EXECUTIVE SUMMARY

Heavy metals including lead (Pb), cadmium (Cd) and mercury (Hg) are known as toxic pollutants of the environment. Despite a rapid decrease of emissions of heavy metals in the past decades, long-term risks continue to exist for human health and biota. Therefore, as it is stated in the updates and revisions to the long-term strategy for the Convention [*ECE/EB.AIR/WG.5/2018/3*], *"… the Convention should pursue mitigation activities on heavy metals within the ECE region and consider acting as a centre of expertise … on reducing heavy metals, focusing on sharing its technical knowledge in terms of best available techniques, emission inventories, modelling and monitoring*". Variety of information related to transboundary pollution by heavy metals is collected and analysed by research centres of the Co-operative Programme for Monitoring and Evaluation of Long-range Transmission of Air Pollutants in Europe (EMEP).

The current Status Report overviews research activities of the EMEP Centres in the field of heavy metal pollution performed in accordance with the bi-annual workplan of the Convention for 2018-2019 [*ECE/EB.AIR/GE.1/2017/20-ECE/EB.AIR/WG.1/2017/13*]. The report covers various aspects of heavy metal pollution assessment based both on monitoring and modelling, research and development aimed at improvement of the modelling approaches, co-operation with national experts within the framework of country-scale case studies as well as collaboration with Subsidiary Bodies to the Convention and other international programmes.

Various input information used in the model assessment is prepared by the EMEP Centres. It includes gridded sector-specific emissions of heavy metals is prepared by the Centre of Emission Inventories and Projections (CEIP), measurements of heavy metals at the EMEP monitoring network collected by the Chemical Coordinating Centre (CCC), variety of other input data for modelling (meteorology, additional emission parameters, wind re-suspension, boundary conditions etc.) prepared by the Meteorological Synthesizing Centre – East (MSC-E).

Assessment of heavy metal pollution of the EMEP region is based on both measurement data and modelling results. Measurements of Cd and Pb in the EMEP region were available at 66 stations located in 21 countries, whereas Hg was measured at 29 sites. Most of the stations are located in the central, western, northern and south-western parts of Europe, while in the vast areas of eastern and southern-eastern Europe and Central Asia measurements of heavy metals are scarce. The lowest heavy metal concentrations in air and precipitation are generally found in Scandinavia, whereas the highest levels are in the Benelux region, Central and Eastern Europe. Strong seasonality in the concentrations of Hg in air is observed at several of the EMEP sites, with higher concentrations in winter, whereas low concentrations are observed in summer. This seasonal variation has been recently explained by vegetation uptake of atmospheric Hg. The new findings can have significant implications for the global Hg cycle and interpretation of long-term trends.

Model assessment of heavy metal pollution in the EMEP countries for 2016 was performed over the new EMEP grid based on the most recent dataset of heavy metal emissions for 2015 available at the moment of the study[1]. The highest levels of heavy metal pollution are noted for the central part of

[1] *Update of the modelling results based on the new emission data for 2016 is available at the MSC-E web site [www.msceast.org].*

Europe, northern Italy, Benelux and Balkans regions. Deposition levels differ significantly among different land cover categories with larger fluxes to vegetated surfaces and lower ones to barren lands and inland waters. Heavy metal deposition in the EMEP countries is originated from the EMEP anthropogenic sources, secondary emissions, and contribution of non-EMEP sources. Contribution of anthropogenic sources to total deposition in the EMEP countries varies within 6-63% and 8-74% for Pb and Cd, respectively. For Hg the anthropogenic contribution is lower (4-19%) due to significant effect of intercontinental transport (non-EMEP sources). Contribution of transboundary transport to anthropogenic deposition of Pb, Cd, and Hg exceeded deposition from national sources in 38, 38, and 40 of 51 EMEP countries, respectively. Moreover, proportion of various emission sectors in the transboundary transport vary markedly among the countries. In most of the EMEP countries more than 60% of emitted heavy metals were transported beyond the national borders.

