CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

WORKING GROUP ON EFFECTS

INTERNATIONAL COOPERATIVE PROGRAMME ON EFFECTS OF AIR POLLUTION ON NATURAL VEGETATION AND CROPS (ICP VEGETATION)

ICP VEGETATION

Minutes of the 23rd Task Force Meeting

The twenty-third meeting of the Programme Task Force was held from 1 – 3 February, 2010 in Tervuren, Belgium and hosted by the Veterinary and Agrochemical Research Centre (CODA-CERVA).

1. The meeting was attended by 53 delegates from 18 Parties to the LTRAP Convention: Austria, Belgium, Croatia, Czech Republic, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom. Also present were a representative from EMEP/MSC-East and four guests from Cuba and Japan. Amongst others, apologies were received from the Secretariat of the LRTAP Convention.

2. The Programme Task Force adopted the agenda of the meeting.

3. Mr Harmens (Chairman of the ICP Vegetation, UK) welcomed all participants to the 23rd Task Force Meeting and thanked CODA-CERVA for hosting the meeting. Mr Kerkhofs, Director General of CODA-CERVA, welcomed the participants to Tervuren and gave an overview of the scientific activities of CODA-CERVA.

4. Mr Harmens (UK) gave an overview of the LRTAP Convention and the collaboration between ICP Vegetation and other subsidiary bodies of the Convention:
   - other ICPs/Task Force on Health, in particular regarding the common items of the Working Group on Effects (WGE);
   - EMEP/MSC-West and East regarding activities on mapping areas at risk from ozone and establishing the relationship between i) nitrogen and ii) heavy metal concentrations in mosses and modelled atmospheric deposition for these elements;
   - Task Force on Integrated Assessment modelling regarding the revision of the Gothenburg Protocol and target setting for 2020 and 2050 (see also paragraph 5);
   - Task Force on Reactive Nitrogen regarding airborne nitrogen impacts on vegetation;
   - Task Force on Hemispheric Transport regarding the 2010 assessment report.

5. Mr Harmens continued with reporting on the activities and achievements of the ICP Vegetation in 2009. He informed the Task Force on progress made with the ICP Vegetation workplan items for 2010 (see ECE/EB.AIR/2009/6), which will be reported to the secretariat of the Convention in May 2010 and presented at the 29th session of the WGE, 22 – 24 September 2010 in Geneva:

- *Report on the ozone biomonitoring experiment with bean in 2009*. So far, data have been submitted from 15 sites in 9 countries, with higher ozone leaf injury scores often being observed in the ozone-sensitive genotype, leading to a reduction in bean yield. Further data are required to establish a dose-response/flux-effect relationship (see also paragraph 11).
- *Report on ozone impacts in Mediterranean areas*. This review will be conducted with input from Greece, Italy and Spain.
- *Review of ozone flux modelling methods and their application to different climatic regions*. This review was part of the preparations for the ozone critical levels workshop in Ispra and was further discussed during this Task Force Meeting (see below).
- *Report of workshop on "Flux-based assessment of ozone effects for air pollution policy"*. At the workshop in Ispra, Italy, 9-12 November 2009, flux-based critical levels of ozone for vegetation were reviewed. It was decided to replace the name of the current flux-based parameter ($AF_{st}Y$) with a more user-friendly term called Phytotoxic Ozone Dose (POD). As revised/new flux-based critical levels of ozone could not be finalised in Ispra, further work has been conducted and the flux-based critical levels were finalised during the 23rd Task Force Meeting (see paragraph 7 and Annex I).
- *Progress report on European heavy metals and nitrogen in mosses survey 2010*. So far 14 countries have secured national funding to conduct the moss survey in 2010, 4 countries are likely to obtain funding, whereas 15 countries are still unsure whether they will receive funding to participate in the 2010/11 European moss survey. The inclusion of persistent organic pollutants (POPs) in a pilot study was discussed during the meeting (see paragraph 14).
- *Report on the relationship between heavy metal concentration in mosses and EMEP modelled deposition*. Work on this item is continuing in collaboration with Ilia Ilyin of EMEP/MSC-East, and shows generally good correlations between concentrations in mosses and modelled deposition for cadmium and lead, but not for mercury. Country-specific correlations and the specific chemistry of mercury were further discussed during the meeting (see paragraphs 13).

