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Working Group on Effects

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RECENT RESULTS AND UPDATING OF SCIENTIFIC AND TECHNICAL KNOWLEDGE

HEALTH RELEVANCE OF PARTICULATE MATTER FROM VARIOUS SOURCES

<u>Report by the joint Task Force on the Health Aspects of Air Pollution of the World Health Organization (WHO)/European Centre for Environment and Health (ECEH) and the Executive Body</u>

INTRODUCTION

1. The tenth meeting of the Task Force on the Health Aspects of Air Pollution was held in Bonn, Germany, on 28 March 2007. Seventeen experts from 15 Parties to the Convention attended the meeting. A member of the secretariat also attended the meeting, as well as WHO staff. Mr. M. Krzyzanowski (WHO/ECEH) chaired the meeting. This report comprises the results of the meeting, including a review of a workshop on the health relevance of particulate

matter from various sources, held from 26 to 27 March 2007 at WHO, and reports from Eastern Europe, the Caucasus and Central Asia (EECCA), given in the annex, presented here in accordance with the Convention's 2007 workplan (item 3.8).

2. The Task Force noted the results from the Workshop on air pollution and its relations to climate change and sustainable development ("Saltsjobaden III") held from 12 to 14 March 2007 in Gothenburg, Sweden. Health effects of air pollution and climate change were highlighted and close cooperation with WHO was recommended.

I. 2007 WORKPLAN

3. The Chair presented the Convention's 2007 workplan items for the Task Force on Health. The Task Force mainly assisted the Executive Body and the Working Group on Effects in assessing health effects of air pollution; however, it might propose additional items for its workplan. Some delegates suggested work on impacts due to biomass combustion emissions and on long-range transport of vegetal emissions, such as pollen.

4. The Task Force noted that health hazards of particulate matter (PM) due to biomass combustion were addressed by the *Air Quality Guidelines* of WHO. PM was associated with various adverse health impacts. Little evidence existed to suggest reduced or altered toxicity compared to the more commonly studied urban air PM. Biomass burning, in fields or wildfires, sometimes caused prolonged pollution episodes, which might affect large areas and substantial segments of the population.

5. Emission reductions from vegetation are not addressed by the Convention. Biogenic particles, e.g. spores or pollens, in particular when fragmented, may exacerbate allergies and asthma. They cause significant public health problems in large parts of Europe, and are linked to climate change and air pollution interactions. Biogenic particles are not included in the atmospheric transport model of the Convention's Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants (EMEP), although they are long-range transported and may contribute considerably to particle mass in rural and urban environments. The Task Force recommended consulting relevant effects programmes and EMEP on this issue.

6. Annual progress report on health impacts of ozone (O_3) and PM. Recent results were discussed within the review of the workshop (see section II).

7. Annual progress report on health impacts of O_3. The Task Force took note of the draft report "Health risks of ozone from long-range transboundary air pollution". The document

required some revision to incorporate new results on O_3 levels, atmospheric modelling and health hazards. The Task Force welcomed the proposal of Georgia to provide data on the national concentrations of ground-level O_3. It invited other EECCA countries to provide similar data to improve the geographical coverage.

8. Assessment of the health hazards of "new" persistent organic pollutants (POPs). The Task Force on Health had received no requests from the Working Group on Strategies and Review for revising the health risk assessment of persistent organic pollutants. Therefore, no work on health hazard evaluation was initiated.

9. The Task Force noted the progress made in editing the report, "Health risks of heavy metals from long-range transboundary air pollution". Its publication was foreseen at the end of 2007.

10. The Task Force agreed to concentrate on updating the assessment of health impacts of O_3 and PM, and adopted its draft 2008 workplan:

(a) Annual progress report on health impacts of PM;
(b) Interim report on health impacts of O_3;
(c) Final report on health risks of heavy metals;
(d) Eleventh meeting of the Task Force on the Health Aspects of Air Pollution, tentatively scheduled to be held in Bonn, Germany, in March/April 2008.

II. HEALTH RELEVANCE OF PARTICULATE MATTER FROM VARIOUS SOURCES

11. The Task Force noted the results from a workshop on the health relevance of PM from various sources, held on 26 and 27 March 2007 at WHO. The proceedings will be published as a WHO report.

