4. Emissions and Source Allocation Budgets

Emissions from the HELCOM countries and emissions from the international ship traffic on the Baltic Sea are the major sources of pollution deposition on the Baltic Sea. However, emissions from other parts of the entire EMEP region have also, in some cases, important contribution to such a deposition. Therefore, we will deal with the emissions from the entire EMEP domain first.

4.1 Emissions from the EMEP region in the period 1996 - 2000

Annual emissions of nitrogen oxides, ammonia and total nitrogen (nitrogen oxides plus ammonia) in the period 1996 - 2000 are shown in Figure 4.1.

Emissions of both, nitrogen oxides and ammonia are slightly lower in 2000 than in 1996, but the difference is not significant, especially for ammonia. In the 5-year period, reduction of oxidized nitrogen oxides emissions is more effective, approximately 9%, then the reduction of ammonia emissions, approximately 4%.

In comparison with the emissions of nitrogen oxides and ammonia, the reduction of lead anthropogenic emissions is more significant during the same period (Figure 4.2). Thus lead emissions in 2000 were 31%, cadmium 22%, and mercury 17% lower than those of 1996.

According to available official information and expert estimates, lindane emissions were more or less on the same level during the 1996-1998 (Figure 4.3). More significant changes took place earlier from 1970 to 1990. During this period the emission of lindane within the EMEP region dropped more than three times.

4.2 Map with ship emissions on the Baltic Sea

Emissions from the international ship traffic on the Baltic Sea, are only available for nitrogen oxides at present, and only for one year – 1990. Total annual emissions of nitrogen oxides from the international shipping operation on the Baltic Sea are relatively high, 353 ktonnes (NO_x). Compared to annual emissions from the individual HELCOM countries, for the same year, only emissions from Russian Federation, Germany and Poland are higher than emissions from the ship traffic. Therefore, ship emissions have to be taken into account as a very important source of the deposition to the Baltic Sea. Map of annual nitrogen oxides emissions from the ship traffic on the Baltic Sea in 1990 is shown in Figure 4.4.

4.3 Nitrogen emissions from the HELCOM countries in the period 1996 - 2000

A map with annual emissions of nitrogen oxides in the period 1996 – 2000 is shown in Figure 4.5 for all HELCOM countries. In all these countries emissions are lower in 2000 than in 1996 with the most significant drop of nitrogen oxides emissions in Denmark – 32%. Monotone reduction, in the considered period, can be noticed in Finland, Sweden, Denmark, Germany and Poland, whereas some ups and downs are visible in emissions from Russian Federation, Estonia, Latvia and Lithuania.

Similar map for annual emissions of ammonia from all HELCOM countries, in the period 1996 – 2000 is shown in Figure 4.6. Also for ammonia, emissions in all HELCOM countries are lower in 1996 than in 2000, however, differences are smaller than in the case of nitrogen oxides. No clear pattern can be observed in the annual emissions of ammonia from the HELCOM countries for the considered period.

Annual emissions of nitrogen oxides, ammonia and total nitrogen (nitrogen oxides plus ammonia), form all HELCOM countries, in the period 1996 - 2000 are shown in Figure 4.7. Nitrogen oxides emissions from the international ship traffic on the Baltic Sea are not taken into account in Figure 4.7 because of the lack of data for the considered period. HELCOM countries emissions of nitrogen oxides and ammonia are lower in 2000 than in 1996. In the 5-year period, reduction of nitrogen oxides emissions, 13.5%, is higher then the reduction of ammonia emissions, 9%. Total (nitrogen oxides + ammonia) nitrogen emissions are 11% lower in 2000 than in 1996. This means, that nitrogen emission reduction is more effective in case of HELCOM countries than for the entire EMEP domain.

4.4 Heavy metal emissions from the HELCOM countries in the period 1996 - 2000

Maps with the annual emissions of cadmium, mercury, and lead in the period 1996–2000 are shown in Figures 4.8-4.10 for all HELCOM countries. Most of these values are based on officially submitted information by countries. In case when there was no information on emission the values for the previous years were taken.

For lead total emission in the Baltic Sea region decreased from 4051 t in 1996 to 3632 t in 2000. The most significant drop is encountered for Latvia (more than 90%). Cadmium emissions in this region dropped from 160 t in 1996 to 117 t in 2000 with maximum decrease in Sweden about 90%. For mercury the emissions changed from 80 t in 1996 to 68 t in 2000. As for lead maximum drop is encountered for Latvia (76%).

Based on available official data and expert estimates the emissions of heavy metals of HELCOM Contracting Parties have decreased during 1996-2000 by 26% for Cd, 15% for

Hg, and 10% for Pb (Fig. 4.11). In comparison with changes of total emissions within the EMEP region the HM emissions of the HELCOM CPs has decreased to a less extent.

4.5 Lindane emissions from the HELCOM countries in the period 1996 - 1998

Computations of lindane depositions to the Baltic Sea were made for longer period comparing to heavy metals and nitrogen compounds. This was done to take into account its accumulation in and subsequent re-emission from soil and seawater compartments. Modeling results were obtained using available expert estimates of POPCYCLING Baltic project (Pacyna, 1999b) for 1970-1996 and available official data on lindane emissions of HELCOM CPs for 1990-1998. According to official information submitted by HELCOM countries there was no emission of lindane in Finland and Sweden from 1990. For Germany official emission data are available for 1994 and for Russia - for 1990. Due to the absence of official information it was assumed that there was no emission of lindane in Russian Federation starting from 1991.

Map with the annual emissions of lindane in the period 1970–1998 is shown in Figure 4.12 for all HELCOM countries. Most of changes in emissions have taken place in 70s and 80s as a result of restrictions or banning of use of lindane in these countries. Since 1990 the level of γ-HCH emissions in this region was more than an order of magnitude lower comparing to 1970 (Figure 4.13). According to available data lindane emissions of HELCOM countries during the 1996-1998 were practically on the same level.

4.6 Source allocation budget for nitrogen

Source allocation budget for the nitrogen compounds is not available for the entire period 1996 – 2000. Therefore, as an example, in Figure 4.14 we present the source allocation budget for nitrogen for one year, 1997. We assume, that with some uncertainty, Figure 4.13 can represent a typical pattern for the entire period 1996 – 2000. As soon as, the model rest are available source allocation budgets for 1997 will be replace by the nitrogen source allocation budgets for the period 1996 – 2000.

4.7 Source allocation budgets for heavy metals

Source allocation budgets of depositions of the heavy metals to the Baltic Sea were computed for the entire period 1996 – 2000. Figures 4.15-4.17 present the source allocation budgets for cadmium, lead, and mercury, respectively for 1996 and 2000. It can be seen that in comparison with depositions for 1996 the input of anthropogenic sources in 2000 is decreased. An essential contribution belongs to the input of natural, previous and remote anthropogenic sources.

For cadmium the contribution of HELCOM CPs to its total deposition to the Baltic Sea is decreased in this period from 50% to 39%. Among these countries the most significant contribution belongs to anthropogenic emission sources of Poland – 34% in 1996 and 24% in 2000. Other EMEP countries contribute 7% in 1996 and 11% in 2000.

For lead the contribution of HELCOM CPs to its total deposition to the Baltic Sea is decreased from 39% to 31%. The fraction of depositions from other EMEP countries is more significant comparing to cadmium – about 20%. From HELCOM CPs the most significant contribution belongs also to anthropogenic emission sources of Poland – 14% in 1996 and 11% in 2000.

For mercury the decrease of contribution of HELCOM CPs to its total deposition to the Baltic Sea is less significant – from 46% to 43%. According to modeling results the contributions of emissions from HELCOM countries and other EMEP countries were practically on the same level during the period from 1996 to 2000. The input of HELCOM countries is more significant (46% in 1996 and 43% in 2000) comparing to other EMEP countries which amounts to 5-6%. The most significant contribution from HELCOM countries in 1996 belongs to Poland (15%) and in 2000 to Germany (19%).

