9. Conclusions

The results presented in the report lead to the following conclusions for nitrogen, heavy metals and lindane.

Nitrogen

Annual emissions of nitrogen oxides and ammonia from the HELCOM Parties have not changed much from 2001 to 2002, but calculated annual nitrogen depositions in 2002 are lower than in 2001 and also lower than in 2000. The lack of updated information about nitrogen oxides emission from the international ship traffic still remains a problem. The latest ship emission data are from 1990.

For all HELCOM Parties, transport and combustion are the main sources of nitrogen oxides emissions into the Atmosphere. The transport sectors dominate in all HELCOM countries except Poland and the Russian Federation with the road transport (sector 7) being the major source of nitrogen oxides pollution. In Poland and the Russian Federation, combustion in energy and transformation industry is the major contributor to emissions, however, road transport is the next on the list also in these countries.

In case of ammonia emissions, emissions from the agriculture (sector 10) are much higher than emission from any other sector in all HELCOM countries. Contribution of agricultural emissions to annual total ammonia emissions in 2002 varies between 80% and 96% in different HELCOM Parties. Contribution from other sectors to ammonia emission is one order of magnitude lower.

Computed 2002 annual depositions of both, oxidized and reduced nitrogen are lower than corresponding 2001 depositions in all six sub-basins of the Baltic Sea. The most likely reason for lower computed depositions in 2002 is probably meteorological situation in this year. However, also two other reasons have to be taken into account: 1) revision of the Unified EMEP model and 2) review and revision of the emissions.

Like in the previous years, there is no clear seasonal pattern of computed deposition in 2002, but in general maxima of the deposition can be observed in April, and minima in May.

Source-allocation budgets for nitrogen are based on 2000 data. Main emission sources of oxidized nitrogen deposition to the Baltic Sea sub-basins and catchments are located in Germany, Poland and belong to the ship traffic on the Baltic Sea. It should be noted, however, that the distant emission sources, such as the United Kingdom, France and ship

traffic on the North Sea have also significant contributions to the deposition. In case on reduced nitrogen, local sources are more important. The main contributors to reduced nitrogen deposition are: Germany, Poland and Denmark.

In general, the comparison between modelled and measured concentrations of nitrogen compounds at HELCOM stations is good and comparable to the model performance for the EMEP sites. The model provides a reliable tool in order to assess the nitrogen supply to the Baltic Sea.

Heavy metals

Modelling of atmospheric transport and depositions of lead, cadmium, and mercury was carried out using MSC-E Eulerian Heavy Metal transport model MSCE-HM on the basis of latest available official information on emission from HELCOM countries and other European countries. Levels of annual and monthly lead depositions to the Baltic Sea region have been obtained and contributions of HELCOM countries emission sources to the depositions over the Baltic Sea and its catchment area have been estimated.

Total annual emission of heavy metals from anthropogenic sources of HELCOM countries in 2002 amounted to 120 tonnes of cadmium, 65 tonnes of mercury, and 3320 tonnes of lead. The largest contributions to the total emission of heavy metals from anthropogenic sources within the Baltic Sea region belonged to Poland, Germany, and Russia. In comparison to 2001 emissions of mercury and lead have somewhat decreased, while cadmium emissions left on the same level.

Total annual depositions of lead to the Baltic Sea and its catchment area in 2002 amount to 149 and 932 tonnes, of cadmium to 7.4 and 53 tonnes, and of mercury to 3.1 and 19 tonnes, respectively. Elevated levels of heavy metals depositions were obtained for the Belt Sea, the Kattegat, the Gulf of Finland sub-basins, and southern part of the Baltic Proper sub-basin. In comparison to computations for 2001 cadmium depositions have decreased by 11%, mercury depositions have decreased by 3%, while lead depositions have slightly increased by 4%. Changes in depositions over the catchment area between these two years were more significant accounting for about 25%.

HELCOM countries contributed to depositions of heavy metals over the Baltic Sea in 2002 about 48% for lead, 52% for cadmium, and 40% for mercury. Among the HELCOM countries main contributions to lead depositions belonged to Poland (16%) and Germany (16%), in case of cadmium depositions to Poland (31%), in case of mercury depositions to Germany (19%) and Poland (11%). Contribution of European countries outside the Baltic Sea region amounted to 10-20%. Significant contribution belonged also to the input of re-emission and natural sources.

Modelling results for lead, cadmium, and mercury were compared with available measurements carried out within the Baltic Sea region in 2002. Results of the comparison of computed lead and cadmium concentrations in air and precipitation with measurements showed some underestimation of observed levels by a factor of 2-3 which is most likely connected with the underestimation of lead and cadmium emissions from anthropogenic sources. Thus evaluated atmospheric load of lead and cadmium to the Baltic Sea for 2002 can be lower than actual depositions by a factor of 2-3. Reasonable agreement with measurements was obtained for computed mercury concentrations. The differences between computed and observed mercury concentrations were within a range of factor 0.6-1.6.

Lindane

Atmospheric input of lindane to the Baltic Sea and its catchment area was evaluated for 2002 using MSC-E Eulerian multimedia POP transport model MSCE-POP. Modelling was performed using available emission data officially reported by EMEP countries to the UN ECE Secretariat and expert estimates of lindane emissions. Based on these data there was practically no application of lindane in HELCOM countries in 2002. Thus the major sources of pollution of the Baltic Sea by lindane were the United Kingdom, Portugal, Spain, and Croatia, and also North America, and South-east Asia. According to model results concentrations of lindane in air within the Baltic Sea region have decreased significantly in recent decade. Two different scenarios of lindane emission were prepared with the first one assuming no emission of lindane in France in 1990-2002 following officially submitted data and the second one using the expert estimates of lindane emission in France in this period.

Modelling results showed that for most of sub-basins of the Baltic Sea re-emission of lindane from seawater took place exceeding the wet and dry deposition fluxes. The differences in lindane depositions and re-emission indicated that the residues of lindane in soil and in seawater as a result of previous application can be essential for the pollution of the Baltic Sea.

Obtained results were compared with available monitoring data of lindane concentrations in air and precipitation in the Baltic Sea region. MSCE-POP model results for lindane agree with available measurements within a factor of 2-3.