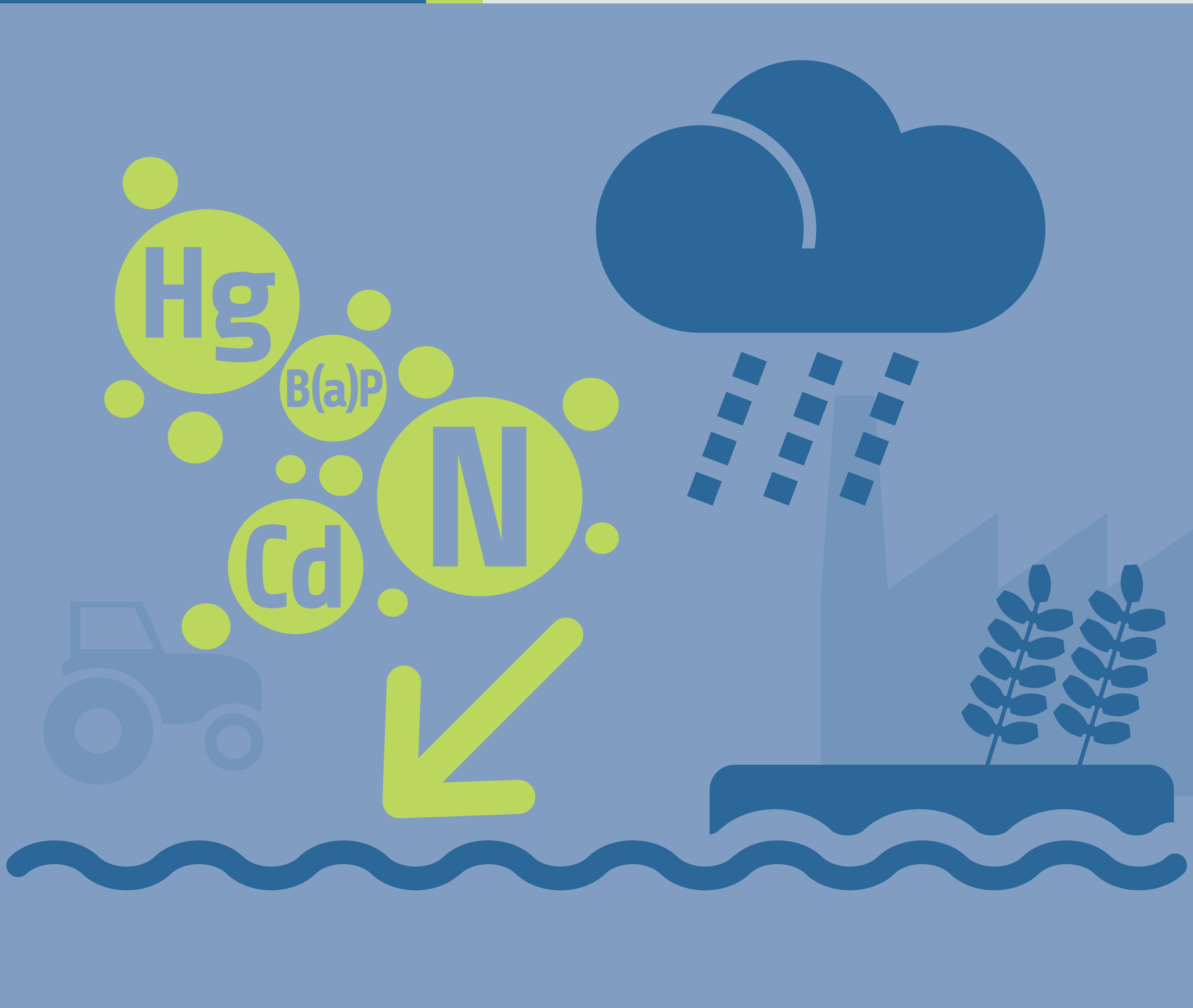
Atmospheric Supply of Nitrogen, Cadmium, Mercury and B(a)P to the Baltic Sea in 2022

Hazardous substances

2025



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EMEP Centres Joint Report for HELCOM
EMEP MSC-W TECHNICAL REPORT 1/2024

Atmospheric Supply of Nitrogen, Cadmium, Mercury and B(a)P to the Baltic Sea in 2022

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Preface

The Co-operative Program for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP) and the Baltic Marine Environment Protection Commission (HELCOM) are both conducting work on air monitoring modelling and compilation of emission inventories. In 1995, HELCOM decided to rationalise its current programs by avoiding duplication of efforts with specialised international organizations.

At the request of HELCOM, the Steering Body of EMEP at its nineteenth session agreed to assume the management of atmospheric monitoring data, the preparation of air emission inventories and the modelling of air pollution in the Baltic region.

Following the coordination meeting held in Potsdam in Germany and the Pollution Load Input meeting held in Klaipeda-Joudkrante in Lithuania, both in 1996, it was agreed that EMEP Centres should be responsible for regular evaluation of the state of the atmosphere in the Baltic Sea region and should produce an annual joint summary report which includes updated emissions of selected air pollutants, modelled deposition fields, allocation budgets and measurement data.

The present web report was prepared for HELCOM, in accordance with the contract between HELCOM and the three EMEP Centres MSC-W, MSC-E and CCC. It is based on model estimates and monitoring results presented to the Tenth Joint session of the Working Group on Effects and the Steering Body to EMEP which took place on 9-13 September 2024.

