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Executive Body for the Convention on Long-range Transboundary Air Pollution

Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe

Working Group on Effects

First joint session*
Geneva, 14–18 September 2015
Item 15 of the provisional agenda
Progress in activities in 2015 and further development of effects-oriented activities

2015 joint progress report on policy-relevant scientific findings

Note prepared by the Chairs of the EMEP Steering Body and the Working Group on Effects in cooperation with the secretariat

Summary

The present report was drafted by the Extended Bureau of the Working Group on Effects[1] and the Extended Bureau of the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe

* The Executive Body to the Convention agreed that, as of 2015, the Working Group on Effects and the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe should meet jointly, to achieve enhanced integration and cooperation between the Convention's two scientific subsidiary bodies (ECE/EB.AIR/122, para. 47 (b)).

[1] Comprising the Bureau of the Working Group; the Chairs of the International Cooperative Programme (ICP) task forces, the Joint Task Force on the Health Effects of Air Pollution and the Joint Expert Group on Dynamic Modelling; and representatives of the ICP programme centres.

(EMEP)[2] in cooperation with the secretariat to the Convention on Long-range Transboundary Air Pollution. The review of recent scientific findings is based on the information provided by the lead countries and the International Cooperative Programme programme centres, and is submitted in accordance with the 2014–2015 workplan for the implementation of the Convention (ECE/EB.AIR/122/Add.2, item 1.1.12).

[2] Comprising the Bureau of the Steering Body; the Chairs of the EMEP task forces; and representatives of EMEP centres.

Contents

I. Introduction

1. In accordance with the 2014–2015 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution (EB.AIR/122/Add.2, item 1.1.12), the present report was compiled by the Chairs of the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) and the Working Group on Effects (WGE), with support from the scientific subsidiary bodies, in order to communicate the main scientific achievements during 2014 and 2015. The report is the first common report of the work under EMEP and WGE, reflecting the new organization of the two bodies with joint, integrated sessions based on a common agenda. While the two scientific bodies of the Convention have held back-to-back sessions for the past few years, with joint sessions in between, the new method of work represents an important step forward towards closer integration of the scientific work under the Convention.

2. The integration of work between EMEP and WGE is also reflected in an increasing number of common activities. Most important of these is the 2016 assessment report, a draft of which will be finished during 2015. There are also other examples of close cooperation that will be mentioned in this report, e.g., the EMEP and WGE trends reports which are being elaborated with mutual support.

3. The main highlights of the present report include:

(a) Costs for air pollution effects within the World Health Organization (WHO) European Region are estimated to be $US 1.6 trillion annually according to a joint report by WHO and the Organization for Economic Cooperation and Development (OECD). Since the WHO European Region is almost identical to the United Nations Economic Commission for Europe (ECE) region excluding Canada and the United States of America, the figures could be used as a rough estimate also for the ECE region;

(b) At the annual meeting of the Joint Task Force on the Health Aspects of Air Pollution (Task Force on Health) communication of health effects from air pollution was discussed. One of the main outcomes of the discussion was that, as contrary to what is often reported by the media and perceived by the general public, the most important health impact of air pollution occurs due to long-term exposure rather than to peaks. In that regard, there is a need to raise public awareness about the risks of long-term exposure together with measures to reduce the risk of health effects;

(c) In May 2015, at its sixty-eighth session, the World Health Assembly adopted a resolution on “Health and the environment: addressing the health impact of air pollution”, including a number of recommendations for further action;

(d) The ongoing United Nations Educational, Scientific and Cultural Organization (UNESCO) study at five cultural heritage sites shows a reduced damage rate due to emissions controls established in the framework Convention;

(e) The new database on critical loads has resulted in increased exceedance areas in Europe. A tentative comparison between the 2011 calculation and the new one with finer resolution shows that the area at risk of acidification increases by about 2 percentage points (from 5 to 7 per cent), while the area at risk of eutrophication increases by about 4 percentage points (from about 55 to 59 per cent);

(f) The subsidiary bodies under WGE have, together with the Meteorological Synthesizing Centre West (MSC-W) and the Chemical Coordinating Centre (CCC), evaluated the long-term trends from monitored and modelled data of atmospheric concentrations, deposition and effects. The trends are in general downward, in line with what is expected from emission trends and modelled concentrations and deposition — but there are deviations. The biological response to decreased sulphur and nitrogen deposition are, however, slow, and indications of ecosystem recovery are only seen for acidification of surface waters;

