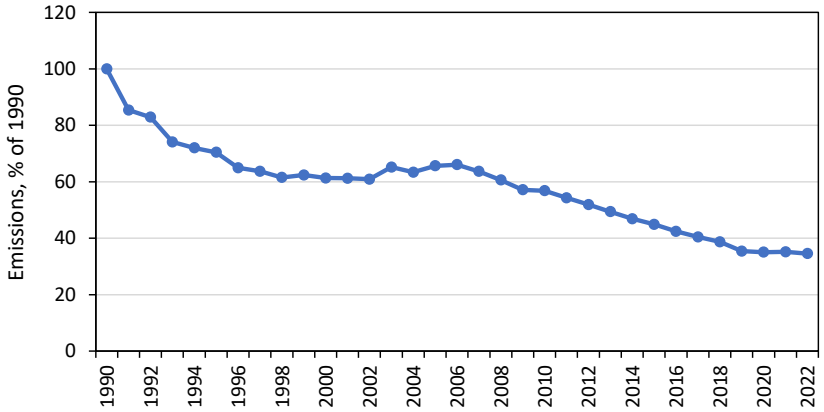

Figure 1. Relative changes of total annual emissions of cadmium to the atmosphere from the HELCOM Contracting Parties in period 1990-2022 (% of 1990).

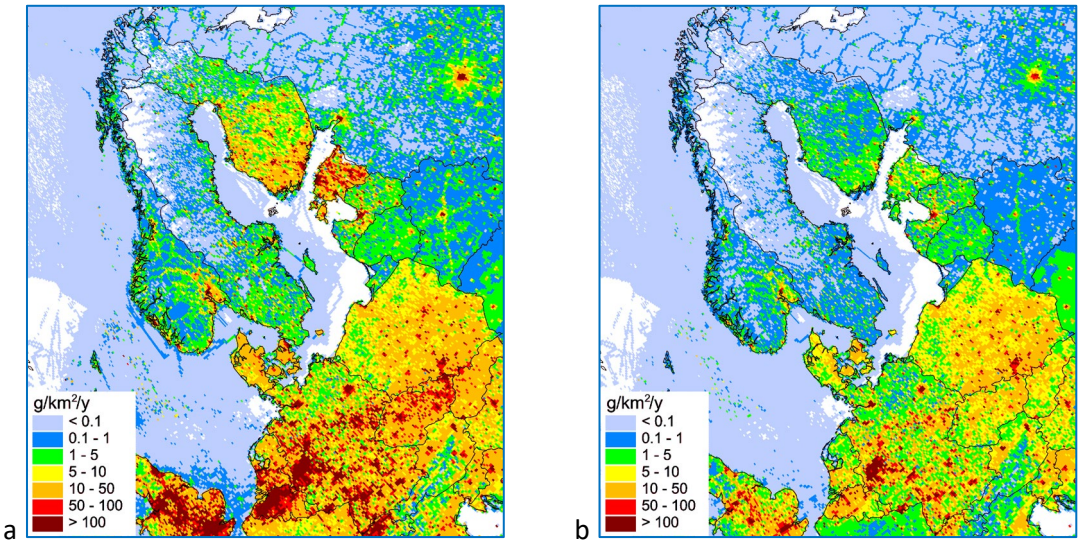

Figure 2. Spatial distribution of annual anthropogenic Cd emissions to the atmosphere in the Baltic Sea region in 1990 (a) and in 2022 (b).