Acknowledgement

The authors thank HELCOM and the EMEP Trust Fund for their continuous support to conduct this type of studies. The authors also acknowledge great help from colleagues at the EMEP Centres, and in particular CEIP for the provision of anthropogenic emission data.

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1. Introduction

The present EMEP Centres Joint Report for HELCOM is focused on the year 2022. It is based on the modelling and monitoring data presented to the Tenth Joint session of the Working Group on Effects and the Steering Body to EMEP, which occurred in September 2024. This introduction gives a brief overview of what is available and which tools and methods have been used.

1.1 Measurements (EMEP CCC)

The HELCOM monitoring stations regularly collect data on nitrogen compounds, heavy metals and persistent organic pollutants (POPs). All the data can be downloaded from the EBAS database hosted by the Norwegian Institute for Air Research (http://ebas.nilu.no/). Measurements are done in air and in precipitation to monitor trends in pollution and to evaluate models that calculate air concentrations and deposition of pollutants. More than twenty HELCOM stations have submitted data for 2022. More details about the methods and the data themselves can be found in Chapter 2.

1.2 Nitrogen modelling (EMEP MSC-W)

Nitrogen components are emitted to the air from a large variety of natural and anthropogenic sources and can be transported over large distances (hundreds to thousands of kilometres) in the atmosphere, undergoing physical and chemical transformations on the way until eventually deposited to land and marine surfaces. Calculating concentrations and deposition of nitrogen requires a detailed representation of all important processes involved, as well as reliable input data on emissions, meteorology, land use data, etc.

For all nitrogen computations, the EMEP MSC-W model, a multi-pollutant 3D Eulerian Chemical transport model, has been used. The model takes into account processes of emissions, advection, turbulent diffusion, chemical transformations, wet and dry depositions and inflow of pollutants into the model domain. It was documented in detail in Simpson et al. (2012) and in the annual chapters on model updates in subsequent EMEP status reports (Simpson et al., 2022; 2023; 2024; and references therein). The model is regularly evaluated against measurements from the EMEP network at online at the AeroVal evaluation server (https://aeroval.met.no/pages/evaluation/?project=emep), but also in a large number of international research projects and operational services (e.g. Copernicus Atmosphere Modelling Service https://regional.atmosphere.copernicus.eu/). The performance of the EMEP MSC-W model can be considered as state-of-the-art over a large range of both gaseous species and particulate matter. The model code (software) is also available as Open Source (https://github.com/metno/emep-ctm) and has been widely used both as a research tool and for underpinning of air quality legislation.

The EMEP MSC-W model version rv5.3 (EMEP, 2024) has been run at 0.1×0.1 degree resolution to calculate nitrogen deposition to the Baltic Sea during the 33-year period 1990-2022. Source-receptor matrices for nitrogen have been calculated for 2022 at 0.3° longitude x 0.2° latitude resolution. Meteorological data have been taken from ECMWF (cy40r1 for the 1990-2017 period, cy46r1 for 2018-2020 and cy48r1 for 2021 and 2022), emissions are based on officially reported data to CEIP (June 2024), and boundary conditions and forest fires for 2022 are based on observations and the FINN database v2.5 (Wiedinmyer et al. 2011, 2023), respectively.

Annexes A and B contain fact sheets with emissions and depositions of nitrogen. Source-receptor data for nitrogen deposition are found in Annex I. All annexes are available at https://emep.int/publ/helcom/2024/.

1.3 Heavy metals and POPs (EMEP MSC-E)

Heavy metals and POPs are toxic substances characterised by their ability for long-range atmospheric transport, accumulation in environmental media, and re-emission back into the atmosphere. Modelling the dispersion of these pollutants in the environment requires detailed information on their anthropogenic, natural, and secondary emissions, as well as representation of their transport, physical and chemical transformation in the atmosphere, and processes of air-surface exchange.

The atmospheric deposition and source attribution of cadmium, mercury and benzo(a)pyrene (B(a)P) to the Baltic Sea were calculated using the GLEMOS model developed by EMEP/MSC-E (https://github.com/glemos-model). GLEMOS is a multi-scale, multi-pollutant simulation framework developed for both operational and research applications within EMEP (Tarrason and Gusev, 2008; Travnikov et al., 2009; Jonson and Travnikov, 2010; Travnikov and Jonson, 2011). The model simulates the dispersion and cycling of various pollutant classes, including heavy metals and POPs, with flexible options for simulation domains ranging from global to local scales and varying spatial resolutions. Vertically, the model domain extends up to 10 hPa (approximately 30 km), consisting of 20 irregular terrain-following sigma layers, 10 of which cover the lowest 5 km of the troposphere. The height of the lowest layer is about 75 metres. Boundary conditions for model simulations over the EMEP domain were evaluated using GLEMOS simulations on a global scale. The GLEMOS model results are regularly evaluated against measurements of the EMEP monitoring network under the LRTAP Convention (e.g. Ilyin et al., 2022; Travnikov et al., 2024) and in numerous multi-model intercomparison studies (e.g. Travnikov et al. 2017; AMAP/ UN Environment, 2019).

