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Recent results and updating of scientific and technical knowledge

Effects of Air Pollution on Health

Report from the fifteenth meeting of the Joint Task Force on the Health Aspects of Air Pollution

Summary

In the 2012–2013 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/109/Add.2, item 3.8), the Executive Body for the Convention called for the preparation of state-of-the-art reports on the direct and indirect effects of long-range transboundary air pollution on human health. In particular, the joint Task Force on the Health Effects of Air Pollution was requested to evaluate and assesses the health effects of long-range transboundary air pollution and report on the subject.

The present report presents the results of the discussions on health impacts of ambient air pollution (particulate matter and ozone) and provides a summary of other workplan items discussed at the Task Force’s fifteenth meeting.
I. Introduction

1. The fifteenth meeting of the Joint Task Force on the Health Aspects of Air Pollution, under the Executive Body for the United Nations Economic Commission for Europe (ECE) Convention on Long-range Transboundary Air Pollution (CLRTAP) and the World Health Organization (WHO)/European Centre for Environment and Health (ECEH), was held in Bonn, Germany, on 22 and 23 May 2012. The present report comprises the results of the discussion on health impacts of ambient air pollution (particulate matter (PM) and ozone) and provides a summary of other workplan items discussed at the Task Force meeting, in accordance with item 3.8 of the 2012–2013 workplan for the implementation of the Convention (ECE/EB.AIR/109/Add.2) adopted by the Executive Body at its twenty-ninth session in December 2011.

2. Altogether, 40 experts from 24 Parties to the Convention attended the meeting, as well as a representative of the CLRTAP secretariat. The European Union (EU), as a Party, was represented by the European Commission. The representatives of the United States of America, Canada, France and Ireland, as well as an additional expert from France, attended a part of the discussion via electronic media. The meeting was chaired by Mr. M. Krzyzanowski (WHO/ECEH) and co-chaired by H. G. Mücke (WHO Collaborating Centre for Air Quality Management and Air Pollution Control, German Federal Environment Agency). L. van Bree (PBL Netherlands Environmental Assessment Agency) acted as a rapporteur. The Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) Centre for Integrated Assessment Modelling and the CLRTAP Network of Experts for Benefits and Economic Instruments were also represented. An observer from the oil companies’ European association for environment, health and safety in refining and distribution (CONCAWE) and staff of WHO also attended the meeting. Financial support for the meeting was received from the Swiss and German Governments.

II. Health impacts of particulate matter and ozone

A. Progress in research on health effects

3. The representative of the CLRTAP secretariat presented an update on the activities of the Convention. On 4 May 2012, Parties to the Convention had reached a consensus and had approved a revision and extension of the 1999 Protocol to Abate Acidification, Eutrophication and Ground-Level Ozone (Gothenburg Protocol). The most important elements of the revision included:

   (a) Adoption of national emission reduction targets for 2020, compared with 2005 base year for key air pollutants: sulphur and nitrogen oxides, ammonia and volatile organic compounds;
   
   (b) Adoption — for the first time — of emission reduction targets for fine particulate matter (PM$_{2.5}$);
   
   (c) Inclusion of black carbon (BC) as an important component of PM$_{2.5}$ (air pollutant and at the same time an important short-lived climate forcer); new tasks and obligations with respect to BC included, inter alia:

      (i) Development of national emission inventories;
      
      (ii) Atmospheric modelling and transboundary exchange;
(iii) Monitoring of adverse health and environmental effects;
(iv) Cost-benefit analysis;
(v) Prioritizing PM$_{2.5}$ mitigation measures with a focus on BC reductions;
(d) Adoption of a uniform set of air pollutant standards for stationary and mobile sources (emission limit values);
(e) Introduction of flexibilities for the countries of Eastern Europe, the Caucasus and Central Asia as well as South-Eastern Europe to facilitate ratification and implementation of the revised Protocol by those Parties.