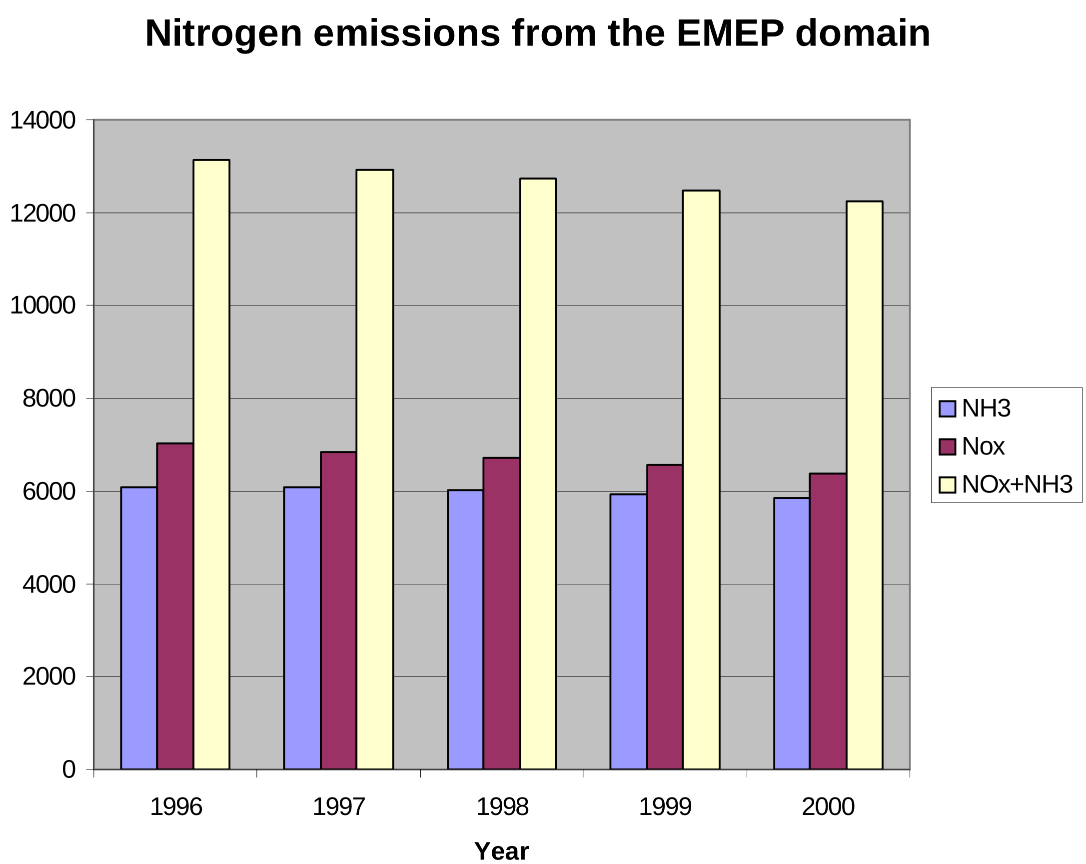


Figure 4.1. Annual emissions of nitrogen oxides, ammonia and total nitrogen (nitrogen oxides + ammonia) from the EMEP domain in the period 1996 - 2000.Units: ktonnes N/yr.

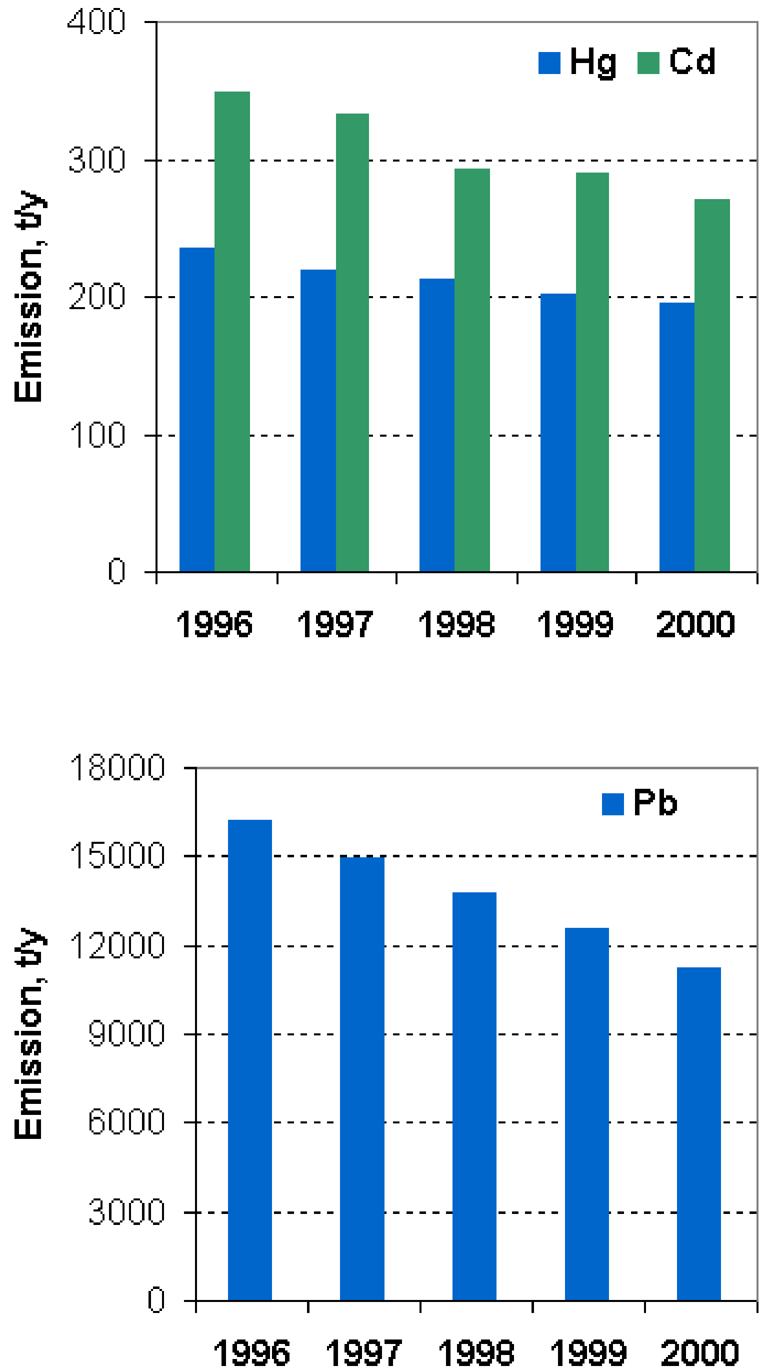


Figure 4.2. Annual emissions of cadmium, mercury and lead form the EMEP domain in the period 1996 - 2000.Units: tonnes /yr.

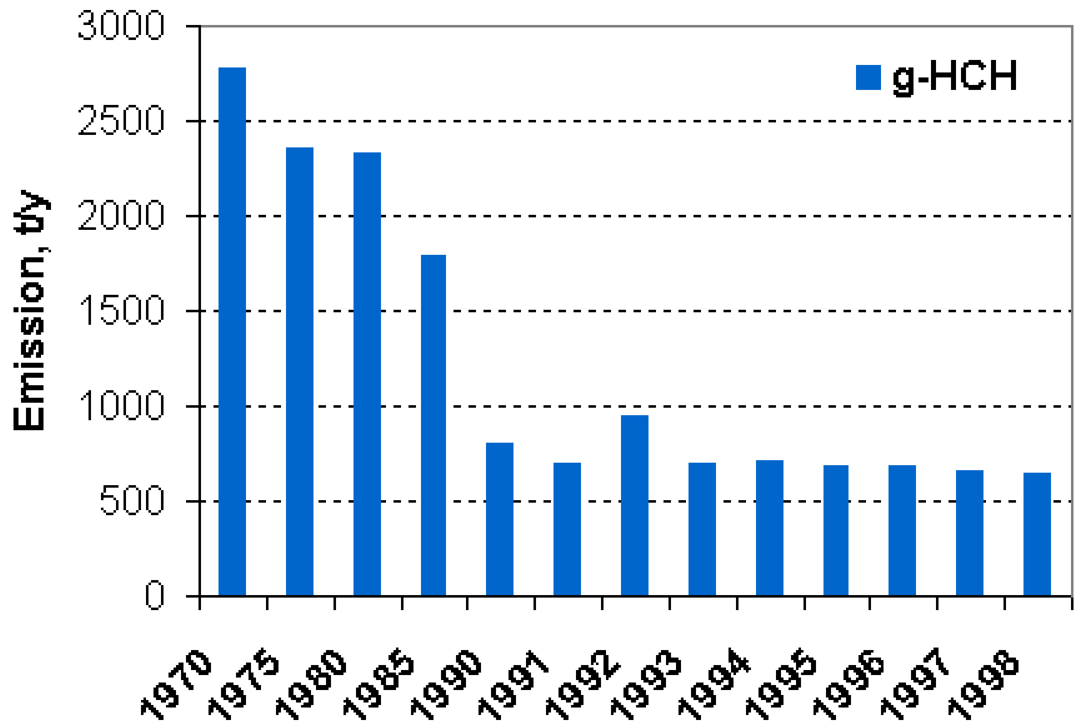


Figure 4.3. Annual emissions lindane (γ-HCH) from the EMEP domain in the period 1996 - 2000.Units: tonnes /yr.

