Baltic Sea Environment Proceedings No. 108

Heavy Metal Pollution to the Baltic Sea in 2004

Helsinki Commission
Baltic Marine Environment Protection Commission

Baltic Sea Environment Proceedings No. 108

Heavy Metal Pollution to the Baltic Sea in 2004

Helsinki Commission
Baltic Marine Environment Protection Commission

For bibliographic purposes this document should be cited to as:
HELCOM 2007
Heavy Metal Pollution to the Baltic Sea in 2004
HELCOM Balt. Sea Environ. Proc. No. 108, 33 pp.

ISSN 0357-2994

Table of Contents

Abstract 4
Preface 5
1. Introduction 6
2. Cadmium 9
    Cadmium emissions and sources 9
    Cadmium loads to the Baltic Sea 9
3. Lead 11
    Lead emissions and sources 11
    Lead loads to the Baltic Sea 11
4. Mercury 13
    Mercury emissions and sources 13
    Mercury loads to the Baltic Sea 13
5. Transboundary riverine pollution 15
6. Long-term changes and trends in emissions and loads 16
    Emissions 16
    Loads 16
7. Actions and policies 20
    HELCOM actions 20
    International efforts 21
8. Conclusions, recommendations and further action 23
References 26
Annex 1: Data tables 27

Abstract

The Helsinki Commission (HELCOM) produces periodic assessments of the state of the Baltic Sea to support the development of appropriate policies aimed at protecting the marine environment of the Baltic Sea area. This report is based on the latest available information on emissions and loads of cadmium, lead and mercury to the Baltic Sea in 2004.[1] Although HELCOM has developed jointly agreed monitoring guidelines, methodologies have differed over time and by country. In addition, the submission of data by the Contracting Parties has been variable, meaning that the available information contains significant uncertainties. The quality of data should be borne in mind when interpreting the results and conclusions presented in this report.

Heavy metals are transported to the sea either via rivers, run-off in coastal areas, direct waterborne discharges to the sea or by wet and dry atmospheric deposition. In the case of airborne loads, these also originate from distant sources outside the Baltic Sea catchment area.

Heavy metals can accumulate in the marine food web up to levels which are toxic to marine organisms, particularly predators, and they may also represent a health risk for humans. Once released into the Baltic Sea, heavy metals can remain in the water for very long periods. The concentrations of heavy metals in Baltic Sea water are up to 20 times higher compared to the North Atlantic.

When considering annual loads of heavy metals, it is important to bear in mind the fluctuations in meteorological conditions, as air current and the amount of precipitation affect atmospheric deposition and run-off, making it difficult to identify clear temporal trends. Nevertheless, HELCOM monitoring activities indicate that the loads of some heavy metals to the sea have declined over the past 10-20 years. Concentrations of some heavy metals have also decreased in many parts of the Baltic Sea although high concentrations can still be found in certain marine organisms.

The total cadmium load to the Baltic Sea in 2004 was 41 tonnes, of which 86% was waterborne and 14% airborne. The waterborne load was about half and the airborne load about two-thirds of the 1994 load.

The total load of lead to the Baltic Sea in 2004 was 567 tonnes, of which 59% was waterborne and 41% airborne. The waterborne load was about half and the airborne load about two-thirds of the 1994 load. Air emissions of lead from HELCOM countries have dramatically decreased since 1990 (87%) with increased use of unleaded fuel. During the same period atmospheric deposition has decreased by 69% and EMEP (Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air pollutants in Europe) modelling results indicate that over half of the present airborne load of lead to the Baltic Sea originates from sources outside the HELCOM area.

The total mercury load to the Baltic Sea in 2004 was 9.3 tonnes of which 69% was waterborne and 31% airborne. The total annual input of mercury has fluctuated dramatically since the early 1990s and no clear trends can be observed despite air emissions and atmospheric deposition of mercury having decreased by approximately 40%.

As heavy metals are long-range transboundary air pollutants, measures taken in the Baltic region to reduce emissions are not sufficient to reach HELCOM's objective of continuously reducing discharges, emissions and losses towards the target of their cessation by the year 2020, with the ultimate aim of achieving concentrations in the environment near background values for naturally occurring substances and close to zero for man-made synthetic substances. The findings in the report suggest that in order to be able to reach this target, further measures will be needed, not only at regional level, but also at European and global levels. Some recommendations for further actions to tackle the Baltic problems with regard to heavy metal pollution are presented in the conclusions of this report.

[1] Note: Latvia and Russia have not submitted their monitoring data on waterborne loads of cadmium, lead and mercury and Lithuania has not reported their waterborne cadmium loads for 2004. The figures used in this report for these countries have been calculated using a five year average of their latest submitted data.

Preface

In 1974, the Baltic Sea coastal states adopted the Convention for the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention) and committed themselves to undertake measures to prevent and eliminate pollution of the marine environment caused by harmful substances. The revised 1992 Convention requires the Helsinki Commission (HELCOM) to produce periodic assessments on the state of the Baltic Sea in order to ascertain the implementation of the Convention. These assessments are based on measurements and calculations of emissions from point sources and of inputs from diffuse sources to water and air, which the Contracting Parties to the Convention compile annually. Article 24 of the Convention requires the Contracting Parties to co-operate in developing intercomparable observation methods, in performing baseline studies and in establishing complementary or joint programmes for monitoring.[2]

This report summarizes and combines the main results from the latest HELCOM airborne and waterborne pollution load compilations and indicator fact sheets and refers to the year 2004. This report deals only with selected heavy metals (cadmium, lead, and mercury), while the original reports also comprise some eutrophying nutrients and dioxins. The data used have been calculated and submitted by the HELCOM Contracting Parties, using jointly agreed monitoring and reporting guidelines, and have been officially approved at the Commission level. Despite efforts to harmonise data collection and reporting; monitoring methodologies vary greatly over time and by country. Also the many gaps present in the time series make it difficult to identify trends and make conclusions. Despite these uncertainties, an assessment of the loads of heavy metals to the Baltic Sea is a necessary contribution to the work of the Helsinki Commission and this one has been compiled using the best available information.

What makes the Baltic Sea so sensitive?

The Baltic Sea, as one of the world's largest bodies of brackish water, is ecologically unique. Due to its special geographical, climatological, and oceanographic characteristics, the Baltic Sea is highly sensitive to the environmental impacts of human activities in its catchment area, which is approximately four times larger than the sea area itself and serves as home to some 85 million people.

[2] Further information is available in the HELCOM Data and Information Strategy at: http://www.helcom.fi/groups/monas/en_GB/datastrategy/ (accessed 9.2.2007)

The Baltic Sea is connected to the world's oceans by only the narrow and shallow waters of the Sound and the Belt Sea, which limits the exchange of water with the North Sea. This means that some of the water may remain in the Baltic Sea for over 30 years.

Box 1. HELCOM's monitoring activities

HELCOM started joint monitoring programmes in the 1970s in order to provide reliable information on the state of the marine environment. To determine the effectiveness of measures taken to reduce pollution in the Baltic Sea and to support the development of HELCOM's environmental policies, reliable data on different pollution sources as well as inputs of harmful substances into the Baltic Sea need to be reviewed. In addition, quantified input data is a prerequisite to interpret and evaluate the environmental status and related changes in the open sea and coastal waters.

To satisfy these needs, HELCOM annually compiles waterborne riverine and direct coastal load data on various pollutants. Approximately every five years, HELCOM assesses the overall pollution load situation for the whole Baltic Sea area, with Baltic Sea-wide waterborne Pollution Load Compilations (PLCs) having been carried out in 1987 (PLC-1), 1990 (PLC-2), 1995 (PLC-3), and 2000 (PLC-4).

Emissions to the air as well as atmospheric deposition onto the sea are assessed annually by EMEP Centres acting as consultants for HELCOM. Comprehensive airborne pollution load compilations (PLC-Air) have been carried out for HELCOM in 1990, 1995 and 2000.

Box 2. Effects of heavy metals

Heavy metals and other hazardous substances can accumulate in the marine food web up to levels which are toxic to marine organisms, particularly predators, and they may also represent a health risk for humans. Once released into the Baltic Sea, hazardous substances can remain in the water for very long periods.

The gradual pollution of the Baltic marine environment by hazardous substances has caused serious threats to the environment, and may even threaten the health of future generations.

Even though monitoring indicates that the loads of some heavy metals have declined considerably over the past 10-20 years, and the concentrations of some heavy metals have decreased in many parts of the Baltic Sea, high concentrations can still be found in certain marine organisms, notably in Baltic herring. Since the 1980s, lead concentrations in herring have generally decreased.

1 Introduction

This report aims to give an overview of the amounts of cadmium, lead and mercury entering the Baltic Sea and their sources. When interpreting the results, the reader should bear in mind the comments on uncertainties in data (see box 4).

Figure 1 shows the sub-basins of the Baltic Sea as well as the countries within the catchment area. Table 1 gives details of the size of the catchment area and the population living in the countries around the Baltic Sea.

HELCOM annually compiles data on the amount of selected waterborne and airborne pollutants entering the Baltic Sea. The waterborne loads include inputs via rivers and point sources discharging directly into the sea. Riverine loads are measured at the river mouth and include inputs from point sources and diffuse sources (such as agriculture, managed forestry, and natural background sources) within the catchment area. The inputs from rivers also include contributions from parts of the Baltic Sea catchment area which lie outside HELCOM countries (e.g. transboundary pollution).

The airborne inputs in this report refer only to atmospheric deposition on the Baltic Sea and originate from sources from both inside and outside the catchment area of the Baltic Sea. These sources are taken into account when modelling heavy metal deposition on the Baltic Sea (Barnicki *et al.* 2006).

The following chapters give information about the sources, the amount of emissions and the loads to the Baltic Sea of cadmium, lead and mercury.

Table 1. **Information on the Baltic Sea catchment area and population sizes by country.**

Country	Total surface area (km^2)	Baltic Sea catchment area (km^2)	% of total national area within catchment	% of total catchment area	Inhabitants within Baltic Sea catchment area in 2000	Population density in catchment area
Denmark	43094	31110	72.2	1.8	4682400	150.5
Estonia	45226	45100	99.7	2.6	1483942	32.9
Finland	337030	301300	89.4	17.5	5107790	17.0
Germany	357021	28600	8.0	1.7	3140000	109.8
Latvia	64589	64600	100.0	3.8	2529000	39.1
Lithuania	65200	65200	100.0	3.8	3717700	57.0
Poland	312685	311900	99.7	18.1	38609000	123.8
Russia	17075200	314800	1.8	18.3	7738000	24.6
Sweden	449964	440040	97.8	25.6	8374000	19.0
Non-HELCOM countries		117520		6.8	No information	
Total	18750009	1720170				

Figure 1. **Map illustrating the sub-basins of the Baltic Sea and the countries in the catchment area.**

Box 3. Pathways and sources of heavy metal inputs

The main sources of heavy metals to the marine environment are diffuse sources such as forest and agricultural soils as well as industrial and municipal waste, which is either discharged directly or transported via rivers and atmospheric deposition to the sea.

Inputs from diffuse sources are mainly the result of old environmental sinks that after decades continue to leach pollutants into waterways via runoff.

Hazardous substances from industries are emitted from all stages of the product chain - from the raw material and the production and combustion processes, from the use of products and from the handling of products as waste.

Inputs of pollutants to the sea via the atmosphere are still high, particularly where heavy metals are concerned, with significant amounts originating from distant sources outside the Baltic Sea catchment area. A significant part of the waterborne heavy metal input to the Baltic Sea is transported via rivers from non-HELCOM countries in the catchment area. Riverine inputs to the sea also include natural background losses of heavy metals, the extent of which is highly uncertain.

Box 4. Remarks about methodology and uncertainties

Heavy metal waterborne inputs have been compiled for each Baltic Sea country and marine sub-region since 1990. Nevertheless it is complicated to form a reliable picture of long-term trends in the total inputs of heavy metals into the Baltic Sea.

In the case of waterborne loads, the data are based on annual average concentrations (mg/l) of heavy metals and mean flows (m^3/s) which are collected by the HELCOM Contracting Parties and submitted to the HELCOM Pollution Load Compilation database (PLC database). The Contracting Parties have calculated the annual loads (t/a) of monitored and unmonitored rivers, coastal areas and direct point sources. In addition, since 2003 loads on direct diffuse sources have been collected. All these data have been pooled together as total loads to the Baltic Sea by country.

