5. COOPERATION AND DISSEMINATION OF INFORMATION

Co-operation is an important component of research and operational pollution assessment performed by MSC-E to support countries with information on heavy metal pollution levels in Europe and other regions. In this context MSC-E closely collaborates with Parties to the Convention and its Subsidiary Bodies and exchanges information with various international organizations.

5.1. Subsidiary bodies of the Convention

Co-operation with Subsidiary bodies of the Convention includes collaborative work with the Task Force on Measurements and Modelling (TFMM), the Task Force on Emissions Inventories and Projections (TFEIP), and the Working Group on Effects (WGE).

5.1.1. Task Force on Measurements and Modelling

MSC-E continued cooperation with TFMM. The Centre took part in the TFMM meeting held in May, 2018 in Geneva, Switzerland. TFMM participants were informed about the results of the country-specific case study of Cd pollution in Poland. Besides, the main outcomes of the case study activities gained during past years were overviewed.

It was shown that the main reason of the discrepancies between modelled and observed Cd levels in Poland was underestimation of emissions from the sector ‘Residential combustion’ (Section 4.1). It was demonstrated that the model could be used as a tool to evaluate national emission data and help to understand the directions to improve the emissions in cooperation with national experts and relevant Task Forces and EMEP Centres. Besides, it was suggested to use emission scenarios or expert estimates to produce an alternative assessment of pollution levels along with the assessments based on official data.

One of thematic session of the recent TFMM meeting was focused on the long range transport and urban air pollution. MSC-E presented results on evaluation of Cd pollution levels in cities of Poland (Section 4.2). In particular, source apportionment of Cd air concentrations in the cities and their seasonal variations were investigated. The results of the study were compared with available data on urban increments for particulate matter.

Plans of further country-specific activities were discussed. Further possible candidates to the study were proposed including Germany and the United Kingdom. In addition, cooperation of the Centre with WGE in the field of evaluation of Hg atmospheric inputs to surface water bodies and catchment areas of Scandinavia is expected.

5.1.2. Task Force on Emission Inventories and Projections

Emissions data are the key information required for pollution assessment. The basic information on anthropogenic emissions is provided by Parties to the Convention and processed by CEIP with methodological support and quality assurance by the Task Force on Emission Inventories and Projections (TFEIP). The EMEP modelling Centres utilize emissions data for pollution assessment and gather important bottom-up information on quality of the data. To contribute to the improvement of emissions data MSC-E participated in the recent Workshop on verification of emission estimates organized back-to-back with the annual TFEIP meeting in April 2018 in Sofia, Bulgaria.

MSC-E presented its approach to preparation of additional emission parameters required for modelling, which include sector-specific seasonal variation, vertical distribution and chemical composition of heavy metal and POP emissions (see Section 1.2 for details). Besides the Centre provided examples of the model application for evaluation of quality and revealing of potential uncertainties of emissions data. The presented analysis was performed in the framework of country-scale case studies for Poland and Spain. In particular, it was shown that data on Cd emissions from 'Residential Combustion' (Section 4.1) and B(a)P emissions from 'Field burning in agriculture' can contain significant uncertainties in Poland and Spain, respectively.

Formulating recommendations for the emissions community the Centre noted that ***information on the chemical composition of Hg and POP emissions required update and refinement, which could be done in co-operation with other international bodies (e.g. UN Environment, Minamata and Stockholm Conventions). Besides, the model evaluation of national emissions can be applied on a regular basis as a part of the emissions review process. It is particularly relevant on a country scale, where variety of national data can be involved.***

5.1.3. Working Group on Effects

In the framework of co-operation with WGE MSC-E took part in the 31th Task Force meeting of the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops (ICP-Vegetation) held in Dessau, Germany. Under supervision of ICP-Vegetation surveys of concentrations of heavy metals in mosses are carried out. The most recent survey took place in 2015. Information on Pb, Cd and Hg concentrations in moss was provided to MSC-E.

Information about concentrations in mosses is useful for evaluation of the atmospheric modelling results. Mosses have no roots and obtain their nutrients from the atmosphere. Hence, concentrations of pollutants in moss tissues depend on atmospheric deposition. Unlike regular station-based measurements carried out at the EMEP monitoring network, measurements in mosses are characterized by higher spatial density. Besides, these measurements are often organized in countries where EMEP network is scarce, e.g. in the EECCA countries and Russia (Fig. 5.1).