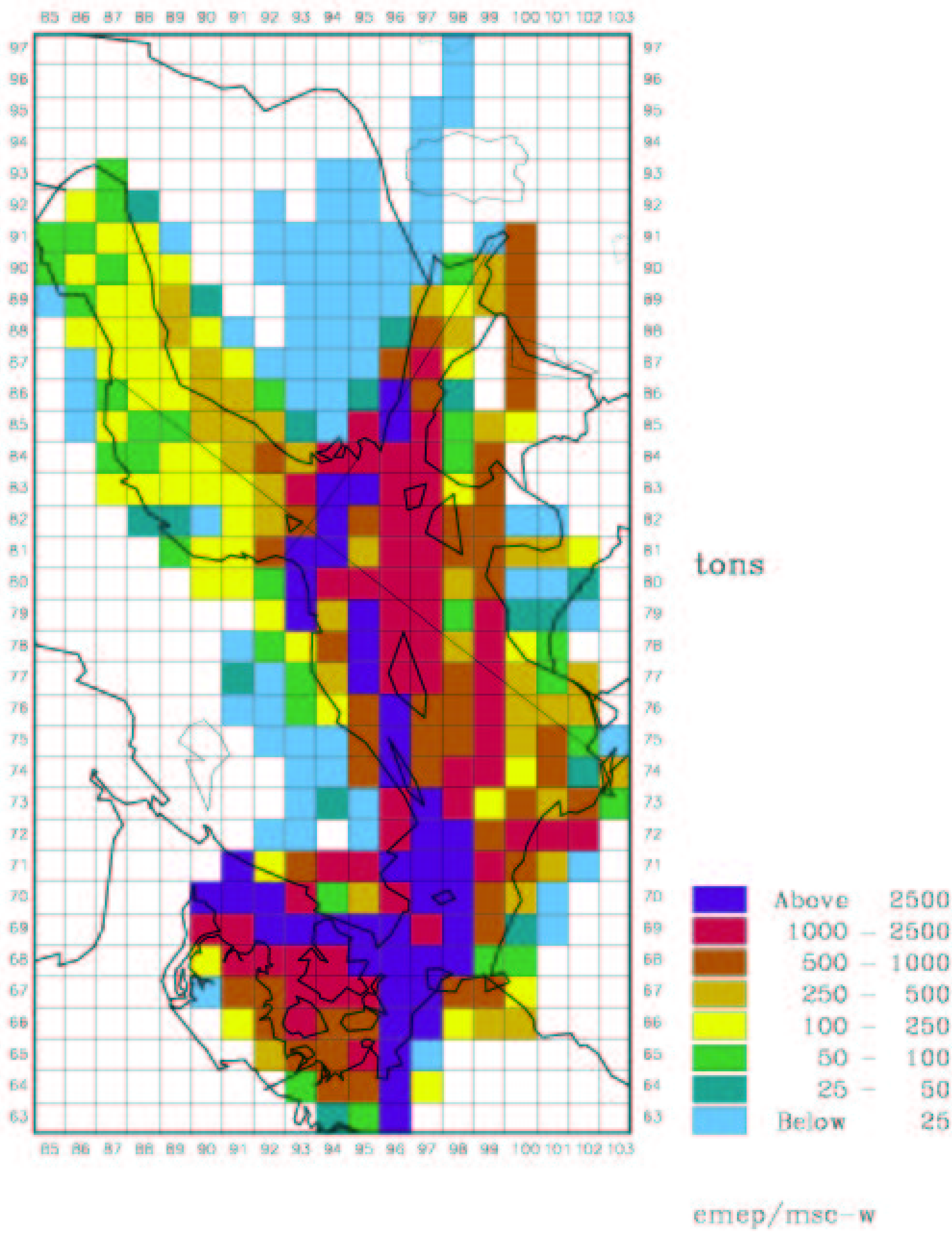


Figure 4.4 Map of annual emissions of nitrogen oxides from the international ship traffic on the Baltic Sea in 1990.Units: tonnes/yr/grid

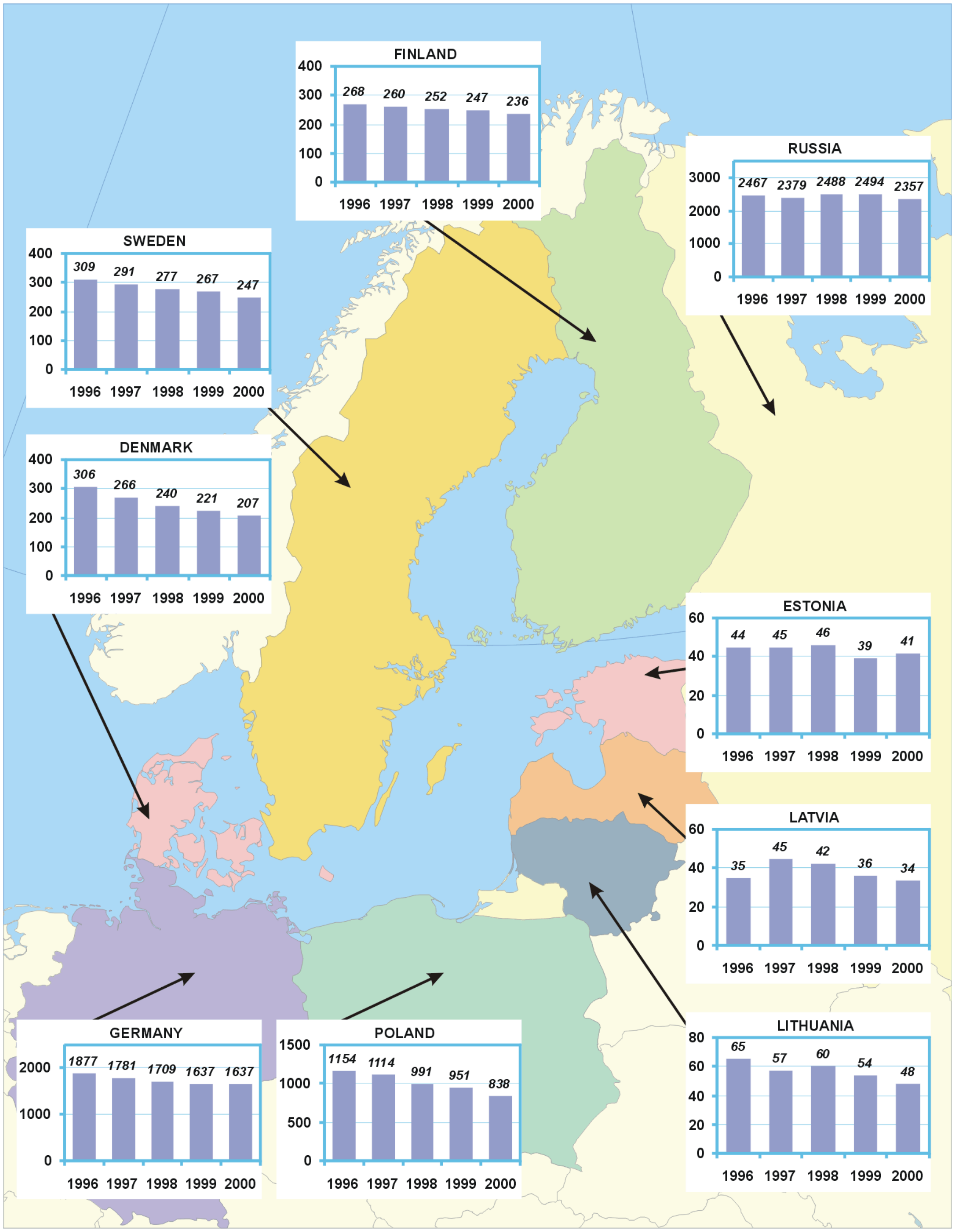


Figure 4.5 *Map of annual emissions of nitrogen oxides from individual HELCOM countries in the period 1996 – 20000.Units: ktonnes/yr.*