The methodology behind the data used in this report is based on the agreed HELCOM Fourth Pollution Load Compilation guidelines and for monitored rivers results are calculated according to daily or monthly flow and concentration measurements. The results for unmonitored areas loads are based on surface area comparison with a similar monitored area. Due to robust analysing methods in some countries, reported loads might be too high.

Despite the jointly agreed guidelines, the accuracy of results is affected by the following: firstly, total inputs have not been compiled every year; secondly, not all HELCOM countries have reported their total waterborne inputs; thirdly, some countries have not monitored the same categories every year; and finally, the methods for analysing concentrations and for calculating loads have varied between the countries and changed over time.

Data on heavy metal air emissions is based on national data which are annually submitted, by Contracting Parties to the Convention on Long-range Transboundary Air Pollution (CLRTAP), to the UNECE Secretariat. The methodology is based on a combination of emission measurements and emission estimates based on activity data and emission factors. The heavy metal atmospheric depositions results were obtained using the latest version of the MSCE-HM model developed at EMEP/MSC-E (Gusev 2006b). MSCE-HM is a three-dimensional Eulerian model which includes processes of emission, advection, turbulent diffusion, chemical transformations of mercury, wet and dry depositions, and inflow of pollutant into the model domain. The latest available official emission data for the HELCOM countries are used in the model computations.

The available time series of heavy metal atmospheric emissions have gaps and as atmospheric deposition figures are based on modelling of emission data, they are also prone to uncertainties. The MSCE-HM model has however been verified in a number of intercomparison campaigns and comparisons against measured levels in air and precipitation measured at monitoring stations around the Baltic Sea have shown the data to be satisfactory. More information on the methodology and the uncertainties regarding data and calculations can be found in the annual EMEP reports and fact sheets.

These uncertainties do not allow for an accurate assessment, however, the available data do give an indication of the extent of heavy metal inputs to the Baltic Sea and are based on the best and most comprehensive information available.

When interpreting the results it has to be borne in mind that the data on air emissions for Germany cover the country's whole territory and for Russia the territory within the EMEP domain. There are gaps in reporting of 2004 waterborne load data from Latvia, Lithuania and Russia and the figures used in this report are based on a five year average of latest available data. The waterborne loads for Lithuania include transboundary pollution from upstream countries, which can make up a significant part of the total loads. When interpreting national contributions for heavy metals loads to the Baltic Sea, it is useful to recall the catchment area sizes and population sizes of the HELCOM countries (see table 1).

2 Cadmium

Cadmium emissions and sources

The estimated total annual air emissions of cadmium from HELCOM countries in 2004 amounted to 107 tonnes. Among these countries, the largest contributions to total cadmium emissions came from Russia (52%) and Poland (42%) (Figure 2). The main sources of cadmium emissions to the air were combustion in power plants and industry (66%) and commercial, residential and other stationary combustion (24%) (Figure 3).

Comprehensive data on waterborne sources of cadmium is lacking for the whole Baltic Sea catchment area, but according to a HELCOM Guidance document[3] and other sources, most of the anthropogenic load of cadmium to the Baltic Sea originates from industrial activity, waste water treatment plants, the use and environmentally unsafe handling of NiCd batteries, as well as agricultural fertilizers. The main contributing industrial activities in the Baltic Sea catchment area include e.g. electronics, metallurgic industry, and production of paints, lacquers and varnishes, chemical products and plastic (mainly PVC). Soils and rocks also naturally contain small amounts of cadmium of which some ends up in the Baltic Sea.

Cadmium loads to the Baltic Sea

The reported total load of cadmium to the Baltic Sea in 2004 was 41.1 tonnes. Of this, 35.4 tonnes (86%) originated from waterborne sources and 5.7 tonnes (14%) was deposited from the atmosphere (Figure 4).[4]

Of the 35.4 tonnes of waterborne cadmium entering the Baltic Sea in 2004, the largest contributors were Russia, with an estimated load of 26.0 tonnes (73%), and Finland, with a reported load of 2.0 tonnes (6%) (Figure 5, Annex Table 16).

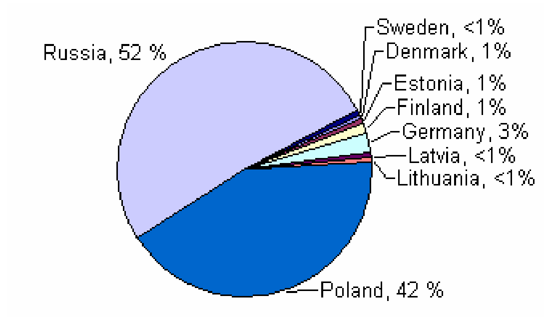

Figure 2. Reported proportion of cadmium emissions to the air by the HELCOM countries in 2004.

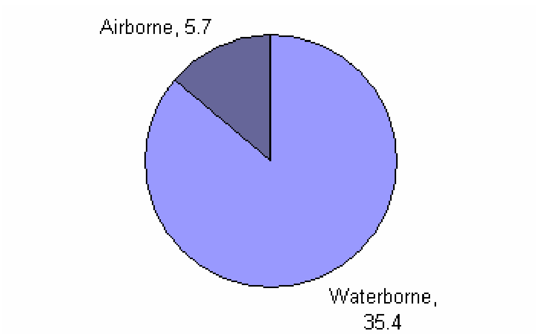

Figure 4. The total cadmium load to the Baltic Sea in 2004 was 41.1 tonnes (units: tonnes). Note: The values for the waterborne load of cadmium from Latvia, Lithuania and Russia are based on a five year average due to a lack of data.

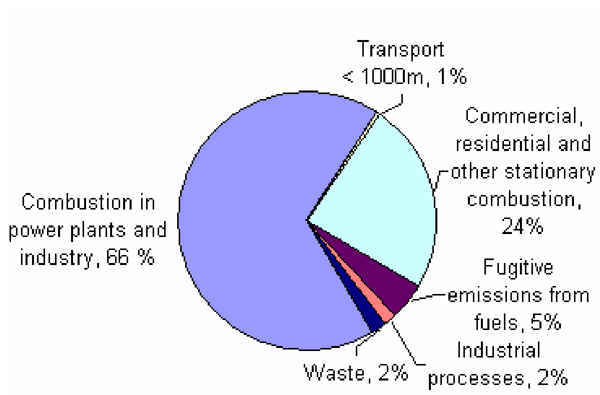

Figure 3. Estimated proportion of contributions from different sectors to the total annual anthropogenic emissions of cadmium from HELCOM countries in 2004.

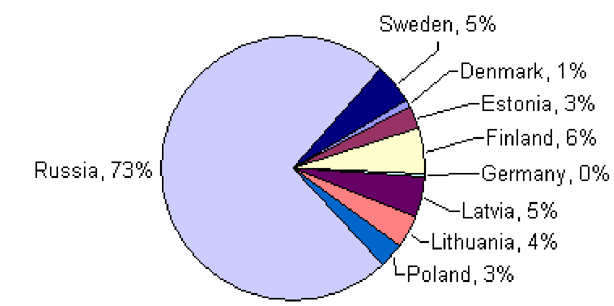

Figure 5. Proportion of waterborne inputs of cadmium by HELCOM countries to the Baltic Sea in 2004. Note: The values for the waterborne load of cadmium for Latvia, Lithuania and Russia are based on a five year average due to lack of data.

[3] HELCOM 2002. Guidance Document on Cadmium and its Compounds. http://www.helcom.fi/groups/LAND/en_GB/publications/ (accessed 9.2.2007)

[4] Note: The waterborne load of cadmium is based on data submitted by HELCOM countries. The 2004 dataset, however, is missing data from Latvia, Lithuania and Russia. The figures used here are based on a five year average of previously reported values.

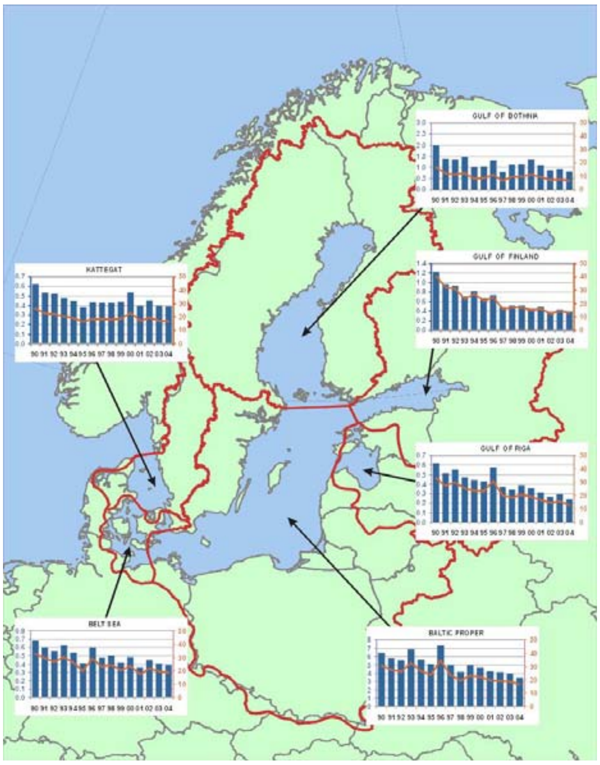

Figure 6. **Time-series of computed total annual atmospheric deposition of cadmium to six sub-basins of the Baltic Sea for the period 1990-2004 in tonnes/year as bars (left axis) and total deposition fluxes in g/km^2/year as lines (right axis). Note that different scales are used for total depositions in tonnes/year and the same scales for total deposition fluxes.**

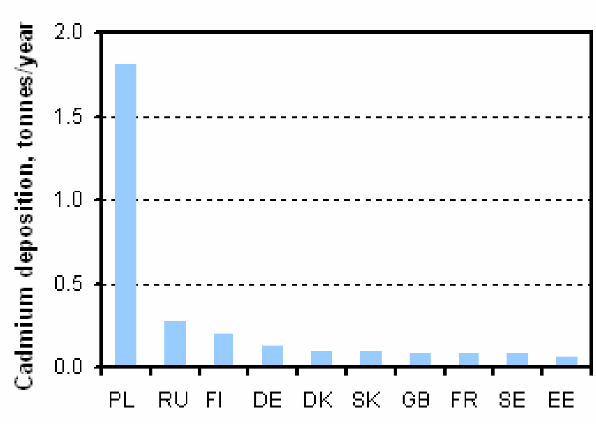

Figure 7. **Ten European countries with the highest calculated contribution to the annual deposition of cadmium to the Baltic Sea in 2004 (units: tonnes/year).**

Of the estimated 107 tonnes of cadmium emitted to the air from HELCOM countries, a calculated 5.7 tonnes was deposited to the Baltic Sea in 2004. A significant majority of the atmospherically deposited cadmium, 3.4 tonnes (60%), ended up in the Baltic Proper with the next largest proportion (14%) ending up in the Gulf of Bothnia (Figure 6, Annex Table 7).

In 2004, HELCOM countries were the source of 48% of airborne cadmium being deposited onto the Baltic Sea and three non-HELCOM countries (United Kingdom, France, and Slovak Republic) were among the top ten contributors (Figure 7, Annex Table 8). Eleven percent of airborne cadmium deposited on the Baltic Sea originated from other European countries and 40% from other sources (re-emission, natural and global sources).[5]

[5] See Annex Table 9

3 Lead

Lead emissions and sources

The estimated total annual air emissions of lead from HELCOM countries in 2004 amounted to 1,124 tonnes. Among these countries, the largest contributions to total lead emissions came from Poland (49%) and Russia (30%) (Figure 8). The main sources of lead emissions were combustion in power plants and industry (58%), commercial, residential and other stationary combustion (13%), as well as industrial processes (13%) (Figure 9).

Comprehensive data on waterborne lead discharges from different sources in the whole Baltic Sea catchment area is lacking, but a significant part of anthropogenic emissions to the air originate from the impurity of processed materials. Combustion for energy production as well as waste incineration is still an important source (Figure 9) and a significant stream of lead also enters the environment with products such as different instruments and electronic equipment. A major source has been lead in fuel for vehicles, but as lead in fuel is nowadays banned, its emission from the transport sector has decreased drastically.