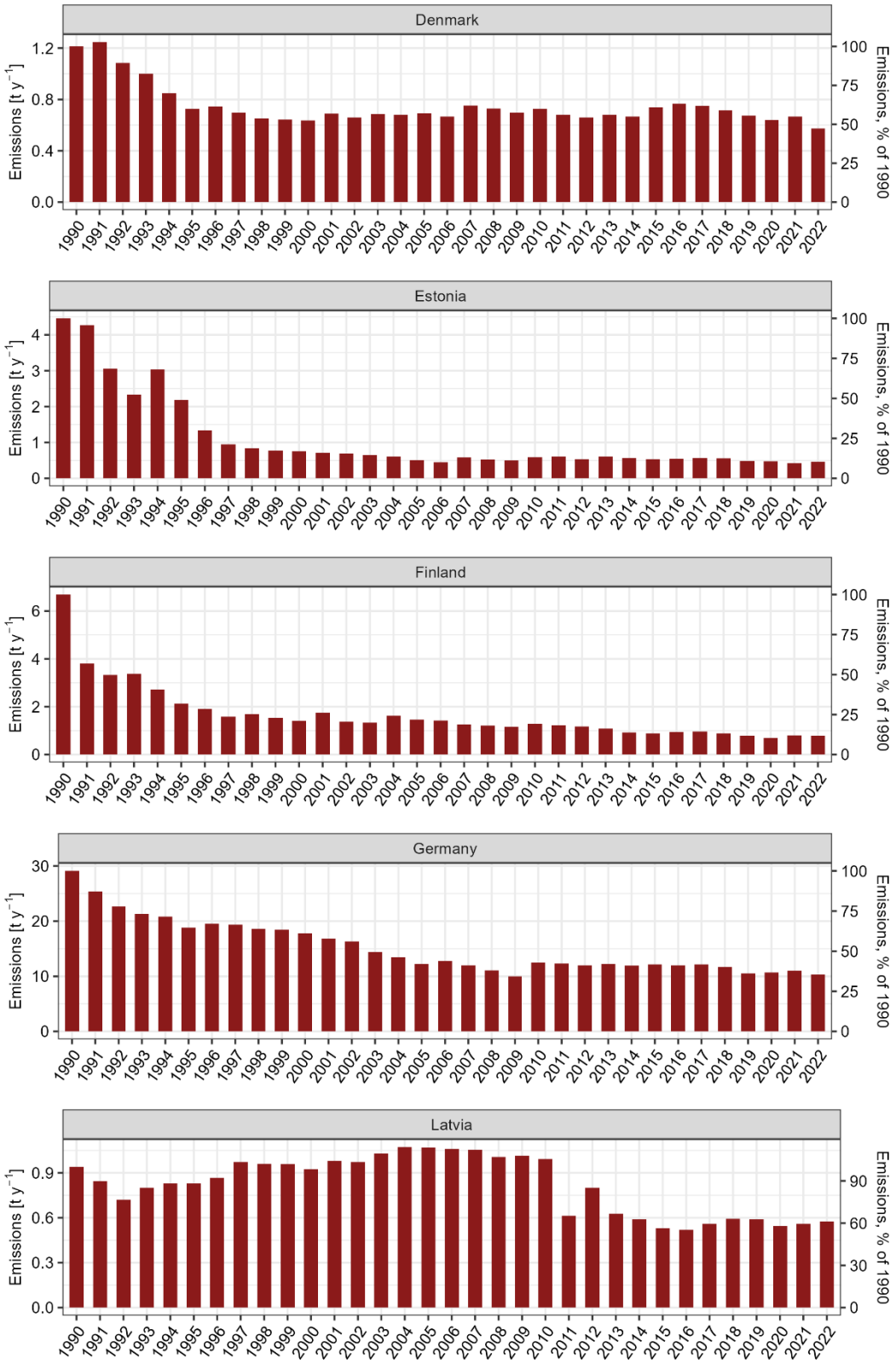

Figure 3. Atmospheric cadmium emissions from HELCOM Contracting Parties during the period 1990-2022. The emission data for Russia pertains to the territory within the EMEP domain.