The model simulations of transport and deposition of the selected pollutants in 2022 were conducted using the GLEMOS model (v2.2.2) with a spatial resolution 0.2°×0.2°. Source-receptor matrices required for source attribution analysis were calculated based on model runs at a 0.4°×0.4° resolution. Due to time constraints, recalculation of the deposition time series for 1990-2021 was not performed. Instead, trend analysis the entire period from 1990-2022 was conducted using previously calculated results. The simulations used the latest officially reported emissions data (EMEP reporting 2024). Meteorological data were generated from ECMWF reanalysis data (ERA-Interim) and processed with the WRF numerical weather prediction model as a meteorological pre-processor (Skamarock et al., 2008). Atmospheric concentrations of chemical reactants and particulate matter, necessary for mercury and B(a)P chemistry, were imported from the GEOS-Chem model (GEOS-Chem, 2024).

Fact Sheets are provided for cadmium, mercury and B(a)P and are available as annexes C to H at https://emep.int/publ/helcom/2024/. On the same page, data tables can be downloaded in Excel format (annexes J to O).

1.4 Model geometry, domains and definitions

For most pollutants the EMEP models are run on a regular longitude-latitude grid covering the EMEP domain as depicted in Figure 1.1.

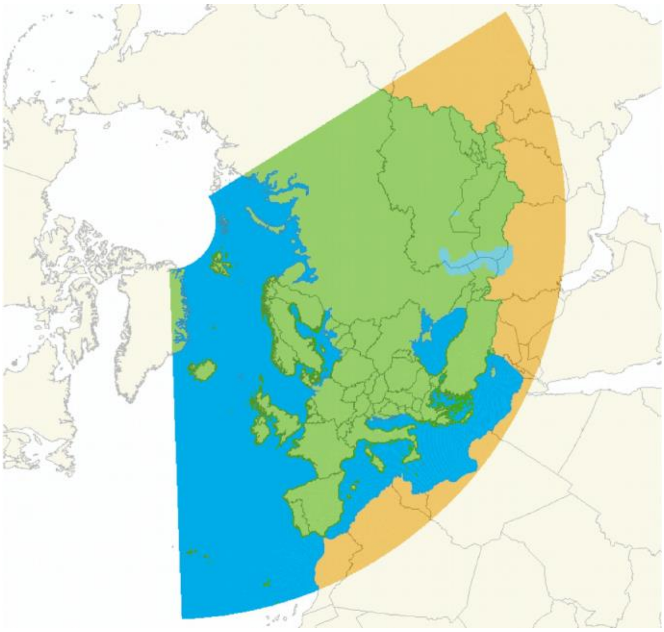


Figure 1.1 The EMEP model domain covering the geographic area between 30°N-82°N latitude and 30°W-90°E longitude.

Table 1.1 The nine sub-basins of the Baltic Sea used for computing deposition of nitrogen, heavy metals and POPs, with abbreviations used in this report and areas given in km^2.

Sub-basin	**Abbreviation**	**Area**
Archipelago Sea	ARC	13405
Baltic Proper	BAP	209258
Bothnian Bay	BOB	36249
Bothnian Sea	BOS	65397
Gulf of Finland	GUF	29998
Gulf of Riga	GUR	18646
Kattegat	KAT	23659
The Sound	SOU	2328
Western Baltic	WEB	18647
Baltic Sea basin	**BAS**	**417587**

The nine sub-basins of the Baltic Sea used in the computations are listed in Table 1.1 and shown in Figure 1.2. There are large differences in the sizes of individual sub-basins. The area of the largest one, Baltic Proper, is almost two orders of magnitude higher than the area of the smallest on, The Sound. The area of the entire Baltic Sea basin, calculated as the sum of sub-basins is 417 587 km^2.

In this report and accompanying data tables, the names of countries, sources and receptors are often abbreviated. The list of these abbreviations is given in Table 1.2 together with the EMEP identification number.

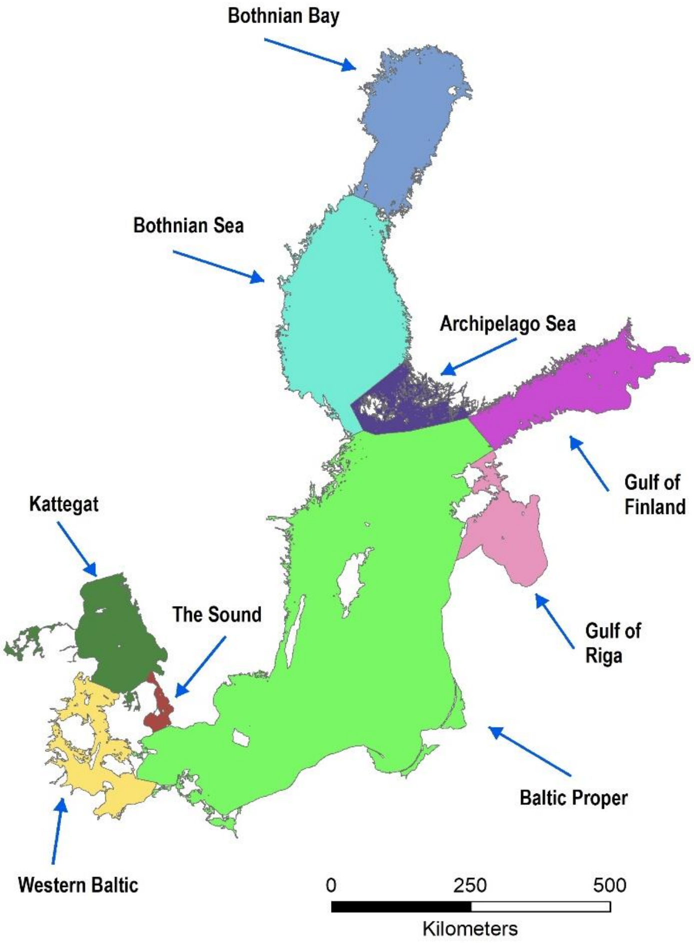


Figure 1.2 Locations of the sub-basins of the Baltic Sea listed in Table 1.1 and used for all deposition calculations of nitrogen, heavy metals and POPs presented in this report. This figure has been provided by the Baltic Nest Institute (BNI).

