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Executive Body for the Convention on Long-range Transboundary Air Pollution

Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe

Working Group on Effects

Sixth joint session
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Progress in activities in 2020 and further development of effects-oriented activities

Integrated monitoring on air pollution effects on ecosystems

Report by the Programme Centre of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems

Summary

The present report is submitted to the Working Group on Effects as requested by the Executive Body for the Convention on Long-range Transboundary Air Pollution in accordance with the 2020–2021 workplan for the implementation of the Convention (ECE/EB.AIR/144/Add.2, items 1.1.1.7 and 1.1.1.15–17) and the Revised mandate for the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (Executive Body decision 2019/18).[1]

The report of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring) presents the results of the activities undertaken since its 2019 report (ECE/EB.AIR/GE.1/2019/15 – ECE/EB.AIR/WG.1/2019/8) and, in particular, the work on assessing long-term trends and accumulation of mercury and heavy metals at sites, as well as an evaluation of long-term trends and indicators of nitrogen pollution.

[1] Available at www.unece.org/env/lrtap/executivebody/eb_decision.html.

I. Introduction

1. The present report of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring) is submitted to the Working Group on Effects in accordance with the 2020–2021 workplan for the implementation of the Convention (ECE/EB.AIR/144/Add.2, items 1.1.1.7 and 1.1.1.15–17) and the Revised mandate for the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (Executive Body decision 2019/18).[2] The report presents the results of the activities carried out between May 2019 and June 2020, and particularly the work on assessing long-term trends and accumulation of mercury and heavy metals at sites, as well as an evaluation of long-term trends and indicators of nitrogen pollution.

2. The Programme, which involves some 100 scientists and 48 active sites in 15 countries, has a Task Force led by Sweden and a Centre hosted by the Finnish Environment Institute in Helsinki.[3]

3. During the reporting period, ICP Integrated Monitoring held two meetings: the twenty-seventh Task Force meeting and scientific workshop (Helsinki, 4–6 June 2019); and the twenty-eight Task Force meeting and scientific workshop (online - due to the coronavirus disease (COVID-19) pandemic, 13 and 14 May 2020). The twenty-seventh Task Force meeting was organized jointly with the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters), with both joint and separate sessions. The online twenty-eighth meeting 2020 was organized back-to-back with the ICP Waters Task Force meeting (online, 11–12 May 2020).

4. Key topics discussed at the 2020 meeting included the status of the ICP Integrated Monitoring database, the reports to be prepared under the Convention's workplan, cooperation with other bodies and activities and the future workplan of ICP Integrated Monitoring. The scientific workshop focused on current work on the key scientific topics of the Programme (see section IV below). The minutes of the meetings are available from the Finnish Environment Institute website.

II. Outcomes and deliverables during the reporting period

5. In 2019–2020, ICP Integrated Monitoring produced or contributed to the following reports:

(a) The 2019 joint progress report on policy-relevant scientific findings (ECE/EB.AIR/GE.1/2019/3–ECE/EB.AIR/WG.1/2019/3);

(b) Integrated monitoring of air pollution effects on ecosystems (ECE/EB.AIR/GE.1/2019/15–ECE/EB.AIR /WG.1/2019/8);

(c) The 2019 ICP Integrated Monitoring annual report;[4]

(d) A report on aluminium fractions in surface waters draining catchments of the ICP Integrated Monitoring network;[5]

[2] Available at www.unece.org/env/lrtap/executivebody/eb_decision.html.

[3] See www.syke.fi/nature/icpim.

[4] Sirpa Kleemola and Martin Forsius, eds., *Twenty-eighth Annual Report 2019: Convention on Long-range Transboundary Air Pollution. International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems*, Reports of the Finnish Environment Institute, No. 33 (Helsinki, 2019). Available at https://helda.helsinki.fi/handle/10138/304484.

[5] Pavel Krám and Sirpa Kleemola, "Aluminium fractions in surface waters draining catchments of ICP Integrated Monitoring network", in Kleemola and Forsius, eds., *Twenty-eighth Annual Report 2019: Convention on Long-range Transboundary Air Pollution*, pp. 31–36.

(e) A report on mercury and heavy metal trends in concentrations and fluxes in ecosystem compartments of ICP Integrated Monitoring sites in Europe;[6]

(f) A report on long-term trends and critical load exceedances of nitrogen compounds at ICP Integrated Monitoring sites;[7]

(g) Contribution to a scientific paper reviewing the long-term developments and achievements of the effects work under the Convention.[8]

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

6. In the second half of 2020 and in 2021, ICP Integrated Monitoring will contribute to or produce the following deliverables, as indicated in the Convention workplan:

(a) The 2020 joint progress report on policy-relevant scientific findings (ECE/EB.AIR/GE.1/2020/3–ECE/EB.AIR/WG.1/2020/3);

(b) A scientific paper on the impacts of internal catchment-related nitrogen parameters to total inorganic nitrogen leaching;

(c) A scientific paper on the effects of nitrogen enrichment on forest vegetation;

(d) A scientific paper on heavy metal trends in concentrations and fluxes across ICP Integrated Monitoring sites in Europe;

(e) The thirtieth annual ICP Integrated Monitoring report (covering activities in 2020/21), forthcoming in August 2021.

IV. Cooperation with other groups, task forces and subsidiary bodies, including synergies and possible joint approaches or activities

7. ICP Integrated Monitoring has established useful cooperation with the following bodies under the Working Group on Effects: the International Cooperative Programme on Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends – on critical load calculations; the Centre for Dynamic Modelling – on changes in biodiversity; the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters); and the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) – on long-term trends calculations and effects indicators. ICP Integrated Monitoring also uses emission scenario data from the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe.