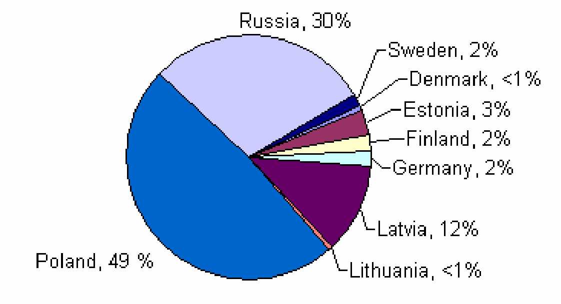

Figure 8. Reported proportion of lead emissions to the air by the HELCOM countries in 2004.

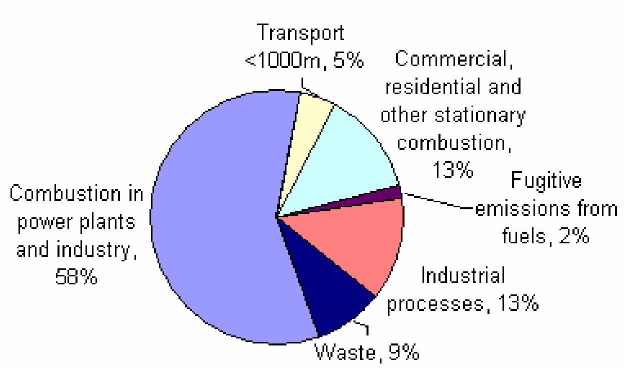

Figure 9. Estimated proportion of contributions from different sectors to the total annual anthropogenic emissions of lead from HELCOM countries in 2004.

Lead loads to the Baltic Sea

The reported total load of lead to the Baltic Sea in 2004 was 567 tonnes. Of this, 332 tonnes (59%) was waterborne and 235 tonnes (41%) was deposited to the sea via the atmosphere (Figure 10).[6]

Of the 332 tonnes of waterborne lead entering the Baltic Sea in 2004, the largest contributors were Russia with 202.7 tonnes (60%), Sweden with 41.7 tonnes (13%), Poland with 28.4 tonnes (9%) and Finland with 24.4 tonnes (7%) (Figure 11, Annex Table 17).

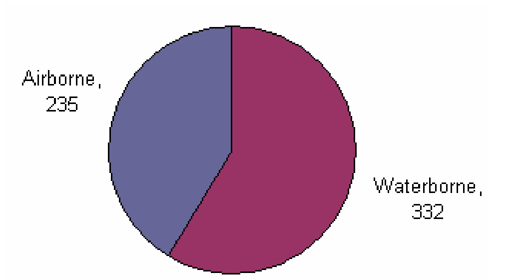

Figure 10. The total load of lead to the Baltic Sea in 2004 was 567 tonnes (units: tonnes). Note: The values for the waterborne load of lead for Latvia and Russia are based on a five year average due to lack of data.

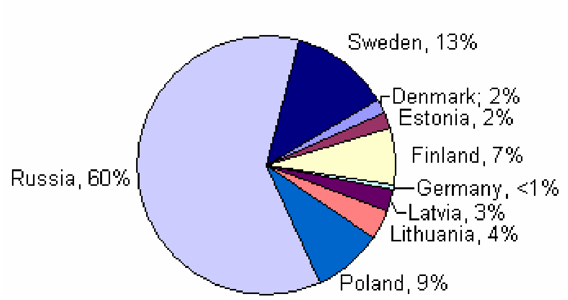

Figure 11. Proportion of waterborne inputs of lead by HELCOM countries to the Baltic Sea during 2004. Note: The values for the waterborne load of lead for Latvia and Russia are based on a five year average due to lack of data.

[6] Note: The waterborne load of lead is based on data submitted by HELCOM countries. The 2004 dataset, however, is missing data from Latvia and Russia. The figures used here are based on a five year average of previously reported values.

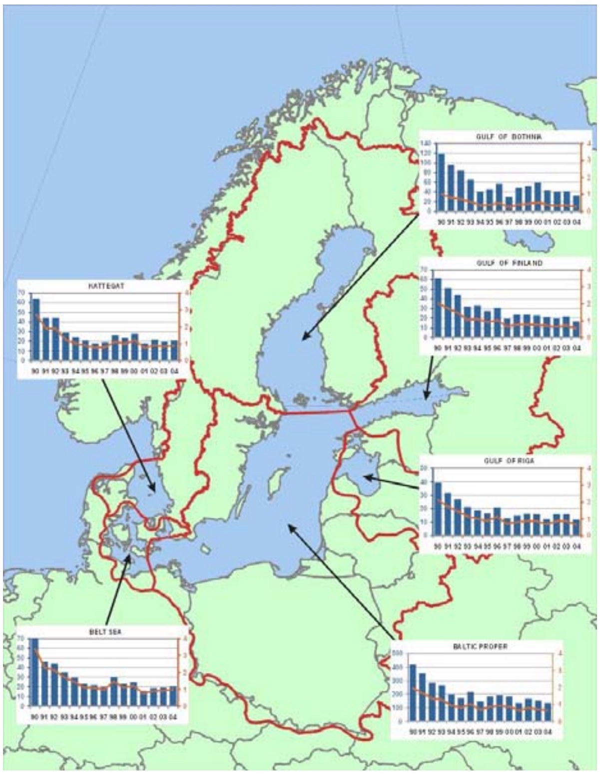

Figure 12. Time-series of computed total annual atmospheric deposition of lead to six sub-basins of the Baltic Sea for the period 1990-2004 in tonnes/year as bars (left axis) and total deposition fluxes in kg/km^2/year as lines (right axis). Note that different scales are used for total depositions in tonnes/year and the same scales for total deposition fluxes.

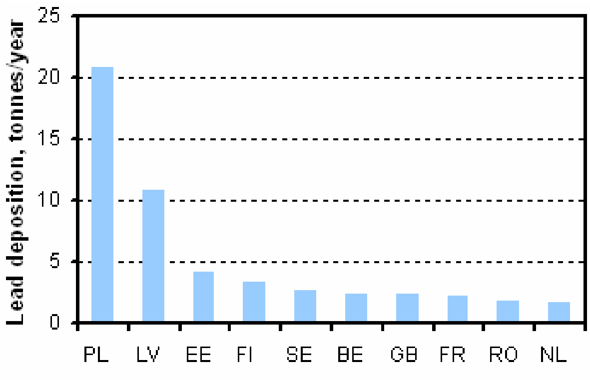

Figure 13. Ten countries with the highest contribution to the annual deposition of lead to the Baltic Sea in 2004 (units: tonnes/year).

Of the estimated 1,124 tonnes of lead emitted to the air from HELCOM countries, a calculated 235 tonnes was deposited to the Baltic Sea in 2004. A significant majority, 134 tonnes (57%), of atmospherically deposited lead, ended up in the Baltic Proper (Figure 12, Annex Table 10).

In 2004 HELCOM countries were the source of 19% of airborne lead being deposited onto the Baltic Sea and five non-HELCOM countries (Belgium, United Kingdom, France, Romania and the Netherlands) were among the top ten contributors (Figure 13, Annex Table 11). Eight percent of airborne lead deposited on the Baltic Sea originated from other European countries and 73% from other sources (re-emission, natural and global sources).[7]

[7] See Annex Table 12

4 Mercury

Mercury emissions and sources

The estimated total annual air emissions of mercury from HELCOM countries in 2004 amounted to 38 tonnes. Among these countries, the largest contributions to total airborne mercury emissions came from Poland (53%) and Russia (31%) (Figure 14). The main sources of mercury air emissions were combustion in power plants and industry (71%) and transportation below an altitude of 1000m (17%) (Figure 15).

Comprehensive data on waterborne mercury discharges from different sources in the whole Baltic Sea catchment area is lacking, but the HELCOM Guidance document on mercury[8] presents compiled data on available information. A significant part of anthropogenic emissions comes from impurities released during the processing of materials. Coal combustion is still an important source of energy production contributing to large emissions of mercury in some HELCOM Contracting Parties. The chlor-alkali industry is the main contributor to mercury air emission as regards the intentional use of mercury. Other industries still represent minor sources of mercury emission, mainly due to contamination of the materials being processed, such as cement manufacture, iron and steel production as well as phosphate production.

Another significant source of air emissions of mercury is cremation. A significant stream of mercury also enters the environment via products such as dental fillings (amalgam), batteries, biocides, pesticides and fertilisers as well as various laboratory and medical instruments and lightning equipment.

Mercury loads to the Baltic Sea

The reported total load of mercury to the Baltic Sea in 2004 was 9.3 tonnes. Of this, 6.4 tonnes (69%) was from waterborne sources and 2.9 tonnes (31%) was deposited to the sea via the atmosphere (Figure 16).[9]

Of the 6.4 tonnes of waterborne mercury entering the Baltic in 2004, the vast majority, 3.9 tonnes (61%), originated from Estonia and 18% and 13% originated from Poland and Lithuania, respectively (Figure 17, Annex Table 18).

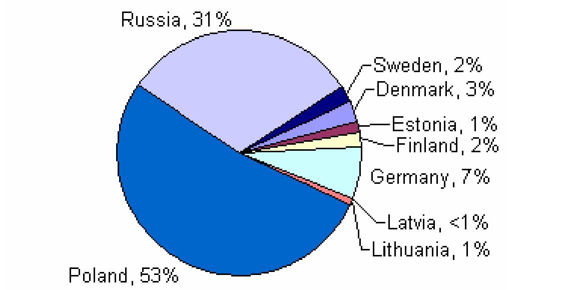

Figure 14. Reported proportion of mercury emissions to the air by the HELCOM countries in 2004.

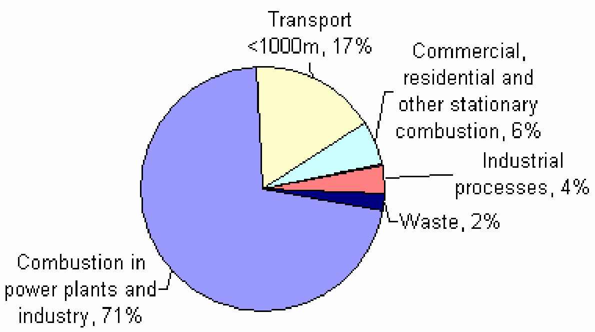

Figure 15. Annual estimated anthropogenic emissions of mercury of HELCOM countries from different sectors in 2004.

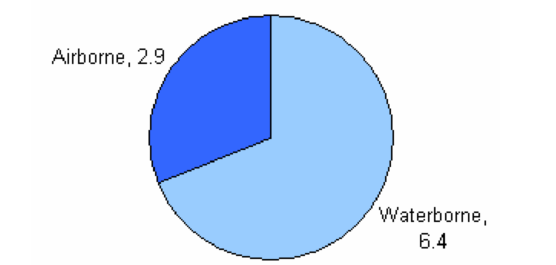

Figure 16. The total load of mercury to the Baltic Sea in 2004 was 9.3 tonnes (units: tonnes). Note: The values for the waterborne load of mercury for Latvia and Russia are based on a five year average due to lack of data.

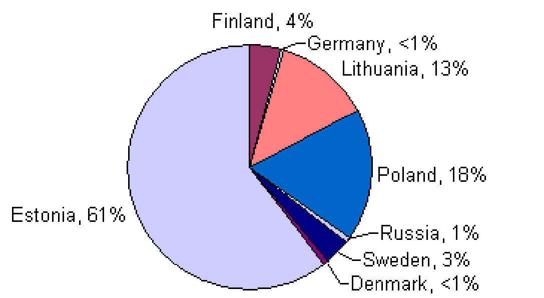

Figure 17. Proportion of waterborne inputs of mercury by HELCOM country to the Baltic Sea during 2004. Note: The value for the waterborne load of mercury for Russia is based on a five year average due to lack of data. No waterborne mercury load data exists for Latvia.

[8] HELCOM 2002. Guidance Document on Mercury and Mercury Compounds. http://www.helcom.fi/groups/LAND/en_GB/publications/ (accessed 9.2.2007)

[9] Note: The waterborne load of mercury is based on data submitted by HELCOM countries. The 2004 dataset, however, is missing data from Latvia and Russia. The figures used here are based on a five year average of previously reported values.