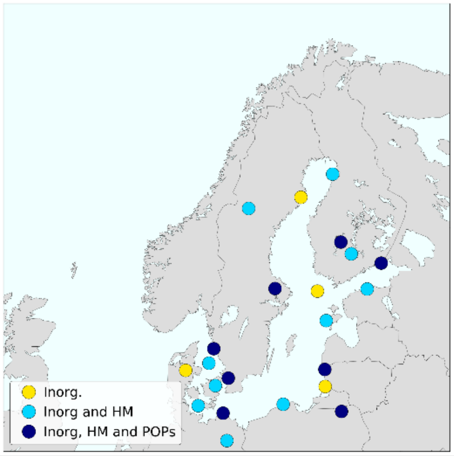
Table 1.2 Country and area names and abbreviations used in this report and accompanying tables.

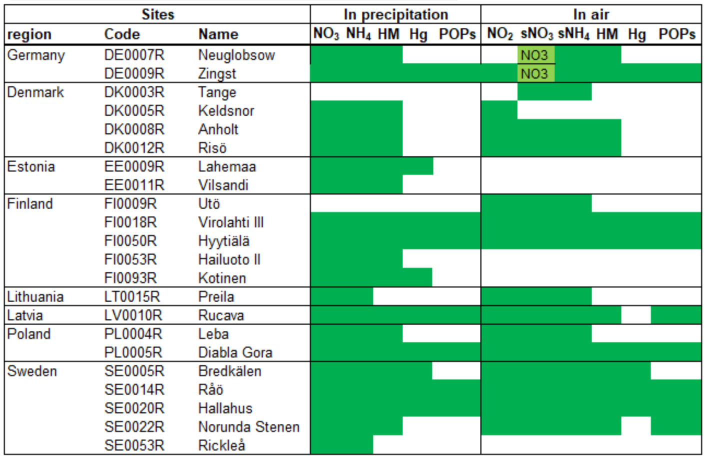
CODE	**NAME**	**CODE**	**NAME**
AL	Albania	**IT**	Italy
AM	Armenia	**KG**	Kyrgyzstan
AST	Asian areas	**KZ**	Kazakhstan
AT	Austria	**LI**	Liechtenstein
ATL	North-East Atlantic Ocean	**LT**	Lithuania
AZ	Azerbaijan	**LU**	Luxembourg
BA	Bosnia and Herzegovina	**LV**	Latvia
BAS	Baltic Sea	**MC**	Monaco
BE	Belgium	**MD**	Moldova
BG	Bulgaria	**ME**	Montenegro
BIC	Boundary/Initial Conditions	**MED**	Mediterranean Sea
BLS	Black Sea	**MK**	North Macedonia
BY	Belarus	**MT**	Malta
CH	Switzerland	**NL**	Netherlands
CY	Cyprus	**NO**	Norway
CZ	Czechia	**NOA**	North Africa
DE	Germany	**NOS**	North Sea
DK	Denmark	**PL**	Poland
EE	Estonia	**PT**	Portugal
ES	Spain	**RO**	Romania
EU	European Union (EU-27)	**RS**	Serbia
FI	Finland	**RU**	Russian Federation
FR	France	**SE**	Sweden
GB	United Kingdom	**SI**	Slovenia
GE	Georgia	**SK**	Slovakia
GL	Greenland	**TJ**	Tajikistan
GR	Greece	**TM**	Turkmenistan
HR	Croatia	**TR**	Türkiye
HU	Hungary	**UA**	Ukraine
IE	Ireland	**UZ**	Uzbekistan
IS	Iceland		

2. Observations at HELCOM Stations in 2022

Eight countries have submitted data from a total of twenty-two HELCOM stations for 2022. In Figure 2.1 and overview Table 2.1, the measurements program is indicated. No changes in the measurement programme or the methodology are reported for 2022, compared to what was reported for the previous year.