4. Belarus, Croatia, Norway, Switzerland and the EU had already announced their reduction commitments (-59%, -42%, -6%, -28%, -22% for sulphur dioxide, nitrogen oxides, ammonia, volatile organic compounds and PM$_{2.5}$, respectively). The Unites States provisionally indicated a similar level of ambition with respect to abatement commitments to that of the EU. The Russian Federation and other countries of Eastern Europe, the Caucasus and Central Asia indicated their intention to ratify the revised Gothenburg Protocol in the near future. Special emphasis was put on interlinkages and co-benefits with climate change policy and greening the economy. Those developments were welcomed by the Task Force as essential for the reduction of health effects of air pollution. The Task Force emphasized the need for full ratification and implementation of the Protocol in order to achieve the health relevant reduction of population exposure to PM.

5. The Task Force discussed the implications of a recent publication in Environmental Health Perspectives by Crouse et al. of an article on the risk of non-accidental, cardiovascular mortality in relation to long-term exposure to low concentrations of PM$_{2.5}$. In that large Canadian cohort study, health effects associations had been observed with exposures to PM$_{2.5}$ at concentrations predominantly lower (mean of 8.7 µg/m$^3$; interquartile range: 6.2 µg/m$^3$) than those that had previously been reported. That cohort study was the first to include rural as well as urban populations. The paper also compared risk estimates for satellite-derived PM concentration/exposure estimates and ground-based measurements for a subset, and had found similar associations for non-accidental mortality. The Task Force noted the continued need to mitigate sources of PM in order to reduce health risks to a minimum, even at PM$_{2.5}$ levels close to WHO Air Quality Guidelines. The Task Force was also briefly informed about the ongoing large European cohort study, the European Study of Cohorts for Air Pollution Effects (ESCAPE), on health effects from long-term exposure to PM and other pollutants, on which reports were expected starting in late 2012.

6. The representative of the European Commission (EC) gave a brief update on the ongoing reviews of EU air pollution policy. In the second half of 2013, EC would come forward with a comprehensive evaluation of past and current air quality policy and propose further action that would make progress towards the long-term objectives of protecting human health and the environment. By spring 2013, WHO would provide EC with key information on air pollution health risks that would contribute to the EU policy review.

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4. See http://ec.europa.eu/environment/air/review_air_policy.htm
7. As a follow-up, a WHO representative presented the EC-WHO jointly funded project on evidence of health aspects of air pollution to review EU policies (REVIHAAP),\(^5\) which would provide EC and its stakeholders with scientific evidence-based advice on health aspects of air pollution in support of the comprehensive review of air quality legislation in 2013. Specific questions posed by EC on health aspects of PM, ground-level ozone, nitrogen dioxide and sulphur dioxide, as well as emissions into the air of arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons, would be answered. The review would also consider emerging issues on risks to health from air pollution, the role of specific components or characteristics of PM, the need to update WHO guidelines and the implications for EU policies. Expert reviewers had been identified for the first phase of the work, and answers to the questions, with accompanying background papers, were currently being drafted. The project was ongoing until spring 2013, but the first results from the review were expected in autumn 2012.

8. The Task Force was also updated on several of the United States air pollution health risk assessments, including on coarse particles (PM\(10-2.5\)),\(^6\) PM\(2.5\) and ultrafine particles, short-term and long-term PM effects, a proposal for an annual PM\(2.5\) standard (11 µg/m\(^3\)–13 µg/m\(^3\)), evidence on long-term exposure effects of ozone, as well as a black carbon report to Congress.\(^7\) It was noted that there was a large difference between the annual nitrogen dioxide standards for the United States (~188 µg/m\(^3\) based on the three-year average of the ninety-eighth percentile of the yearly distribution of one-hour daily maximum concentrations) and for the EU (annual average 40 µg/m\(^3\)).