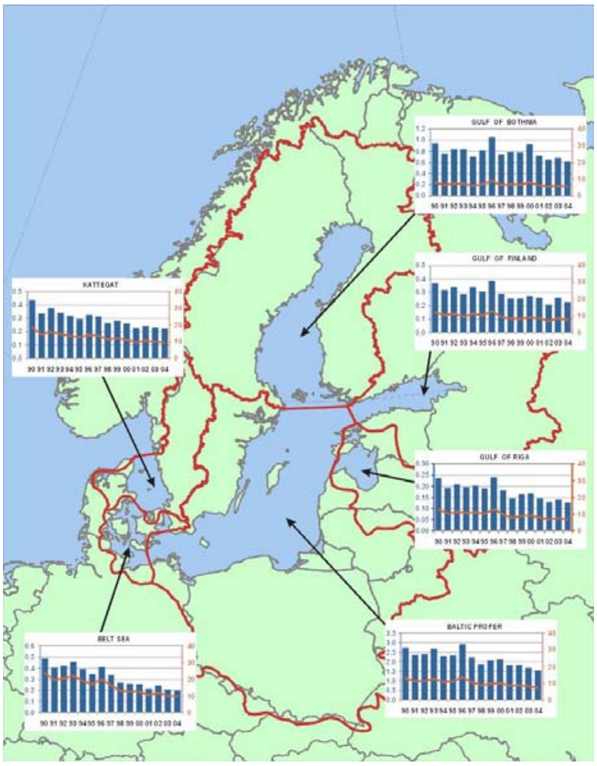

Figure 18. **Time-series of computed total annual atmospheric deposition of mercury to six sub-basins of the Baltic Sea for the period 1990-2004 in tonnes/year as bars (left axis) and total deposition fluxes in g/km^2/year as lines (right axis). Note that different scales are used for total depositions in tonnes/year and the same scales for total deposition fluxes.**

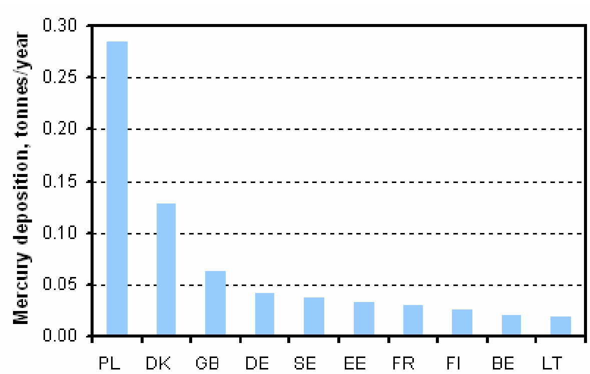

Figure 19. **Ten countries with the highest contribution to annual deposition of mercury to the Baltic Sea in 2004 (units: tonnes/year).**

Of the 38 tonnes of mercury emitted to the air mercury from HELCOM countries, a calculated 2.9 tonnes was deposited to the Baltic Sea in 2004. The majority of this, 1.5 tonnes (52%), ended up in the Baltic Proper (Figure 18, Annex Table 13).

In 2004 HELCOM countries were the source of 20% of airborne mercury being deposited onto the Baltic Sea and three non-HELCOM countries (United Kingdom, France, and Belgium) were among the top ten contributors (Figure 19, Annex Table 14). Eight percent of airborne lead deposited on the Baltic Sea originated from other European countries and 72% from other sources (re-emission, natural and global sources).[10]

[10] See Annex Table 15

5 Transboundary riverine pollution

Significant transboundary pollution loads of heavy metals originate from Belarus, the Czech Republic and Ukraine. Although the exact loads of heavy metals originating from upstream countries in the Baltic Sea catchment have not been accurately measured or assessed, a HELCOM project evaluated the proportion of transboundary pollution in 2000 (HELCOM 2005).

It was estimated that in 2000 the total load from the three countries at HELCOM country borders compared to the total load to the Baltic Sea was 14% for cadmium, 5% for mercury and 13% for lead. The findings show that the Czech Republic contributes the largest loads of mercury while Ukraine accounts for the most substantial loads of cadmium and lead (Table 2).

Although these findings are based only on data for one year and have been calculated using different monitoring methods, they do give a rough indication of the magnitude of transboundary pollution. The significance of this transboundary pollution is naturally higher in certain sub-catchments than in the Baltic Sea overall.

Table 2. Reported riverine load figures from Belarus, Czech Republic and Ukraine in 2000 (units: tonnes).

Heavy metal	Belarus	Ukraine	Czech Republic	Load from upstream countries at border	Total load to the Baltic Sea (PLC-4 data)	Total load at the borders compared to total load to Baltic Sea
Cadmium	0.7	3.8	3	7.5	53	14%
Mercury	0	0.4	2	2.4	46	5%
Lead	14	32	16	62	477	13%

6 Long-term changes and trends in emissions and loads

This chapter compares long-term measurements and calculations of emissions to the air as well as the waterborne and airborne loads of cadmium, lead and mercury to the Baltic Sea. When evaluating possible trends and interpreting the results given here, it is important to bear in mind the uncertainty of the data. As discussed in Box 4 of this report, monitoring methods have not been consistent during the entire period of data collection, atmospheric deposition calculations are based on reported emission values, and the reporting of all datasets has been imperfect – with data for some countries missing during some years. Nevertheless some trends can be observed for some heavy metal loads, though often it is difficult to determine clear trends due to the effects of variable meteorological conditions.

Emissions

Annual emissions of heavy metals from HELCOM countries to air have decreased during the period from 1990 to 2004 by 44% for cadmium, 42% for mercury, and 86% for lead (Figure 20). For individual countries, the most significant drop of cadmium emissions can be noted for Estonia (87%) and Lithuania (86%) (Annex Table 1). In the case of lead emissions, the most significant decrease can be seen for Germany where the emission in 2004 was less than two percent of that in 1990. The drastic reduction of annual lead emissions by HELCOM countries from 2003 to 2004 is largely the result of a change in emissions from Russia (Annex Table 3). Mercury emissions most significantly decreased in Sweden (by 83%) (Annex Table 5).

The reductions in heavy metal emissions to the air are largely due to the increased use of lead-free fuels, the wider use of cleaner production technologies, the substitution of different production inputs as well as the economic decline and industrial restructuring that occurred in Poland, Estonia, Latvia, Lithuania, and Russia in the early 1990s.

Loads

Atmospheric deposition

The annual atmospheric deposition of heavy metals is dependent on meteorological conditions, therefore decreases in emissions do not always lead to corresponding reductions in atmospheric deposition rates. Calculated[11] annual deposition rates of heavy metals have halved since 1990 in the Baltic Sea as a whole (Figure 21). Total annual atmospheric depositions of heavy metals to the Baltic Sea have decreased during the period of 1990 to 2004 by 51% for cadmium, 44% for mercury, and 69% for lead, respectively.

On the level of individual sub-basins the most significant reduction in cadmium depositions were calculated for the Gulf of Finland (68%) (Figure 6, Annex Table 7). The most significant decrease for lead were calculated for the Gulf of Bothnia and the Gulf of Finland (73%) (Figure 12, Annex Table 10). The largest decrease in mercury depositions is calculated for the Belt Sea (60%) (Figure 18, Annex Table 13).

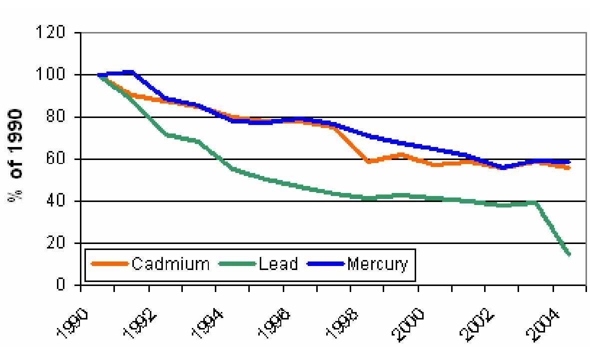

Figure 20. **Total annual emissions of cadmium, mercury, and lead to air from HELCOM countries for the period 1990-2004 (% of 1990).**

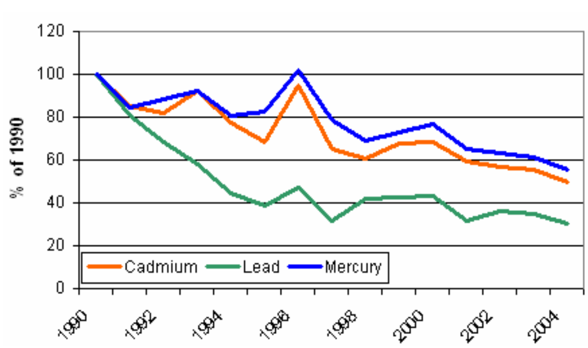

Figure 21. **Computed total annual atmospheric depositions of cadmium, mercury, and lead to the Baltic Sea for the period 1990-2004 (% of 1990).**

[11] Information about atmospheric deposition calculations can be found in Box 4 and the EMEP indicator fact sheets and annual reports referenced at the end of this assessment.

Waterborne loads

Waterborne loads of heavy metals also vary significantly depending on annual meteorological conditions.[12] Nevertheless, total loads (notably of cadmium and lead) have decreased in several countries since the mid 1990s (Figure 22). Incomplete data from some countries, however, makes it difficult to draw conclusions concerning the total heavy metal loads entering the Baltic Sea.

Total loads

Trends indicate that there has been a decrease in the total loads of cadmium and lead to the Baltic Sea during the period 1994 to 2004 (Figure 23 and Figure 25). For mercury, on the other hand, there are no clear trends with sudden increases in waterborne load occurring during 1999 and 2000 (Figure 27). The total annual atmospheric depositions of heavy metals to the Baltic Sea have decreased during the period of 1990 to 2004 by 51% for cadmium, 44% for mercury, and 69% for lead atmospheric depositions, and there is no clear change in the proportion of inputs coming via the atmosphere compared to waterborne sources (Figure 24, Figure 26, and Figure 28).

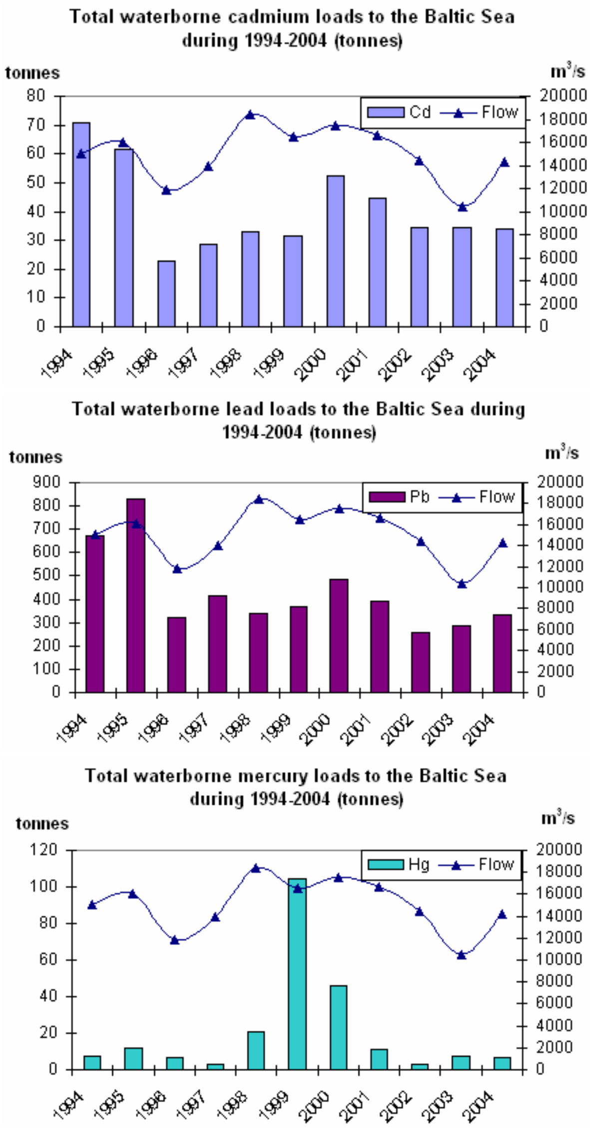

Figure 22. Annual waterborne loads to the Baltic Sea of cadmium, lead and mercury during the period 1994-2004 (units: tonnes). Note: the observed increase in waterborne loads in 2000 is in part due to improved monitoring techniques adopted by the HELCOM monitoring programme.

[12] The apparent increase in heavy metal loads in 2000 may also be partly attributed to improved monitoring methods adopted by the HELCOM monitoring programme.