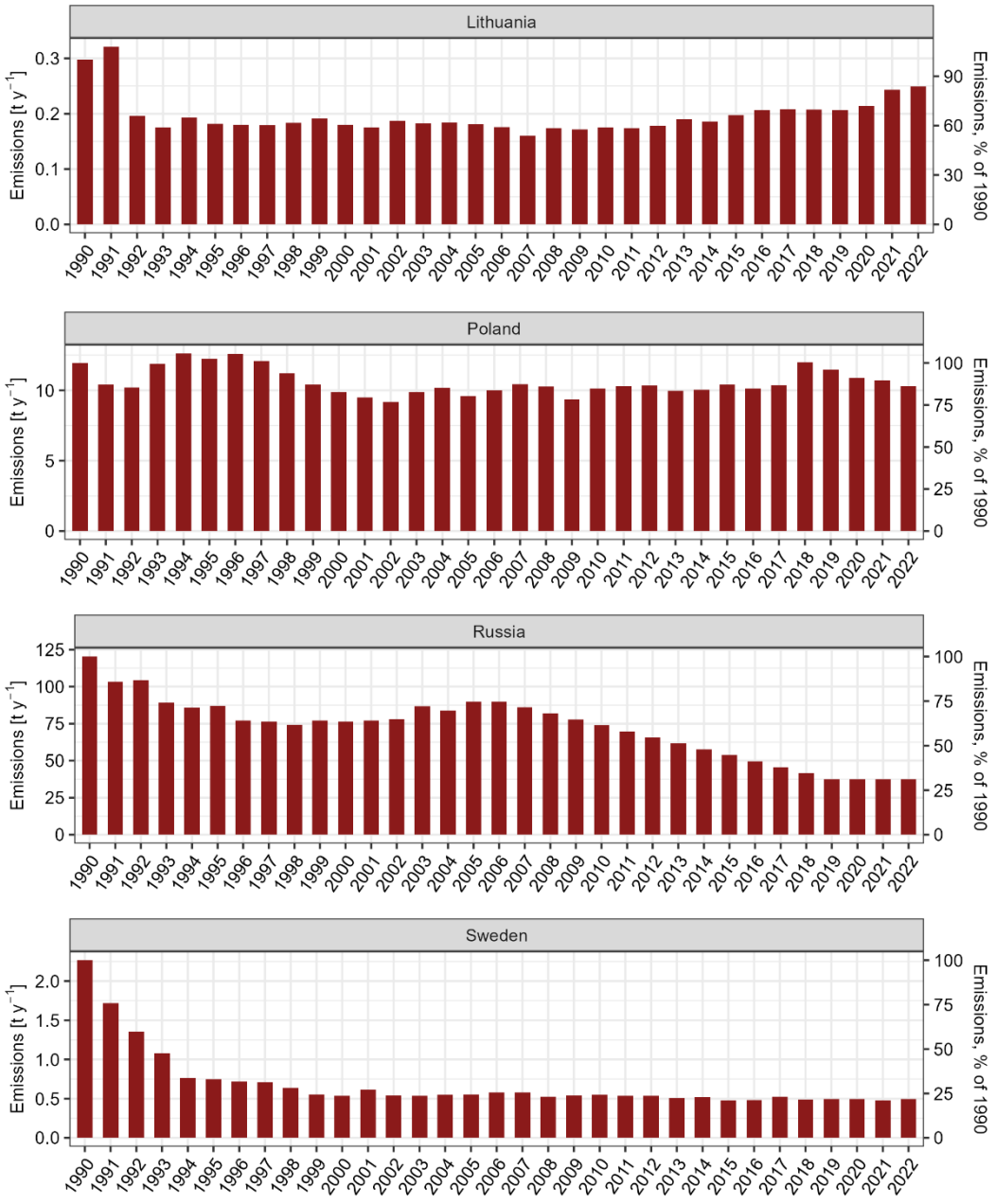

Figure 3 (continued). Atmospheric cadmium emissions from HELCOM Contracting Parties during the period 1990-2022. The emission data for Russia pertains to the territory within the EMEP domain.

Data

Supporting Excel here

Numerical data on anthropogenic cadmium emissions from HELCOM Contracting Parties are provided in the table below.

Table 1. Cadmium emissions from anthropogenic sources in HELCOM Contracting Parties from 1990 to 2022. Units: t y^{-1}.

