Atmospheric emissions of mercury 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 mercury in the HELCOM Contracting Parties decreased by 66% 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 mercury emissions from anthropogenic sources in the HELCOM Contracting Parties, which are used in modelling mercury deposition to the Baltic Sea (see BSEFS "Atmospheric deposition of mercury 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: mercury, 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 mercury emissions to the atmosphere from HELCOM Contracting Parties decreased by 66% between 1990 and 2022 (Figure 1). The spatial distribution of mercury emission fluxes for 1990 and 2022 is shown in Figure 2, with the highest fluxes observed along the southern and western coasts of the Baltic Sea.

Time-series of annual mercury emissions from the HELCOM Contracting Parties are presented in Figure 3. Among these countries, Denmark saw the largest reduction in emissions (92%), followed by Estonia (84%) and Germany (82%). Lithuania experienced the smallest decrease, with a 38% reduction.

In 2022, total anthropogenic mercury emissions from the HELCOM Contracting Parties amounted to 28 tonnes. The largest contributors were Russia (49%), Germany (23%), and Poland (22%).

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

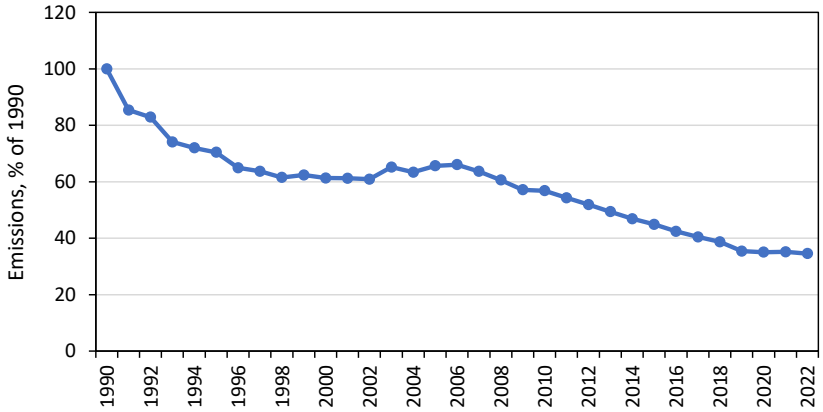

Figure 1. Relative changes of total annual emissions of mercury to the atmosphere from the HELCOM Contracting Parties in period 1990-2022 (% of 1990).

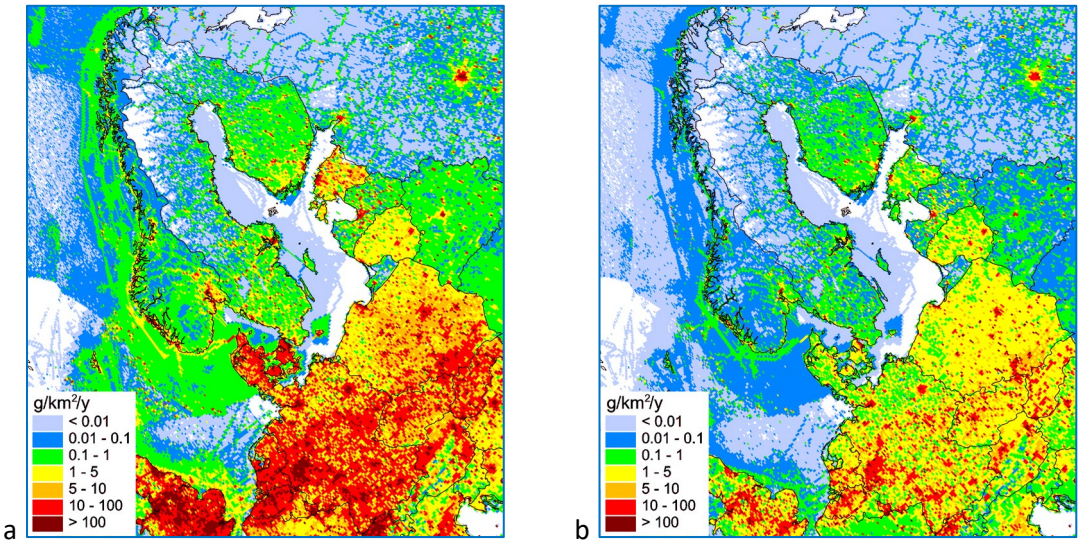

Figure 2. Spatial distribution of annual anthropogenic Mercury emissions to the atmosphere in the Baltic Sea region in 1990 (a) and in 2022 (b).

