Atmospheric emissions of benzo(a)pyrene in the Baltic Sea region

Baltic Marine Environment Protection Commission

Hazardous substances

HELCOM Baltic Sea Environment Fact Sheets 2024

Co-funded by
the European Union

HELCOM

Published by:

Helsinki Commission – HELCOM
Katajanokanlaituri 6 B
00160 Helsinki, Finland

www.helcom.fi

For bibliographic purposes this document should be cited as:
"Atmospheric emissions of benzo(a)pyrene in the Baltic Sea region. HELCOM Baltic Sea Environment Fact Sheets 2024. Online. HELCOM (2024)"

Authors: Oleg Travnikov, Jan Gačnik, EMEP MSC-E

Layout: Laura Ramos Tirado

Atmospheric emissions of benzo(a)pyrene in the Baltic Sea region

HELCOM Baltic Sea Environment Fact Sheet (BSEFS), 2024

Authors: Oleg Travnikov, Jan Gačnik, EMEP MSC-E

Key Message

Annual atmospheric emissions of benzo(a)pyrene in the HELCOM Contracting Parties have decreased by 25% during the period from 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 B(a)P emissions from anthropogenic sources in the HELCOM Contracting Parties, which are used in modelling B(a)P deposition to the Baltic Sea (cf. BSEFS "Atmospheric deposition of B(a)P 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 B(a)P emissions to the atmosphere falls under the framework of the UN ECE Convention on Long-Range Transboundary Air Pollution (CLRTAP). The CLRTAP Protocol on Persistent Organic Pollutants (1998) targets a list of harmful organic substances, including B(a)P. Among its key obligations is the requirement to reduce B(a)P emissions to levels below those recorded in 1990. The Protocol, which entered into force in 2003, has been signed or ratified by 40 countries. In EU member states, B(a)P pollution is also regulated by European Directive 2004/107/EC.

Assessment

Annual anthropogenic B(a)P emissions to the atmosphere from HELCOM Contracting Parties decreased by 25% between 1990 and 2022 (Figure 1). The spatial distribution of B(a)P 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.

The time series of annual B(a)P emissions from the HELCOM Contracting Parties is presented in Figure 3. Among these countries, Sweden saw the largest reduction in emissions (68%), followed by Denmark (65%) and Estonia (62%). In contrast, Finland's emissions in 2022 were 6% higher than those in 1990.

In 2022, total anthropogenic B(a)P emissions from the HELCOM Contracting Parties amounted to 217 tonnes, with the largest contributors being Russia (51%), Poland (34%), and Germany (8%).

Given the generally high uncertainties of emission estimates and the lack of reported data for the Russian Federation (see Metadata), the total estimate of B(a)P emissions from the HELCOM countries and its temporal changes remains highly uncertain.

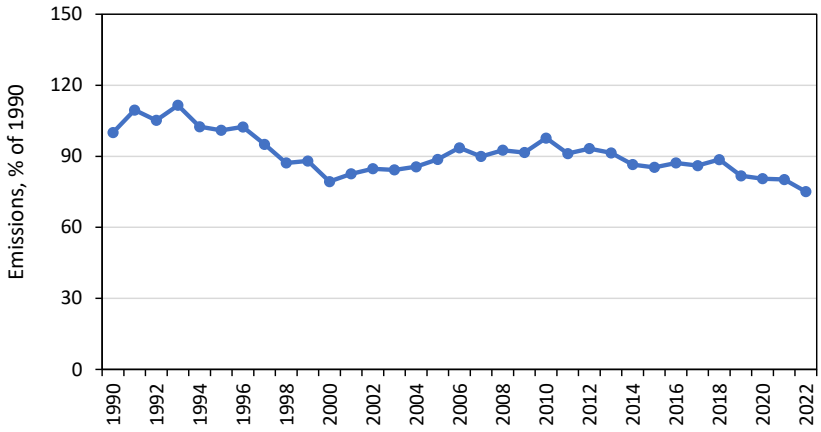

Figure 1. Relative changes of total annual emissions of B(a)P to the atmosphere from the HELCOM Contracting Parties in period 1990-2022 (% of 1990).