(g) In early 2015, for the first time black carbon emissions were reported by twenty four Parties. Those data will soon be used by MSC-W as input for the EMEP model to test the added value of such data on particulate matter and elemental carbon modelling;

(h) In 2014 six Parties submitted applications for adjustments to their emission inventory data or reduction targets under the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol) in accordance with the Executive Body decisions 2012/3 and 2012/4. This was the first time this process was run and the review of those applications had been organised by the Centre on Emission Inventories and Projections (CEIP). It was not possible to complete the review of all the applications submitted because of lack of time and resources, but this first step led to the improvement of the process and to the development of additional guidance for both national experts and the review teams for use in the reviews in the following years;

(i) In the field of monitoring and modelling, improved cooperation with the European Union (infrastructure and research) projects offered bilateral benefits. The intensive measurements periods have been an important addition to the routine monitoring and given insight in chemical composition (including mineral dust) and sources (trace analysis) and transport (higher time resolution);

(j) Extension of the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS)[3] model in order to assess local air quality was developed in order to improve the estimates of health impacts from air pollution. One of the lessons from this effort is that local measures alone will not be sufficient to meet WHO Air Quality Guideline values.[4] International co-ordination (e.g., to tackle secondary particulate matter with diameter of 2.5 micrometres or less $PM_{2.5}$) remains indispensable for such a target.

II. Air pollution effects on health

A. World Health Organization estimates annual health cost of air pollution in the European Region at US$ 1.6 trillion

4. WHO has recently launched a publication together with OECD: *Economic cost of the health impact of air pollution in Europe: Clean air, health and wealth*.[5] This report provides estimates on the economic cost of ambient and household air pollution for the 53 member States of the WHO European Region, which corresponds roughly to the ECE region excluding Canada and the United States of America. The economic cost of the approximate 600,000 premature deaths and the diseases caused by air pollution in the Region in 2010 is estimated at US$ 1.6 trillion. The economic value of deaths and diseases

[3] See http://gains.iiasa.ac.at/models/.
[4] World Health Organization, Air Quality Guidelines: particulate matter, ozone, nitrogen dioxide and sulfur dioxide — Global Update 2005 (Copenhagen, WHO Regional Office for Europe, 2006). Available from http://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/.
[5] WHO Regional Office for Europe (Copenhagen, 2015). Available from http://www.euro.who.int/en/media-centre/events/events/2015/04/ehp-mid-term-review/publications.

due to air pollution corresponds to the amount societies are willing to pay to avoid these deaths and diseases with necessary interventions. The report describes and reviews the topic of air pollution from a “Health in All Policies” perspective,[6] reflecting the best available evidence from a health, economics and policy angle, and identifies future research areas and policy options.

B. Increased attention to air pollution on World Health Organization agenda

5. A resolution on “Health and the environment: addressing the health impact of air pollution” was adopted by the World Health Assembly at its sixty-eighth session in May 2015.[7] The key aim of the resolution is to support member States in improving the health sector’s ability to combat the effects of air pollution. Among the actions outlined in the resolution, member States are urged to:

(a) Develop policy dialogue and partnerships and to strengthen multisectoral cooperation at the national, regional and international levels, taking into account WHO guidelines;

(b) Raise awareness among the public and stakeholders of the impacts of air pollution on health and the opportunities to reduce or avoid exposure, and to encourage and promote such measures;

(c) Facilitate relevant research;

(d) Collect and utilize data relevant for health risk assessment and surveillance of illnesses related to air pollution;

(e) Take effective steps to address and minimize air pollution from health care facilities, and identify actions by the health sector to reduce health inequities related to air pollution;

(f) Meet the commitments made at the 2011 United Nations High-level Meeting on Non-communicable Diseases.[8]

6. The WHO secretariat will report to the sixty-ninth session of the World Health Assembly on the implementation of the resolution and progress in mitigating the health effects of air pollution, and other challenges to air quality, and to propose a road map for an enhanced global response to the adverse health effects of air pollution. The resolution and its outcome will be further highlighted at the first joint session of EMEP Steering Body and WGE.