B. Communication on health risks of particulate matter and ozone

9. In line with the Task Force’s workplan item on harmonization of scales facilitating communication on air pollution health effects, a recent French advice and expertise report on the health risks associated with particulate air pollution\(^8\) was presented to the Task Force. The objective of the report was to give advice on the relevance of the current information and alert thresholds for PM\(10\) and to establish health advice messages adapted to different population targets. The approach gave priority to reducing long-term exposure, noting that the actions focused on elimination of pollution peaks had little impact on the burden on population health due to PM\(2.5\) and PM\(10\). The report recommended a representation of PM levels measured over the past 365 days by using a “journal of daily standards exceeded”, providing good public readability of the quality of the air in a town and allowing for comparisons over time and between cities. The report reiterated that communication on the quality of the air and on the efforts aimed at guaranteeing it had to be regular, with the occurrence of daily peaks able to be considered as an opportunity to reactivate vigilance in order to achieve that objective.

10. The Task Force was updated on the status of levels and on trends in air quality in the following countries of Eastern Europe, the Caucasus and Central Asia and South-Eastern Europe: Albania, Armenia, Azerbaijan, Belarus, Georgia, Kyrgyzstan and the former Yugoslav Republic of Macedonia. A recent effort to establish PM\(10\) monitoring in two sites in Uzbekistan was also discussed. The presentations confirmed that monitoring of PM\(10\) and

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\(^6\) I.e., particles between 2.5 and 10 micrometres in diameter.

\(^7\) See http://www.epa.gov/blackcarbon/.

\(^8\) Available from http://www.hcsp.fr/explore.cgi/avisrapportsdomaine?ae=avisrapportsdomaine&clefr=264&menu=09.
PM$_{2.5}$ was still very limited in the subregion, with only a small number of monitoring stations in Albania, Belarus and the former Yugoslav Republic of Macedonia. In many cases, stations monitoring PM$_{10}$ or PM$_{2.5}$ measured background levels in remote areas, and therefore did not adequately represent urban population exposure. It was suggested to the Task Force that, in the absence of ground-level data for particles, remote (satellite) sensing could be used for the assessment of population exposure at country level. Some recent developments in that field were discussed during the meeting, especially as part of the Global Burden of Diseases, Injuries and Risk Factors project.\(^9\) Despite the lack of monitoring, delegates of countries from the subregion pointed out the significance of the aging vehicle fleet as an air pollution source, along with industrial activities, local heating and biomass burning. The presentations also revealed the need to increase general knowledge as well as expert capacity on monitoring and modelling technology, data analysis, impact assessment, and co-benefit opportunities in countries of the subregion. Presentations on the levels and trends in Western Europe, more specifically in Germany and the Netherlands, reiterated that air pollution was an ongoing issue and continued effort to mitigate its sources was required.

11. With communication on health aspects of air pollution in support of the implementation of the revised Gothenburg Protocol as an overarching theme, the Task Force discussed the development of a short paper summarizing the evidence of the health effects of PM and relevant policy implications for non-technical users and policymakers of various backgrounds, primarily in countries of Eastern Europe, the Caucasus and Central Asia. The document would be produced in English and Russian, and translation in other relevant languages would be encouraged. Several delegates expressed interest in such a document. The Task Force discussed the format, as well as the need to present success stories and best practices from other countries to reduce PM levels. The Task Force agreed to develop a draft of the document in time for the thirty-first session of the Working Group on Effects in September 2012, with the plan of finalizing the document in early October for presentation to the Convention’s Executive Body in December 2012.

12. While discussing its work plan, some delegates proposed that the Task Force develop a review of the health effects of residential wood biomass burning. The Task Force agreed that such a document would be beneficial to the Parties. The Task Force would develop a first draft of that report for the next Task Force meeting in 2013.

III. Health aspects of wildfire smoke

13. A workshop on the health aspects of wildfire smoke had been jointly organized on 21 May 2012 by the National Institute for Health and Welfare, Finland, and WHO-ECEH, back to back with the fifteenth meeting of the Task Force. Based on the presentations and discussions during the workshop, the Task Force discussion focused on the formulation of the conclusions presented below.