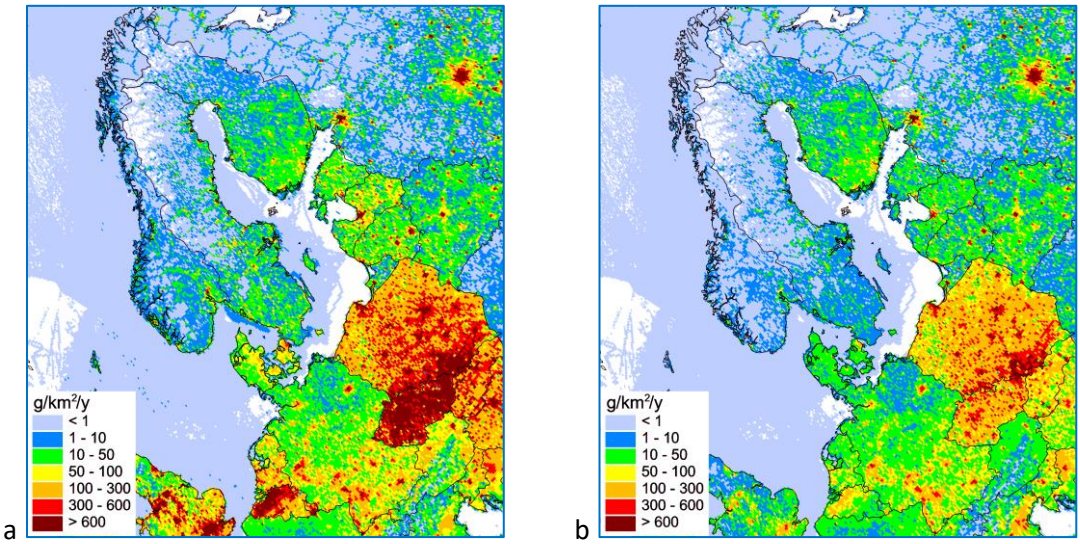

Figure 2. Spatial distribution of annual anthropogenic B(a)P emissions to the atmosphere in the Baltic Sea region in 1990 (a) and in 2022 (b).

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

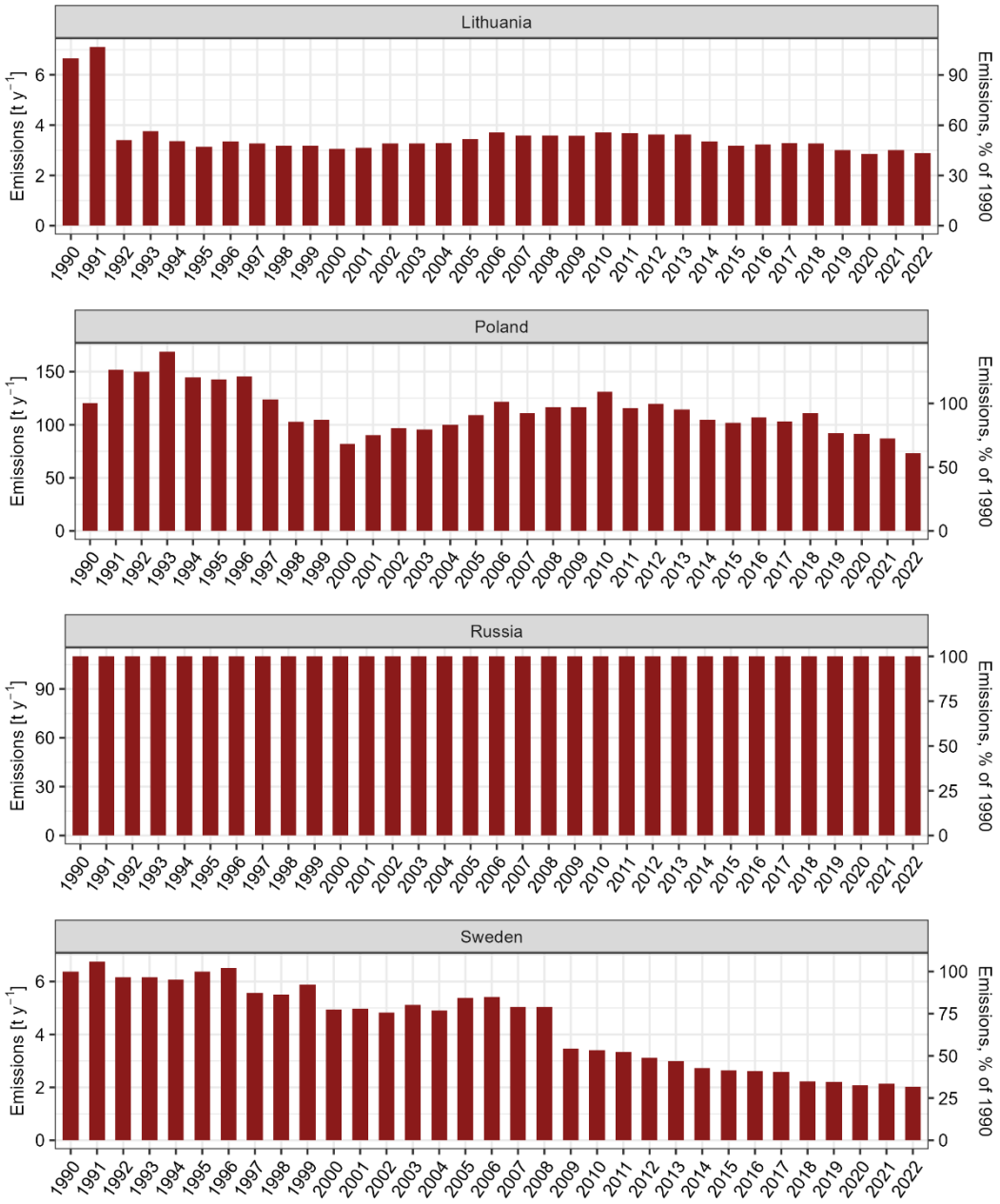

Figure 3 (continued). Atmospheric B(a)P emissions from HELCOM Contracting Parties during the period 1990-2022. The emission data for Russia pertains to the territory within the EMEP domain.