C. Communicating air pollution health effects

7. The 2015 Task Force on Health meeting (Bonn, Germany, 14–15 April 2015) included a session on communication and public health messages for air pollution. Participants at the session established the main principles for communicating environmental health risks; discussed a recent survey from WHO on the availability of public health messages for ambient air pollution in Parties to the Convention; presented selected case studies and experiences in Parties to the Convention; and discussed general conclusions and

6 See http://www.healthpromotion2013.org/health-promotion/health-in-all-policies.
7 World Health Assembly resolution A68/A/CONF./2 Rev.1
8 See http://www.un.org/en/ga/president/65/issues/ncdiseases.shtml.

next steps. The main conclusions of the discussion on the communication of health hazards of air pollution were:

(a) Contrary to what is often reported by the media and the perception of the general public, the most important health impacts of air pollution occur due to long-term exposure rather than to pollution peaks. In that regard, the need to raise public awareness about the risks of long-term exposure to air pollution, along with providing individual measures that can be taken in order to reduce exposure on a daily basis (besides the occurrence of peaks), remains a very important public health goal;

(b) Information channels used to disseminate air pollution and health messages need to be carefully chosen in order to reach the majority of the target population, including susceptible and/or vulnerable population groups such as the elderly, those with health problems or children;

(c) It is important to carefully choose the appropriate group to deliver the health message in order to gain the trust of the general population or the specific target audience (different age groups, vulnerable subgroups or even policymakers);

(d) Air quality indices have developed differently in different countries, and the harmonization of the different scales and messages is therefore not always possible or a straightforward process;

(e) Improvements are needed in air quality monitoring as a prerequisite to implementing effective communication strategies (and evaluating the health impacts of air pollution). This remains a main goal overall in many Parties to the Convention, and more especially for the WHO member States in the eastern part of the European Region.

D. Update of the World Health Organization Air Quality Guidelines

8. The WHO Air Quality Guidelines will be globally updated in a programme expected to last for at least three years. The work is just starting and an expert consultation meeting in September 2015 will help to identify the priorities and define the objectives and extent of the work required, including new health evidence on air pollutants and methodological issues.

III. Air pollution effects on materials

Reduced damage rates at cultural heritage sites due to emissions control within the Convention

9. The ongoing UNESCO study at five cultural heritage sites in Europe is now beginning to show some results. Three sites located in the heart of European capitals (the Clementinum, Prague; the Parthenon, Athens; and the Neues Museum, Berlin) were thoroughly investigated to better understand the role of anthropogenic activities in cities in damaging the materials used to build these objects.

10. The improvement in air quality between 2000 and 2010 in the cities that host the sites studied has produced a small but quantifiable decrease in the recession rate for limestone (5–8 per cent), mainly attributable to a significant reduction in air concentrations of sulphur dioxide. By contrast, air concentrations of nitrogen dioxide (NO_2), nitric acid, ozone and particulate matter with diameter of 10 micrometres or less (PM_{10}) were basically stagnant, with small increases or decreases depending on the particular site.

11. Sulphur dioxide is no longer the dominant factor for the degradation of these selected monuments exposed to the outdoor environment. Particulate matter and nitric acid seem to play a prominent role in determining corrosion damage of limestone. In developing future actions for protecting historical and cultural monuments like the UNESCO cultural heritage sites, it will be important to consider the reduction of atmospheric NO_2 and PM_{10} concentrations. Human health-driven air quality policies will therefore also support protection of monuments and historic buildings.

12. The International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments (ICP Materials) is in the process of launching a call for data on the inventory and condition of stock materials at UNESCO cultural heritage sites. A proposal will be submitted to the first joint session of EMEP Steering Body and WGE in September 2015, and it is expected the call will be adopted and then launched in late 2015 or early 2016.

IV. Critical loads and levels

A. New database on critical loads results in increased exceedance areas in Europe

13. The new grid system with finer spatial resolution recently introduced in the EMEP modelling system is also being implemented for the critical loads assessment, and 12 Parties to the Convention[9] have already updated their contribution to the European critical loads database. For the other Parties, the European background database was used. The updated European critical loads database has been tentatively compared with the 2011 database by exploring the area at risk computed for 2010. Results show that the area at risk of acidification using the updated critical loads database increases by about 2 percentage points (from 5 to 7 per cent), while the area at risk of eutrophication increases by about 4 percentage points (from about 55 to 59 per cent). The updated European critical load database will be transferred to the EMEP Centre for Integrated Assessment Modelling (CIAM) and incorporated in the GAINS model.