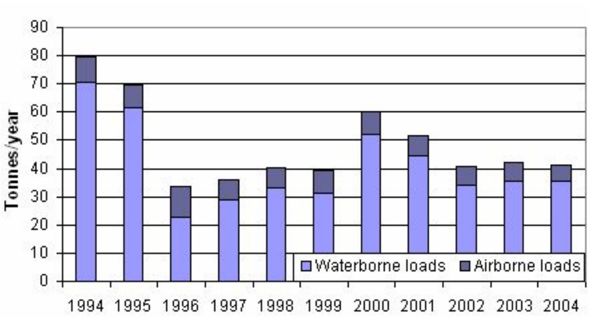

Figure 23. Total cadmium loads to the Baltic Sea during 1994-2004 (units: tonnes/year). Note that the observed increase in waterborne loads in 2000 is in part due to improved monitoring techniques adopted by the HELCOM monitoring programme.

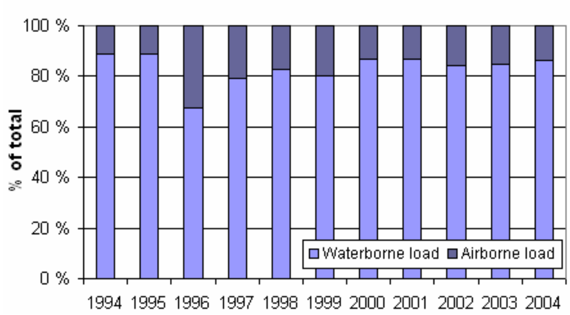

Figure 24. Proportions of waterborne and airborne loads of the total cadmium load to the Baltic Sea during 1994-2004.

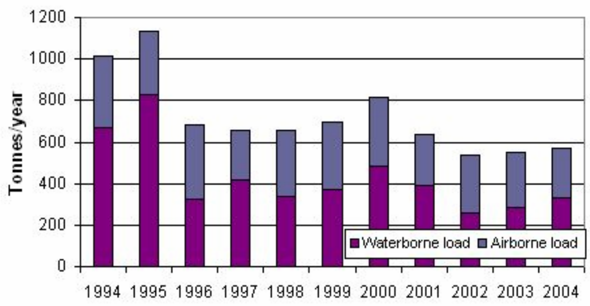

Figure 25. Total lead loads to the Baltic Sea during 1994-2004 (units: tonnes/year). Note that the observed increase in waterborne loads in 2000 is in part due to improved monitoring techniques adopted by the HELCOM monitoring programme.

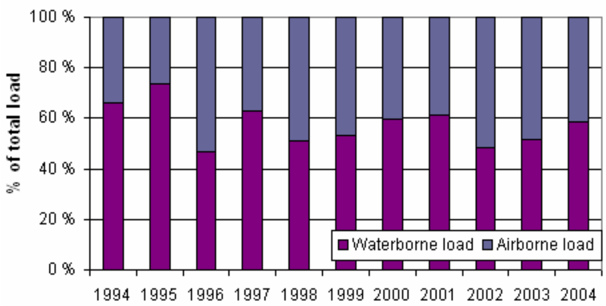

Figure 26. Proportions of waterborne and airborne loads of the total lead load to the Baltic Sea during 1994-2004.

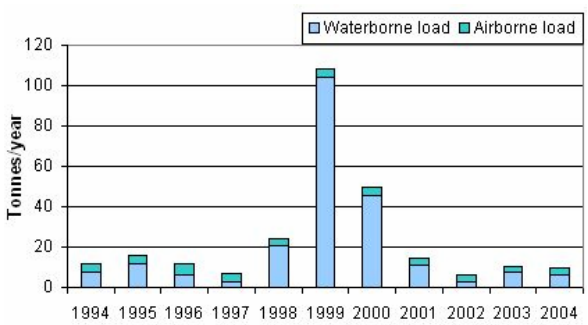

Figure 27. Total mercury loads to the Baltic Sea during 1994-2004 (units: tonnes/year). Note that the observed increase in waterborne loads in 2000 is in part due to improved monitoring techniques adopted by the HELCOM monitoring programme.

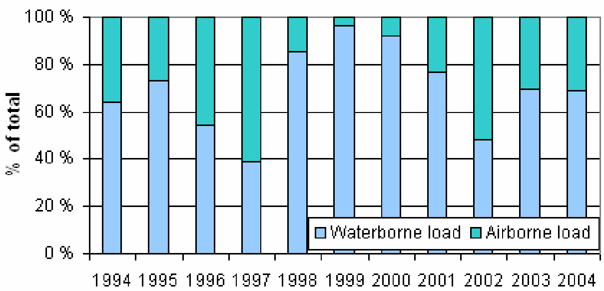

Figure 28. Proportions of waterborne and airborne loads of the total mercury load to the Baltic Sea during 1994-2004.

Despite reductions in at least the airborne inputs, concentrations of heavy metals in the Baltic Sea are still up to 20 times higher than in the North Atlantic (Table 3). The concentrations of some metals, such as cadmium, are declining in marine organisms in some areas (e.g. the Gulf of Bothnia and the Gulf of Finland) but increasing in others (e.g. the western Baltic Proper). The best news is the clear decrease in lead concentrations in herring observed in many areas (Figure 29).

Table 3. Concentrations of dissolved trace metals in North Atlantic and the Baltic Sea water (ng/kg) (Pohl & Hennings 2006).

Element	North Atlantic	Baltic Sea	Factor
Mercury	0.15-0.3 (4)	5-6 (3)	~ 20
Cadmium	4 (+-2) (1)	12-16 (3)	~ 4
Lead	7 (+-2) (1)	12-20 (3)	~ 3
Copper	75 (+-10) (2)	500-700 (3)	~ 10
Zinc	10-75 (1)	600-1000 (3)	~ 10-50

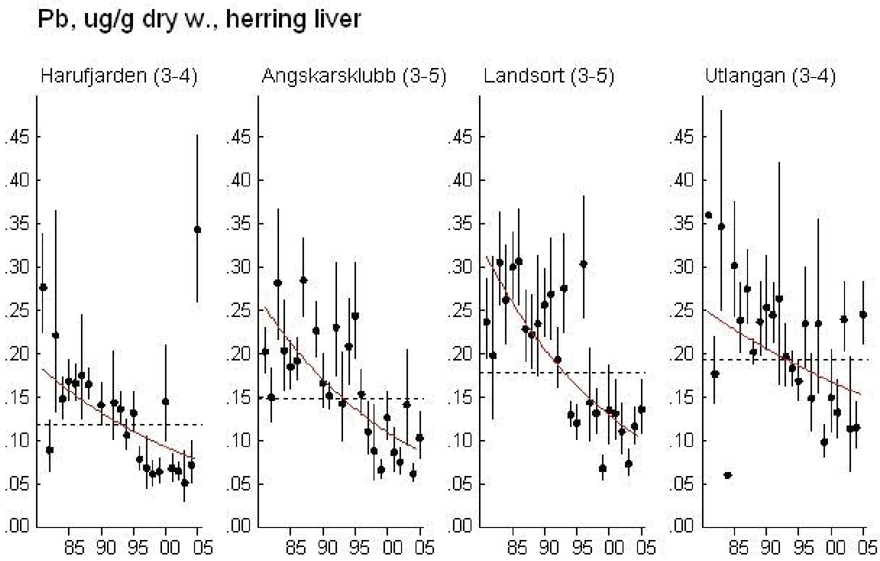

Figure 29. Temporal trends of lead concentration (ug/g dry) in herring liver, 1983-2005 (Bignert & Nyberg 2006).

7 Actions and policies

<u>What is HELCOM?</u>

The Helsinki Commission, or HELCOM, works to protect the marine environment of the Baltic Sea from all sources of pollution through intergovernmental co-operation between Denmark, Estonia, the European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden.

HELCOM is the governing body of the "Convention on the Protection of the Marine Environment of the Baltic Sea Area" - more usually known as the Helsinki Convention.

HELCOM’s vision for the future is a healthy Baltic Sea environment with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable economic and social activities.

In pursuing this objective and vision, the riparian countries have jointly pooled their efforts in HELCOM, which works as:

- an environmental policy maker for the Baltic Sea area, by developing common environmental objectives and actions;
- an environmental focal point, providing information about (i) the state of/trends in the marine environment; (ii) the efficiency of measures to protect it, and (iii) common initiatives and positions which can form the basis for decision-making in other international *fora*;
- a body for developing, according to the specific needs of the Baltic Sea, Recommendations of its own and Recommendations supplementary to measures imposed by other international organisations;
- a supervisory body, dedicated to ensuring that HELCOM environmental standards are fully implemented by all parties throughout the Baltic Sea and its catchment area; and
- a co-ordinating body, ascertaining multilateral response in case of major maritime incidents.

HELCOM actions

From the beginning of its work, HELCOM has been committed to “counteract” hazardous substances. Already in the 1974 Helsinki Convention, the input of heavy metals and some other hazardous substances into the Baltic Sea and its catchment area was prohibited. The revised 1992 Helsinki Convention includes 29 banned or restricted hazardous substances and more than 20 Recommendations addressing hazardous substances have been adopted throughout the years.

A HELCOM hazardous substance project in 2002 concluded that the 50% reduction target of some 46 hazardous substances included in HELCOM’s 1988 Ministerial Declaration has been largely reached. This 50% reduction target is thus replaced by HELCOM's objective, contained in HELCOM Recommendation 19/5, to prevent pollution of the Convention area by continuously reducing discharges, emissions and losses of hazardous substances towards the target of their cessation by the year 2020, with the ultimate aim of achieving concentrations in the environment near background values for naturally occurring substances and close to zero for man-made synthetic substances. Cadmium, mercury and lead are amongst these priority substances.

Having concentrations of hazardous substances close to natural levels in the marine environment is also one of the ecological objectives of the HELCOM Baltic Sea Action Plan – a strategic plan designed to achieve the common vision of a healthy Baltic Sea environment which supports a wide range of sustainable economic and social activities. The Action Plan intends to achieve this vision by implementing an ecosystem approach to the management of human activities.

HELCOM Recommendations

Historically, efforts to reduce inputs of heavy metals to the Baltic Sea marine environment were focus on addressing major point sources of heavy metal emissions to air and water. Later, attention has moved to activities which result in more diffuse emissions, such as content in batteries and light sources as well as waste disposal. Today, HELCOM Recommendations contain provisions relating to heavy metals for 11 industrial sectors such as iron and steel industry, metal surface treatment, chemical industry, etc.

One important requirement concerning lead is HELCOM Recommendation 9/4 concerning the reduction of emissions from combustion fuel, which has been implemented in all HELCOM Contracting Parties and has consequently resulted in a significant reduction in lead emissions.

A complete list of HELCOM Recommendations dealing with land-based sources of pollution is available at: http://www.helcom.fi/Recommendations/en_GB/land/ (accessed 9.2.2007).

International efforts

European Union

Heavy metals are referred to in many legal instruments of the European Commission both as substances intentionally or unintentionally used and contained in products, and as contamination discharged to the environment with various streams of pollution. Mercury and cadmium are also included as priority substances under the EU Water Framework Directive.

The main areas are concerned with emissions and use of mercury. Emissions and discharges of heavy metals from major industrial sources are now subject to the EU Directive 96/61/EC on Integrated Pollution Prevention and Control (IPPC), which had to be implemented in the Member States by October 1999, with a period of until October 2007 to bring existing installations into compliance.

Mercury and other heavy metal emissions have been reduced by the application of sector-specific EU Directives, dealing with large combustion plants and waste incineration.

Directives 2002/95/EC on the restriction of the use of certain hazardous substances, including heavy metals in electrical and electronic equipment and 2002/96/EC on waste electrical and electronic equipment are designed to tackle the fast increasing waste stream of electrical and electronic equipment and complements European Union measures on landfill and incineration of waste.

In January 2005, the European Commission adopted a mercury strategy that envisages a number of actions to protect citizens' health and the environment. The strategy proposes action in the following areas:

- Global action: The EU will provide input to international activities and cooperation with other countries to address the mercury problem. The strategy also contains actions to help other countries reduce their use and emissions of mercury, and to support the UNEP mercury programme.
- Reducing EU supply: As a proactive contribution to the proposed international initiative described above, the export of mercury from the EU will be phased out by 2011.
- Reducing EU demand: The strategy will prohibit the marketing of measuring devices containing mercury (e.g. thermometers) for consumer use and health care, with certain exceptions.
- Addressing EU surpluses: The phasing out of mercury use by the chlor-alkali industry will create a large surplus of this substance.
- Further reducing emissions.

