9. Conclusions

Based on the results presented in the report, the following conclusions can be drawn for each of the considered pollutant.

Nitrogen

Annual emissions of nitrogen oxides and ammonia from the HELCOM Parties have not changed much from 2000 to 2001 and these changes do not influence much calculated annual nitrogen depositions in 2001. 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.

Computed 2001 annual depositions of both, oxidized and reduced nitrogen are lower than corresponding 2000 depositions in five of six sub-basins of the Baltic Sea. A small increase of the reduced nitrogen deposition occurs only in the Belt Sea sub-basin. Since, emissions remain on the same level in both years, new model version used for 2001 computations, different meteorological conditions and larger precipitation amount over the most of the Baltic Sea region in 2000 than in 2001 are the main reasons for reduced depositions. It especially applies to wet deposition, which in case of nitrogen accounts for approximately 70% of the total deposition. There is no clear seasonal pattern of computed deposition in 2001, 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 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 United Kingdom, France and ship traffic on the North Sea have also significant contribution 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. Thus, the model provides a reliable tool in order to assess the nitrogen supply to the Baltic Sea. However, in order to make a proper evaluation of model performance, monthly measurements from the HELCOM database are not satisfactory and we have to rely on the evaluation of the Unified EMEP model against daily measurements from the total EMEP network when drawing conclusions on the model performance for the HELCOM sites. We would like to have daily data for the model evaluation.

Heavy metals

Atmospheric depositions of cadmium, mercury and lead to the Baltic Sea region in 2001 were evaluated on the basis of official information on heavy metals emissions using the latest version of MSCE-HM model. Total annual emission of heavy metals from anthropogenic sources of HELCOM countries in 2001 amounts to 3578 tonnes for lead, 120 tonnes for cadmium, and 66 tonnes for mercury. Lead and mercury emissions of HELCOM countries for 2001 are slightly lower comparing to 2000 by 2-4% whereas for cadmium some increase can be noted. HELCOM countries contributed to heavy metals emissions from anthropogenic sources within the whole EMEP region approximately 40%. The highest emissions within the HELCOM region were reported by the Russian Federation, Poland, and Germany.

Total annual depositions of lead to the Baltic Sea and its catchment area in 2001 amount to 143 and 1262 tonnes, of cadmium to 8.3 and 75 tonnes, and of mercury to 3.2 and 29 tonnes, respectively. Comparing to 2000 depositions of heavy metals to the Baltic Sea for 2001 are lower by approximately 10%. Depositions of cadmium and mercury over the catchment area for 2001 are practically the same as in previous year. For lead the decrease of depositions to the catchment area by 9% can be indicated. Elevated values of heavy metals deposition fluxes can be noted in the southern part of the Baltic Proper sub-basin (BAP), the Belt Sea (BES) sub-basin, and the Gulf of Riga (GUR) sub-basin. Over the Baltic Sea catchment area the highest deposition fluxes of lead are obtained for the Baltic Proper catchment (BAP).

HELCOM countries contributed to depositions of heavy metals over the Baltic Sea in 2001 about 40-50%. Among the HELCOM countries main contributions belong to Poland, Germany, and Russia. In case of mercury essential contribution belongs to Denmark. Contribution of European countries outside the Baltic Sea region amounts to 5-10%. Significant contribution belongs to the input of re-emission and natural sources.

Obtained modelling results for heavy metals were compared with available data of HELCOM monitoring stations. Computed mean annual air concentrations of heavy metals are in a reasonable agreement with observations. For most of the stations the ageement between the modelled mean annual air concentrations of lead, cadmium, and mercury and measurement data is about factor of 2. Some underestimation of mean annual concentrations in precipitation of lead and cadmium by the model can be indicated. For mercury computed concentrations in air and precipitation are somewhat higher than measured values.

Lindane

Atmospheric input of lindane to the Baltic Sea and its catchment area in 2001 was evaluated 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 this information the most significant sources of lindane in 2001 were located in the United Kingdom, Portugal, Spain, and Belgium. Contribution of HELCOM countries to total lindane emissions within the EMEP region amounts to approximately 15%.

Evaluation of lindane long-range transport and depositions to the Baltic Sea area was based on computations for the period 1990-2001. Computations for long period were carried out to take into account long-term accumulation of lindane in soil and sea water. For most of sub-basins of the Baltic Sea in 2001 the re-emission process takes place exceeding the wet and dry deposition fluxes. Over the southern part of the Baltic Proper sub-basin (BAP) wet and dry depositions dominate in total deposition of lindane.

Modelling results for lindane were compared with available observations of lindane concentrations in air and precipitation obtained at EMEP stations. MSCE-POP model results for lindane agree with available measurements within a factor of four. Observed mean annual concentrations of lindane in precipitation are to some extent underestimated by the model.