B. New concept for mapping critical loads for nitrogen introduced in three countries

14. Work on the new Habitat Suitability Index (HSI), designed to assess the biodiversity effects of air pollution, resulted in submissions by Germany, Italy and the United Kingdom of Great Britain and Northern Ireland, while Austria and Switzerland announced at the 2015 meeting of the International Cooperative Programme on Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends (ICP Modelling and Mapping) that HSI results are planned in 2016 as part of a new call for data proposed by the Parties. The HSI needs further work, however, before it can be used for policy support.

[9] Austria, Belgium (Walloon Region), Finland, France, Germany, Italy, the Netherlands, Norway, Poland, Sweden, Switzerland and the United Kingdom of Great Britain and Northern Ireland.

C. Verifying critical loads

15. Results of an analysis of long-term monitoring data from 28 forest sites of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring) and the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) show that the cover of plant species that prefer nutrient-poor soils (oligotrophic species) decreased the more the measured nitrogen (N) deposition exceeded the empirical critical load for eutrophication effects. Key conclusions from the study include:

(a) The cover of N-sensitive plant species has decreased in European forest ecosystems, but diversity, in terms of species numbers, is still not affected by airborne N deposition;

(b) Estimated critical loads are useful to describe the sensitivity of forest floor vegetation to N deposition. The use of critical load exceedances is particularly suitable for revealing the eutrophication signal of N deposition. It is superior to N deposition alone, which ignores the differences in sensitivity among ecosystems;

(c) The observed response was the first detection of the N deposition effect on vascular plants of forest floor vegetation in a European-wide long-term monitoring data set.

V. Ozone effects on vegetation

A. Effects of ozone control in Europe displaced by increasing background concentrations

16. Despite a more than 30 per cent reduction in European emissions of ozone precursors during the past two decades, a decline in mean ozone concentrations is generally not seen at the EMEP and International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops (ICP Vegetation) ozone monitoring sites. However, the ozone profile in Europe has changed: background concentrations have generally risen while peak concentrations have declined. Between 1999 and 2010, the risk of ozone impacts on vegetation has not changed at ICP Vegetation monitoring sites when the flux-based approach was applied. By using this approach, current background concentrations are included in assessing ozone impacts on vegetation, highlighting the importance of global actions to abate ozone effects, including the control of methane emissions.

B. Combined effects from ozone, nitrogen and climate change difficult to estimate

17. Climate change and nitrogen modify the response of vegetation to ozone pollution. Experimental and modelling evidence indicates that the responses of vegetation to a combination of changing environmental drivers — such as elevated ground-level ozone and carbon dioxide concentrations, enhanced nitrogen deposition, warming and drought — are nonlinear, variable and difficult to predict. For example, the combined impacts of ozone and nitrogen on vegetation appear to be additive to a certain level of ozone exposure, but are synergistic at high ozone exposure. The responses to a combination of stresses need further attention in the future.

VI. Emissions

A. Development of a high-resolution gridding system

18. The development of a high resolution (0.1°×0.1° latitude-longitude) gridding system for reported emissions is ongoing for 10 pollutants for the years 2012–2013. It requires a lot of work for gap filling and for dealing with some technical challenges. The technical challenges are associated with reporting on the spatial distribution of persistent organic pollutants (POPs), reporting on emissions from international shipping and general reporting issues for Parties in Eastern Europe the Caucasus and Central Asia. Evaluation and assessment of the quality of the results will be an important issue, and it is also expected that some comparison with other inventories developed for research purposes (e.g., the Copernicus Monitoring Atmospheric Composition and Climate (MACC)/the Netherlands Organisation for Applied Scientific Research (TNO) emission inventory)[10] could be performed.

B. Black carbon emissions

19. For the first time black carbon emissions have been reported by 24 Parties. It is a very good result for 2015, the first year when Parties were invited to report on black carbon emissions on a voluntary basis. Those data will soon be used by MSC-W as input for the EMEP model to test the added value of such data on particulate matter and elemental carbon modelling. Also in the perspective of closer cooperation, those data will be provided to feed scientific programmes of the Arctic Council which has launched a dedicated initiative on black carbon, and its impact in the Arctic region.