12. PM is a complex, heterogeneous mixture and its composition (particle size distribution, chemical characteristics) changes over time. PM is formed by emissions from various sources, atmospheric chemistry and weather conditions. Current knowledge does not allow precise quantification or ranking of its health effects due to different sources or specific characteristics of PM. However, available evidence suggests that PM from major combustion sources, mobile and stationary, is associated with serious health effects. These include increased morbidity and mortality from cardiovascular and respiratory disease. Current risk assessment should consider particles of different size, source and composition equally hazardous to health. *Air Quality Guidelines* of WHO recommend using $PM_{2.5}$ (or PM_{10}) mass concentration as the health-risk

indicator. Improved future understanding could help in targeting abatement policies and control measures.

13. The prerequisite for more informative studies of PM health effects is the accurate characterization of population exposure to PM from specific sources. Temporal and spatial differentiation of PM composition requires dispersion models with high spatial and temporal resolution, based on precise emission inventories. However, such inventories were not available in many European countries. Existing inventories suffered from incomplete emission data, in particular on primary PM. These gaps affect the accuracy of air pollution models. In addition, the scarcity of monitoring data on component-specific PM hinders model validation. Analysis of health impacts during high pollution episodes, when composition is often different compared to non-episode periods, may use back trajectory models to identify contributions from individual sources. Such models and other methods might reveal changes of toxic properties of long-range transported PM, e.g. windblown Sahara dust.

14. The Task Force took note on the recent overview on the health effects of PM, which was part of the global update of the *Air Quality Guidelines* of WHO, and on recent but unpublished research results in Europe and the United States. Long-term exposure to air pollution not only affected acute outcomes, such as death, but also contributed to disease development. The attribution to specific PM characteristics remained limited due to the scarcity of relevant exposure data. However, some results suggested differential toxicity among PM components for a chosen health endpoint as well as differences in the affected health endpoints. For example, subchronic studies with animals exposed to ambient particles showed severe cardiopulmonary effects and unexpected responses in the liver and brain. Future studies should include other effects than classically measured ones.

15. Adverse health outcomes have been associated with various size fractions within the PM_{10} range. Coarse particles might preferentially affect airways and lungs and fine particles the cardiovascular system. Ultrafine particles might also migrate via the lungs to other locations, including the liver, spleen, brain, placenta and foetus. Health implications of this observation were not revealed.

16. Different chemical characteristics of PM seemed to have different relative risks based on the particle mass. Different characteristics might be associated with different outcomes. Most studies used single chemical characteristics of PM as an exposure indicator; therefore, the components found to be associated with health outcomes (e.g. sulphate content) could be indicators of components not measured (e.g. heavy metals). Emissions from road traffic were linked with a wide range of health effects, including impacts on cardiovascular and respiratory systems and on atopic sensitisation to allergens in outdoor air.

17. The oxidative potential of particles was considered as a plausible hypothesis explaining PM toxicity. Several in vitro studies have indicated that PM with high oxidative potential had high activity in reducing antioxidants, indicating involvement of transition metals and oxidized organics. PM from traffic seemed to have high oxidative activity. Several studies indicated an important role for transition metals in increasing the hazardousness of PM.

18. Although secondary inorganic aerosols have less toxic activity in laboratory conditions, epidemiological studies showed the impact of sulphates and nitrates on various health outcomes. In ambient air, this fraction might act as a carrier for other components or as a surrogate for PM emitted from combustion of fuels containing sulphur. At the local level, correlated gaseous pollutants, such as nitrogen dioxides, might indicate PM sources. The use of different markers and surrogates for specific particle sources was deemed important for the understanding of the complex interactions between particles and different health outcomes, as well as early signs of disease.

19. Research on health effects of exposure to PM from various sources has implications for air pollution regulation and public health. It would justify a carefully targeted, intensive research programme. Such programmes are currently under way at the national and state levels in the United Stateswhere, for example, the Health Effects Institute has recently commenced an extensive programme, “National particle component toxicity initiative (NPACT)”. It comprises integrated epidemiologic and toxicological studies on effects on chronic and acute cardiovascular and respiratory diseases using air quality data on specific PM components and characteristics from many sites. Similar studies combining source-specific air quality information, epidemiologic studies and toxicological analysis should be done in Europe. Air quality monitoring should include PM speciation and source apportionment with high spatial and temporal resolution. Studies evaluating effects of interventions, such as implementation of pollution control measures or urban planning (“accountability studies”) could further provide important and timely evidence.

