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Progress in activities in 2014 and further development of effects-oriented activities

Effects of air pollution on forests*

Report by the Programme Co-ordinating Centre of the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests

Summary

The present report presents the results of the activities undertaken since the previous report by the Programme Co-ordinating Centre for the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests. The activities and the report on them are in accordance with the request of the Executive Body to the Convention on Long-range Transboundary Air Pollution in its 2014–2015 workplan for the implementation of the Convention (ECE/EB.AIR/122/Add.2, item 1.1.16 (a)). The report details, in particular, work on monitoring and modelling in 2014.

* The present document is being issued without formal editing.

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I. Introduction

1. This report presents the results of the activities undertaken by the Programme Co-ordinating Centre (PCC) of the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) between May 2013 and May 2014. The activities and the report on them are in accordance with the request of the Executive Body to the Convention on Long-range Transboundary Air Pollution in its 2014–2015 workplan for the implementation of the Convention (ECE/EB.AIR/122/Add.2), specifically with workplan item 1.1.16 which states, e.g., to "Collect, assess and carry out integrated evaluation of: (a) comprehensive and comparable data on nitrogen deposition and/or critical load exceedance on tree defoliation".

2. Germany is the lead country of ICP Forests and its Programme Co-ordinating Centre is hosted by the Johann Heinrich von Thünen Institute.[1] Approximately 500 participants in 42 Parties to the Convention on Long-range Transboundary Air Pollution participate in the activities of ICP Forests.

3. The thirtieth Task Force meeting and the third scientific conference "Impact on nitrogen deposition and ozone on the climate change mitigation potential and sustainability of European forests" held back to back in Greece (Athens, 26–30 May 2014).

II. Results/impact achieved of the activities carried out

4. Monitoring activities of ICP Forests were taken into consideration by the European Commission within the context of the proposal for a "Directive of the European Parliament and of the Council on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35EC" from 13 Dec. 2013 (COM(2013)920 final, 2013/0443 (COD)). Under Article 8 member states are recommended to monitor, where practicable, the adverse impacts of air pollution upon terrestrial ecosystems. The associated Annex 5 under paragraph 2b items i) to iv) lists parameters, which are to be measured obligatorily within the ICP Forests monitoring programme. Under paragraph 3 the methodologies developed under the Convention as laid down in the manuals of its ICPs (cf. ECE/EB.AIR/wg.1/2008/16) are explicitly mentioned.

III. Expected outcomes/deliverables over the next period and in the longer term

5. Over the next period and in the longer term, ICP Forests will report on:

(a) Continuation of data collection activities on condition and development of forest ecosystems and efforts to improve the data quality;

(b) Further development of the data base and the data base management system;

(c) Further implementation of guidelines for the reporting and monitoring and modelling approaches of air pollution effects in Europe;

(d) Continuation of exploring cause-effect relationships between deposition of acidifying and eutrophying substances (nitrogen and sulphur oxides, reduced nitrogen) as

[1] See http://www.ti.bund.de/en/startseite/institutes.html.

well as ozone air concentration on the causal side and effects on forest ecosystems as a whole and the more sensible parts of these on the response side;

(e) Further contribution to the key issues of maintaining biodiversity and mitigating the effects of climate change;

(f) A joint evaluations and report on cause-effect relationships with the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring) has been initiated and further joint activities with the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops (ICP Vegetation), the International Cooperative Programme on Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends (ICP Modelling and Mapping), and International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters) are envisaged;

(g) Continue producing integrated/thematic reports and brochures aiming at a broader audience and popularizing the scientific results.

IV. Policy-relevant issues, findings and recommendations

6. Deposition of acidifying and eutrophying substances as well as tropospheric ozone impacts may directly or indirectly influence the productivity of forest ecosystems with consequences for the socio-economic status especially of rural regions.

7. Findings on soil nutrient and acidification status, performance or health of trees, and findings regarding biodiversity issues derived from the monitoring programme feed directly into the regional and national forest management planning or even influence and stimulate supra-national (Forest Europe) forest policies.

8. Reduction of possible ozone damages may enhance productivity of forests and foster climate change mitigation potentials of forests with all positive implications for the forestry sector and wood supply chain.

9. As far as biodiversity issues are affected by deposition of eutrophying and acidifying substances in forests, the situation might positively be influenced by further emission reductions especially of nitrogen compounds.

10. Deposition of heavy metals may bear a long-term risk for forest ecosystems and connected (ground-) water bodies and has to be carefully monitored.

11. Special concern is to be put on forests in the Caucasus region and in other countries of Eastern Europe, the Caucasus and Central Asia regarding the points mentioned above.

V. Issues for the attention and advice of other groups/task forces or subsidiary bodies, notably with regard to synergies and possible joint approaches or activities

12. The assessment of ozone induced symptoms in the forest canopy and at the forest edge (LESS), the monitoring of ozone exposures by means of passive and active monitoring devices, both in the vicinity of ICP Forests intensive monitoring plots, as well as ozone flux modelling bears considerable potential for further collaboration with ICP Vegetation and external studies on ozone risks.

13. Soil solution studies on intensive monitoring plots bear a high potential for collaboration with ICP Integrated Monitoring and ICP Waters.