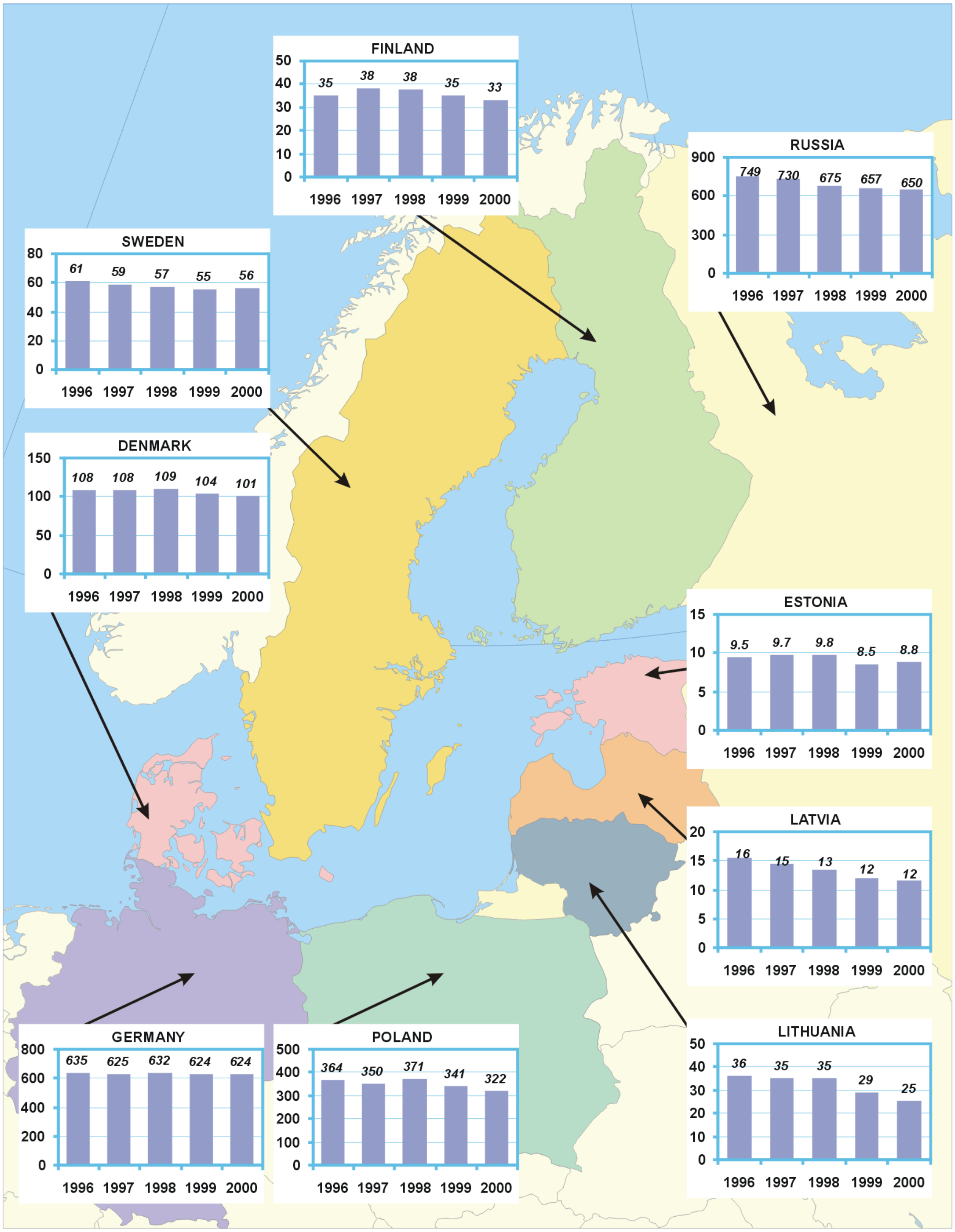


Figure 4.6 Map of annual emissions of ammonia from the HELCOM countries in the period 1996 – 20000. Units: ktonnes/yr.

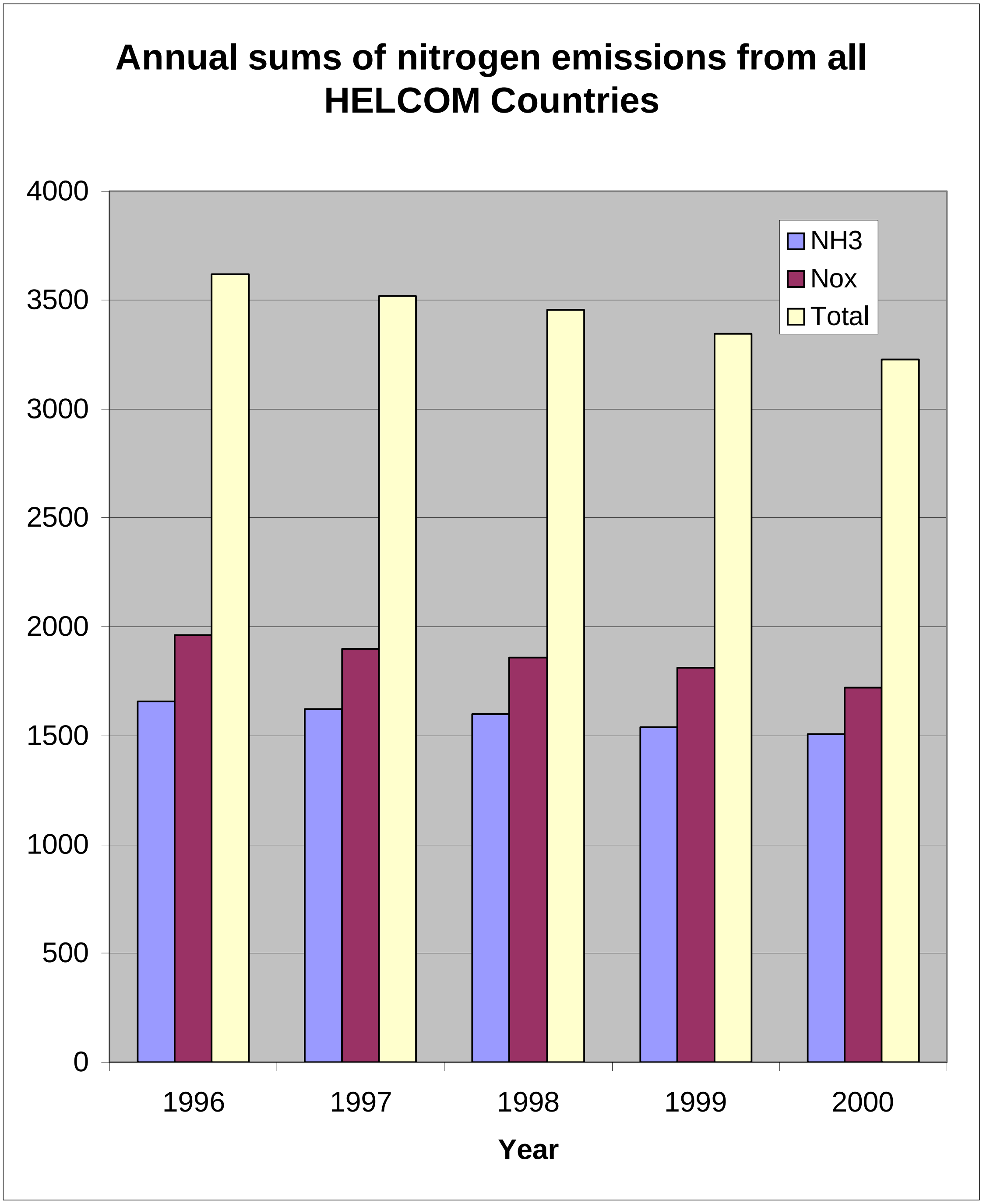


Figure 4.7 Annual emissions of nitrogen oxides, ammonia and total nitrogen (nitrogen oxides plus ammonia) from all HELCOM countries in the period 1996 – 20000. Units: ktonnes N/yr.