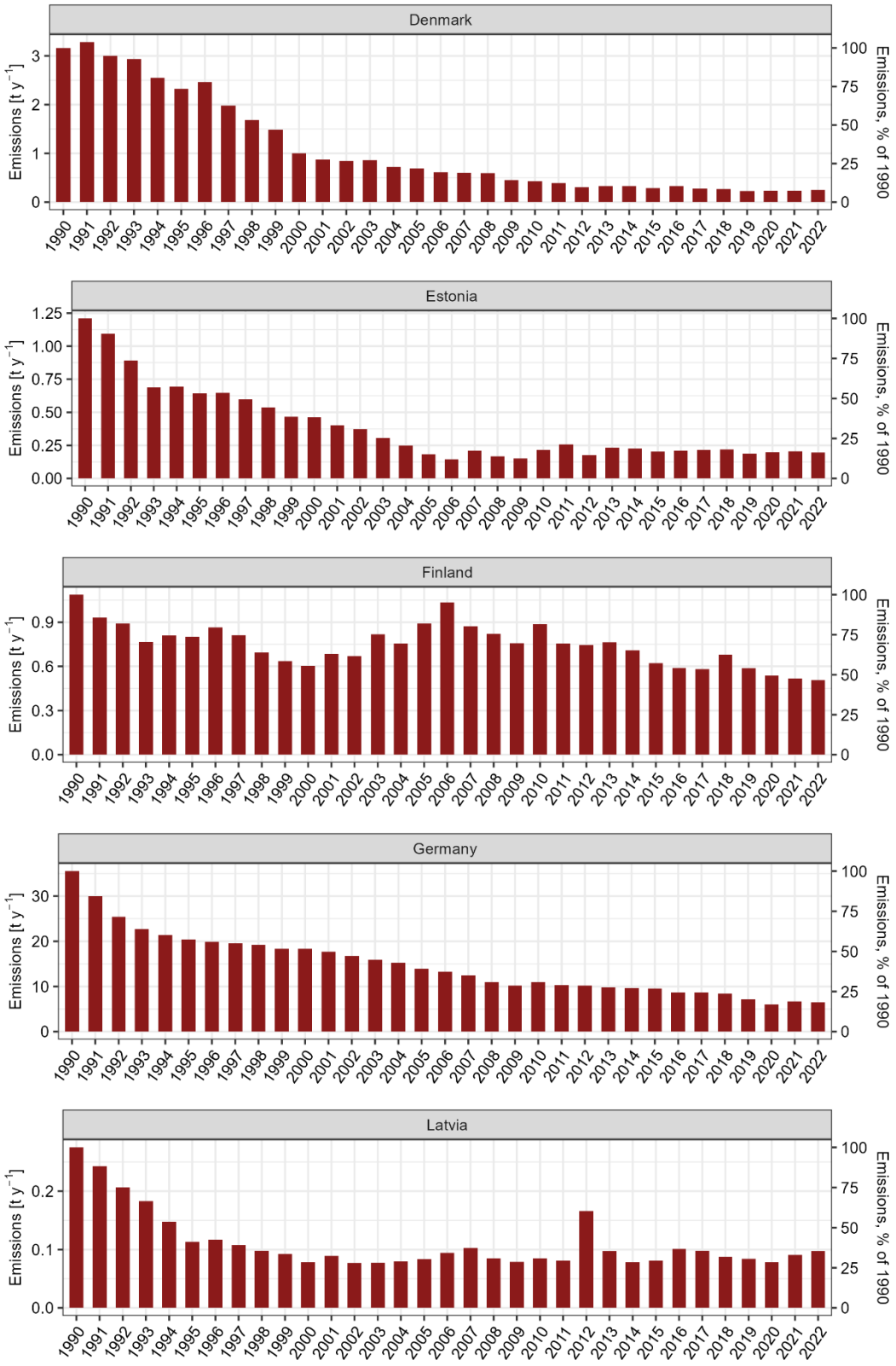

Figure 3. Atmospheric mercury emissions from HELCOM Contracting Parties during the period 1990-2022. The emission data for Russia pertains to the territory within the EMEP domain.

