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Recent results and updating of scientific and technical knowledge

Effects of Air Pollution on Natural Vegetation and Crops

Report by the Programme Coordinating Centre of the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops

I. Introduction

1. Recent results on the effects of ozone on vegetation, and progress with the European moss survey on heavy metals, nitrogen and persistent organic pollutants (POPs) are presented here in accordance with item 3.5 of the 2011 workplan for the implementation of the Convention (ECE/EB.AIR/106/Add.2) adopted by the Executive Body at its twenty-eight session in December 2010.

II. Workplan items common to all programmes

A. Further implementation of the Guidelines

2. Table 1 provides an overview of the monitoring and modelling effects reported by the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops (ICP Vegetation) according to the Guidelines (ECE/EB.AIR/2008/11).

Table 1.
Monitoring and modelling effects reported by the ICP Vegetation.

Parameter	*Ozone*	*Heavy metals*	*Nitrogen*	*POPs*
Growth and yield reduction				
Leaf and foliar damage	X			
Exceedance critical levels	X			
Climatic factors	X			
Concentrations in mosses	X	X	X	X

B. Heavy metals baseline assessment

3. We refer to the results reported in ECE/EB.AIR/WG.1/2011/10.

C. Activities across continents and regions

4. Table 2 provides a comparison of the recent participation of countries from different continents and regions in activities of the ICP Vegetation. The ICP Vegetation was most active in Western Europe, followed by South-Eastern Europe (SEE) and some countries in Eastern Europe, the Caucasus and Central Asia (EECCA). Some outreach activities took place recently in Asia (China, India, Japan, Pakistan), Cuba, Egypt and South-Africa.

Table 2.
Number of countries from different continents and regions participating recently in activities of the ICP Vegetation.

Activity	*Western Europe*	*SEE*[1]	*EECCA*[2]	*North America*	*Other regions*	*Total*
Ozone-related activities	11	3	1	1	7	23
Moss survey	19	9	3	-	1	32
Task Force meeting 2011	13	6	3	-	4	26

D. Ex-post analysis

5. We refer to the results reported in ECE/EB.AIR/WG.1/2011/3.

III. Nutrient nitrogen

6. Fourteen countries participating in the European moss survey 2010/11 planned to submit data on the nitrogen concentration in mosses.

[1] South-Eastern Europe
[2] Eastern Europe, the Caucasus and Central Asia

IV. Ozone

7. Data on the impacts of ozone on French dwarf bean were submitted from 11 sites in eight countries, indicating the occurrence of widespread leaf damage on the ozone-sensitive compared to the resistant variety. This led to a reduction in the relative bean yield in the ozone-sensitive variety. However, the relationships between these effects and ozone concentrations were not clear. Although an ozone flux model was developed for bean, not enough suitable climate and effects data were available to develop a flux-effect relationship for bean.

8. A comprehensive report has been prepared on the effects of ozone on food security in Europe and south-east Asia. Contributions from the Programme Coordination Centre together with those from participants and from studies conducted in collaboration with EMEP[3] were included. A short colour report aimed at policy makers that summarises the main findings has also been produced.

9. Published data on ozone effects on crop yield has been collated and analysed to provide an updated ozone sensitivity index for 26 species based on the 7h mean ozone concentration, the most commonly reported parameter. Important staple food crops in the world are amongst the most ozone sensitive, including wheat, soybean and rice. Other important European crops such as potato, sugar beet and oilseed rape are moderately sensitive to ozone.

10. In collaboration with EMEP, economic losses due to ozone effects on wheat and tomato yield were estimated to be 3.20 and 1.07 billion Euro respectively in EU27+Norway+Switzerland in 2000, based on modelling ozone uptake (stomatal flux, the phytotoxic ozone dose). Implementation of the NAT scenario was predicted to reduce these losses to 1.95 and 0.63 billion Euro in 2020 for wheat and tomato respectively. Although ozone effects were predicted to reduce in 2020, exceedance of the flux-based critical level for wheat representing a 5% reduction in grain yield was only decreased from 84.8% of EMEP grid squares in 2000 to 82.2% in 2020. Thus, precursor emission reductions in addition to those included in the NAT scenario would be necessary before there was a substantial reduction in exceedance.

11. In south Asia, ICP Vegetation participants have contributed to raising awareness of ozone impacts by organizing the Global Atmospheric Pollution Forum seminar on “Ground level ozone and food security in Asia” in India in November 2010. Yield losses due to ambient ozone are currently predicted to be in the range 10 to 20% for important staple crops (wheat, rice, pulses), with European/North American dose-response relationships likely to underestimate effects.

12. Also included in the ICP Vegetation food security report were reviews of ozone effects on food and feed quality including changes in protein (e.g. wheat), sugar (e.g. grape) and oil (e.g. oilseed rape) content and digestibility of forage for cattle and sheep; concerns in northern and Mediterranean Europe and representative countries (e.g. UK, Germany) and impacts of ozone in a changing climate including interactions with drought.

[3] Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe

V. Heavy metals

13. Between 24 to 27 countries participating in the European moss survey 2010/11 planned to submit data on the heavy metal concentration in mosses.

VI. Persistent organic pollutants (POPs)

14. Five countries participating in the European moss survey 2010/11 planned to submit data on the concentration of persistent organic pollutants (polycyclic aromatic hydrocarbons in particular) in mosses.

Mosses have been used primarily as biomonitors of polycyclic aromatic hydrocarbons (PAHs). Limited data is available on the application of mosses as biomonitors of other POPs, such as organochlorine pesticides, polychlorinated biphenyls, hexachlorobenzenes, pentachlorobenzenes, dioxins and furans, and polybrominated diphenyl ethers. PAHs concentrations in mosses indicate both spatial and temporal variation of atmospheric deposition of PAHs to terrestrial ecosystems, including long-term historical trends. Comparison of concentrations in mosses between different studies was confounded by species-specific accumulation, seasonal and climatic variability (temperature in particular) and geo-morphological variability.

VII. Black carbon

16. A preliminary review showed that little is known about the direct impacts of black carbon on vegetation. Sensitivity of plants to dust is species-specific as the smoothness and composition of the leaf surface determines how much dust is adsorbed. Small dust particles might affect leaf transpiration by blocking leaf pores. A high density of dust might reduce carbon fixation by shading leaves and might damage the wax layer of leaves. Black carbon on the leaf surface increases the leaf temperature as it absorbs light. On the other hand, black carbon in the atmosphere enhances diffuse radiation which is known to enhance plant carbon fixation.