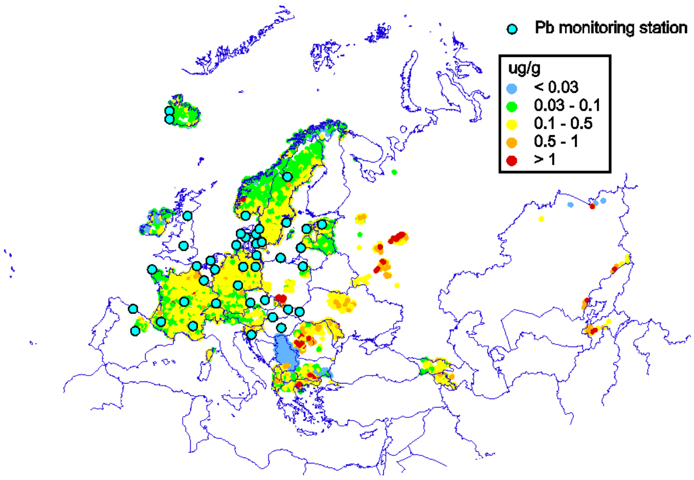

Fig. 5.1. *Concentrations of Cd in mosses in 2015 and location of the EMEP heavy metal monitoring stations.*

Heavy metal concentrations in mosses cannot be compared directly with modelled deposition. However, spatial distributions and long-term trends of concentrations in mosses and total deposition can be compared. For example, spatial pattern of concentrations in mosses is similar to that of total deposition of Cd in the Scandinavia region (Fig. 5.2). Both fields demonstrate higher levels in the southern part and lower levels in the northern part of the region. Spatial correlation between two fields is significant (0.64). In the whole region, the correlation between the modelled deposition and concentration in mosses exceeds 0.5 in 6 countries for Pb, and in 5 countries for Cd.

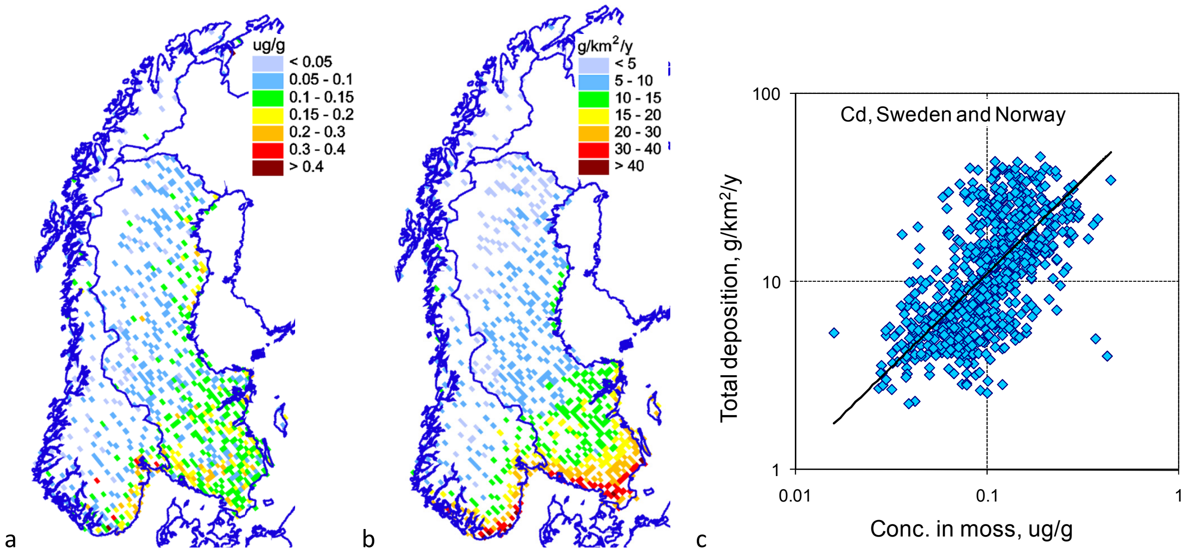

Fig. 5.2. *Cd concentrations in mosses (a), deposition flux (b), and comparison of both parameters (c) for Scandinavia in 2015.*

Comparison of normalized country-averaged deposition and concentrations in mosses demonstrates that spatial gradients of Pb and Cd pollution levels between the countries were generally reproduced by the model. Relatively high concentrations in mosses and total deposition of Pb and Cd are noted for Poland, Slovenia, Armenia, Georgia, and the Czech Republic (Fig. 5.3). Relatively low levels occur in Ireland, Iceland, Estonia, Latvia, and Norway. This comparison allows identifying regions where difference between the considered normalized parameters is substantial. For example, concentrations in mosses of Pb is high compared to mean deposition fluxes in Bulgaria. On other hand, deposition of Pb in Slovakia is much higher than concentrations in mosses. These discrepancies may be caused by uncertainties of emission data used in the modelling or approaches of measurements in mosses, and need additional research.