Common work plan items for all ICPs, Task Force on Health and Joint Expert Group on Dynamic modelling:

- *Report on the development of targets for 2020 and 2050 and application in ex-post integrated assessment using harmonized data on concentrations and depositions, in collaboration with the Task Force on Integrated Assessment Modelling (TFIAM).* The ICP Vegetation is awaiting base-line scenarios from TFIAM to conduct ex-post analysis on ozone risk assessments for vegetation. Ms Mills (Head of Programme Coordination Centre) will attend the 37th Task Force Meeting of TFIAM, 22 – 24 February 2010, Geneva, to discuss this item further. Recommendations were made regarding the application of the new ozone critical levels for vegetation in integrated assessment modelling (see paragraph 7 and Annex I).
- *Report on the updating of robustness of air pollution effects in integrated assessment modelling*. This item will be included in the reporting of new flux-based critical levels for ozone, based on discussions at the workshop in Ispra and the 23rd Task Force Meeting.
- *Report on the links between air pollution effects and biological diversity*. Although these links have been established in the literature for nitrogen, little information is available so far on the impacts of ozone on biological diversity in the field.

- *Quantified trends on selected key monitored and modelled parameters, based on the Guidelines on reporting of monitoring and modelling of air pollution effects.* To be decided and reported in due course.

Mr Harmens also reported on participation of countries from Southern Eastern Europe (SEE) and Eastern Europe, the Caucasus and Central Asia (EECCA) in the ICP Vegetation programme and current and future outreach activities to countries outside the ECE region, including Malé Declaration Countries, China, Japan, South-Africa and Cuba. The ICP Vegetation Coordination Centre has good links with the Stockholm Environment Institute in York, UK, which provides the secretariat for the Global Air Pollution (GAP) Forum. Mr Harmens concluded by summarising the outputs from the ICP Vegetation in 2009 and thanked the Parties for their invaluable contribution to the ICP Vegetation.

6. Ms Gina Mills (Head of Programme Coordination Centre, UK) gave an overview of the contributions of the ICP Vegetation to the revision of the Gothenburg Protocol and the conclusions and recommendations from the ozone critical level workshop in Ispra, including the urgent need to finalise those conclusions and recommendations during the 23rd Task Force Meeting in order to be considered in the revision of the Gothenburg Protocol. She emphasized the need for persuasive/tempting damage indicators for ozone in order to communicate to policy makers the threat of ozone damage to vegetation in the current and future climate. Examples of such indicators are the impacts of ozone on i) food security and ii) carbon storage in forests and (semi-)natural vegetation. Hence, the ICP Vegetation will produce a glossy report on these issues for submission to the Executive Body of the LRTAP Convention at its meeting in December 2010 and 2011 respectively (see Annex II).

7. Throughout the meeting, there were discussions within the ozone sessons as well as in plenary on the further development of flux-based critical levels and their application within integrated assessment modelling. In the final plenary, new critical levels were agreed by the Task Force for ozone effects on the yield quantity and quality of wheat, yield quantity of potato, yield quantity of tomato, biomass of Norway Spruce, Beech and Birch, and biomass of representative species of productive grasslands and grasslands of high conservation value (Annex I, Table 1). Recommendations for integrated assessment modelling were also approved (Annex I, Table 2), including critical levels for effects on food security, carbon storage, ecosystem services, and grassland vitality, and a generic crop response function for assessment of maximum risk of damage. Further details on the scientific basis of these new critical levels, their robustness and application in integrated assessment modelling can be found in the EB.AIR report "Flux-based assessment of ozone effects for air pollution policy". The Task Force agreed to retain the existing AOT40-based critical levels within the Modelling and Mapping Manual; no new evidence was presented to indicate that any changes were needed to these.

8. For most of the meeting there were two parallel sessions considering the ozone and heavy metals/nitrogen sub-programmes. The topics of oral presentations in the parallel sessions are given below, for further details on the content of oral presentations and posters we refer to the book of abstracts and powerpoint files, both available on the ICP Vegetation web site (http://icpvegetation.ceh.ac.uk). The posters covered similar topic as discussed during the oral presentations and discussions and provide valuable additional information.

9. The first ozone session focussed on progress at and since the workshop on "Flux-based assessment of ozone effects for air pollution policy", 9 – 12 November, 2009, Ispra, Italy. Ms Mills gave an overview of the decisions that were required at this Task Force Meeting

and updates on flux modelling and flux-based critical levels for ozone were presented for crops (Mr Håkan Pleijel, Sweden), forest trees (Ms Sabine Braun, Switzerland) and (semi-)natural vegetation (Ms Felicity Hayes, UK).