C. Applications for adjustments to emission inventories

20. In 2014 six Parties submitted applications for adjustments to their emission inventory data or reduction targets in accordance with Executive Body decisions 2012/3 and 2012/4. This was the first time this process was run, and the review of those applications was organized by the CEIP. It was not possible to complete the review of all the applications submitted because of a lack of time and resources. An important feedback from the first round of reviews is that it is essential that Parties, and especially those that submit an application, nominate experts for the expert review team (ERT). The review of the 2014 applications required nine sectoral experts and one leader for the ERT. The first reviewing round in 2014 also showed that additional information was needed for both the Parties and the reviewers to frame the process. For example, the exact definition of a "new source" had to be improved. Discussions during the thirty-eighth session of the EMEP Steering Body in September 2014 and the Executive Body meeting in December 2014 led to some clarifications and updated documentation and guidance supported by CEIP and the Task Force on Emission Inventories and Projection co-Chairs. For those reasons and because it was the first year the adjustment emission review process was run, some applications kept in an "open" status were reported to the Implementation Committee. This status allowed resubmission of the applications in 2015 with additional rationale and data. In 2015, seven Parties submitted applications, which are currently being analysed by the ERT. It is important to note that the EMEP Steering Body notified Parties that the review of

[10] See e.g. http://copernicus-atmosphere.eu/.

the adjustment applications would be performed only for countries that have nominated at least one expert, and if there are enough available resources and time once the essential work on the planned in-depth review of the emissions inventories of selected countries is completed.

VII. Hemispheric transport of air pollution

21. The Task Force on Hemispheric Transport of Air Pollution has been working to update its findings from its model intercomparison review undertaken in 2010. To that end, it established a framework for a new model intercomparison experiment, which will update the previous intercomparison study and allow for a new analysis of air pollution impacts (e.g., ozone fluxes, higher resolution results). Currently, approximately 20 global models and 15 regional models are running coordinated experiments, evaluating the impacts on ozone and aerosol of 20 per cent emission reductions of air pollutants. To that end, the Task Force is cooperating with regional modelling communities in Europe and the United States through the Air Quality Model Evaluation International Initiative (AQMEII)[11] project, coordinated by the European Commission Joint Research Centre (JRC),[12] while a similar exercise is foreseen for Asia (Model Inter-Comparison Study for Asia III).

22. A lot of work has been done within this project to make an emission inventory of the major air pollutants to serve as the basis for multi-model simulations. In a dialogue with partners from Asia, Europe and the United States, Task Force scenarios (current legislation (CLE); maximum feasible reductions (MFRs); and no further control (NFC)) are being developed at the International Institute for Applied Systems Analysis, and will be evaluated using the Task Force model results.

23. Global results are collected and analysed on the Aerosol Comparisons between Observations and Models (AEROCOM) server at the Norwegian Meteorological Institute (MetNo),[13] and regional modelling results are analysed by JRC in Ispra, Italy. An analysis of common global-regional results is foreseen as well. More emphasis will be put than previously on the evaluation of results at the various stations available.

24. The development of the GAINS model database by CIAM continues to provide global emission estimates and projections for air pollutants and greenhouse gasses, together with the Task Force on Integrated Assessment Modelling. The GAINS model has now been used for several European Union (EU) projects, and has been used by other organizations and processes, such as the Climate and Clean Air Coalition, the United Nations Environment Programme and OECD. GAINS also offers a platform to exchange views on expected economic developments and policy measures outside the ECE region, e.g., in China and India.

VIII. Methodological developments for particulate matter assessment

25. A major focus of the activities of MSC-W, CCC and the scientific task forces under the Convention in this period were related to particulate matter (PM), which has become a priority given recent findings about the health impacts of PM. Scientific activities dedicated

[11] See http://www.epa.gov/amad/Research/RIA/aqmeii.html.
[12] See https://ec.europa.eu/jrc/.
[13] See http://aerocom.met.no/data.html.

to the improvement of tools (measurements and modelling) for the assessment of PM levels have been developed in recent years. They aim at improving the quality and the reliability of model results and facilitating source-receptor analysis to optimize emission reduction strategies.

26. In particular, the following should be noted with regard to PM modelling:

(a) Black carbon inventories reported for the first time in EMEP are implemented in model calculations. Comparisons with elemental carbon observations will soon be performed for evaluation and will also be used compare them with other available black carbon inventories;

(b) There has been an improvement in the assessment of levels of non-anthropogenic PM, which is especially important for the Mediterranean countries given the impact of transported Saharan dust;

(c) Since ammonia (NH_3) is important for PM, there has been an improvement in NH_3 modelling in the EMEP model, including with regard to dynamic (meteorology-dependent) NH_3 emissions and bidirectional exchange.