14. Soil and soil solution studies should constitute a valuable basis for Critical Loads modelling and more general considerations on contents and fluxes in soils and ecosystems. ICP Mapping and Modelling and ICP Integrated Monitoring are the most likely collaborators in this field of activity.

VI. Recommendations to further strengthen implementation and ratification of Convention Protocols in Eastern and South-Eastern Europe, the Caucasus and Central Asia:

15. Countries of eastern and south-eastern Europe are fully integrated mainly in the extensive Level I monitoring of forest ecosystems, however, the more complex intensive Level II monitoring of forest ecosystems is performed at fewer sites.

16. Up until today, neither the states of the Caucasus region nor those of Central Asia are part of the ICP Forests network. As large parts of Central Asia are covered with steppe vegetation, forests are generally of minor relevance, except for sites along rivers and at the foothills of mountain ranges (Caucasus, Tien Shan).

17. The Acid Deposition Network in East Asia (EANET) has established collaboration with ICP Forests in the field of acid deposition, forest vegetation monitoring, tree growth and chemical soil and soil solution properties, heavy metals, adverse tropospheric ozone, nitrogen deposition, and sulphate/nitrogen leaching from soils. A common workshop on acidification and eutrophication issues has been proposed by our Asian partners, however, financial issues have to be solved first.

VII. Scientific and technical cooperation activities with relevant international bodies

18. While in the past there was an extensive cooperation between ICP Forests and the European Union, at the moment the relationships are rather restrained. There is a memorandum of cooperation between ICP Forests and Long-term Ecological Research Network (LTER) Europe currently underway.

VIII. Relevant scientific findings: highlights

19. In total 42 scientific papers that are based on ICP Forests data, have been published in 2013 and in the first five month of 2014. Additionally, the book “Forest Monitoring: Methods for terrestrial investigations in Europe with an overview of North America and Asia”, Elsevier, Amsterdam, 507 p., edited by M. Ferretti and R. Fischer has been published in 2013. The book presents the scientific concepts and methods, developed within the ICP Forests community. It forms the basis of the transnational, long-term forest monitoring in Europe and looks at other initiatives at the global level. The following findings extracted from the literature mentioned above, deserve particular attention:

(a) A gradual replacement of oligotrophic by eutrophic species in forest ground vegetation as a response to N deposition was found to be a consistent pattern across European forests, however, neither species richness nor homogeneity of forest ground vegetation did respond to nitrogen critical load exceedances;

(b) Nitrophilous species of the forest floor vegetation are more abundant at sites with higher N concentrations in the upper mineral soil and the humus layer in Central Europe (Czech Republic);

(c) Ecotoxicological relevance of monomethyl-mercury has been shown for Swiss forest soils by microcosm experiments with bacterial communities being more sensitive than fungal communities; in certain soils a methyl-Hg concentration of 5 µg kg-1 significantly affected 13 per cent of the bacterial operational taxonomic units;

(d) Critical limits for lead and mercury are partly exceeded in Swiss forest soils. For cadmium the critical limits will hardly be reached in the next 1000 years, however, for lead critical limits might partly be reached within the next 400 years;

(e) Chlorophyll content and chlorophyll a fluorescence in Viburnum lantana leaves responded towards high ozone concentrations before symptoms become visible;

(f) Soil solution dissolved organic carbon (DOC) concentrations increased over 11 years in Flanders/Belgium at all depth intervals; this could not be explained by temporal deposition patterns confirming that air-borne or canopy-derived DOC has a limited impact on soil solution DOC;

(g) The carbon to nitrogen (C/N) ratio in soils is strongly influenced by tree species and further site-related factors. N deposition has been found to be of minor importance at the European scale. Therefore, the C/N ratio should not exclusively be used as an indicator of N status;

(h) Crown condition (defoliation and discolouration) shows a statistical relationship with the foliar nitrogen to phosphorous (N/P) ratio at the European scale; N deposition is kept to be a causal agent behind the foliar N/P ratio, supporting the idea of enhanced defoliation (or discoloration) with higher N deposition above a certain threshold;

(i) In a European-wide study crown condition was found to be statistically related to N deposition parameters in stands of *Quercus ilex* and in combination with meteorological parameter in stands of *Quercus petraea* and *Pinus sylvestris*;

(j) A critical load of 2.4 kg/ha/year has been found empirically for epiphytic lichen communities across Europe; due to its direct dependency on ambient air and water supply lichens are among the most sensitive group of organisms in forests;

(k) Forest tree stem growth on Swiss Level II plots was found to be enhanced by nitrogen deposition up to a level of 20-25 kg/ ha/year with no further increase beyond that threshold; overall, no general increase or decrease of productivity between 1995 and 2010 could be observed for the 18 sites;

(l) Phosphorous nutrition of major forest trees have deteriorated over the last 20 years at the European level; this decrease was more pronounced on sites with an already low P status; this suggests that high nutrient demands due to increased tree productivity could not always be met and/or that a high nitrogen status impair the P uptake; this has to be taken into account in planning to mitigate climate change effects by enhanced tree growth.

IX. Additional comments and lessons learned

20. Data policy is of high relevance for ICP Forests as an empirically-based programme. The policy has to be further developed in accordance with the respective perception projected by the Convention.

X. Publications

21. For a list of ICP Forests publications and references for the present report, please visit the ICP Forests website[2] and see informal document No. 2.

[2] See http://icp-forests.net/page/publications.