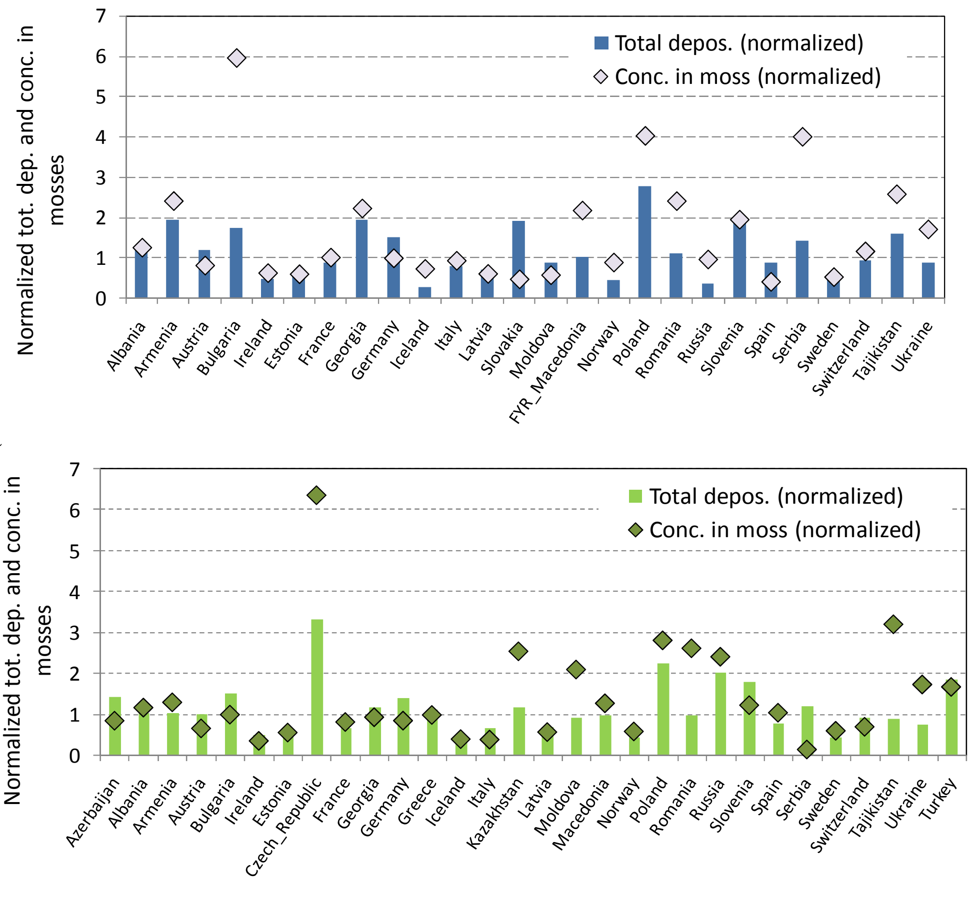

Fig. 5.3. *Normalized country-averaged total deposition and concentrations in mosses of Pb (a) and Cd (b) in 2015.*

Long-term changes of heavy metal deposition during the period 1990-2015 were compared with the changes of concentration in mosses. Relative reduction of Pb deposition over the period varies within 80-90%, which is comparable with the corresponding reduction of concentrations in mosses (Fig. 5.4a). For Cd the reduction is somewhat lower: 30-70% for concentrations in mosses and 25-70% for total deposition (Fig. 5.4b). Relative reduction of both Hg deposition and concentration in mosses is 4-40% over the period 1995-2015.