Figure 2.1. *HELCOM sites and their measurement programme in 2022*





Sites			In precipitation					In air					
region	**Code**	**Name**	**NO_3**	**NH_4**	**HM**	**Hg**	**POPs**	**NO_2**	**sNO_3**	**sNH_4**	**HM**	**Hg**	**POPs**
Germany	DE0007R	Neuglobsow	🟩	🟩	🟩				NO3	🟩	🟩		
	DE0009R	Zingst	🟩	🟩	🟩	🟩	🟩	🟩	NO3	🟩	🟩	🟩	🟩
Denmark	DK0003R	Tange							🟩	🟩			
	DK0005R	Keldsnor	🟩	🟩	🟩			🟩					
	DK0008R	Anholt	🟩	🟩	🟩			🟩	🟩	🟩	🟩		
	DK0012R	Risö	🟩	🟩	🟩			🟩	🟩	🟩	🟩		
Estonia	EE0009R	Lahemaa	🟩	🟩	🟩	🟩							
	EE0011R	Vilsandi	🟩	🟩	🟩								
Finland	FI0009R	Utö						🟩	🟩	🟩			
	FI0018R	Virolahti III	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	FI0050R	Hyytiälä	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	FI0053R	Hailuoto II	🟩	🟩	🟩								
	FI0093R	Kotinen	🟩	🟩	🟩	🟩							
Lithuania	LT0015R	Preila	🟩	🟩				🟩	🟩	🟩			
Latvia	LV0010R	Rucava	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		🟩
Poland	PL0004R	Leba	🟩	🟩	🟩			🟩	🟩	🟩			
	PL0005R	Diabla Gora	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Sweden	SE0005R	Bredkälen	🟩	🟩	🟩	🟩		🟩	🟩	🟩	🟩	🟩	
	SE0014R	Råö	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	SE0020R	Hallahus	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	SE0022R	Norunda Stenen	🟩	🟩	🟩			🟩	🟩	🟩	🟩		🟩
	SE0053R	Rickleå	🟩	🟩									

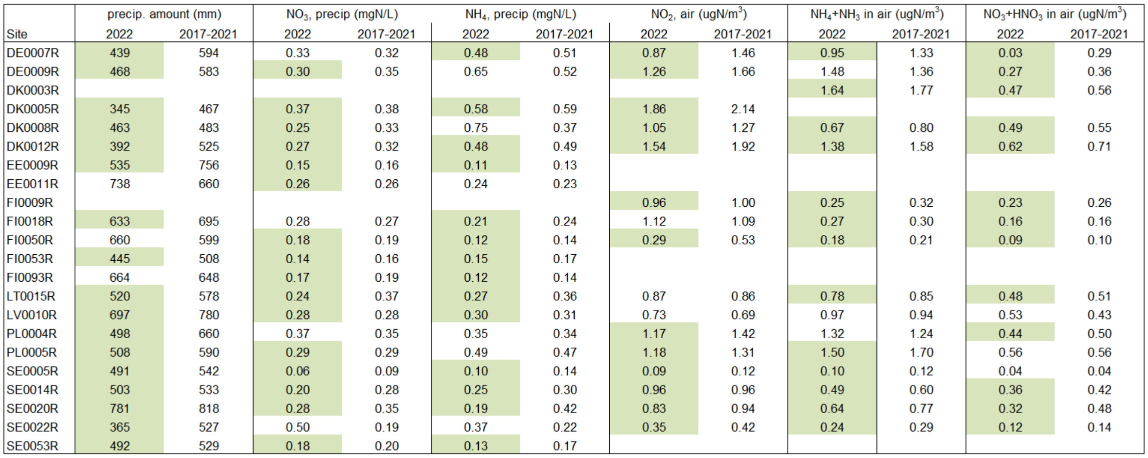
Statistical details and information on measurement methods can be found in the EMEP reports (Hjellbrekke, 2024; Aas et al., 2024), and all data are available in the EBAS database (http://ebas.nilu.no/). The annual mean concentrations of nitrogen components and heavy metals in air and precipitation for 2022 are shown in Tables 2.1 and 2.2, compared to the average of the preceding five years.

As shown in Table 2.1, most sites, except for those in Sweden, recorded lower concentrations of both reduced and oxidized nitrogen in 2022 compared to the five-year average. From 2000 to 2022, average oxidized nitrogen concentrations decreased by 25–

30%, while reduced nitrogen concentrations fell by about 20% in precipitation and more than 40% in air (Figure 2.2). The sum of NH_3 and NH_4 in the air is dominated by ammonium, and this change is closely linked to sulfate, which has also decreased substantially over the same period (Aas et al., 2024).