14. It was clarified that the term “landscape fires”, which was commonly used among fire experts, encompassed wild and prescribed forest fires, tropical deforestation fires, peat fires, agricultural burning and grass fires.

15. It had been emphasized in the workshop that the satellite techniques to assess emissions from landscape fires and the utilization of real-time meteorological data to assess smoke transport allowed spatially and temporally accurate modelling of smoke dispersion, and forecasting with reasonable uncertainty of the resulting PM$_{2.5}$ concentrations for the

\(^9\) See http://www.globalburden.org/.
whole of Europe 24 to 48 hours in advance. Analyses from Canada indicated that smoke forecasts also predicted respiratory health responses in affected populations, suggesting the utility of forecasts for public health response measures.

16. The daily averaged emissions of PM$_{2.5}$ from landscape fires (~7.5 kilotons/day) in Europe were assessed to be nearly as large as the similarly averaged total PM$_{2.5}$ emissions (~9 kilotons/day) from registered anthropogenic sources in 2006–2008. The highest daily peaks of PM$_{2.5}$ emissions in dry summer periods were 200–400 kilotons. The smoke from nearby or distant (500–1,000 kilometres) landscape fires usually increased daily PM$_{2.5}$ concentrations in smaller or larger areas by five to twentyfold and the hourly peak concentrations could rise to hundreds of $\mu$g/m$^3$ or even up to 1 mg/m$^3$–2 mg/m$^3$.

17. A building shell without mechanical air ventilation plus PM filtration or air conditioning reduced the outdoor-to-indoor penetration of smoke PM$_{2.5}$ by about 20%–30%, but substantially lower indoor PM$_{2.5}$ concentrations could be achieved by the use of more-effective-than-conventional air filters in buildings or by using effective High-Efficiency Particulate Air (HEPA) filter room air cleaners. Suddenly starting or sometimes several-week-long increases in PM$_{2.5}$ concentration owing to landscape fires had been associated with increased adverse health effects and reliever medication use as well as increased out-patient visits to doctors and hospital visits, especially among subjects with bronchial asthma. The most recent epidemiological studies suggested that PM$_{2.5}$ or PM$_{10}$ from landscape fires were also associated with increased mortality and that there might be an additive effect on mortality with a simultaneous heat wave. A 10-day episode of long-range transported smoke from landscape fires had recently been associated with acute systemic inflammation in blood among ischemic heart disease patients.

18. It was estimated that long-term exposure to PM$_{2.5}$ from landscape fires was the main cause of 339,000 (range 262,000 to 532,000) excessive deaths per year globally, mostly in sub-Saharan Africa and South-East Asia. In Europe, excess mortality from exposure to landscape fire smoke PM$_{2.5}$ had been estimated at 12,800 (range 11,600–22,700) deaths per year. The Task Force suggested strengthening interdisciplinary collaboration between experts and professionals on health and experts on landscape fire assessment and management, such as the Global Fire Monitoring Center, the European Forest Fire Information System and the Global Wildland Fire Network. Improved cooperation would greatly enhance capabilities to mitigate severe health effects in the vulnerable groups and impaired well-being in the general population, particularly in countries such as those in the southern Mediterranean and Eastern Europe, where landscape fires were a prominent feature.