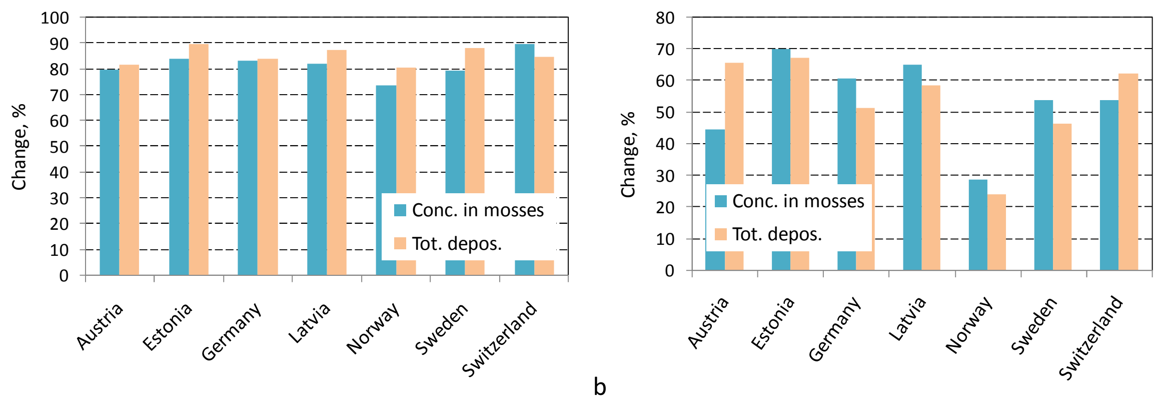

Fig. 5.4. *Relative change [(1990-2015)/1990 x 100%] of country-averaged concentrations in mosses and total deposition of Pb (a) and Cd (b) over the period 1990-2015.*

Measurement data on concentrations of heavy metals in mosses is valuable type of information for the analysis of heavy metal pollution in the EMEP region and for the evaluation of the model performance. Comparison of country-averaged values of the concentrations and deposition demonstrates that the model capable of reproducing spatial gradients and long-term pollution changes. However, comparison of deposition and levels in mosses at smaller spatial scales reveals higher discrepancies in spatial patterns of these two parameters. Most likely it is explained by the fact that concentrations in mosses depend not only on atmospheric deposition but on a number of other environmental factors. Further research of these factors is needed in cooperation with the experts of WGE for improvement of interpretation of the biomonitoring results as well as for the model evaluation.

5.2. International organizations

5.2.1. UN Environment and Minamata Convention

MSC-E continuously co-operates with the United Nations Environment Programme (UN Environment) on assessment of Hg pollution. Mercury is a global pollutant that causes growing public concern about the dangerous effects on human health and biota. To support the international negotiation process aimed at Hg pollution reduction UN Environment coordinated preparation of a series of Global Mercury Assessments (GMA) [*UNEP*, 2002; *AMAP/UNEP*, 2008; *AMAP/UNEP*, 2013; *AMAP/UNEP*, 2015]. MSC-E has been involved in all the assessments sharing information on Hg pollution and coordinating activities on global scale modelling.

Currently, MSC-E takes part in the new Global Mercury Assessment 2018 (GMA 2018). The Centre is responsible for the part of GMA 2018 focused on assessment of Hg fate and transport in the atmosphere and coordinates activities of international group of experts on modelling of Hg pollution on global and regional scales. The expert group includes modelling teams from different scientific institutions of Europe and North America: Helmholtz-Zentrum Geesthacht (HZG, Germany), Institute of Atmospheric Pollution Research (CNR-IIA, Italy), Massachusetts Institute of Technology (MIT, USA), Environment and Climate Change Canada (ECCC, Canada), National Oceanic and Atmospheric Administration (NOAA, USA), and Lamar University (LU, USA). The work consists of both review of recent studies on model assessment of Hg pollution and new model estimates of Hg intercontinental transport involving an updated global inventory of Hg anthropogenic emissions. The major results of the multi-model assessment of Hg pollution on a global scale are summarized in Section 2.1 of the current report. The MSC-E co-ordination work for GMA 2018 is funded by the Arctic Monitoring and Assessment Programme (AMAP) as a part of a bi-lateral contract.

In addition, MSC-E participated in the first meeting of the Conference of the Parties to the Minamata Convention on Mercury (COP1) held in September 2017 in Geneva, Switzerland. MSC-E contributed to discussions at the thematic session focused on various aspects of atmospheric Hg pollution. In particular, approaches used within CLRTAP to assess Hg atmospheric pollution in the EMEP region were overviewed including evaluation of national emissions by countries, assessment of pollution levels by means of monitoring and modelling, and evaluation of the effects on human health and biota. The experience gained within CLRTAP in the field of assessment and abatement of Hg pollution could be shared with the Minamata Convention. Further collaboration between these two Conventions is appreciated.

Co-operation with UN Environment and the Minamata Convention broaden dissemination of scientific and policy oriented information generated within the Convention. Besides, it improves pollution assessment within EMEP by possibility to evaluate and refine the modelling tools and involve variety of additional input data (emission inventories and observations).

5.2.2. Helsinki Commission

MSC-E performs regular evaluation of airborne pollution load of heavy metals to the Baltic Sea in the framework of cooperation with the Helsinki Commission. This work is carried out in accordance with the Memorandum of Understanding between the Baltic Marine Environment Protection Commission (HELCOM) and the United Nations Economic Commission for Europe (UN ECE) and is based on the long-term EMEP/HELCOM contract.