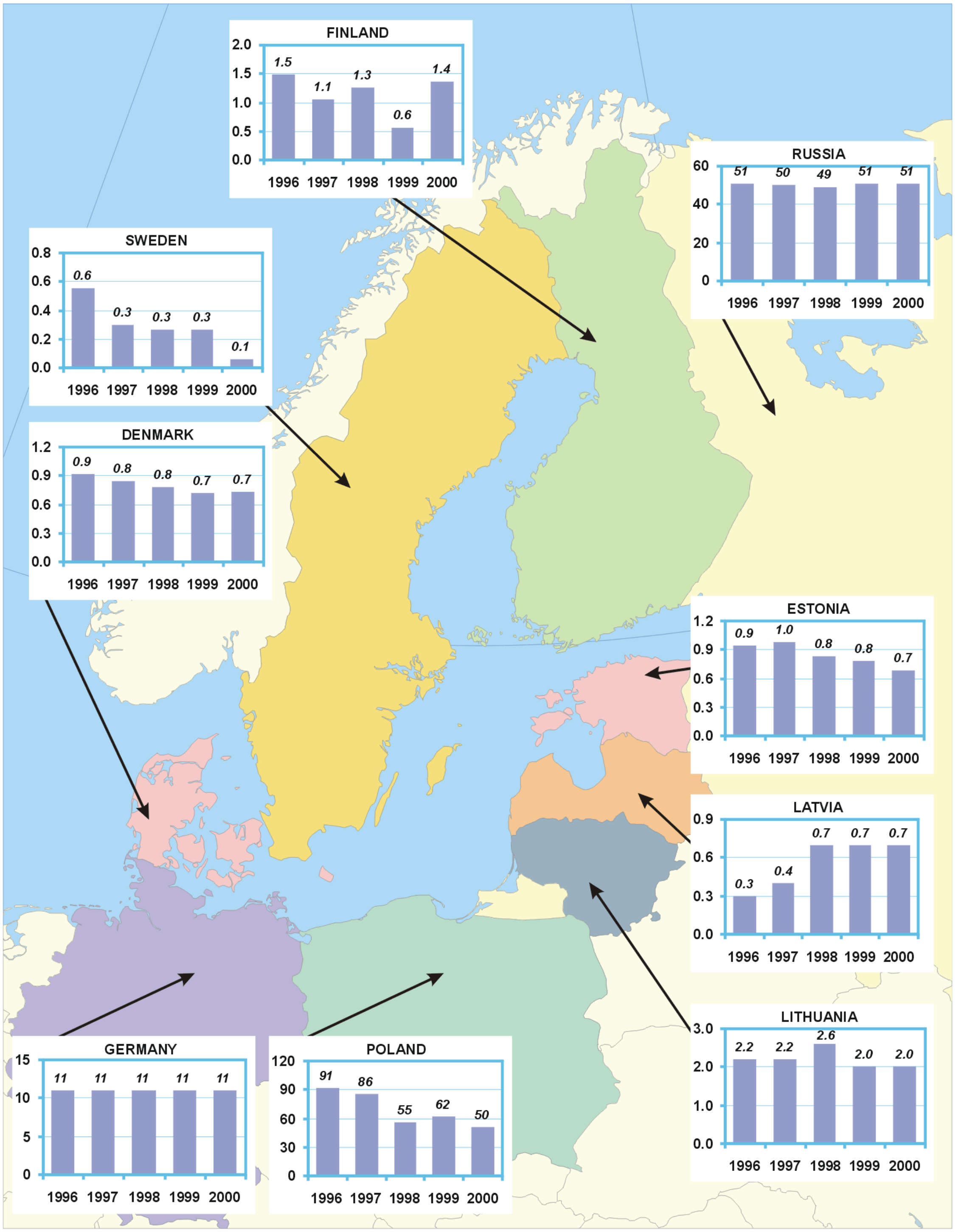


Figure 4.8 Map of annual emissions of cadmium from individual HELCOM countries in the period 1996 – 2000. Units: tonnes/yr.

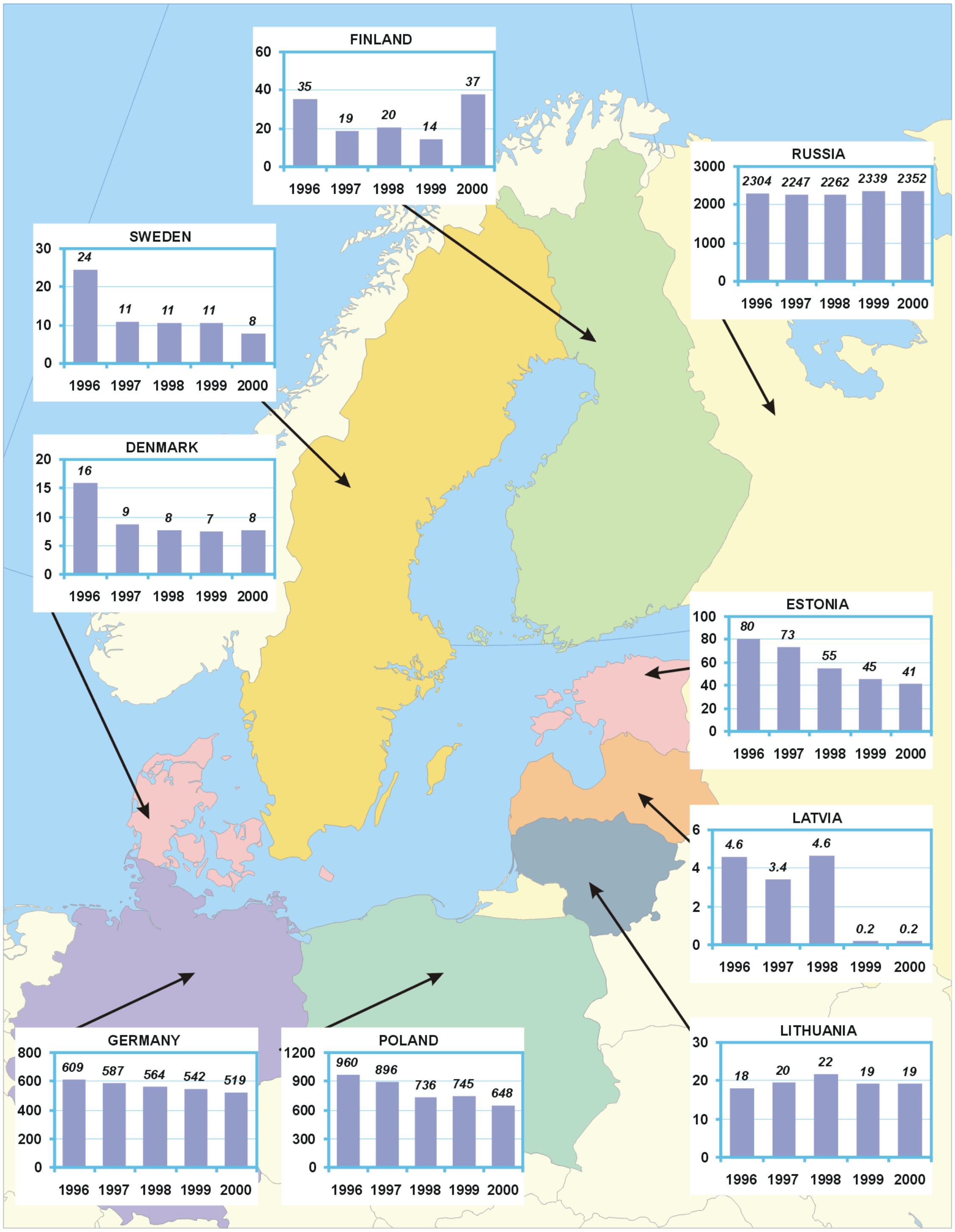


Figure 4.9 Map of annual total emissions of lead from individual HELCOM countries in the period 1996 – 2000. Units: tonnes/yr.