10. Presentations in the second and third ozone sessions focussed on ozone impacts on crops for specific regions and ozone dose-response relationships for specific crop species. Mr Feng (Japan) discussed the important role of apoplastic ascorbate in the detoxification of ozone in determining ozone sensitivity in wheat varieties in the field. Mr Gonzalez Fernandez (Spain) reported on the application of the ozone dose-response model for wheat in southern Europe and concluded that the typical environmental conditions in southern Europe need to be considered in modelling the phytotoxic ozone dose. Ms Bermejo (Spain) provided ozone dose-response functions for the horticultural crops lettuce, tomato and bean, showing that lettuce and bean are more ozone sensitive than tomato. Mr De Bock and Op de Beeck (Belgium) showed that broccoli was insensitive to ozone and that concentration-based response functions worked best for oilseed rape considering the low climatic variations in Tervuren. Mr Vellisariou (Greece) showed many examples of visible ozone injury on leafy crops and discussed the economic implications for individual growers whose crops became un-sellable overnight. Mr Ramírez (Cuba) described the development of an early warning system to mitigate adverse ozone impacts on main agricultural crops in Central America and the Caribbean, with ozone peaks of up to 150 ppb regularly being reported.

11. In the fourth ozone session, Ms Hayes (Programme Coordination Centre, UK) presented in more detail the results of the ozone biomonitoring experiment with bean (*Phaseolus vulgaris*) for 2009. It was concluded that further data are required to develop ozone dose-response/flux-effect relationships for bean. The bean biomonitoring protocol was discussed and will be updated for 2010; the need for participants to adhere to the protocol was emphasized once again. Ca. 15 countries are expected to participate in the bean biomonitoring experiment for 2010, including China, Cuba and South-Africa. During the same session it was decided to conduct a survey on ozone-induced visible leaf injury on leafy horticultural crops in 2010. A protocol for such a survey will be produced by the Programme Coordination Centre and at least 16 countries have indicated their intent to participate, including China and Cuba. The outcome of the survey will be included in the report on ozone impacts on food security, to be produced by December 2010.

12. The final ozone session focussed on (semi-)natural vegetation. Mr Volk (Switzerland) showed that the net ecosystem productivity and above-ground biomass production of a sub-alpine grassland was not affected by elevated atmospheric ozone in the field. For the same open air ozone exposure study, Ms Blanke (Switzerland) reported that elevated ozone tends to reduce root but not shoot biomass of a representative grass species. In addition, ozone-stressed grasses had reduced investment of carbon in mycorrhizal associations. Ms Toet (UK) described how elevated ozone resulted in a reduction in methane emission and soil ammonium concentrations and an increase in gross photosynthesis and the abundance of *Sphagnum* moss in temperate peatland mesocosms. Finally, Mr Karlsson (Sweden) discussed the large variation in local ozone concentrations due to variation in local climate, distance to the sea and local topography in Sweden.

13. In the first heavy metal/nitrogen session, Mr Ilyin (EMEP/MSC-East, Russian Federation) reported on further progress made with the analysis of the relationship between heavy metal concentrations in mosses and EMEP modelled atmospheric deposition. Country-specific correlations were observed, with correlations improving in some countries but deteriorating in most others when based on modelled wet or dry deposition alone rather

than total deposition. Potential causes of these country-specific correlations were discussed in ensuing discussions. Mr Holy (Germany) reported on the final outcome of a comprehensive geostatistical analysis on factors affecting heavy metal and nitrogen concentrations in mosses. Primary drivers for the lead and cadmium concentrations in mosses were EMEP modelled atmospheric deposition rates for these metals, however, this was not the case for mercury. Similarly, the total nitrogen concentration in mosses was best explained by the EMEP modelled atmospheric deposition rates and air concentrations of various forms of nitrogen. In a later session, Mr Pesch (Germany) described how the moss data and EMEP modelled deposition data were combined to produce European wide maps of cadmium, lead and nitrogen deposition applying kriging methods. Mr Ilyin (Russian Federation) and Mr De Temmerman (Belgium) further discussed the specific characteristics of mercury as a global air pollutant and its chemical speciation and stated that the deposition of gaseous mercury is primarily determining its concentration in vegetation. The latter might be an important factor explaining the low correlations between mercury concentration in mosses and EMEP modelled mercury deposition rates, with other potential factor being identified in the ensuing discussion.