Assessment of Hg pollution is among priority tasks within the Convention. Significant efforts of MSC-E during the past year were focused on collaborative work with the scientific community for evaluation of Hg pollution on global and regional scales as a part of the UN Environment Global Mercury Assessment 2018. The Centre co-ordinated a multi-model study of Hg dispersion on a global scale. Results of the analysis showed the relative share of direct anthropogenic emissions varies within 21-50% and decrease from industrial regions to remote regions. Both domestic and foreign anthropogenic sources contribute almost equally to the total anthropogenic Hg deposition in Europe. The largest foreign contributors are ranked in the order of East Asia (18%), Africa (8%), CIS countries (6%), and South Asia (5%). Mercury deposition in Europe and Central Asia are dominated by contributions from power generation and industrial emission sectors. The assessment provides valuable information for evaluation of Hg pollution levels in the EMEP countries and improves co-operation with the UN Environment and with the Minamata Convention.

The work on refinement of the Hg chemical scheme applied in the Global EMEP Multi-media Modelling System (GLEMOS) was further continued. For this purpose, the chemical mechanism of Hg oxidation by Br was incorporated into the model and evaluated in test runs and comparison with measurements. Further steps of implementation of the Br oxidation chemistry for the EMEP operational modelling will include evaluation of possible Hg reduction mechanisms in the atmosphere. Update and refinement of the model Hg chemical scheme should improve quality of assessment of Hg pollution of the EMEP countries.

The Centre co-operates with Parties to the Convention in the framework of heavy metal pollution assessment on a country scale. This year a case study for Poland has been completed. Polish national experts was provided with detailed model assessment of Cd pollution including source-receptor relationships for the country as a whole and for various provinces of the country, contribution of emission source categories and large point sources to Cd pollution levels. The study demonstrated that available emission data could contain significant uncertainties, which affected results of pollution assessment. The dispersion modelling supplemented by monitoring data can be used as an independent tool for evaluation of reported emissions. However, this activity requires close cooperation between monitoring, modelling and emissions communities. Results of the study were published in a special Technical Report [*Ilyin et al*., 2018]. In addition, major findings of the country-scale studies gained during the whole period of the project were summarised in [*Travnikov et al*., 2018].

A special attention of the country-scale study for Poland was paid to assessment of heavy metal pollution of cities. The source-receptor modelling with fine spatial resolution was applied to distinguish contribution of external sources and city emissions (urban increment) to pollution in selected cities of the country. Besides, seasonal variability of the urban increment was investigated. The suggested method of direct fine resolution modelling allowed matching modelled and observed Cd air concentrations in cities with sufficient quality. Comparison of the urban increments calculated in the current study with results of other studies, based on modelling or observations, revealed reasonable agreement of the applied methods for large cities. Thorough testing and evaluation of the applied approach will be continued for other countries and pollutants.

Collaboration with subsidiary bodies to the Convention and other international organisations is an important part of MSC-E activities. Main results and plans of future activities were presented at annual TFMM meeting. The Centre also contributed to the Task Force on Emission Inventories and Projections (TFEIP) with discussion on possible application of transport models for evaluation of reported emissions. Ecosystem-specific deposition maps of Pb, Cd and Hg were prepared by MSC-E on the new EMEP grid to support effect-based activity of the Working Group on Effects (WGE). Besides, the Centre performed a combined analysis of heavy metal pollution using both model estimates and data from the recent moss measurement survey.

MSC-E continued co-operation with the United Nations Environment Programme (UN Environment). The Centre took part in the new Global Mercury Assessment 2018 (GMA 2018) coordinating work of an international group of experts focused on modelling of mercury pollution on global and regional scales. In addition, MSC-E participated in the first meeting of the Conference of the Parties to the Minamata Convention on Mercury (COP1) presenting the experience and approaches used within CLRTAP. Besides, MSC-E performs regular model assessment of the Baltic Sea pollution by various pollutants including heavy metals. This work is carried out in accordance with the Memorandum of Understanding between CLRTAP and the Baltic Marine Environment Protection Commission (HELCOM).

Future directions of MSC-E activities will be aimed at quality improvement of heavy metal pollution assessment in the EMEP region. Further development and evaluation of the GLEMOS model will include further testing of the Br oxidation mechanism, evaluation of possible reduction pathways and further development of the multi-media approach for Hg simulations. The country-scale case studies will be continued for a number of countries (e.g. Germany, the UK, Norway) with particular focus on Hg pollution and the link with adverse effects on human health and biota. Besides, evaluation of the direct fine resolution modelling for assessment of city pollution will be continued for other countries and pollutants. Finally, MSC-E will continue co-operation with subsidiary bodies of the Convention (WGE, TFMM, TFEIP, TF HTAP), international organizations (UN Environment, AMAP, HELCOM etc.) and national experts.