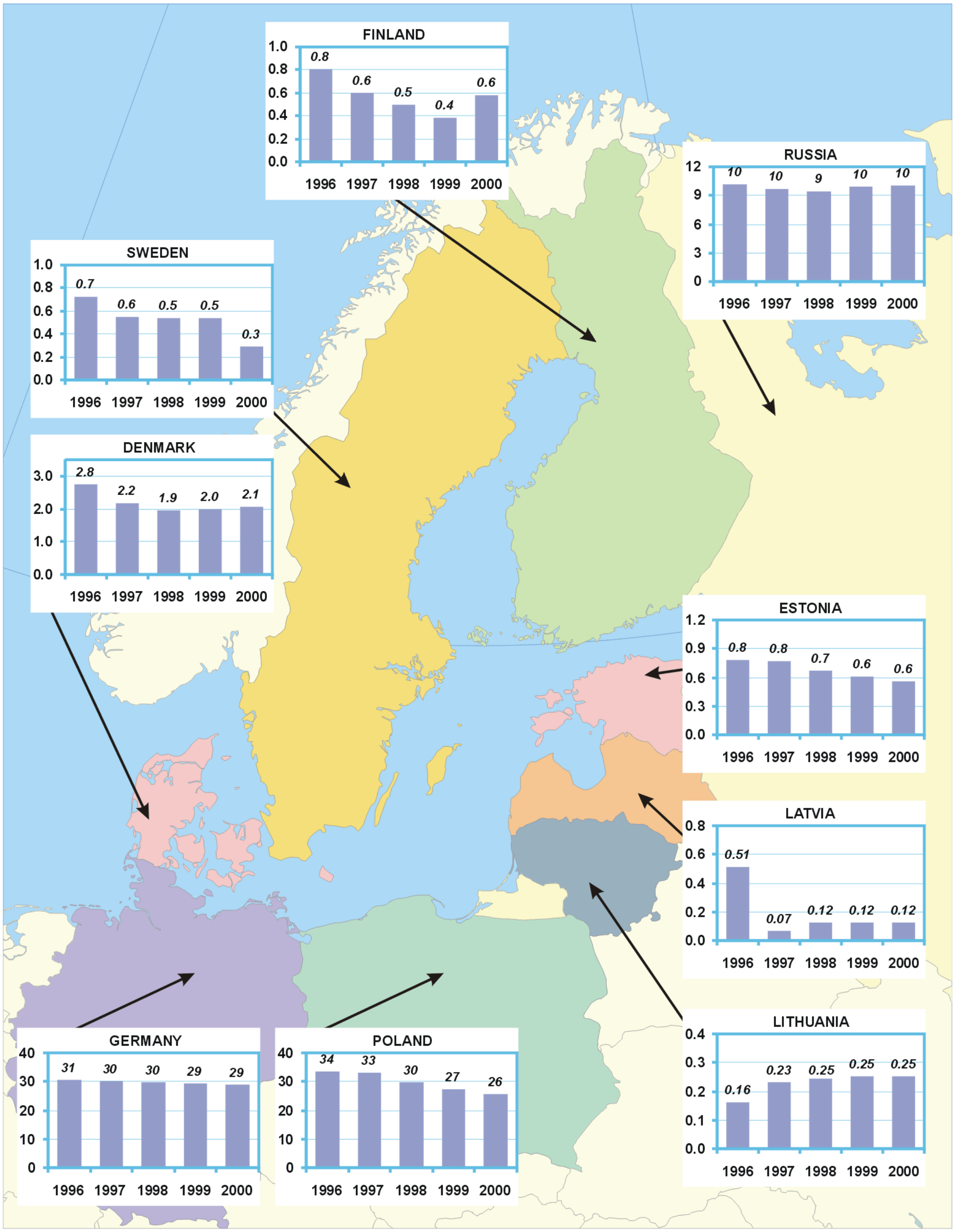
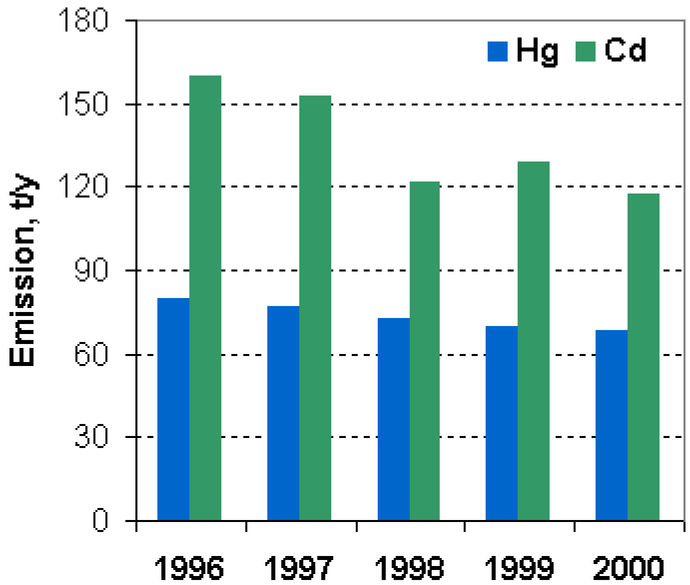


Figure 4.10 Map of annual total emissions of mercury from individual HELCOM countries in the period 1996 – 20000. Units: tonnes/yr



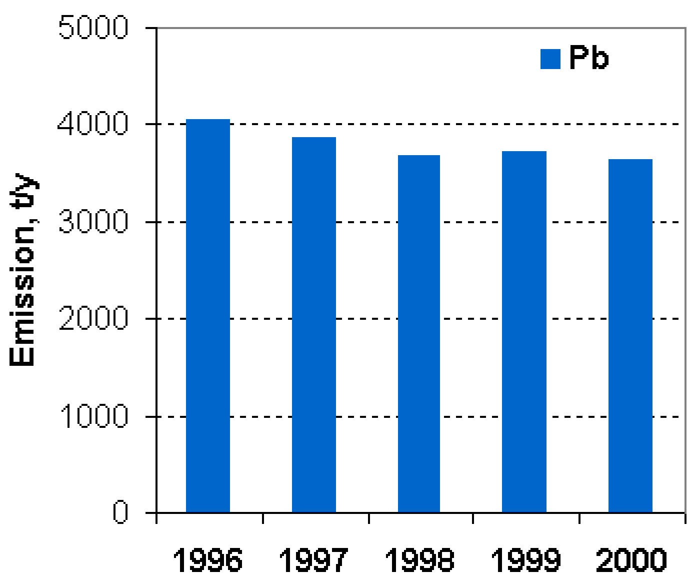


Figure 4.11 Annual emissions of cadmium, mercury and lead from all HELCOM countries in the period 1996 – 20000. Units: tonnes/yr.