Other international initiatives

Apart from regional initiatives to reduce anthropogenic sources of pollution to the environment, various international instruments have been set up to address hazardous substance pollution, amongst others:

UNECE

The UN/ECE Protocol to the Convention on Long-Range Transboundary Air Pollution on heavy metals (CLRTAP-HM) was adopted in Aarhus (Denmark) in 1998. It targets three particularly harmful metals: mercury, cadmium and lead. According to one of the basic obligations, Parties will have to reduce their emissions for these three metals below their levels in 1990 (or any alternative year between 1985 and 1995). The Protocol aims to cut emissions from industrial sources (iron and steel industry, non-ferrous metal industry), combustion processes (power generation, road transport), and waste incineration. It lays down stringent limit values for emissions from stationary sources and suggests Best Available Technology (BAT) for these sources, such as special filters or scrubbers for combustion sources or mercury-free processes. The Protocol requires Parties to phase out leaded petrol. It also introduces measures to lower heavy metal emissions from other products, such as mercury in batteries, and the introduction of management measures for other mercury-containing products, such as electrical components (thermostats, switches), measuring devices (thermometers, manometers, barometers), fluorescent lamps, dental amalgam, pesticides and paint.

The Protocol entered into force in 2003 and all

HELCOM Contracting Parties, except the Russian Federation, have signed it.

UNEP

UNEP has adopted a global programme for mercury which has the long-term objective to facilitate national, regional and global actions to reduce, or eliminate as far as possible, uses and releases of mercury; thereby significantly reducing its adverse impacts on humans and the environment. The immediate objective of the programme is to initiate technical assistance and capacity-building activities to support the efforts of countries to take action regarding mercury pollution, as appropriate, with the objective of identifying exposed populations and ecosystems and reducing anthropogenic mercury releases which impact human health and the environment.

UNEP has also initiated a number of activities relating to lead and cadmium in order to inform future discussions of the Governing Council on the possible need for global action in relation to these two heavy metals.

BASEL

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was signed at Basel in 1989. The central goal of the Convention is environmentally sound management (ESM), with the aim of protecting human health and the environment by minimising hazardous waste production whenever possible. Initial work was principally devoted to setting up a framework for controlling the “transboundary” movements of hazardous wastes. More recently, the Convention has been focusing on the minimisation of hazardous waste generation. Recognising that the long-term solution to the stockpiling of hazardous wastes is a reduction in the generation of those wastes - both in terms of quantity and hazardousness, the Convention is now working on active promotion and use of cleaner technologies and production methods; further reduction of the movement of hazardous and other wastes; the prevention and monitoring of illegal traffic; improvement of institutional and technical capabilities, especially for developing countries and countries with economies in transition; and further development of regional and sub-regional centres for training and technology transfer. The Convention entered into force in 1995 and has been signed by all HELCOM countries.

8 Conclusions and recommendations

One of the roles of HELCOM is to produce scientific assessments that support decision-makers to agree on measures aimed at improving the environmental status of the Baltic Sea marine environment. These assessments are based on data which is collected using methods that have been jointly agreed upon by the Contracting Parties to HELCOM. Methodologies vary by country and over time, and there are gaps in time series, meaning that uncertainties in the data exist. These uncertainties should be borne in mind when interpreting the results and conclusions presented in this report. Nevertheless, these results are based on the best available, and officially agreed upon, data and do give an indication of the loads of heavy metals to the Baltic Sea.

Reported and calculated load data indicate that significant reductions in heavy metal emissions and loads have been achieved in the HELCOM area. Further work however needs to be carried out if the ecological objective of concentrations of hazardous substances in the marine environment close to natural levels is to be accomplished. As the majority of heavy metal input originates from the Baltic Sea catchment area, local and regional measures continue to be of utmost importance. Nevertheless, as modelling results show, a large part of airborne heavy metal depositions to the Baltic Sea are coming from either natural or remote anthropogenic sources.

There is a need to collect information on the magnitude of natural background losses as this is a prerequisite for defining “natural levels” of hazardous substances, which in turn are important for establishing targets for reaching the common ecological objectives. Although we are far from defining such levels, due to the limited data on the magnitude of natural background losses, this should not inhibit rapid actions under all relevant sectors.

Furthermore, the long-range transboundary nature of airborne heavy metals means that there is a necessity for regulations made globally, or at least on a European level, as measures taken only in HELCOM Contracting Parties are not sufficient for tackling the problems in the Baltic Sea region. As products are marketed widely across Europe, EU regulations for product controls could be seen as an effective tool to reduce the diffuse losses of especially mercury in the whole Baltic Sea catchment area.

Cadmium

Waterborne loads of cadmium have decreased by 91% from 1994 to 2004. A significant decrease in air emissions from HELCOM countries has been observed with a 44% reduction from 1990 to 2004. During the same period the calculated atmospheric deposition of cadmium decreased by 51%. The proportion between waterborne and airborne loads has not changed significantly, with atmospheric deposition constituting about 15% of the total cadmium load to the Baltic Sea in 2004, compared to 11% in 1994.

In 2004, 86% of the cadmium load to the Baltic Sea was waterborne, 6.6% originated from air emissions in HELCOM countries, 1.5% from air emissions in other European countries and 5.5% from other sources such as re-emission, natural and global sources. Although emissions from HELCOM countries have decreased significantly, there is still a clear need for further reductions. Contributions from other sources should, however, also be investigated and addressed. According to data from the year 2000, as much as 14% of the waterborne cadmium load originates in non-HELCOM countries in the Baltic Sea catchment area.

Lead

In 2004, the total load of lead was 56% less than the load in 1994. Waterborne loads of lead have decreased by about 50%. A dramatic decrease in air emissions from HELCOM countries has been observed with an 87% reduction from 1990 to 2004. During the same period, atmospheric deposition of lead to the Baltic Sea decreased by 69%. The proportion between airborne and waterborne loads has not changed significantly, with about 40% of the total load of lead to the Baltic Sea being via the atmosphere in 2004 compared to 34% in 1994.

In 2004, 59% of the total load of lead to the Baltic Sea was waterborne, 8% originated from air emissions in HELCOM countries, 3.3% from air emissions in other European countries and 30% from other sources (re-emission, natural and global sources). The increase in use of lead-free fuel and wider application of cleaner production technologies in the HELCOM region and European countries has clearly had positive impacts. The large contribution from other sources (re-emission, natural and global sources) to lead deposition to the Baltic Sea warrants further investigation of emission sources as well as the identification of appropriate measures to address the problem. According to data from the year 2000, as much as 13% of the waterborne load of lead originates in non-HELCOM countries in the Baltic Sea catchment area.

Mercury

Although waterborne loads of mercury have fluctuated dramatically during the period 1994 to 2004, a 16% decrease in inputs was observed in 2004 compared to ten years earlier. A 42% decrease in air emissions of mercury from HELCOM countries has been observed from 1990 to 2004. During the same period, atmospheric deposition of mercury decreased by 44%. The ration between waterborne and airborne loads has not changed significantly, with atmospheric deposition constituting about 30% of the total mercury load to the Baltic Sea in 2004, compared to 36% in 1994.

In 2004, 69% of the total load of mercury to the Baltic Sea was waterborne, 6% originated from air emissions in HELCOM countries, 3% originated from air emissions in other European countries and 22% from other sources (re-emission, natural and global sources). With waterborne inputs of mercury constituting 69% of the total mercury load, it is clear that further measures need to be taken to address waterborne emission sources. According to data from the year 2000, about five percent of the waterborne mercury load originates in non-HELCOM countries in the Baltic Sea catchment area.

Because almost a quarter of the mercury load in 2004 originated from atmospheric deposition resulting from emissions from sources such as re-emission, natural and global sources, it could be useful to investigate further the sources and identify potential measures for reducing emissions from these.

Further actions

With the EU enlargement and development of new EU measures, there is a reduced need for developing corresponding HELCOM measures. There remain, nevertheless, continuing needs for identifying the specific problems of the Baltic marine environment and reviewing whether measures by the various organisations (global-level, EU, HELCOM or national) adequately cover the general obligations of the Helsinki Convention and the HELCOM Objective with regard to the cessation target for hazardous substances by 2020 in the whole catchment area. In particular, it is important to ensure that the interests of all HELCOM Contracting Parties are taken into account, meaning that there may be need for HELCOM to adopt own additional measures.

The basic steps for taking action in HELCOM are:

1. Identification of threats;
2. Identification of fields of action and the need for measures;
3. Screening the coverage of existing international and national provisions; and
4. Deciding whether to develop measures at international, regional or national level.

Because HELCOM assessments indicate that a significant share of especially the airborne inputs to the Baltic Sea originate in non-HELCOM countries, it is of utmost importance that these assessment results be taken into account in other *fora*, where decisions are made on measures that will inevitably have an impact on pollution loads to the Baltic Sea. This means that HELCOM Contracting Parties should take into account these assessments and act jointly in the EU and UNECE to take more stringent actions with regard to these metals. There is a good opportunity to influence as the EU is currently developing strategies for mercury and UNECE is in the process of revising its heavy metal protocol. Although the UNECE goal to reduce heavy metal emissions below levels in 1990 seems to have been reached in many of the countries affecting depositions to the Baltic Sea, there is still a need for more reductions as the concentrations in the Baltic Sea marine environment are still high.

Also UNEP is currently investigating the need to develop global strategies for lead and cadmium, in addition to the already existing mercury strategy.

As mentioned earlier, HELCOM is currently developing the HELCOM Baltic Sea Action Plan, which will also include the identification of measures for heavy metals to be taken at global, regional or national level.

Based on findings in the HELCOM Guidance Document on mercury and other HELCOM sources, as well as assessments on emissions and the levels of mercury in the Baltic Sea, HELCOM has given input to the development of the EU mercury strategy. This input, as well as other proposed actions, is outlined below.

Proposed actions for cadmium, lead and mercury

1. Combustion processes of fuel and waste: Impurities in the materials used for combustion processes in industrial plants, energy production as well as residential heating are the biggest sources for all three metals and should be addressed thoroughly. Furthermore, the emissions of heavy metals from waste incineration need addressing. The reduction of these emissions may be obtained by effective use of BAT:
   - Reduced consumption of contaminated fuel, or
   - Use of cleaner/heavy metal-free alternative materials, or
   - End-of-pipe measures.
2. Product controls: As products are marketed widely all over Europe, EU regulations for product controls could be seen as an effective tool to reduce the diffuse losses of especially mercury also in the whole Baltic Sea catchment area. Some example include:
   - the introduction of restrictions for products which may contain mercury, cadmium and lead e.g. in instruments, electronic equipment, light sources, batteries and others. HELCOM has already regulated light sources by adopting HELCOM Recommendation 23/4.
   - control measures for products such as thermometers and other instruments and electronic equipment. Significant amounts of mercury are still used in measuring and control devices. There are currently no approved HELCOM Recommendations or EU regulations in this field, although the EU is presently considering relevant measures. Some HELCOM Contracting Parties, however, have nationally restricted the use of mercury in e.g. thermometers. Examples exist where the use of mercury thermometers as well as other instruments and electronic equipment have been successfully phased out.
3. Requirements for mercury emissions from cremation: The source of mercury in cremation is due to amalgam dental fillings. There are no EU regulations, but a HELCOM Recommendation on BAT for this activity is under development in line with the OSPAR Recommendation OSPAR 2003/4.
4. Requirements for management of building components of constructions where mercury-based production has taken place, e.g. chlor-alkali plants.
5. The restriction of cadmium content in fertilizer should be addressed at an appropriate level.

The information available on inputs and sources for heavy metals presented here is rather limited and affected by a number of uncertainties. Furthermore, substantial gaps exist in information on sources from non-HELCOM countries. Although this assessment is far from comprehensive and does not allow for a full evaluation of the present situation in the Baltic regarding heavy metal loads, it does give some indication of trends and highlights areas where further measures are needed.