27. A question arose on the actual impact of condensables and emissions of semi-volatile organic aerosols that are not well known yet, in the context of some underestimations of PM in model results. This aspect should be investigated together by the modelling and emission communities and will be one of the priorities for the future workplan.

28. Regarding PM monitoring, there have been major improvements in both the EMEP network and the data quality over the past decade. This holds in particular for the level 2 measurements. There are now routine measurements of aerosol absorption (“equivalent black carbon”) and scattering with quite good spatial and temporal resolution in Europe. Also, the chemical speciation of PM has improved, with more co-located measurements of inorganic and organic components. Standardization and reference methodologies have been developed, and the reporting has improved significantly with much more metadata information available. The increased number of harmonized elemental carbon and absorption measurements have significantly improved in the monitoring of short-lived climate pollutants in Europe. For volatile organic compounds (precursors of ozone and organic aerosols), EMEP is able to anticipate improvements in measurement capabilities resulting from the focus of research projects like those carried out by the Aerosols, Clouds, and Trace gases Research InfraStructure Network (ACTRIS).[14]

29. For level 1 measurements, however, the trend is in the opposite direction, with a decrease in analytical performance for sulphate, nitrate and ammonium measurement in recent years. There is also a decrease in the number of sites with recommended sampling frequency, and in large parts of Europe the implementation of the EMEP monitoring strategy is far from being satisfactory. CCC developed an EMEP monitoring implementation index and presented it to the recent EMEP Steering Body session. It shows that less than one third of the EMEP Parties have an implementation index exceeding 50 per cent. This topic needs increased attention in the coming years.

30. In general, there has been improved cooperation with EU (infrastructure and research) projects, with benefits for both communities. The intensive observation periods have been an important addition to the routine monitoring, and provided insight into the

[14] See http://www.actris.net/.

chemical composition (including mineral dust), sources (trace analysis) and transport (higher time resolution) of pollutants.

IX. Understanding heavy metals levels

31. Country-specific case studies on the assessment of heavy metal pollution levels with fine spatial resolution have been initiated by the Meteorological Synthesizing Centre East (MSC-E) and the Task Force on Measurements and Modelling. This project considers discrepancies that exist in some parts of the EMEP domain between emissions, monitoring data and modelling results. In particular, one of the main purposes of the studies is to examine the effects of the refinement of spatial resolution on the quality of pollution level assessment in a country. This research activity allows taking into account specific features of a country's geography, meteorological conditions, location of emission sources and data from national monitoring programmes, etc. It also assumes the integrated analysis of factors affecting the quality of the assessment, including emissions, measurements and modelling with fine spatial resolution, and involves national experts in closer cooperation within EMEP. Additional information on pollution levels in a country, compared with that regularly produced under EMEP, could help countries in improving their national air quality management strategies.

32. The first two case studies focused on Croatia and the Czech Republic. In 2014 an evaluation was carried out of atmospheric pollution of the Netherlands by lead in 2007, with the use of detailed country-specific data on emissions and monitoring and modelling with fine (5x5 km^2) spatial resolution. It was shown that in most of the Dutch provinces the main contribution to lead anthropogenic deposition was made by foreign emission sources from Belgium, France, Germany and the United Kingdom, as well as by national emission sources in the Noord-Holland province (from the emission source category "Iron and steel production"). Moreover, the study demonstrated the importance of individual large point sources for understanding air pollution origin in the country. Improvement of wind resuspension parameterization was extremely helpful for increasing the quality of the model assessment.

33. In 2015, a country-specific activity focused on the investigation of lead pollution levels with fine spatial resolution (10x10 km^2) in Belarus. Joint analysis of initial national data (emissions and measurements) and modelled pollution levels has been started. Moreover, since pollution in Belarus is affected to a great extent by transboundary transport, cooperation with experts from neighbouring countries is needed. In this context, focusing the next case study on Poland would be a welcome development. Assessment of pollution levels in the countries of Eastern Europe, the Caucasus and Central Asia requires development of specific approaches, because of scarce background monitoring networks and insufficient emission data in most of these countries. The research carried out for Belarus could serve as a test approach to evaluate pollution levels in the other countries of the subregion.