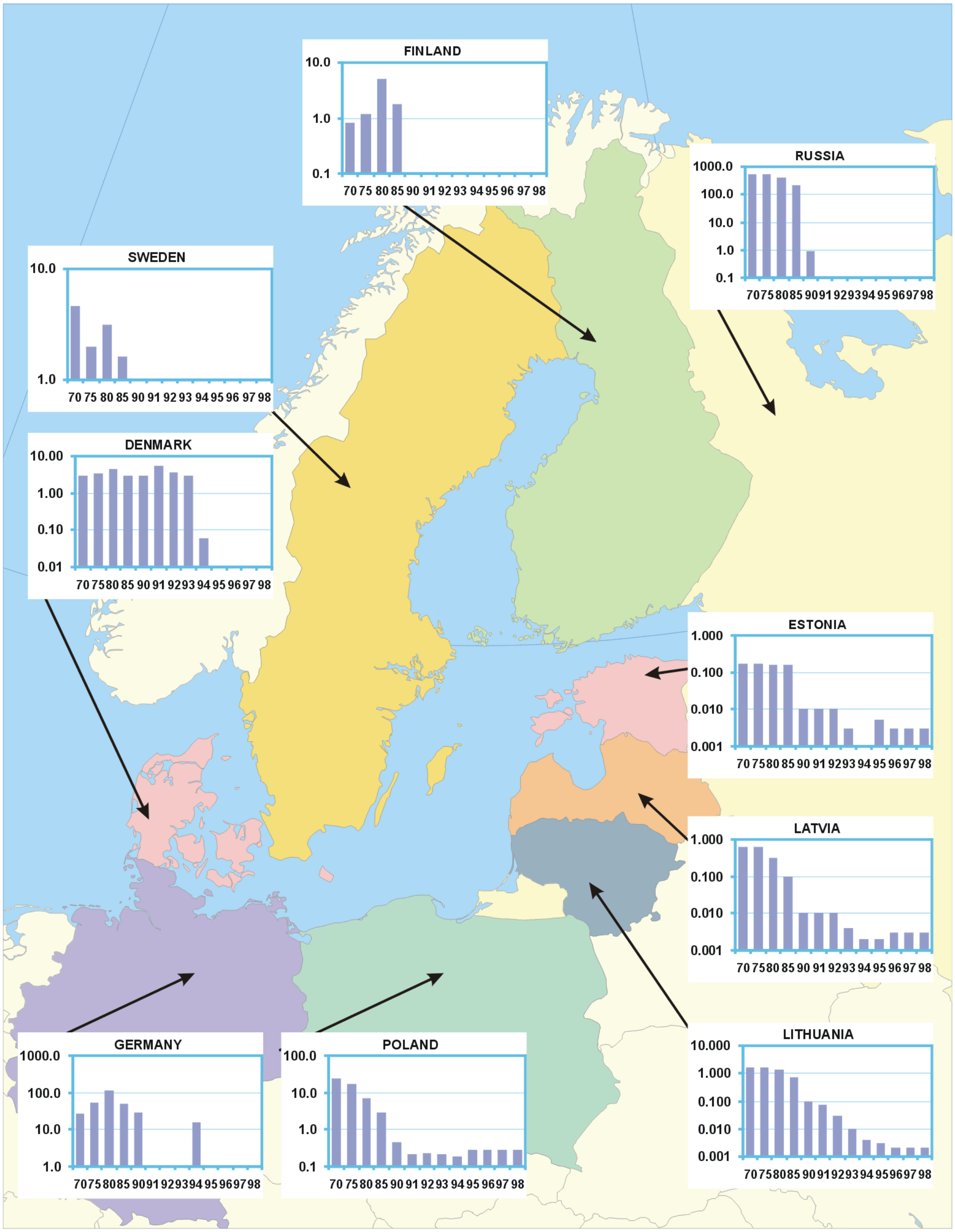


Figure 4.12 Map of annual total emissions of lindane from individual HELCOM countries in the period 1970 – 1998. Emission values are presented in the logarithmic scale. Missing bars correspond to lack of lindane emissions in particular year. Units: tonnes/yr.

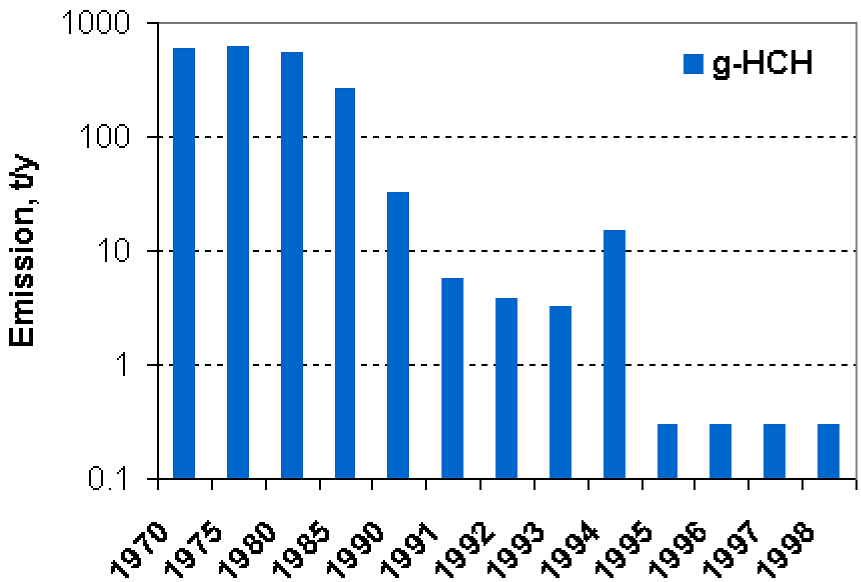


Figure 4.13 Annual total emissions of lindane from all HELCOM countries in the period 1970 – 1998. Emission values are presented in the logarithmic scale. Units: tonnes/yr.

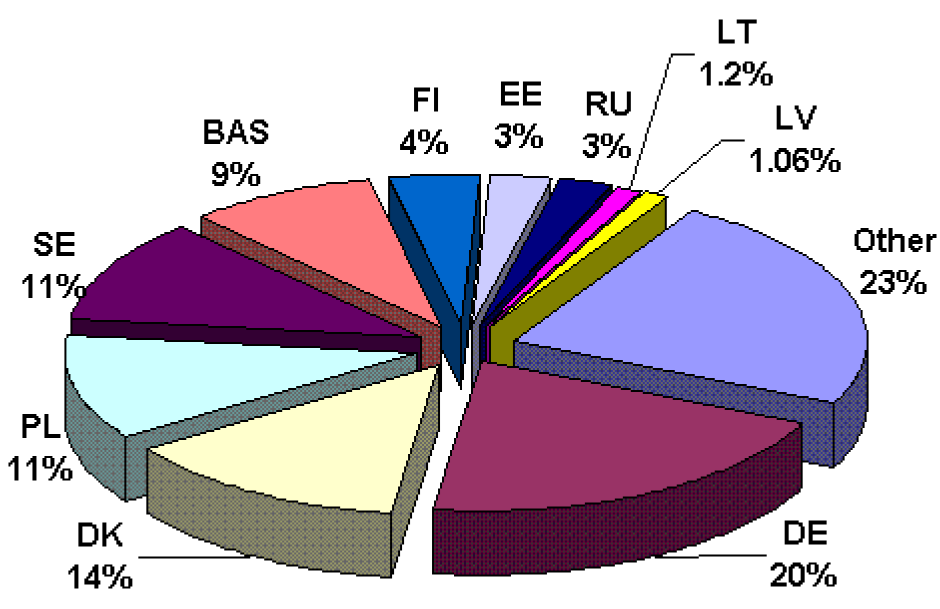
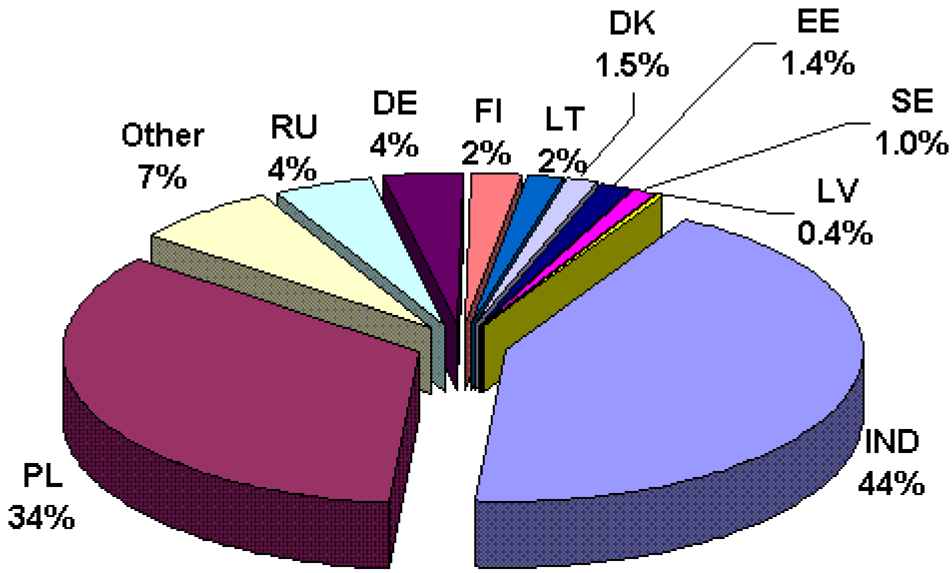


Figure 4.14 Main emissions sources of nitrogen contributing to its annual deposition over the entire Baltic Sea Basin in 1997.

(a)



(b)