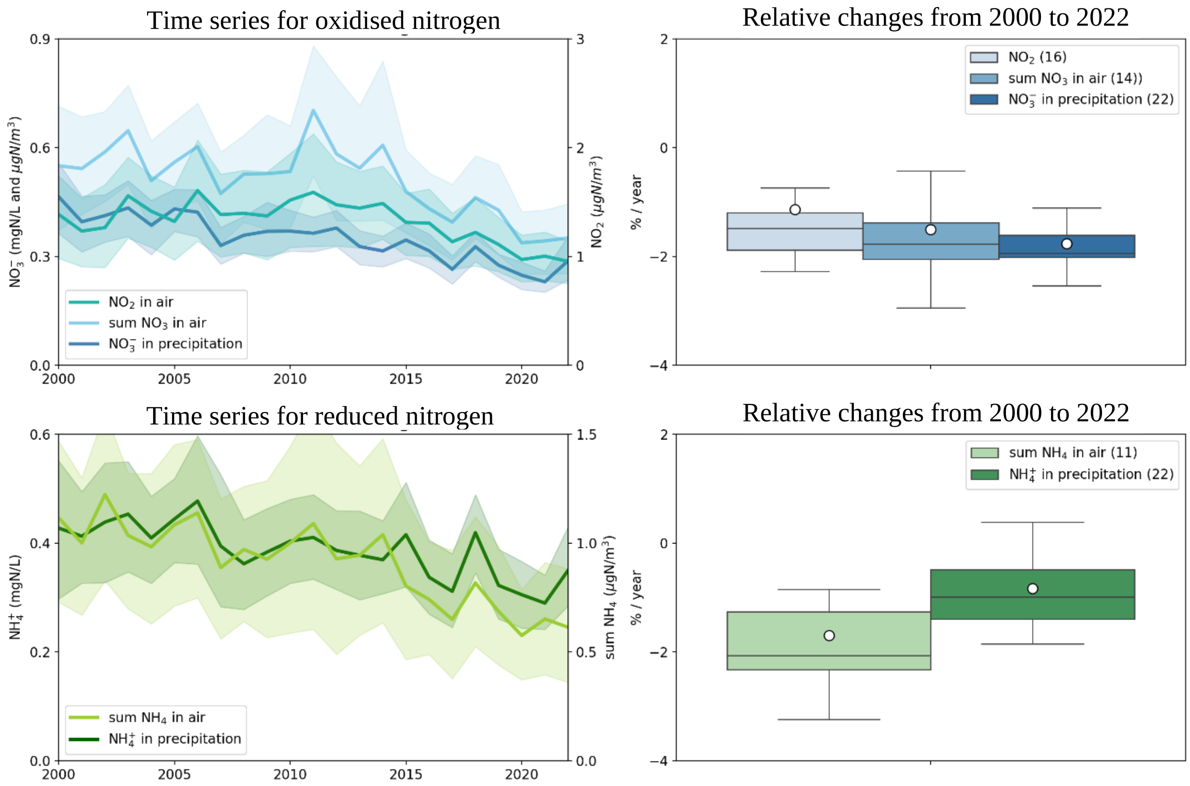
For heavy metals, most elements showed lower concentrations in 2022 in both air and precipitation across most sites, except for Cu in precipitation, which showed somewhat higher concentrations in 2022 for unknown reasons. Time series for this year's priority elements, cadmium and mercury, are shown in Figure 2.3, with significant reductions for both. Cadmium concentrations have decreased by around 80% since 2000, while mercury has seen higher reductions in precipitation (around 50%) than in air (around 10%), though the trends for mercury are uncertain due to relatively few sites with measurements dating back to 2000, and the time series of especially mercury in precipitation show large inter-annual variability.

The priority POPs (persistent organic pollutants) to be assessed are PAHs. Table 2.3 presents the annual concentrations of selected PAHs in air and precipitation or deposition. It is difficult to compare concentration levels in precipitation due to differing methods, such as measuring concentrations in precipitation versus deposition. In air the largest concentrations are seen Poland, though there are some variations between the different PAHs.



	precip. amount (mm)		NO_3, precip (mgN/L)		NH_4, precip (mgN/L)		NO_2, air (ugN/m^3)		NH_4+NH_3 in air (ugN/m^3)		NO_3+HNO_3 in air (ugN/m^3)	
Site	2022	2017-2021	2022	2017-2021	2022	2017-2021	2022	2017-2021	2022	2017-2021	2022	2017-2021
DE0007R	439	594	0.33	0.32	0.48	0.51	0.87	1.46	0.95	1.33	0.03	0.29
DE0009R	468	583	0.30	0.35	0.65	0.52	1.26	1.66	1.48	1.36	0.27	0.36
DK0003R									1.64	1.77	0.47	0.56
DK0005R	345	467	0.37	0.38	0.58	0.59	1.86	2.14				
DK0008R	463	483	0.25	0.33	0.75	0.37	1.05	1.27	0.67	0.80	0.49	0.55
DK0012R	392	525	0.27	0.32	0.48	0.49	1.54	1.92	1.38	1.58	0.62	0.71
EE0009R	535	756	0.15	0.16	0.11	0.13						
EE0011R	738	660	0.26	0.26	0.24	0.23						
FI0009R							0.96	1.00	0.25	0.32	0.23	0.26
FI0018R	633	695	0.28	0.27	0.21	0.24	1.12	1.09	0.27	0.30	0.16	0.16
FI0050R	660	599	0.18	0.19	0.12	0.14	0.29	0.53	0.18	0.21	0.09	0.10
FI0053R	445	508	0.14	0.16	0.15	0.17						
FI0093R	664	648	0.17	0.19	0.12	0.14						
LT0015R	520	578	0.24	0.37	0.27	0.36	0.87	0.86	0.78	0.85	0.48	0.51
LV0010R	697	780	0.28	0.28	0.30	0.31	0.73	0.69	0.97	0.94	0.53	0.43
PL0004R	498	660	0.37	0.35	0.35	0.34	1.17	1.42	1.32	1.24	0.44	0.50
PL0005R	508	590	0.29	0.29	0.49	0.47	1.18	1.31	1.50	1.70	0.56	0.56
SE0005R	491	542	0.06	0.09	0.10	0.14	0.09	0.12	0.10	0.12	0.04	0.04
SE0014R	503	533	0.20	0.28	0.25	0.30	0.96	0.96	0.49	0.60	0.36	0.42
SE0020R	781	818	0.28	0.35	0.19	0.42	0.83	0.94	0.64	0.77	0.32	0.48
SE0022R	365	527	0.50	0.19	0.37	0.22	0.35	0.42	0.24	0.29	0.12	0.14
SE0053R	492	529	0.18	0.20	0.13	0.17						