X. Integrated assessment modelling

34. Since the adoption of the amended Gothenburg Protocol in May 2012, work on integrated assessment modelling has focused on four elements:

(a) Further exchange with the Parties to improve the database on emissions and emission projections and link emission estimates to activity levels and existing and planned policy measures. For several pollutants (especially $PM_{2.5}$, NH_3 and volatile organic compounds) this is an ongoing activity as methodologies used by the Parties to estimate emissions still tend to change frequently;

(b) Extension of the GAINS model in order to assess local air quality. This has made it possible to assess whether or not air quality limit values are met. It has also improved the estimates of health impacts from air pollution. One of the lessons from this effort is that local measures alone will not be sufficient to meet WHO Air Quality Guideline values. International coordination (e.g., to tackle secondary $PM_{2.5}$) remains indispensable to reach that target;

(c) Assessment of the impact of air pollution for ecosystem services and the loss of biodiversity in protected areas. In cooperation with WGE (especially ICP Vegetation and ICP on Modelling and Mapping/Coordination Centre for Effects) efforts have been made to estimate the loss of biodiversity due to excess nitrogen depositions as well as to monetize the damage to nature. Reduction of ammonia emissions remains an important challenge for air policymakers, and would not profit from decarbonization of the energy supply.

XI. Assessment of long-term trends

35. One major activity under WGE during 2014 and 2015 has been the compilation of long-term trends on the effects of pollutants to ecosystems, human health and materials. A report on the long-term trends is being produced by the WGE subsidiary bodies in close cooperation with MSC-W and CCC.

36. The Task Force on Measurements and Modelling, together with the MSC-E, MSC-W and CCC, has worked to gather data and define a consistent methodology to calculate trends of air pollution concentrations and deposition over the past 20 years for all pollutants covered by EMEP (including heavy metals and POPs). This is a huge cooperative project based on the in-depth involvement of national experts working together with the scientists of the EMEP centres. The European Environment Agency and researchers from the World Meteorological Organization/Global Atmospheric Watch participate actively as well. This study is based on trends not only at the EMEP monitoring sites, but also at other country sites (even urban) considered as relevant by national experts; this provides the opportunity to assess the trends for various site typologies and to compare observed and modelled trends. First results show globally good consistency between modelled and observed trends, except for some sites which vary with the pollutants. Investigation on these situations will help in model and even emission improvement and in enhancing the representativeness of the EMEP network. All the trends will be calculated using the same methodology, defined by the Task Force on Measurements and Modelling, with stringent rules for the selection of the data sets (in terms of temporal coverage, rate of missing data, etc.). This increases the robustness of the study, with results strictly comparable from one region to another. The modelling of trends in the EMEP region will be performed not only by the EMEP bodies, but also by other national modelling teams. This aspect of the study was initiated during the second phase of the EURODELTA model intercomparison exercise[15] launched by the Task Force two years ago. With a panel of several model responses, it is possible to account for model uncertainty in trend assessment, and to help in their interpretation (especially when comparing with observations). The first results of the Task Force trend study will be presented at the first joint session of EMEP Steering Body and WGE, and an advanced draft report should be circulated by the end of 2015. Results will be analysed regarding the trends in effects established by WGE;

[15] See http://aqm.jrc.ec.europa.eu/eurodelta/background.html.

however, because WGE needed some inputs related to ambient air concentrations and deposition for its own work before the Task Force concluded its study, the EMEP Centres provided some requested input in advance.

37. The WGE report will include trends analysis with respect to PM exposure to human populations, ecosystem effects with respect to acidification and eutrophication, ozone concentrations and ozone effects on agricultural crops and forests and air pollution effects on materials. It also includes analyses of trends in deposition and ecosystems concentrations of heavy metals and POPs. Finally, the report will present an analysis of the changes in critical loads exceedances. In most cases the trends analyses cover the period from about 1990. In some cases, in particular for PM, the analyses cover a shorter period.

Key results from the Working Group on Effects trend report

38. *Acidification*: In acid-sensitive lakes and streams in Europe and North America, sulphate concentrations have decreased on average 45 to 55 per cent since 1988 as a result of decreased sulphate deposition. This has led to a widespread chemical recovery of surface waters, while pH and acid-neutralizing capacity have increased. Biological recovery of acid-sensitive waters is also occurring, but full biological recovery may not be possible in some ecosystems. Climate change and variability are expected to offset and delay recovery of acid-sensitive waters. Some catchments release sulphur that has accumulated in the past, delaying the recovery of the surface waters. In European forested ecosystems sulphate still remains the dominant source of soil acidification, despite the fact that the greatly reduced sulphur deposition has resulted in lower input of sulphur than nitrogen. The large soil retention of nitrogen thus results in generally higher leaching fluxes of sulphate than those of nitrate.