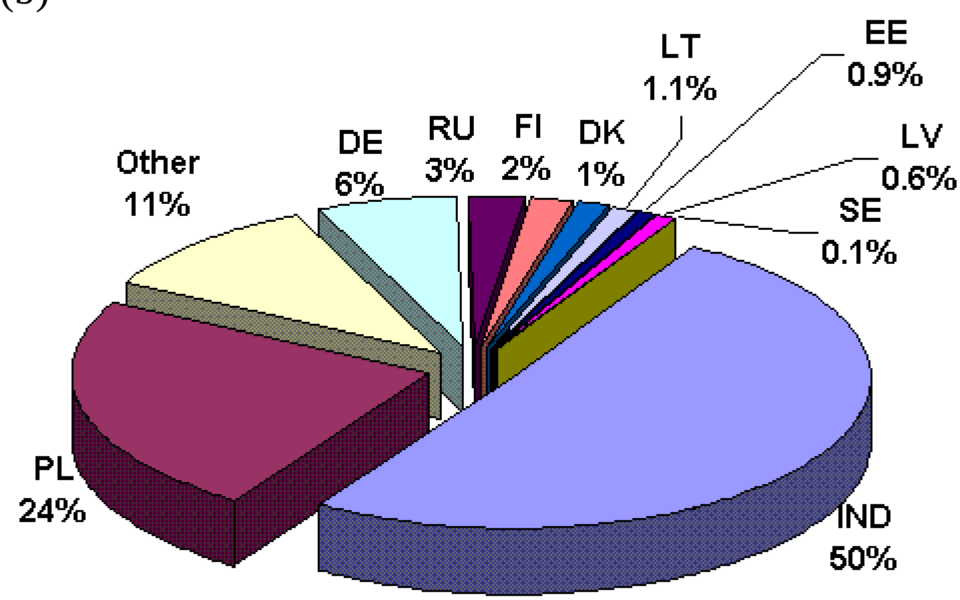
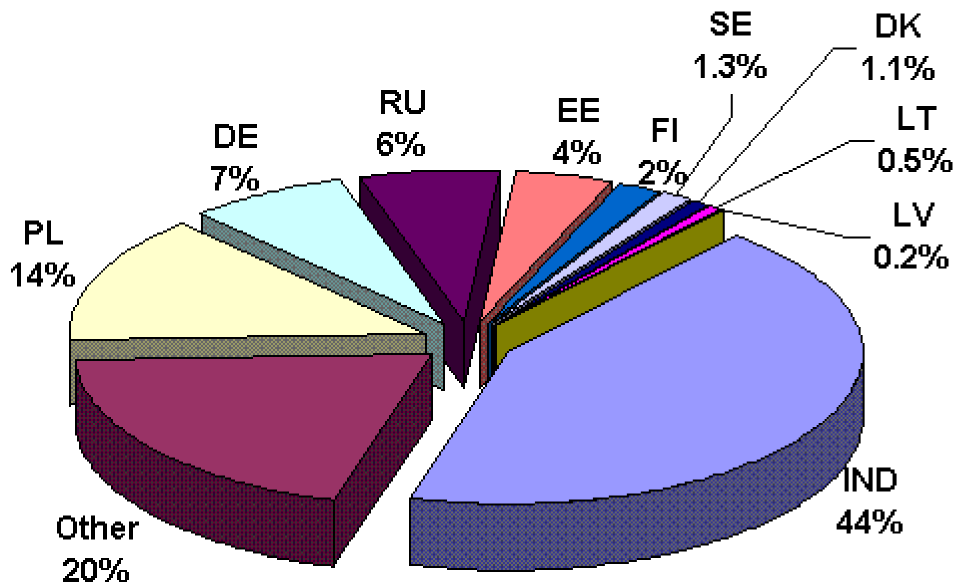


Figure 4.15 Comparison of main emissions sources of cadmium contributing to its annual deposition over the entire Baltic Sea Basin 1996 (a) and 2000 (b). Other – means other European countries in total, IND – means indeterminate sources: natural, previous and remote anthropogenic sources.

(a)



(b)

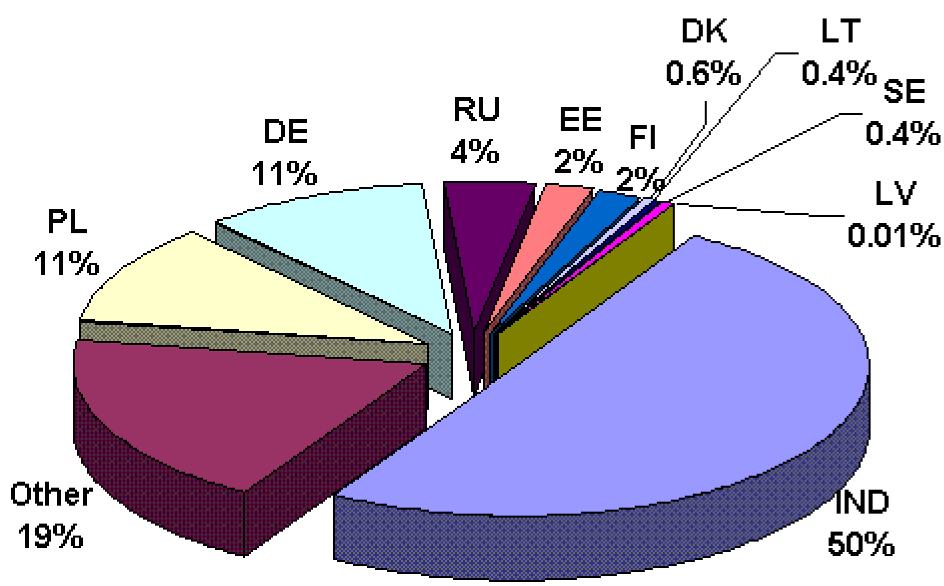
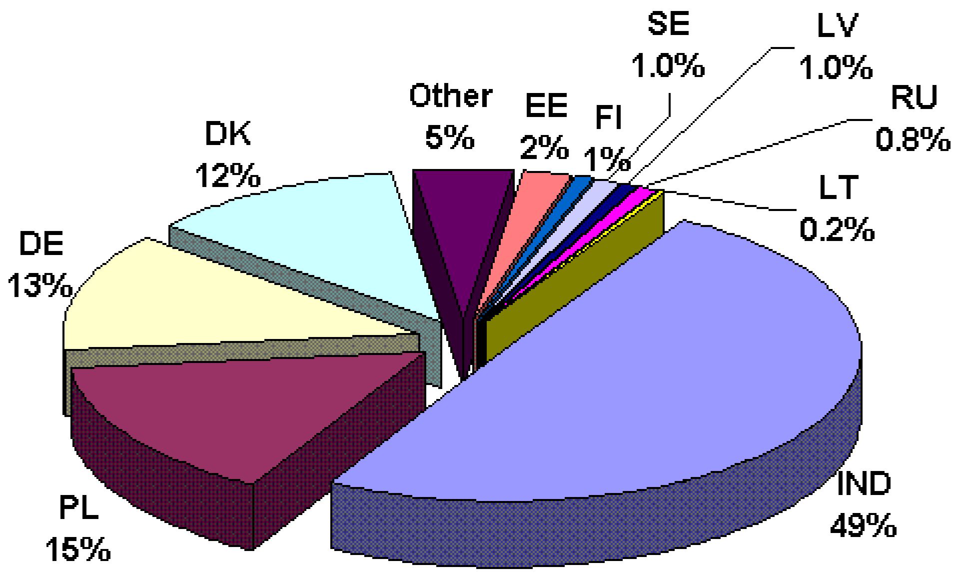


Figure 4.16 Comparison of main emissions sources of lead contributing to its annual deposition over the entire Baltic Sea Basin in 1996 (a) and 2000 (b).Other – means other European countries in total, IND – means indeterminate sources: natural, previous and remote anthropogenic sources.

(a)



(b)

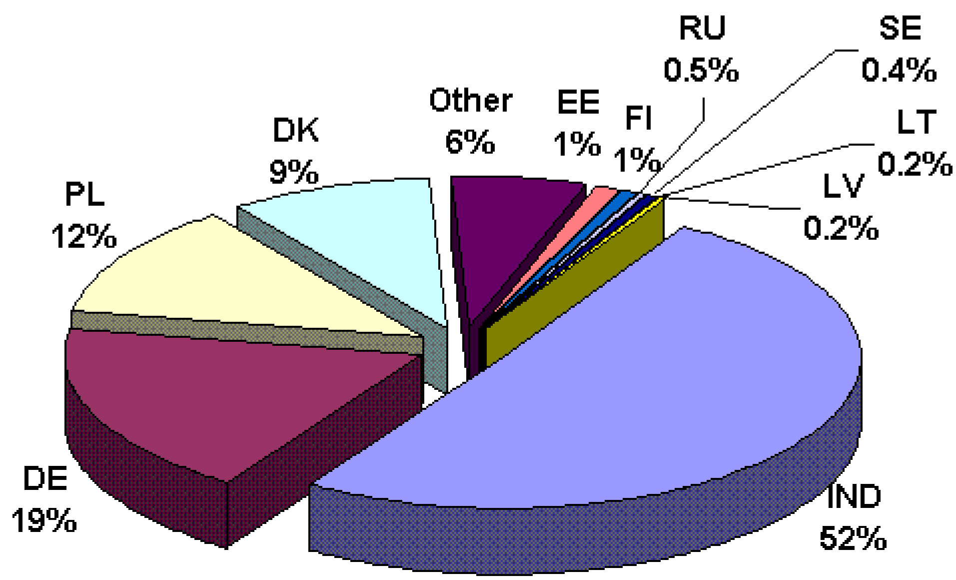


Figure 4.17 Comparison of main emissions sources of mercury contributing to its annual deposition over the entire Baltic Sea Basin in 1996 (a) and 2000 (b). Other – means other European countries in total, IND – means indeterminate sources: natural, previous and remote anthropogenic sources.