Year	DK	EE	FI	DE	LV	LT	PL	RU	SE	HELCOM
1990	1.21	4.46	6.69	29.1	0.94	0.30	11.9	120	2.27	177
1991	1.25	4.27	3.81	25.4	0.84	0.32	10.4	103	1.72	151
1992	1.08	3.06	3.33	22.7	0.72	0.20	10.2	104	1.36	147
1993	1.00	2.33	3.39	21.3	0.80	0.17	11.9	89	1.08	131
1994	0.85	3.04	2.72	20.8	0.83	0.19	12.6	86	0.77	128
1995	0.73	2.18	2.13	18.8	0.83	0.18	12.2	87	0.75	125
1996	0.74	1.34	1.91	19.5	0.87	0.18	12.6	77	0.72	115
1997	0.69	0.95	1.59	19.3	0.97	0.18	12.1	76	0.71	113
1998	0.65	0.84	1.69	18.6	0.96	0.18	11.2	74	0.64	109
1999	0.64	0.77	1.53	18.4	0.96	0.19	10.4	77	0.55	111
2000	0.64	0.76	1.41	17.8	0.92	0.18	9.9	77	0.54	109
2001	0.69	0.72	1.75	16.8	0.98	0.18	9.5	77	0.62	109
2002	0.66	0.69	1.37	16.3	0.97	0.19	9.2	78	0.54	108
2003	0.69	0.66	1.33	14.4	1.03	0.18	9.9	87	0.54	116
2004	0.68	0.60	1.62	13.5	1.07	0.18	10.2	84	0.55	112
2005	0.69	0.51	1.45	12.3	1.07	0.18	9.6	90	0.55	116
2006	0.67	0.45	1.43	12.8	1.06	0.18	10.0	90	0.58	117
2007	0.75	0.58	1.27	12.0	1.05	0.16	10.4	86	0.58	113
2008	0.73	0.53	1.21	11.1	1.01	0.17	10.3	82	0.53	107
2009	0.70	0.50	1.15	10.0	1.01	0.17	9.4	78	0.54	101
2010	0.73	0.59	1.28	12.5	0.99	0.18	10.1	74	0.55	101
2011	0.68	0.60	1.22	12.3	0.61	0.17	10.3	70	0.53	96
2012	0.66	0.53	1.17	12.0	0.80	0.18	10.3	66	0.53	92
2013	0.68	0.60	1.08	12.2	0.63	0.19	10.0	62	0.51	88
2014	0.67	0.57	0.92	11.9	0.59	0.19	10.0	58	0.52	83
2015	0.74	0.54	0.89	12.2	0.53	0.20	10.4	54	0.48	80
2016	0.76	0.55	0.94	12.0	0.52	0.21	10.1	50	0.48	75
2017	0.75	0.57	0.95	12.2	0.56	0.21	10.4	46	0.52	72
2018	0.72	0.56	0.88	11.7	0.59	0.21	12.0	41	0.49	69
2019	0.67	0.49	0.79	10.6	0.59	0.21	11.5	37	0.50	63
2020	0.64	0.47	0.70	10.7	0.54	0.21	10.9	37	0.49	62
2021	0.67	0.43	0.80	11.0	0.56	0.24	10.7	37	0.48	62
2022	0.57	0.46	0.78	10.3	0.57	0.25	10.3	37	0.49	61

Metadata

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:

   Official cadmium emissions data reported by the HELCOM Contracting Parties to the UN ECE Secretariat were used for the calculations and the emission trend analysis. These data are collected and made available by the EMEP Centre on Emission Inventories and Projections (EMEP/CEIP) (http://www.ceip.at/).

3. Geographical coverage:

   EMEP region.

4. Temporal coverage:

   Data on annual cadmium emission totals are available for the period from 1990 to 2022 for all HELCOM Contracting Parties, except the Russian Federation. For the Russian Federation, fragmented officially reported time series were supplemented with expert estimates based on the methodology provided by CEIP (Poupa, 2023).

5. Methodology and frequency of data collection:

   National cadmium emissions data are submitted annually by the Parties to the LRTAP Convention to the UN ECE Secretariat. The methodology combines measurements of atmospheric releases with estimates based on activity data and emission factors. The submitted data undergo a quality assurance and quality control process before being stored in the UN ECE/EMEP emissions database at the EMEP/CEIP Centre. Gaps in emissions data are filled with expert estimated using methodology described in (Poupa, 2023).

Quality information

6. Strengths and weaknesses:

   Strength: National emissions data are submitted annually, quality checked, and stored at a specialised centre.

   Weakness: The data contain gaps in the time series of national emissions, uncertainties in the reported figures, lack of gridded emissions, and incomplete sectoral distribution.

7. Uncertainty:

   Among the HELCOM countries, the level of uncertainty in official data on cadmium emissions was reported by Denmark, Estonia, Finland, Latvia, Poland, and Sweden. The uncertainties in reported cadmium emissions by HELCOM Contracting Parties, expressed as a percentage relative to the mean emission value, are presented in Table 2. No uncertainty estimates are available for Germany, Lithuania and Russia.

   The evaluation of emission uncertainties is conducted by national experts from each country based on the methodology outlined in the EMEP/EEA Guidebook (EEA, 2019). This methodology accounts for

uncertainties in both activity data and the emission factors applied to each emission sector. It is important to note that the uncertainties associated with emission factors are much higher than those for activity data. For heavy metals, the guidebook suggests a default emission factor uncertainty that exceeds 100%. Additionally, the estimates of uncertainties typically do not account for possible data incompleteness.

Table 2. Uncertainty estimates for cadmium emissions reported by HELCOM Contracting Parties.

Country	Uncertainty
Denmark	360%
Estonia	133%
Finland	33%
Germany	–
Latvia	29%
Lithuania	–
Poland	17%
Russia	–
Sweden	35%

8. Further work required:

Further work is needed to refine national inventories of cadmium emissions, reduce uncertainties, fill gaps in emission trends, and improve the spatial distribution of emissions. Additionally, further studies to evaluate cadmium releases into the atmosphere from natural and secondary emission sources are important for assessing 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. [2023] 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).