14. After a brief update on participation in the European moss survey 2010/11 and final amendments to the moss monitoring manual for 2010 in the following heavy metal/nitrogen session, the group split in two discussion groups to discuss the potential factors contributing to difficulties with securing national funding for the moss survey. For example, funding problems were likely associated with:
    - climate change rather than air pollution being a priority in many European countries;
    - atmospheric deposition of heavy metals has declined considerably in recent decades and is therefore not a priority anymore, apart from the global pollutant mercury;
    - monitoring of heavy metal and nitrogen deposition is a requirement under EMEP, such a firm requirement does not exist for concentrations in mosses;
    - aims and benefits of the moss survey are not always clearly communicated;
    - lack of an accredited methodology.

    The groups also discussed the future of the European moss survey and made the following recommendations:
    - keep the frequency at every five years;
    - stress the importance of the moss survey as a high-density measurement network for validating the EMEP model for at least cadmium and lead, in particular in areas where EMEP measurement stations are scarce or absent, i.e. southern and eastern Europe. In some countries the concentration of metals (including mercury) in mosses better reflects actual deposition rates than the EMEP modelled deposition;
    - conduct a review on mosses as biomonitors of POPs (to be reported in 2011);
    - conduct a pilot study on the concentration of selected POPs in selected countries; during the meeting ca. 7 countries expressed an interest in such a study;
    - in particular for nitrogen to further investigate the relationship between concentrations in mosses and critical loads for ecosystems, including Natura 2000 sites;
    - links with human health impacts should be further investigated, e.g. the relationship between lead concentrations in mosses and in blood of children (see paragraph 15);
    - consider the inclusion of metals such as platinum and silver (applied as nanoparticle).

15. In the following three heavy metal/nitrogen sessions, examples of national studies regarding biomonitoring of heavy metals were presented. Mr Leblond (France) showed that there were hardly any significant relationships between metal concentrations in mosses and soluble concentrations in deposition or soil. Mr Suchara (Czech Republic) illustrated the decline in moss concentrations of most non-earth crust trace elements in the Czech Republic between 1995 and 2005 and also reported that mosses accumulate 2 – 3

times higher concentrations of metals than grasses or biennial spruce needles. Mr Zechmeister (Austria) gave an example of how mosses were used to monitor indoor pollution in the Girona area in Spain and showed that tracers of outdoor pollution sources such as traffic were well mimicked indoors. Ms Frontasyeva (Russian Federation) reported on an outreach activity in Northern Vietnam, where mosses were used to monitor atmospheric deposition of heavy metals near local pollution sources. Mr Spiric (Croatia) described the outcome of the first moss survey in Croatia conducted in 2006 and reported on work in progress for lead on the correlation between concentrations in mosses and blood of children in selected European countries. Ms Thöni (Switzerland) concluded that high background concentrations of sulphur in mosses were confounding the application of mosses as biomonitors of sulphur in Switzerland and invited other countries to share their experiences regarding sulphur with her. Finally, Mr De Temmerman (Belgium) found that concentration of arsenic, cadmium and lead in the storage organs of carrot and celeriac is low and that there is no relationship between atmospheric deposition and the concentration in the inner storage organs.

16. In the final plenary session, Mr Bender (Germany) gave an overview of presentations, conclusions and recommendations from the ozone sub-group, followed by a summary from Mr Eiliv Steinnes (Norway) on the presentations and the outcome of discussions in the heavy metal/nitrogen sub-group. The Task Force took note of the conclusions and recommendations of both sub-groups (as described above) and adopted the new flux-based critical levels of ozone and the recommendations for application in integrated assessment modelling as described in Annex I. The Task Force discussed and adopted the medium-term (2011 – 2013) workplan of the ICP Vegetation as described in Annex II.

17. The Task Force encouraged continuation of collaboration with other bodies within the LRTAP Convention (see paragraph 4) and encouraged further collaboration with Malé Declaration countries and outreach activities to other regions and countries outside the ECE region.