References

Barnicki, J., Gusev, A., Aas, W., Fagerli, H. 2006. Atmospheric Supply of Nitrogen, Lead, Cadmium, Mercury and Dioxins/Furans to the Baltic Sea in 2004. Available online: http://www.emep.int/publ/helcom/2006/index.html (accessed 9.2.2007)

Bignert, A. and Nyberg, E. 2006. Lead concentrations in fish liver. HELCOM Indicator Fact Sheets 2006. Online. http://www.helcom.fi/environment2/ifs/en_GB/cover/ (accessed 9.2.2007)

Gusev, A. 2006a. Atmospheric emissions of heavy metals in the Baltic Sea region. HELCOM Indicator Fact Sheets 2006. Online. http://www.helcom.fi/environment2/ifs/en_GB/cover/ (accessed 9.2.2007)

Gusev, A. 2006b. Atmospheric depositions of heavy metals to the Baltic Sea. HELCOM Indicator Fact Sheets 2006. Online. http://www.helcom.fi/environment2/ifs/en_GB/cover/ (accessed 9.2.2007)

HELCOM PLC Group 2006. Waterborne inputs of heavy metals to the Baltic Sea. HELCOM Indicator Fact Sheets 2005. Online. http://www.helcom.fi/environment2/ifs/en_GB/cover/ (accessed 9.2.2007)

HELCOM 2005. Evaluation of transboundary pollution loads. HELCOM Environmental Focal Point Information. http://www.helcom.fi/stc/files/Publications/OtherPublications/Transboundary_Poll_Loads.pdf (accessed 9.2.2007)

HELCOM 2004. The Fourth Baltic Sea Pollution Load Compilation (PLC-4). Balt. Sea Environ. Proc. No. 93. http://www.helcom.fi/stc/files/Publications/Proceedings/bsep93.pdf (accessed 9.2.2007)

HELCOM 2004. Dioxins in the Baltic Sea. Environmental Focal Point Information. http://www.helcom.fi/stc/files/Publications/OtherPublications/Dioxins_in_BS-2004.pdf (accessed 9.2.2007)

Pohl, C. and Hennings, U. 2006. Heavy metals in Baltic Sea water, 1993-2005. HELCOM Indicator Fact Sheets 2006. Online. http://www.helcom.fi/environment2/ifs/en_GB/cover/ (accessed 9.2.2007)

HELCOM 2002. Guidance Document on Cadmium and its Compounds. http://www.helcom.fi/groups/LAND/en_GB/publications/ (accessed 9.2.2007)

HELCOM 2002. Guidance Document on Mercury and Mercury Compounds. http://www.helcom.fi/groups/LAND/en_GB/publications/ (accessed 9.2.2007)

Further information

HELCOM website: http://www.helcom.fi/environment2/hazsubs/en_GB/front/ (accessed 9.2.2007)

EU Environment pages: http://ec.europa.eu/environment/index_en.htm (accessed 9.2.2007)

UNECE Convention on Long-Range Transboundary Air Pollution: http://www.unece.org/env/lrtap/welcome.html (accessed 9.2.2007)

UNEP Chemicals' Programme: http://www.chem.unep.ch/chemicals/default.htm (accessed 9.2.2007)

Annex

Annex: Data tables

The tables in this annex present data which have been submitted by HELCOM Contracting Parties and compiled by the HELCOM data consultants EMEP and the Finnish Environment Institute. Although monitoring guidelines have been jointly developed and agreed upon by the HELCOM countries, methodologies differ by country and over time. Submission of data by the Contracting Parties has also been variable, meaning that the information presented in this report contains significant uncertainties. The quality of data should be borne into mind when interpreting these results.

Air emissions

Table 1. Cadmium emissions from anthropogenic sources of HELCOM countries from 1990 to 2004. Units: tonnes/year

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	1.1	1.2	1.1	1.1	1.0	0.8	0.8	0.7	0.7	0.7	0.6	0.7	0.6	0.6	0.6
Estonia	4.4	4.2	3.0	2.2	2.9	2.0	1.0	1.1	1.0	0.9	0.7	0.6	0.6	0.6	0.6
Finland	6.3	3.4	2.9	2.9	2.4	1.7	1.5	1.1	1.3	0.6	1.4	1.6	1.3	1.2	1.5
Germany	1.3	6.6	3.7	2.0	0.6	0.8	0.8	0.8	0.8	0.8	3.0	3.0	2.9	2.9	2.8
Latvia	1.5	1.2	0.9	0.7	2.0	1.2	0.9	0.8	1.1	0.9	0.8	0.8	0.6	0.5	0.5
Lithuania	3.8	2.8	2.5	2.3	2.1	2.1	2.2	2.2	2.6	2.0	1.4	1.2	1.0	0.9	0.5
Poland	91.6	85.0	84.1	91.9	85.8	82.6	91.2	85.8	55.4	61.7	50.4	52.5	48.7	48.5	44.9
Russia	79.4	68.2	68.8	59.0	56.6	57.4	51.0	50.4	49.0	50.9	50.5	51.0	51.5	57.3	55.4
Sweden	2.6	1.5	1.4	1.1	0.8	0.8	0.8	0.8	0.7	0.6	0.5	0.6	0.5	0.5	0.5

Note: Russia did not provide information for 2001, so emission values from Russia for 2001 were obtained using interpolation.

Table 2. Annual total anthropogenic emissions of cadmium of HELCOM countries from different sectors for 2004. Units: tonnes/year

Sector name	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
Combustion in Power Plants and Industry	0.38	0.55	0.77	2.33	0.05	0.35	12.32	55.40	0.21
Transport above 1000m	0.0003	0	0	0		0			0
Transport below 1000m	0.04	0.01	0	0	0.01	0.16	0.58		0.02
Commercial, Residential and Other Stationary Combustion	0.15	0.03	0.25	0.54	0.01	0.004	24.32		0.13
Fugitive Emissions From Fuels	0	0	0	0		0	5.01		0
Industrial Processes	0.005	0	0.47	0	0.39	0.01	0.78		0.17
Solvent and Other Product Use	0	0	0	0		0			0
Agriculture	0	0	0	0		0			0
Waste	0	0	0.0004	0	0.06	0	1.91		0.0001
Other									
Total	**0.58**	**0.59**	**1.49**	**2.86**	**0.52**	**0.52**	**44.92**	**55.40**	**0.53**

Table 3. Lead emissions from anthropogenic sources of HELCOM countries from 1990 to 2004. Units: tonnes/year

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	122	95	86	44	16	16	15	8	7	7	7	6	5	5	5
Estonia	201	185	121	101	124	84	65	52	46	44	41	37	37	39	38
Finland	326	247	175	100	60	57	35	19	20	14	38	38	40	34	27
Germany	1653	986	691	534	333	259	149	22	18	18	25	25	23	23	21
Latvia	142	138	131	128	131	130	131	133	135	134	134	134	134	136	135
Lithuania	47	49	32	28	33	30	18	20	22	19	16	15	15	15	5
Poland	1372	1336	986	997	966	937	960	896	736	745	647	610	588	596	544
Russia	3591	3553	3095	3276	2643	2426	2304	2247	2262	2339	2352	2235	2118	2207	330
Sweden	409	357	331	155	44	28	26	25	24	23	20	19	17	19	19

Note: Russia did not provide information for 2001, so emission values from Russia for 2001 were obtained using interpolation.

Table 4. Annual total lead anthropogenic emissions of HELCOM countries from different sectors for 2004. Unites: tonnes/year

Sector name	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
Combustion in Power Plants and Industry	3.5	32.8	16.7	15.4	0.05	0.6	254.6	330.0	4.4
Transport above 1000m	0	0	0	0	0	0	0	0	0
Transport below 1000m	1.5	3.8	1.8	0	0.002	4.4	35.8		7.4
Commercial, Residential and Other Stationary Combustion	0.2	1.1	2.7	5.4	0.1	0.1	139.0		0.7
Fugitive Emissions From Fuels	0	0	0.02	0		0	17.4		0
Industrial Processes	0.07	0	5.9	0	134.5	0.08	2.2		6.1
Solvent and Other Product Use	0	0	0	0		0			0
Agriculture	0	0	0	0		0			0
Waste	0	0.2	0.005	0	0.5	0	95.6		0.002
Other									
Total	**5.3**	**38.0**	**27.2**	**20.8**	**135.1**	**5.2**	**544.6**	**330.0**	**18.6**

Table 5. Mercury emissions from anthropogenic sources of HELCOM countries from 1990 to 2004. Units: tonnes/year

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	3.3	3.3	3.2	3.2	2.3	2.2	2.5	2.0	1.9	2.0	1.1	1.3	1.1	1.3	1.1
Estonia	1.1	1.0	0.8	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.5	0.5	0.6	0.5
Finland	1.1	0.9	0.8	0.6	0.7	0.7	0.8	0.6	0.5	0.4	0.6	0.7	0.7	0.8	0.7
Germany	5.3	12.8	8.1	5.0	2.5	2.4	2.5	2.4	2.5	2.5	2.7	2.8	2.7	2.8	2.6
Latvia	0.3	0.2	0.2	0.5	0.4	0.2	0.2	0.2	0.4	0.1	0.1	0.1	0.0	0.0	0.0
Lithuania	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.3	0.3	0.5	0.3	0.4	0.4
Poland	33.3	32.7	31.9	32.5	32.4	32.3	33.6	33.0	29.5	27.1	25.6	23.2	19.8	20.2	19.8
Russia	15.6	13.4	11.4	11.8	10.4	10.4	10.1	9.6	9.4	9.9	10.0	10.1	10.2	11.4	11.9
Sweden	4.8	1.3	1.2	1.1	1.1	1.1	1.1	1.0	1.0	0.9	0.8	0.7	0.7	0.8	0.8

Note: Russia did not provide information for 2001, so emission values from Russia for 2001 were obtained using interpolation.

Table 6. Annual total mercury anthropogenic emissions of HELCOM countries from different sectors for 2004. Unites: tonnes/year

Sector name	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
Combustion in Power Plants and Industry	0.8	0.5	0.4	2.8	0.02	0.4	10.1	11.9	0.3
Transport above 1000m	0	0	0	0	0	0	0		0
Transport below 1000m	0.005	0	0.02	0	0	0.0003	6.4		0.0002
Commercial, Residential and Other Stationary Combustion	0.3	0.02	0.03	0.001	0.004	0.02	1.8		0.03
Fugitive Emissions From Fuels	0	0	0	0	0	0	0.1		0.006
Industrial Processes	0	0	0.3	0	0.01	0.02	0.7		0.4
Solvent and Other Product Use	0	0	0.008	0	0	0			0
Agriculture	0	0	0	0	0	0			0
Waste	0	0	0.002	0	0.002	0	0.7		0.1
Other									
Total	**1.1**	**0.5**	**0.7**	**2.8**	**0.03**	**0.4**	**19.8**	**11.9**	**0.8**

Atmospheric deposition

Table 7. Computed total annual depositions of cadmium to six Baltic Sea sub-basins for period 1990-2004. Units: tonnes/year

Subbasin	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
GUB	2	1.4	1.4	1.4	1	1	1.3	0.8	1.1	1.1	1.3	1.1	0.9	0.9	0.8
GUF	1.2	1	0.9	0.7	0.8	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4
GUR	0.6	0.5	0.5	0.5	0.4	0.4	0.6	0.4	0.3	0.4	0.4	0.3	0.3	0.3	0.2
BAP	6.4	5.8	5.5	6.9	5.6	5	7.3	5	4.1	4.9	4.7	4.2	4.1	3.9	3.4
BES	0.7	0.6	0.6	0.6	0.5	0.4	0.6	0.5	0.5	0.4	0.5	0.4	0.4	0.4	0.4
KAT	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.4	0.4
BAS	**11.5**	**9.8**	**9.4**	**10.6**	**8.9**	**7.9**	**10.9**	**7.5**	**7**	**7.8**	**7.9**	**6.8**	**6.5**	**6.4**	**5.7**

Note: GUB=Gulf of Bothnia, GUF=Gulf of Finland, GUR= Gulf of Riga, BAP=Baltic Proper, BES=Belt Sea, KAT=Kattegat and BAS=Total Baltic Sea

Table 8. Top ten contributors to cadmium depositions to the Baltic Sea in 2004. Units: tonnes/year

Country	GUB	GUF	GUR	BAP	BES	KAT	BAS
Poland	0.15	1.39	0.07	0.07	0.06	0.07	1.81
Russia	0.04	0.14	0.07	0.01	0.00	0.00	0.28
Finland	0.14	0.02	0.03	0.00	0.00	0.00	0.20
Germany	0.01	0.08	0.00	0.00	0.02	0.01	0.12
Denmark	0.00	0.04	0.00	0.00	0.02	0.03	0.10
Slovak Republic	0.01	0.07	0.00	0.00	0.00	0.01	0.09
United Kingdom	0.01	0.05	0.00	0.00	0.01	0.01	0.09
France	0.01	0.05	0.00	0.00	0.01	0.01	0.08
Sweden	0.03	0.03	0.00	0.00	0.00	0.00	0.08
Estonia	0.01	0.01	0.04	0.00	0.00	0.00	0.06