III. ACTIVITIES OF EECCA COUNTRIES ASSESSING HEALTH IMPACTS OF AIR POLLUTION

20. Experts from the countries of EECCA, represented at the meeting by Armenia, Belarus, Georgia, Kazakhstan Kyrgyzstan, and Moldova, presented national activities on air pollution. Progress had been made in monitoring air quality in some countries, but a number of challenges remained, such as highly polluting industries using old technologies and ineffective pollution controls. The representatives also emphasized the need for financial assistance to modernize air quality monitoring equipment and methodologies. They also required increased cooperation,

training and technical assistance, to build capacity to assess health effects, economic impacts and the legislative framework for protecting human health.

21. The Task Force welcomed the good participation from EECCA and took note of the information presented by the experts from that region (see annex). The Task Force also noted the WHO programme to assist countries in assessing health risks of air pollution and monitoring of PM, which was responsible for a substantial part of the health impacts of air pollution in EECCA.

<u>Annex</u>

Reports on national air pollution activities submitted by the experts from Eastern Europe, Caucasus and Central Asia

I. ARMENIA

1. Maximum permissible concentrations of 389 air pollutants were approved in 2006. Technical regulations on atmospheric emission norms and control methods were adopted in 2007. These specify the development of an air quality monitoring network; measurement methodologies for sulphur and nitrogen oxides are being prepared.

2. Since 2003, "Armecomonitoring" of the Ministry of Nature Protection has implemented air quality monitoring activities. Currently, there are 13 monitoring sites, including five in Yerevan. Altogether, 11 substances, including dust, carbon monoxide (CO), O_3, sulphur and nitrogen oxides (NOx), are analysed. Pollution levels significantly exceed national air quality standard levels.

3. Air quality in Armenian cities is adversely affected by emissions from motor vehicles, whose number has increased rapidly in recent years. Most vehicles are old, have no emissions control devices, and are poorly maintained. Action plans aim to reduce vehicle emissions and improve monitoring.

4. State Hygiene and Anti-Epidemical Inspection studied residents along the most polluted streets of Yerevan in 2005. The results indicated high prevalence of respiratory (42% in adults and 64% in children), cardiovascular (24% and 2%, respectively) and allergic diseases (10% and 17%, respectively).

II. AZERBAIJAN

5. Monitoring of air quality is an integral part of the public monitoring system of the environment and mineral resources of the Republic of Azerbaijan. It comprises 27 sites in eight industrial cities and covers 18 pollutants, including dust, soot, mercury (Hg), CO, sulphur oxides, nitrogen compounds, and volatile organic compounds (VOC). Snow-cover monitoring is conducted at four sites on 11 indicators. A comprehensive automatic air quality monitoring system is being developed in 2006-2010.

6. The information generated by air quality monitoring is reported to relevant authorities. It is used for air quality assessment in big industrial cities and for decisions related to industrial development, the installation of new technological equipment, new buildings construction, and the regulation of the inter-city transport.

7. Small sources of air pollution contribute to increased levels of specific air pollution (PM_{10}, $PM_{2.5}$, aromatic hydrocarbons and heavy metals). Plans include mobile monitoring along oil and gas pipelines crossing the country and background monitoring for transboundary air pollution.

III. BELARUS

8. Environmental laws regulate air quality management and monitoring. A special programme of the development of national environmental monitoring system covers the period 2006–2010.

9. Monitoring is conducted in 17 cities and covers 67% of the urban population. Data are collected in 58 sites and address 39 pollutants, ranging from 7 to 32 according to site. O_3, PM_{10}, polyaromatic hydrocarbons and VOC have been monitored since 2005. Background monitoring is conducted in Berezinsky biosphere reserve for CO, sulphur compounds, NOx, O_3, total suspended matter, PM_{10}, lead (Pb) and cadmium (Cd). There are two automatic stations (for CO, SO_2, NOx, O_3, PM_{10}, benzene, VOC) and seven automatic analysers (for CO, SO_2, NOx, O_3). Five monitors also measure PM_{10}. Laboratory equipment includes liquid and gas chromatographs as well as atomic absorption spectrometers. The information is reported regularly to the Ministry of Natural Resources and Environmental Protection through the main information and analytical centre. Annual analytical reports are available on the Web (www.ecoinfoby.net).