18. The Task Force accepted the offer from Switzerland to host the 24th Task Force Meeting of the ICP Vegetation in Rapperswil, 31 January – 2 February 2011. Tentative offers to host future Task Force Meetings were also received from Spain, Slovakia and Sweden (depending on national funding).

19. On behalf of the Task Force, Mr Harmens (UK) closed the meeting by thanking Ms Karine Vandermeiren, Mr Ludwig De Temmerman and their colleagues at the Veterinary and Agrochemical Research Centre (CODA-CERVA) for hosting the meeting. He acknowledged the UK Department for Environment, Food and Rural Affairs (Defra), the United Nations Economic Commission for Europe (UNECE) and the Natural Environment Research Council (NERC) for their continuous financial support of the ICP Vegetation Programme Coordination Centre. The Task Force also thanked the Secretariat and the Bureau of the WGE for their continuous support of the ICP Vegetation and other bodies of the LRTAP Convention for their collaboration with the ICP Vegetation. The Task Force expressed the wish that the Secretariat of the Convention will be present again in future meetings. Last but not least Mr Harmens thanked his colleagues at the Programme Coordination Centre and the participants of the ICP Vegetation for their continuing support of the programme.

Annex I. Revised and new flux-based critical levels for effects of ozone on vegetation and recommendations for application in integrated assessment modelling.

Table 1. Flux-based critical levels agreed by the 23rd Task Force Meeting of the ICP Vegetation, 3 February, 2010. *Please note that there are different flux model parameterisations for each species.*

Receptor	Effect (% reduction)	Parameter	Critical level (actual)	Critical level (Mapping Manual)
Wheat	Grain yield (5%)	POD_6	1.2	1
Wheat	1000 grain weight (5%)	POD_6	1.2	1
Wheat	Protein yield (5%)	POD_6	1.8	2
Potato	Tuber yield (5%)	POD_6	3.9	4
Tomato	Fruit yield (5%)	POD_6	2.3	2
Norway Spruce	Biomass (2%)	POD_1	8.2	8
Birch and Beech	Biomass (4%)	POD_1	3.7	4
Holm Oak and Aleppo Pine*		POD_1		
Productive grasslands (clover)	Biomass (10%)	POD_1	2.1	2
Conservation grasslands (clover)	Biomass (10%)	POD_1	2.1	2
Conservation grasslands (*Viola* spp), provisional	Biomass (15%)	POD_1	6.3	6

* With the approval of the Task Force, further analysis has been conducted for Holm Oak and Aleppo Pine since the Task Force Meeting. It has subsequently been agreed that it is not yet possible to derive a flux-based critical level for this vegetation type.

Table 2. Recommendations for application of flux-based critical levels in integrated assessment modelling.

Benefit	Receptor	Basis of Critical Level
For security of food supplies	Wheat Tomato	Protein yield by area Fruit yield
For carbon storage in the living biomass of trees[1]	Beech/birch Norway Spruce	Biomass of young trees Biomass of young trees
For environmental protection (e.g. soil erosion, avalanche protection, flood prevention)[2]	Beech/birch Norway Spruce	Biomass of young trees Biomass of young trees
For vitality and fodder quality of pasture	Productive grasslands	Clover biomass
For protection of the vitality of natural species[3]	Grasslands of high conservation value	Clover biomass and provisional CL for Violets

[1] Supported by epidemiological studies of mature trees
[2] Tree roots may be even more sensitive to ozone than above-ground parts
[3] This critical level may also offer protection against loss in biodiversity but this cannot be confirmed yet.

Annex II. Medium-term workplan of the ICP Vegetation (updated on 3 February, 2010)

2011:

- Report on the 2010 biomonitoring exercise for ozone;
- Report on ozone impacts on food security;
- Progress report on European heavy metals and nitrogen in mosses survey 2010/11;
- Report on mosses as biomonitors of POPs.

2012:

- Report on the 2011 biomonitoring exercise for ozone;
- Report on ozone, carbon sequestration, and linkages between ozone and climate change;
- Progress report on European heavy metals and nitrogen in mosses survey 2010/11;
- Report on the relationship between i) heavy metal and ii) nitrogen concentrations in mosses and impacts on ecosystems.

2013:

- Report on the 2012 biomonitoring exercise for ozone;
- Development of flux-effect relationship for leaf injury and yield reduction in bean;
- Report on ozone impacts on biodiversity (tentatively);
- Report on the European heavy metals and nitrogen in mosses survey 2010/11.