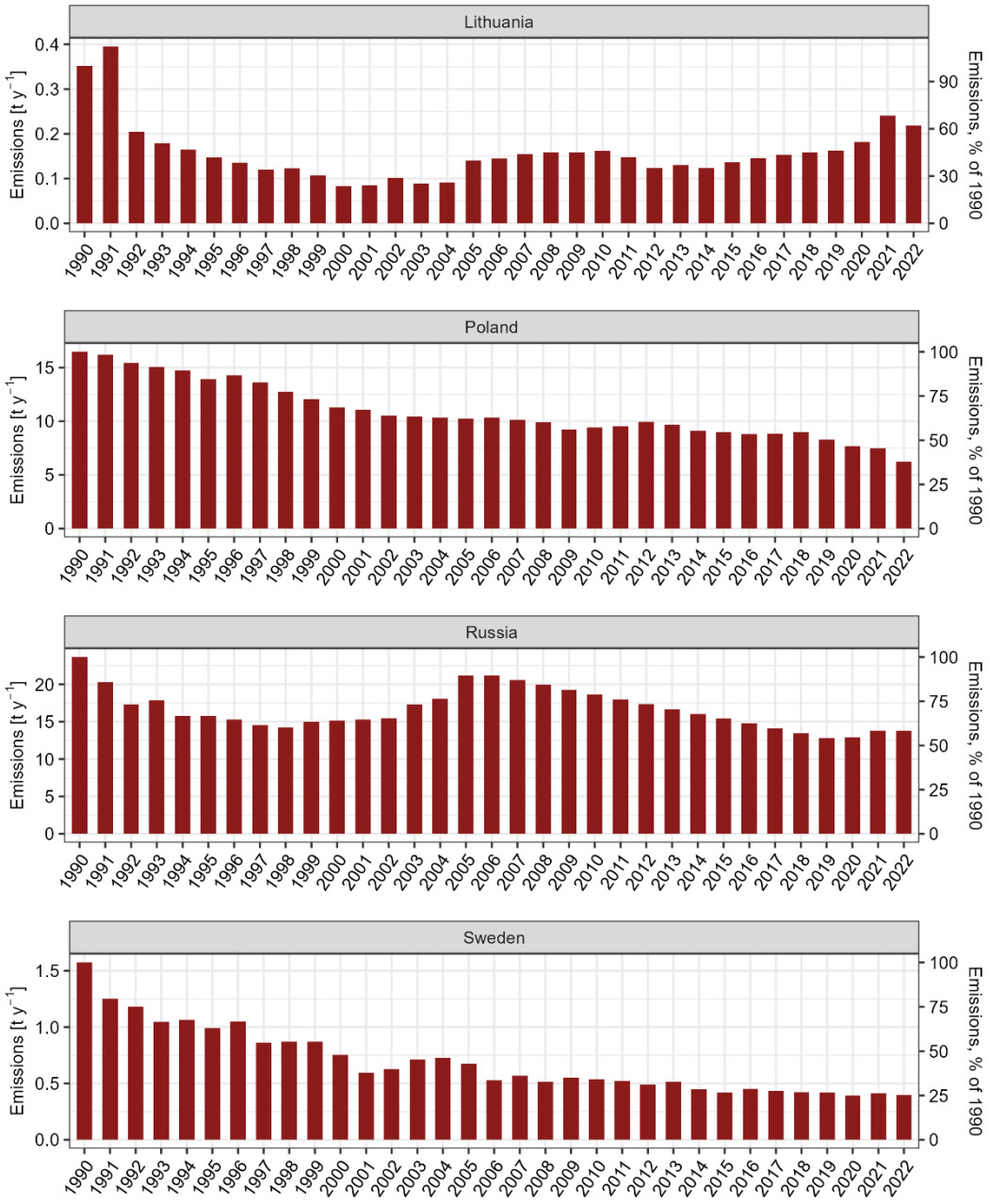

Figure 3 (continued). Atmospheric mercury emissions from HELCOM Contracting Parties during the period 1990-2022. The emission data for Russia pertains to the territory within the EMEP domain.