Table 2.1. *Annual average mean concentrations of different nitrogen components in air and precipitation measured at HELCOM sites in 2022 compared with the average of the period 2017-2021. Green shaded areas indicate lower concentration than the preceding years. The five-year averages are calculated when there are three years of data or more.*

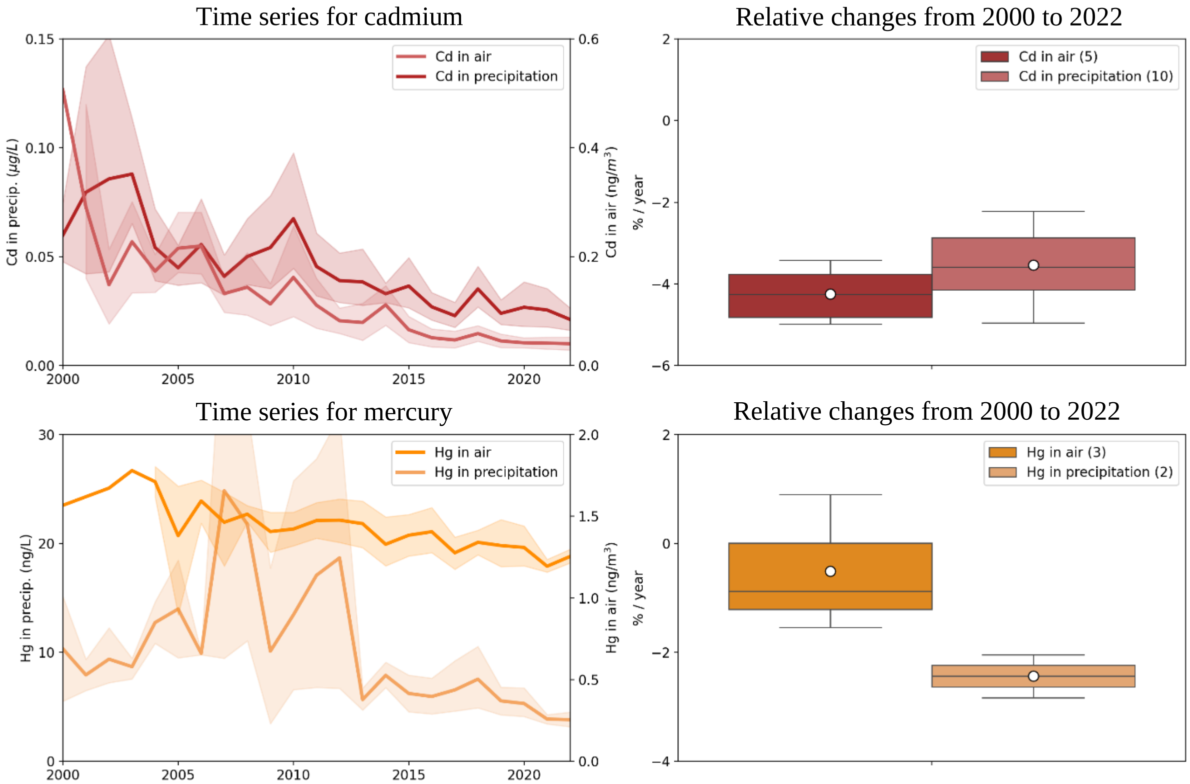

Time series for oxidised nitrogen

Relative changes from 2000 to 2022

Time series for reduced nitrogen

Relative changes from 2000 to 2022

Figure 2.2. *Time series in observed nitrogen concentrations at HELCOM sites from 2000–2022. The solid lines in the time series (left) show the average annual concentrations for all sites, with the shaded area representing the 95% confidence interval. The box plots (right) display the 25th, 50th (median), and 75th percentiles, with whiskers extending within 1.5 inter-quartile ranges. White circles mark the mean changes. The box plot legend shows the number of sites with measurements in 2022 and at least 75% data coverage during the period.*



Time series for cadmium

Relative changes from 2000 to 2022

Time series for mercury

Relative changes from 2000 to 2022

***Figure 2.3**. Changes in cadmium and mercury concentrations at HELCOM sites from 2000–2022. Similar as Figure 2.2.*

	As, precip (ug/L)		Cd, precip (ug/L)		Pb, precip (ug/L)		Cu, precip (ug/L)		Hg, precip (ng/L)	
Site	2022	2017-2021	2022	2017-2021	2022	2017-2021	2022	2017-2021	2022	2017-2021
DE0007R	0.100	0.078	0.018	0.016	0.55	0.48	0.94	0.86		
DE0009R	0.056	0.062	0.012	0.014	0.33	0.37	0.61	0.63	4.79	6.59
DK0005R	0.186	0.098	0.054	0.037	1.84	1.31	0.41	1.70		
DK0008R	0.194	0.205	0.026	0.021	0.90	0.55	0.11	1.05		
DK0012R	0.076	0.101	0.032	0.033	0.61	0.57				
EE0009R	0.038	0.048	0.017	0.042	0.25	0.42	1.01	1.79	2.50	3.97
EE0011R			0.021	0.035	0.25	0.43	0.92	2.01		
FI0018R	0.093	0.080	0.022	0.026	0.72	0.71	0.87	0.65	3.70	3.86
FI0050R	0.055	0.063	0.014	0.016	0.38	0.36	0.51	0.62	3.18	4.04
FI0053R	0.043	0.050	0.009	0.013	0.23	0.31	0.64	0.60		
FI0093R	0.045	0.050	0.010	0.014	0.24	0.33	0.61	0.47	3.43	3.46
LV0010R	0.094	0.149	0.016	0.020	0.30	0.50	1.28		3.95	8.87
PL0004R			0.009	0.014	0.19	0.27	0.62	0.59		
PL0005R	0.274	0.256	0.017	0.032	0.37	0.46	1.37	1.02	3.46	5.29
SE0005R	0.024	0.046	0.011	0.018	0.86	0.24	2.62	1.96	2.49	4.74
SE0014R	0.080	0.103	0.032	0.045	0.40	0.45	2.40	2.44	5.69	6.70
SE0020R	0.102	0.092	0.031	0.048	0.76	0.49	4.13	2.21	5.09	7.54
SE0022R	0.070	0.068	0.030	0.016	0.64	0.33	5.76	2.40		