IV. Methodologies and approaches for estimating the burden of disease due to air pollution

19. The latest developments in the ongoing project to estimate the Global Burden of Diseases, Injuries and Risk Factors were presented to the Task Force. Methods for the assessment of exposure to PM$_{2.5}$ and ozone, based on exposure estimates calculated from satellite data (MODIS/MISR), the global chemistry transport model (TM5) and ground level measurements, had been recently published. The data set was presented separately for 21 regions, but the methods applied did allow for country-level exposure and burden of disease estimation. Preliminary results of the analysis indicated that outdoor air pollution had substantial impacts on global health, significantly greater than those estimated in the

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10 See http://silam.fmi.fi/.
2002 Global Burden of Disease assessment, especially in Asia, Africa, and South-America. Given the widespread population exposure to air pollution, interventions could be very cost-effective, but the non-linearity in the exposure-response functions meant that achieving large benefits from air pollution reduction in very polluted settings would require large improvements in air quality. The results were currently being finalized, and would be published in The Lancet in autumn 2012.

20. A project quantifying the impact of transboundary air pollution in East Asia was presented to the Task Force, with emphasis on ozone and PM$_{2.5}$ and their impact on premature mortality. The premature mortality cases caused by ozone and PM$_{2.5}$ in countries in East Asia were estimated for the years 2000 and 2005 to be around 316,000 and 520,000, respectively. For “policy succeed”, “reference”, and “policy failed case” future scenarios for 2020, the estimated annual premature mortality was 451,000, 649,000 and 1,035,000 cases, respectively. In that project, the concentration-response functions from European and North-American studies had been used in the absence of those functions from Asian studies. The need for Asian-specific concentration-response functions was expressed.

21. Two different analyses of the health impacts of the revision of the Gothenburg Protocol and the Directive on National Emission Ceilings were presented and discussed. First, the Task Force discussed new developments in the estimation of health impacts with the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model, now downscaled to a 1×1 kilometre grid size. Different emission control scenarios had been developed for 2020, enabling quantification of health impacts against ozone and PM$_{2.5}$ for the current legislation, MID-scenario and maximum feasible reductions within the ECE domain or in the 27 States of the EU (EU-27). To measure improvement, the years of life lost for PM$_{2.5}$, as well as the number of premature deaths for ozone in 2020, were compared to year 2000. A summary of impact indicators (total, EU-27 and non-EU) for 2000 and 2020 were presented. Current draft results indicated that PM impacts were expected to decrease by about 25% to 50% and ozone impacts around 30% to 35% in 2020 compared with 2000. The options for target setting for a cost-effectiveness optimization were presented. The cost-effectiveness calculations had the BC approach (primary combustion emission and impact modelling) on its agenda for the coming years, following the WHO Task Force statement on the usefulness of a BC indicator in urban situations, dominated by traffic.

22. The health benefit analysis supporting the revision of the Gothenburg Protocol from the ClimateCost model was also presented to the Task Force. For almost all scenarios, the health benefits were higher than the costs. PM life years lost was the largest share of health impacts to total health benefits. Co-benefits, which were described as benefits associated with greenhouse gas controls not linked to climate, had been considered, and scenarios had also been developed for different years (2005, 2020, 2030, 2050), consistent with a 2°C target for temperature increase. The air quality co-benefits of mitigation scenarios were around €24 per ton of carbon dioxide across the period. Several uncertainties in the methods for estimation of mortality and morbidity impacts, as well as the future use of cause-specific instead of all-cause functions, were raised.

23. Further discussions revealed differences in the approaches and outcomes of the models used for estimating health impacts, with larger mortality impacts observed when

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13 See http://www.climatecost.cc/images/Policy_brief_1_Projections_05_lowres.pdf.
using the AirQ\textsuperscript{14} rather than the GAINS model. That divergence was seemingly due to differences in the selection of impact estimates for the cohort upon entry for follow up at age 30. Other notable differences raised between the models included the use of new birth cohorts when calculating impacts over a long period, as well as a lag structure to reflect gradual gain in health from changes in emissions. Those were currently not included under the GAINS model, but would be considered as part of future revisions.

V. Cross-cutting issues

24. Specifically in relation to the newly revised Gothenburg Protocol, the Task Force noted the opportunity to enhance communication on the health aspects of air pollution, and agreed to develop policy-oriented information to support the future implementation of the Convention, with a focus on particulate matter.