39. *Biodiversity and nitrogen*: In spite of a reduction in deposition of nitrogen there are still large effects on biodiversity. In European forests where critical loads for nitrogen are exceeded species cover of oligotrophic plant species has decreased, but species diversity has not. The area with high exceedances of critical loads of nutrient nitrogen has declined significantly between 1990 and 2010. Nevertheless, even if emissions reductions under the amended Gothenburg Protocol are met, about 55 per cent of the European terrestrial ecosystem area will not be protected from eutrophication in 2020.

40. *PM and health*: Due to the limited amount of data, trends analysis could only be performed for a limited period. Comparisons for two three-year periods, 2003–2005 and 2010–2012, respectively, show a tendency towards decreased exposure. The number of monitoring stations, however, has increased over the years, especially for $PM_{2.5}$. In 2012, PM_{10} data from regular population-relevant monitoring were available for 479 cities in 30 countries, and for $PM_{2.5}$ for 300 cities in 26 countries. In European cities where PM is monitored, 75.4 per cent and 94.0 per cent of people experience annual levels exceeding the WHO Air Quality Guidelines for PM_{10} (20 $\mu g/m^3$) and $PM_{2.5}$ (10 $\mu g/m^3$), respectively.[16] This gives rise to a substantial risk to health. For 28.6 per cent of urban residents, the EU limit value for PM_{10} (40 $\mu g/m^3$) was exceeded in 2012.

41. *Ozone and vegetation*: As a result of the implementation of air pollution abatement policies in Europe, peak concentrations of ground-level ozone have been reduced substantially in most parts of Europe over the past decade. However, a reduction in the average concentration and other ozone metrics during the summer has not been observed, despite a more than 30 per cent reduction in ozone precursor emissions in Europe. This is

[16] Annual average values, WHO Regional Office for Europe, 2006.

because of less ozone titration by nitrogen oxides emissions close to source regions (e.g., urban areas), and the increasing precursor emissions in Asia and methane emissions over large parts of the Northern Hemisphere. Hence, both human health and vegetation (including crops) remain at considerable risk from the adverse impacts of ozone.

42. *Heavy metals and POPs*: Between 1990 and 2010 the metal concentration in mosses declined for lead (77 per cent), followed by vanadium (55 per cent), cadmium (51 per cent), chromium (43 per cent), zinc (34 per cent), nickel (33 per cent), iron (27 per cent), arsenic (21 per cent, since 1995), mercury (14 per cent, since 1995) and copper (11 per cent). For lead and cadmium, the decline is similar to those reported by EMEP for the modelled deposition across Europe, i.e., 74 per cent and 51 per cent for lead and cadmium, respectively. The 14 per cent decline in mercury between 1995 and 2010 is lower than the decline (27 per cent) in EMEP modelled deposition across Europe. For mercury the decline was lower than for cadmium and lead due to hemispheric transport of mercury across the globe, resulting in a considerable contribution of mercury pollution from other continents to mercury deposition in Europe.

XII. 2016 assessment report

43. The 2016 assessment report (item 1.9 of the Convention’s 2014–2015 workplan) has been in preparation since late 2014. The key scientific findings and the outcome of the trends analyses (see chapters II-X above) will feed into the 2016 assessment report. A kick-off workshop (Oslo, 20-22 January 2015) focused on the report contents and the division of work by the various stakeholders. The work on the report is led by an editorial board. The report will consist of two parts:

(a) A policy-directed part of a maximum of 10 pages;

(b) A scientific part of 40–50 pages presenting the scientific evidence for the policy part.

44. A preliminary version of the report will be presented as an informal document for discussions at the first joint session of the EMEP Steering Body and WGE, A draft 2016 assessment report will be presented for consideration by the Working Group on Strategies and Review at its fifty-third session in December 2015.

45. The policy part of the report together with the executive summary will be presented as an official document to the thirty-fifth session of the Executive Body in May 2016. The final report will subsequently be presented to the Eighth Environment for Europe Ministerial Conference (Batumi, Georgia, 8–10 June 2016).