This year activity was focused on the evaluation of Pb, Cd and Hg pollution of the Baltic Sea. In particular, long-term variations of heavy metal deposition fluxes to the Baltic Sea were estimated for the period 1990-2015. Source apportionment of deposition and verification of modelling results against measurements was performed for 2015. Results of the assessment are summarized in the Joint report of the EMEP Centres for HELCOM [*Bartnicki et al*., 2017] and also presented in several indicator fact sheets, published on the HELCOM website [*http://www.helcom.fi*].

Declines of Pb, Cd and Hg anthropogenic emissions in the HELCOM countries from 1990 to 2015 were 87%, 40% and 46%, respectively. Poland, Russia and Germany were the major contributors to heavy metal emissions among the HELCOM countries in 2015. Their share to total emission of the HELCOM countries exceeded 90%.

Analysis of the results of the model simulations revealed significant decrease of atmospheric deposition of Cd, Pb, and Hg to the Baltic Sea over the period 1990-2015. The largest decease is noted for deposition of Pb (80%), followed by Cd (63%) and Hg (34%) (Fig. 5.5a). The decrease of deposition varies substantially among different sub-basins of the Baltic Sea. The largest decrease of Cd deposition occurred in the Bothnian Bay and the Gulf of Finland (76% and 74%, respectively). The most significant changes of Hg deposition took place in the Sound and the Kattegat (60% and 41%). In case of Pb the largest changes of deposition were estimated for the Bothnian Bay and the Gulf of Finland (86% and 85%). The decrease of heavy metal deposition was stronger in the first decade of the considered period, while after 2000 it became smaller or almost levelled off.

Deposition of Pb, Cd and Hg to the Baltic Sea in 2015 was lower than those in 2014. In particular, Pb deposition decreased by 33%, Cd deposition by 39%, and Hg deposition by 12%. These changes can be explained by the influence of inter-annual variability of meteorological conditions, in particular, the atmospheric transport pathways.

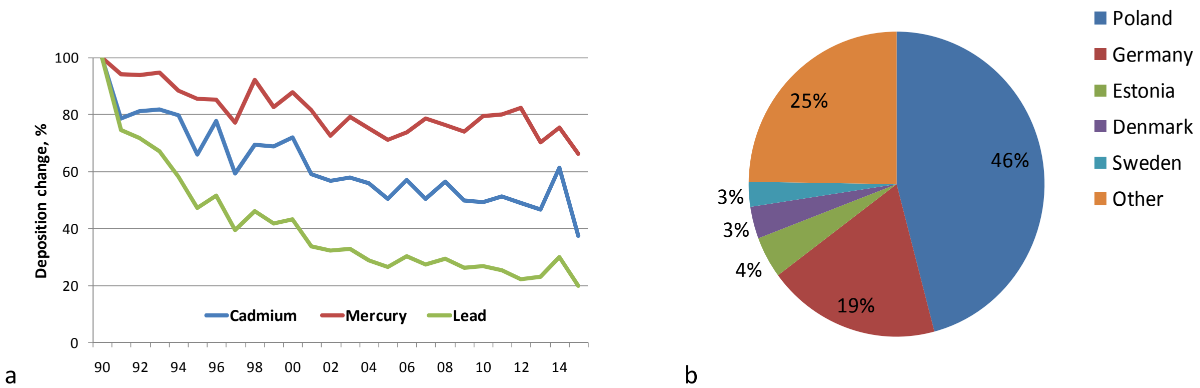

Fig. 5.5. *Relative changes of annual atmospheric deposition of Cd, Pb, and Hg to the Baltic Sea in the period 1990-2015 (a) and contribution of emission sources from the EMEP countries to total anthropogenic deposition of Pb to the Baltic Sea in 2015 (b)*

Model calculations revealed distinct spatial gradients of atmospheric deposition fluxes to the Baltic Sea in 2015 [*Bartnicki et al*., 2017]. Higher deposition levels took place in the southern and western parts of the sea, while the northern part is characterised by the lowest fluxes.

Anthropogenic emission sources of the HELCOM countries contributed about 36%, 30%, and 14% to annual deposition of Cd, Pb, and Hg, respectively, over the Baltic Sea in 2015. Among the HELCOM countries Poland, Russia, and Germany are the main contributors of anthropogenic deposition to the Baltic Sea (Fig. 5.5b). Along with anthropogenic emissions significant contribution (more than 50%) to heavy metal deposition to the Baltic Sea was made by wind re-suspension (Cd and Pb), natural emission and re-emission (Hg) as well as by long-term transport from sources located outside the HELCOM countries.