Note: GUB=Gulf of Bothnia, GUF=Gulf of Finland, GUR= Gulf of Riga, BAP=Baltic Proper, BES=Belt Sea, KAT=Kattegat and BAS=Total Baltic Sea

Table 9. Sources of cadmium depositions to the Baltic Sea in 2004. Units: tonnes/year

Country	GUB	GUF	GUR	BAP	BES	KAT	BAS
HELCOM countries	0.4	1.8	0.2	0.1	0.1	0.1	2.7
Other European countries	0.1	0.4	0.0	0.0	0.1	0.1	0.6
Remote sources	0.18	0.47	0.06	0.04	0.06	0.08	0.90
Natural and resuspension	0.15	0.81	0.07	0.05	0.16	0.14	1.38
Total	**0.8**	**3.4**	**0.4**	**0.2**	**0.4**	**0.4**	**5.7**

Note: GUB=Gulf of Bothnia, GUF=Gulf of Finland, GUR= Gulf of Riga, BAP=Baltic Proper, BES=Belt Sea, KAT=Kattegat and BAS=Total Baltic Sea

Table 10. Computed total annual depositions of lead to six Baltic Sea sub-basins for period 1990-2004. Units: tonnes/year

Subbasin	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
GUB	118	95	83	65	40	45	56	29	48	52	59	43	39	41	32
GUF	62	51	43	32	33	27	30	19	24	23	23	21	20	22	16
GUR	39	32	27	21	19	16	21	13	15	16	16	12	16	16	12
BAP	416	352	283	266	198	168	216	144	180	190	182	135	163	149	134
BES	70	46	44	35	29	23	22	20	30	22	24	16	18	19	20
KAT	64	44	44	29	24	21	18	19	26	23	28	18	21	19	21
BAS	**770**	**621**	**525**	**447**	**342**	**299**	**363**	**244**	**322**	**327**	**332**	**245**	**277**	**266**	**235**

Note: GUB=Gulf of Bothnia, GUF=Gulf of Finland, GUR= Gulf of Riga, BAP=Baltic Proper, BES=Belt Sea, KAT=Kattegat and BAS=Total Baltic Sea

Table 11. Top ten contributors to lead depositions to the Baltic Sea in 2004. Units: tonnes/year

Country	GUB	GUF	GUR	BAP	BES	KAT	BAS
Poland	1.78	15.64	0.84	0.84	0.80	0.87	20.78
Latvia	1.59	4.71	1.31	3.11	0.060	0.056	10.84
Estonia	0.46	0.64	2.86	0.24	0.01	0.011	4.23
Finland	2.09	0.42	0.68	0.06	0.01	0.01	3.26
Sweden	1.37	0.99	0.09	0.07	0.04	0.12	2.69
Belgium	0.18	1.50	0.07	0.06	0.33	0.27	2.41
United Kingdom	0.20	1.30	0.07	0.07	0.33	0.38	2.35
France	0.19	1.29	0.07	0.06	0.29	0.28	2.19
Romania	0.34	1.09	0.13	0.08	0.07	0.10	1.80
Netherlands	0.12	0.95	0.04	0.04	0.26	0.23	1.64

Note: GUB=Gulf of Bothnia, GUF=Gulf of Finland, GUR= Gulf of Riga, BAP=Baltic Proper, BES=Belt Sea, KAT=Kattegat and BAS=Total Baltic Sea

Table 12. Sources of lead depositions to the Baltic Sea in 2004. Units: tonnes/year

Country	GUB	GUF	GUR	BAP	BES	KAT	BAS
HELCOM countries	7.66	24.09	6.35	4.48	1.21	1.40	45.20
Other European countries	2.09	10.90	0.94	0.69	1.71	1.74	18.09
Remote sources	6.10	16.61	2.00	1.33	2.26	2.72	31.02
Natural and resuspension	16.29	82.57	7.18	5.15	15.01	14.81	141.01
Total	**32.14**	**134.17**	**16.48**	**11.66**	**20.20**	**20.67**	**235.33**

Note: GUB=Gulf of Bothnia, GUF=Gulf of Finland, GUR= Gulf of Riga, BAP=Baltic Proper, BES=Belt Sea, KAT=Kattegat and BAS=Total Baltic Sea

Table 13. Computed total annual depositions of mercury to six Baltic Sea sub-basins for period 1990-2004. Units: tonnes/year

Subbasin	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
GUB	0.9	0.8	0.8	0.8	0.7	0.8	1	0.7	0.8	0.8	0.9	0.7	0.6	0.7	0.6
GUF	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2
GUR	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1
BAP	2.7	2.4	2.4	2.7	2.3	2.3	2.9	2.2	1.9	2.1	2.1	1.8	1.8	1.7	1.5
BES	0.5	0.4	0.4	0.5	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2
KAT	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2
BAS	**5.2**	**4.4**	**4.6**	**4.8**	**4.2**	**4.3**	**5.3**	**4.1**	**3.6**	**3.8**	**4**	**3.4**	**3.3**	**3.2**	**2.9**

Note: GUB=Gulf of Bothnia, GUF=Gulf of Finland, GUR= Gulf of Riga, BAP=Baltic Proper, BES=Belt Sea, KAT=Kattegat and BAS=Total Baltic Sea

Table 14. Top ten contributors to mercury depositions to the Baltic Sea in 2004. Units: tonnes/year

Country	GUB	GUF	GUR	BAP	BES	KAT	BAS
Poland	0.02	0.22	0.01	0.01	0.01	0.01	0.28
Denmark	0.00	0.05	0.00	0.00	0.04	0.04	0.13
United Kingdom	0.01	0.03	0.00	0.00	0.01	0.01	0.06
Germany	0.00	0.03	0.00	0.00	0.01	0.00	0.04
Sweden	0.02	0.01	0.00	0.00	0.00	0.00	0.04
Estonia	0.00	0.00	0.03	0.00	0.00	0.00	0.03
France	0.00	0.02	0.00	0.00	0.00	0.00	0.03
Finland	0.02	0.00	0.01	0.00	0.00	0.00	0.03
Belgium	0.00	0.01	0.00	0.00	0.00	0.00	0.02
Lithuania	0.00	0.01	0.00	0.00	0.00	0.00	0.02

Note: GUB=Gulf of Bothnia, GUF=Gulf of Finland, GUR= Gulf of Riga, BAP=Baltic Proper, BES=Belt Sea, KAT=Kattegat and BAS=Total Baltic Sea

Table 15. Sources of mercury depositions to the Baltic Sea in 2004. Units: tonnes/year

Country	GUB	GUF	GUR	BAP	BES	KAT	BAS
HELCOM countries	0.1	0.3	0.1	0.02	0.1	0.1	0.6
Other European countries	0.03	0.1	0.01	0.01	0.02	0.02	0.2
Remote sources	0.50	1.03	0.16	0.10	0.11	0.14	2.04
Natural and resuspension	0.01	0.02	0.003	0.002	0.002	0.002	0.03
Total	**0.6**	**1.5**	**0.2**	**0.1**	**0.2**	**0.2**	**2.9**

Note: GUB=Gulf of Bothnia, GUF=Gulf of Finland, GUR= Gulf of Riga, BAP=Baltic Proper, BES=Belt Sea, KAT=Kattegat and BAS=Total Baltic Sea

Waterborne loads

Table 16. Riverine, coastal and direct point and diffuse source inputs of cadmium from HELCOM countries in 1994-2004. Units: tonnes/year

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	0.0	0.32	0.0	0.0	0.0	0.0	0.30	0.24	0.20	0.12	0.27
Estonia	2.28	0.0	0.0	0.0	0.0	0.0	0.77	0.0	0.0	0.0	0.96
Finland	2.05	2.33	2.39	2.88	2.90	2.48	3.39	2.17	1.33	1.43	2.03
Germany	1.15	0.24	0.13	0.10	0.25	0.25	0.12	0.13	0.19	0.13	0.09
Latvia	3.29	1.62	0.73	1.36	1.82	0.61	1.66	1.21	2.57	3.02	1.81
Lithuania	4.01	0.82	1.35	1.24	2.40	0.77	1.31	1.42	0.74	1.33	1.33
Poland	17.57	9.90	7.31	5.12	6.24	6.57	6.89	2.09	1.42	2.34	1.07
Russia	39.17	45.25	9.65	16.11	16.71	18.23	34.41	34.87	25.86	26.02	26.02
Sweden	1.08	1.34	1.27	1.93	2.89	2.35	3.42	2.46	1.97	1.19	1.81
Total	**70.6**	**61.8**	**22.8**	**28.7**	**33.2**	**31.3**	**52.3**	**44.6**	**34.3**	**35.58**	**35.39**

Note: No data for 1994, 1996-1999 from Denmark; for 1995-1999 and 2001-2003 from Estonia; for 2002-2004 from Russia; for 2003-2004 from Lithuania; or for 2004 from Latvia. The 2004 values for Latvia, Lithuania and Russia have been calculated according to a five year average of previously reported values.

Table 17. Riverine, coastal and direct point and diffuse source inputs of lead from HELCOM countries in 1994-2004. Units: tonnes/year

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	0.0	0.36	0.0	0.0	0.0	0.0	8.52	1.54	0.0	0.0	5.77
Estonia	26.32	0.00	0.0	0.0	0.0	0.0	2.16	0.0	0.0	0.0	6.08
Finland	28.96	31.16	32.00	27.57	41.31	33.11	42.36	32.72	16.84	11.58	24.44
Germany	6.69	2.91	2.25	1.92	5.14	2.91	1.89	3.59	4.95	2.02	1.43
Latvia	11.21	8.80	2.09	4.88	5.35	4.32	12.33	6.51	7.70	14.24	9.02
Lithuania	40.12	17.87	44.63	38.42	18.83	25.29	23.76	28.01	2.71	9.10	12.54
Poland	203.69	137.95	57.95	61.99	58.51	65.97	47.33	66.76	31.77	33.49	28.41
Russia	257.88	474.82	100.02	155.13	157.13	183.98	290.03	196.41	157.30	186.00	202.74
Sweden	94.67	157.83	83.06	125.51	50.41	53.06	57.63	55.13	36.95	29.61	41.65
Total	**669.5**	**831.7**	**322.0**	**415.4**	**336.7**	**368.6**	**486.0**	**390.7**	**258.2**	**286.0**	**322.1**

Note: No data for 1994, 1996-1999 and 2002-2003 from Denmark; for 1996-1999 and 2001-2003 from Estonia; or for 2004 from Latvia and Russia. The 2004 values for Latvia and Russia are based on a five year average of previously reported values.

Table 18. Riverine, coastal and direct point and diffuse source inputs of mercury from HELCOM countries in 1994-2004. Units: tonnes/year

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	0.0	0.26	0.0	0.0	0.0	0.0	0.05	0.03	0.03	0.01	0.03
Estonia	0.44	0.0	0.0	0.0	0.0	0.0	1.18	0.0	0.0	0.0	3.9
Finland	0.02	0.04	0.01	0.01	0.01	0.01	0.70	0.92	0.33	0.38	0.27
Germany	0.16	0.15	0.12	0.06	0.06	0.05	0.04	0.02	0.03	0.02	0.01
Latvia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lithuania	0.0	0.0	0.0	0.0	0.0	0.23	0.00	0.27	0.0	0.30	0.82
Poland	6.76	10.19	5.80	2.16	20.38	103.56	43.09	9.30	2.47	6.48	1.13
Russia	0.09	0.35	0.02	0.13	0.02	0.01	0.14	0.12	0.01	0.01	0.06
Sweden	0.00	0.61	0.31	0.23	0.32	0.32	0.63	0.46	0.23	0.14	0.21
Total	**7.5**	**11.6**	**6.3**	**2.6**	**20.8**	**104.2**	**45.8**	**11.1**	**3.1**	**7.3**	**6.42**

Note: No data on mercury from Latvia; for 1994, 1996-1999 from Denmark; for 1995-1999 and 2001-2003 from Estonia; for 1994-1998 and 2002 from Lithuania; and for 2004 from Russia. The 2004 values for Russia are based on a five year average of previously reported values.

www.helcom.fi