Data

Supporting Excel here

Numerical data on anthropogenic B(a)P emissions from HELCOM Contracting Parties are provided in the table below.

Table 1. B(a)P 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	3.5	2.8	5.7	27	6.3	6.7	120	110	6.4	289
1991	3.9	2.8	5.8	21	6.9	7.1	152	110	6.7	316
1992	3.8	1.9	5.8	17	5.9	3.4	150	110	6.2	304
1993	4.0	1.6	5.8	16	6.3	3.8	169	110	6.2	322
1994	3.7	1.7	6.1	14	6.2	3.4	145	110	6.1	296
1995	3.6	2.9	5.5	11	6.0	3.1	143	110	6.4	291
1996	3.6	3.4	5.9	11	6.2	3.3	145	110	6.5	295
1997	3.4	3.1	5.9	13	6.3	3.3	124	110	5.6	274
1998	2.8	2.3	6.2	13	6.3	3.2	103	110	5.5	252
1999	2.6	2.3	6.0	13	6.9	3.2	105	110	5.9	254
2000	2.9	2.1	5.6	12	6.1	3.1	82	110	4.9	229
2001	3.0	2.0	6.4	13	5.6	3.1	90	110	5.0	238
2002	2.7	1.9	6.4	13	5.5	3.3	97	110	4.8	244
2003	2.9	1.9	6.6	12	5.8	3.3	95	110	5.1	243
2004	2.9	1.9	6.7	12	5.7	3.3	100	110	4.9	247
2005	3.1	1.6	7.0	12	4.7	3.4	109	110	5.4	256
2006	3.0	1.5	6.7	13	4.8	3.7	122	110	5.4	270
2007	3.4	1.7	7.0	14	4.4	3.6	111	110	5.0	259
2008	3.0	1.7	6.9	16	4.3	3.6	117	110	5.0	267
2009	2.5	1.7	7.3	15	4.7	3.6	117	110	3.5	264
2010	2.4	1.7	8.1	18	3.6	3.7	131	110	3.4	282
2011	2.1	1.4	7.0	16	3.6	3.7	116	110	3.3	263
2012	2.0	1.4	7.6	18	3.6	3.6	120	110	3.1	269
2013	2.1	1.4	7.3	19	3.2	3.6	115	110	3.0	264
2014	1.9	1.3	7.4	15	3.1	3.4	104	110	2.7	250
2015	2.1	1.2	7.0	16	2.5	3.2	102	110	2.6	246
2016	2.1	1.2	7.6	15	2.5	3.2	107	110	2.6	252
2017	1.9	1.2	7.5	16	2.7	3.3	103	110	2.6	248
2018	1.7	1.2	7.4	16	2.9	3.3	111	110	2.2	256
2019	1.5	1.1	7.3	16	2.7	3.0	92	110	2.2	236
2020	1.3	1.2	5.9	15	2.4	2.8	92	110	2.1	232
2021	1.3	1.0	6.6	18	2.5	3.0	87	110	2.1	231
2022	1.2	1.1	6.1	18	2.4	2.9	73	110	2.0	217

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 B(a)P 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/). No official emissions data on B(a)P is available from the Russian Federation; instead, expert estimates by EMEP/CEIP are used for this country (Poupa, 2023).

3. Geographical coverage:

   EMEP region.

4. Temporal coverage:

   Data on annual B(a)P emission totals are available for the period from 1990 to 2022 for all HELCOM Contracting Parties, with the exception of the Russian Federation. For the Russian Federation, a single available expert emission estimate provided by CEIP (Poupa, 2023) was applied for the entire period.

5. Methodology and frequency of data collection:

   National B(a)P 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 PAH or B(a)P emissions was reported by Denmark, Estonia, Finland, Latvia, Poland, and Sweden. The uncertainties in reported PAH or B(a)P 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 POPs, 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 PAH/B(a)P emissions reported by HELCOM Contracting Parties.

Country	Pollutant	Uncertainty
Denmark	B(a)P	747%
Estonia	B(a)P	154%
Finland	PAH	184%
Germany	–	–
Latvia	PAH	46%
Lithuania	–	–
Poland	PAH	59%
Russia	–	–
Sweden	PAH	699%

8. Further work required:

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