IV. GEORGIA

10. The main source of air pollution in Georgia is road transport, especially in the main cities of the country, followed by energy and industry. The growth of the urban population in Georgia has adversely affected the environment in the cities, in particular through the impacts of air pollution. It has also created excessive noise and traffic congestion, and led to the loss of green areas, and the degradation of historical buildings and monuments. The number of vehicles, mostly 10–15 years old, is growing. Lack of fuel quality control and inefficient management of road traffic also affect air quality. Public transport is insufficient but improving.

11. Current monitoring system consists of 11 measuring sites in the main cities. The pollutants include dust, CO, NOx, SO_2, manganese dioxide and hydrogen sulphide, which are measured three times per day. There is no equipment to monitor PM_{10} or O_3. Collaboration between various sectors in air quality assessment and management would require strengthening.

12. Improvement of air quality in Georgia requires better control of vehicle emissions, implementation of fuel quality standards and promotion of the better maintenance and technical status of the vehicles. Non-technical measures are needed as well, such as improved transport demand management and better urban planning.

V. KAZAKHSTAN

13. Environmental pollution measurements have been carried out since 1972. The Environmental Pollution Monitoring Center, including air pollution monitoring, has been re-established within the structure of the Kazhydromet in 2000. The air pollution monitoring network consists of 47 stationary posts, which are located in 20 settlements. The list of controlled pollutants has been defined taking into account the amount and composition of air emissions and the results of preliminary research of air pollution. Sixteen components are measured, including dust, sulphur compounds, CO, nitrogen dioxide, hydrogen fluoride, hydrogen sulphide and heavy metals. The network is supported by laboratories in Almaty, as well as in Regional Hydrometeorological Centres.

14. An important contribution to the development of air quality management is the UNECE project, “Capacity-building for air quality management and the application of clean coal combustion technologies in Central Asia” (CAPACT) (website: http://www.unece.org/ie/capact/), focusing on the implementation of the Convention. This project has been implemented in collaboration with energy and environmental authorities in Central Asia. An EMEP monitoring station will be established within the project. A national programme for air quality management has been developed, which will allow for the implementation of selected Convention protocols in Kazakhstan in the period 2008–2010.

VI. KYRGYZSTAN

15. The Kyrgyz Republic has acceded to most important environmental conventions in recent years. The main pollution sources in the country are the energy industry, construction plants, public utilities, the mining and processing industries, the private sector, and motor transport. Vehicles still use leaded gasoline.

16. Systematic stationary monitoring is conducted at 14 sites in five cities (Bishkek, Cholpon-Atam, Kara-Balta, Osh and Tokmok). The sampling for each location is individually designed, taking into consideration location, proximity to the sources, and composition of discharges. The measured pollutants include sulphur and nitrogen oxides, ammonia and formaldehyde. Samples are taken three times a day. Earlier, dust measurements were conducted, but these were cancelled in 2000 due to lacking funds. O_3 is not measured.

17. Air pollution levels are expressed in permissible concentration units. Information is presented to the different ministries and agencies monthly. Monthly and yearly reports of atmospheric air pollution in the cities are published at websites (http://www.meteo.ktnet.kg and http://www.ecokg.caresd.net).

VII. MOLDOVA

18. The State Ecological Inspection is responsible for monitoring air emissions from 710 sources. The National Scientific and Applied Center of Preventive Medicine of the Ministry of Health carries out air quality monitoring in protection zones of industrial areas. The National Institute of Ecology and Geography conducts research and assessment of industrial emissions effects on air quality. It also introduces modern techniques and international standards to national applications.

19. The air quality monitoring network of the Hydrometeorological Service consists of 17 monitoring stations located in five industrial cities: Chisinau, Balti, Ribnita, Tiraspol and Bender. A background station in Leovo will monitor air quality according to EMEP standards (level 1) starting in 2007. Another background station is located in Rezina, which makes automatic measurements of PM and O_3.

20. National air quality standards and air quality monitoring need to be harmonized with international standards. Compliance with international approaches will require the modernization of the monitoring strategy, the redesign of the monitoring network, and the upgrade of equipment and laboratories. Monitoring should include PM and O_3. Public communication regarding air quality and the health effects of the pollution requires improvement.