	As, aerosol (ng/m^3)		Cd, aerosol (ng/m^3)		Pb, aerosol (ng/m^3)		Cu, aerosol (ng/m^3)		Hg air (ng/m^3)	
Site	2022	2017-2021	2022	2017-2021	2022	2017-2021	2022	2017-2021	2022	2017-2021
DE0007R	0.52	0.46	0.074	0.082	2.34	2.69	1.46	1.50		
DE0009R	0.30	0.35	0.050	0.067	1.57	2.15	1.36	1.33	1.37	1.42
DK0008R	0.22	0.24	0.032	0.035	0.96	1.15				
DK0012R	0.22	0.34	0.048	0.049	1.37	1.53				
FI0018R	0.22	0.22	0.045	0.053	1.46	1.76	0.62	0.78	1.18	1.24
FI0050R	0.17	0.19	0.030	0.039	0.72	1.04	0.42	0.55	1.21	1.14
LV0010R	0.17	0.26	0.049	0.059	3.00	1.52	1.32			
PL0005R	0.22	0.24	0.087	0.076	1.64	2.18	0.91	1.38	1.31	1.46
SE0005R	0.04	0.05	0.007	0.009	0.18	0.26	0.13	0.18	1.23	1.27
SE0014R	0.20	0.23	0.026	0.031	0.71	0.92	0.66	0.84	1.24	1.23
SE0020R	0.20	0.21	0.031	0.034	1.03	1.15	0.99	1.04	1.24	1.28
SE0022R	0.13	0.13	0.022	0.024	0.59	0.71	0.52	0.55		

Table 2.2. *Annual average mean concentrations of Arsenic (As), cadmium (Cd). Lead (Pb), copper (Cu) and mercury (Hg) in air and precipitation measured at HELCOM sites in 2022 compared with the average of the period 2017-2021. Green shaded area indicates lower concentration than the preceding years. The five-year averages are calculated when there are three years of data or more.*

In air and aerosols (ng/m^3)

Site	Matrix	B[a]A	B[a]P	B[ghi]P	DiB[ah]A	fluoranthene	Ind[123-cd]P	phenanthrene	pyrene
DE0009R	air+pm10	0.109	0.136	0.148	0.028	0.864	0.162	2.070	0.604
FI0018R	pm10	0.204	0.277	0.239	0.010	0.755	0.184	0.564	0.718
FI0050R	pm10	0.144	0.206	0.176	0.007	0.509	0.133	0.278	0.515
LV0010R	pm10	0.064	0.093		0.022		0.136		
PL0005R	pm10	0.310	0.405		0.058		0.500		
SE0014R	air+aerosol	0.038	0.031	0.039	0.006	0.263	0.046	0.694	0.193
SE0020R	air+aerosol	0.024	0.007	0.041	0.006	0.069	0.044	0.044	0.059
SE0022R	air+aerosol	0.023	0.020	0.022	0.004	0.203	0.027	0.612	0.151

In precipitation or total depostion

Site	Matrix	unit	B[a]A	B[a]P	B[ghi]P	DiB[ah]A	fluoranthene	Ind[123-cd]P	pyrene
DE0009R	precip_tot	ng/l	1.92	2.10	3.55	0.56	15.29	3.84	8.40
FI0018R	precip+dry_dep	ng/m^{2}day	13.58	15.40	14.63	1.91	55.39	11.61	47.08
FI0050R	precip+dry_dep	ng/m^{2}day	5.00	6.44	6.92	1.07	26.21	5.72	18.73
LV0010R	precip	ng/l	6.27	6.11		1.90		10.21	
PL0005R	precip	ng/m^{2}day	16.00	20.52		2.79		24.56	
SE0014R	precip+dry_dep	ng/m^{2}day	2.32	1.92	1.88	0.38	9.92	2.65	7.03
SE0020R	precip+dry_dep	ng/m^{2}day	3.63		3.82	0.67	17.32	5.21	12.39

B[a]A: benz[a]anthracene, B[a]P: benzo[a]pyrene, B[ghi]P: benzo_ghi_perylene, DiB[ah]A: dibenzo_ah_anthracene, Ind[123-cd]P: indeno[123-cd]pyrene

Table 2.3. *Annual average mean concentrations of various PAHs in air and aerosol, and precipitation or deposition at HELCOM sites in 2022.*

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