Data

Supporting Excel here

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

Table 1. Mercury 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	3.16	1.21	1.09	35.5	0.27	0.35	16.5	23.6	1.57	83
1991	3.28	1.09	0.93	30.0	0.24	0.39	16.2	20.3	1.25	74
1992	3.00	0.89	0.89	25.4	0.21	0.20	15.4	17.3	1.18	64
1993	2.93	0.69	0.77	22.6	0.18	0.18	15.1	17.9	1.04	61
1994	2.54	0.69	0.81	21.4	0.15	0.17	14.7	15.8	1.06	57
1995	2.32	0.64	0.80	20.4	0.11	0.15	13.9	15.8	0.99	55
1996	2.46	0.65	0.87	19.8	0.12	0.14	14.3	15.3	1.05	55
1997	1.98	0.60	0.81	19.5	0.11	0.12	13.6	14.6	0.86	52
1998	1.68	0.54	0.69	19.2	0.10	0.12	12.8	14.2	0.87	50
1999	1.48	0.47	0.64	18.3	0.09	0.11	12.1	15.0	0.87	49
2000	1.00	0.46	0.60	18.3	0.08	0.08	11.3	15.2	0.75	48
2001	0.87	0.40	0.68	17.7	0.09	0.08	11.1	15.3	0.59	47
2002	0.84	0.37	0.67	16.7	0.08	0.10	10.5	15.5	0.63	45
2003	0.87	0.31	0.82	15.9	0.08	0.09	10.4	17.3	0.71	46
2004	0.72	0.25	0.75	15.2	0.08	0.09	10.4	18.0	0.73	46
2005	0.69	0.18	0.89	13.9	0.08	0.14	10.2	21.2	0.68	48
2006	0.61	0.15	1.03	13.3	0.09	0.15	10.4	21.2	0.53	47
2007	0.60	0.21	0.87	12.4	0.10	0.15	10.1	20.6	0.57	46
2008	0.59	0.17	0.82	11.0	0.08	0.16	9.9	19.9	0.52	43
2009	0.45	0.15	0.76	10.2	0.08	0.16	9.2	19.3	0.55	41
2010	0.43	0.21	0.89	11.0	0.08	0.16	9.4	18.6	0.54	41
2011	0.39	0.26	0.76	10.3	0.08	0.15	9.6	18.0	0.52	40
2012	0.31	0.18	0.74	10.2	0.17	0.12	9.9	17.3	0.49	39
2013	0.33	0.23	0.76	9.8	0.10	0.13	9.7	16.7	0.51	38
2014	0.33	0.23	0.71	9.7	0.08	0.12	9.1	16.0	0.45	37
2015	0.28	0.20	0.62	9.5	0.08	0.14	9.0	15.4	0.42	36
2016	0.33	0.21	0.59	8.7	0.10	0.15	8.8	14.8	0.45	34
2017	0.28	0.22	0.58	8.7	0.10	0.15	8.8	14.1	0.43	33
2018	0.27	0.22	0.68	8.4	0.09	0.16	9.0	13.5	0.42	33
2019	0.23	0.19	0.59	7.1	0.08	0.16	8.3	12.8	0.42	30
2020	0.23	0.20	0.54	6.1	0.08	0.18	7.7	12.9	0.39	28
2021	0.24	0.20	0.52	6.7	0.09	0.24	7.5	13.8	0.42	30
2022	0.25	0.20	0.50	6.6	0.10	0.22	6.2	13.8	0.40	28

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 mercury 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 mercury 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 mercury 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 mercury emissions was reported by Denmark, Estonia, Finland, Latvia, Poland, and Sweden. The uncertainties in reported mercury 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	114%
Estonia	42%
Finland	47%
Germany	–
Latvia	23%
Lithuania	–
Poland	35%
Russia	–
Sweden	72%

8. Further work required:

Further work is needed to refine national inventories of mercury emissions, reduce uncertainties, fill gaps in emission trends, and improve the spatial distribution of emissions. Additionally, further studies to evaluate mercury releases into the atmosphere from natural and secondary emission sources are important for assessing mercury 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 2023. 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 03/2023 (https://www.ceip.at/ceip-reports).