[6] Karin Eklöf and others, “Temporal trends and input-output budgets of heavy metals in ICP IM catchments”, in Kleemola and Forsius, eds., *Twenty-ninth Annual Report 2020: Convention on Long-range Transboundary Air Pollution*, Reports of the Finnish Environment Institute, No. 31 (Helsinki, 2020), pp. 29–34.

[7] Jussi Vuorenmaa and others, “Long-term changes in the inorganic nitrogen output in European ICP Integrated Monitoring catchments – an assessment of the impact of internal nitrogen-related parameters and exceedances of critical loads of eutrophication”, in Kleemola and Forsius, eds., *Twenty-ninth Annual Report 2020: Convention on Long-range Transboundary Air Pollution*, pp. 35–45.

[8] Peringe Grennfelt and others “Acid rain and air pollution – 50 years of progress in environmental science and policy”, *Ambio*, vol. 49 (April 2020), pp. 849–864.

V. Strengthening the involvement of countries of Eastern and South-Eastern Europe, the Caucasus and Central Asia in work under the Convention

8. Participants from Armenia, Georgia and the Russian Federation participated in the fourth joint ICP Integrated Monitoring/ICP Waters Task Force meeting (Helsinki, 4–6 June 2019). Serbian sites were included in the scientific papers on dynamic modelling on soil impacts and plant recovery.[9]

VI. Scientific and technical cooperation activities with relevant international bodies

9. ICP Integrated Monitoring cooperates closely with the Long-term Ecosystem Research in Europe network (eLTER),[10] and many sites are common to both bodies. With the approval of two projects with funding from the European Union Horizon 2020 programme totalling €14 million for eLTER, the development of a permanent infrastructure for long-term ecosystem, critical zone and socioecological research in Europe will advance greatly. This funding will enable significant development of the eLTER Research Infrastructure, in areas such as the Research Infrastructure's organization, business model and legal basis. It will also give a major boost to scientific work done at eLTER/ICP Integrated Monitoring sites and platforms. Altogether, 34 partners from 24 countries will be involved in these projects.

VII. Highlights of the scientific findings: policy-relevant issues

10. The following findings of ICP Integrated Monitoring are of particular scientific relevance:

(a) Declining metal deposition and/or recovery from acidification during recent decades have resulted in decreasing temporal trends of cadmium (Cd) and lead (Pb) concentrations in runoff in many of the European ICP Integrated Monitoring sites during the last 30 years.[11] The concentrations of mercury (Hg) in runoff did not show any significant trend. Decreasing trends of Cd and Pb were detected in previous studies, but the data from ICP Integrated Monitoring are unique in the sense that they are both widespread and long-term. Catchment budgets of Cd and Pb indicated that releases to runoff water of these metals accounted for only 13–70 per cent and 21–56 per cent, respectively, of the throughfall and litter fall input. These results are in agreement with earlier catchment budgets for metals, indicating that metals are accumulating in catchment soils;

(b) Results of the ICP Integrated Monitoring network confirm the positive effects of the continuing emission reductions in Europe. ICP Integrated Monitoring sites showed dominantly negative trend slopes of total inorganic nitrogen (TIN) in concentrations and bulk/wet deposition between 1990 and 2017 (95 per cent and 91 per cent of the sites, respectively).[12] Decrease of nitrate (NO_3) and ammonium (NH_4) in concentrations was significant at 91 per cent and 77 per cent of the sites, respectively, and in fluxes at 64 per cent and 59 per cent of the sites, respectively. Long-term trends in precipitation amounts in 1990–2017 showed dominantly increasing trend slopes (68 per cent of the sites), but trends were rarely significant. The short- and long-term variations in precipitation may mask long-

[9] Maria Holmberg and others, "Modelling study of soil C, N and pH response to air pollution and climate warming using European LTER site observations", *Science of the Total Environment*, vols. 640 and 641 (November 2018), pp. 387–399.

[10] See www.lter-europe.net.

[11] Karin Eklöf and others "Temporal trends and input-output budgets of heavy metals in ICP IM catchments".

[12] Jussi Vuorenmaa and others, "Long-term changes in the inorganic nitrogen output in European ICP Integrated Monitoring catchments – an assessment of the impact of internal nitrogen-related parameters and exceedances of critical loads of eutrophication".

term trends caused by nitrogen deposition. TIN concentrations in throughfall deposition also showed predominantly decreasing trend slopes (81 per cent of the sites) and decrease in NO_3 and NH_4 concentrations was significant at 62 per cent and 54 per cent of the sites, respectively. Deposition of TIN in throughfall decreased at 81 per cent of the sites, and the decrease in NO_3 and NH_4 fluxes was significant at 69 per cent and 46 per cent of the sites, respectively. Only a few sites showed significant increases in inorganic nitrogen concentrations and fluxes in throughfall. Biological processes such as nitrogen uptake by plant tissue and other complex canopy interactions control inorganic nitrogen fluxes in throughfall, and thus long-term trends can be largely controlled by factors other than direct deposition effect;

(c) ICP Integrated Monitoring catchments have increasingly responded to the decreases in the emission and deposition of nitrogen in Europe.[13] Concentrations and fluxes of TIN in runoff exhibited dominantly downward trend slopes (76 per cent and 69 per cent of the sites, respectively). Decrease of NO_3 and NH_4 in concentrations was significant at 59 per cent and 36 per cent of the sites, and but the decrease in fluxes was significant only at 25 per cent and 31 per cent of the sites, respectively. A significant negative correlation was found between the annual change of TIN concentrations and fluxes in runoff, and mean TIN fluxes in throughfall, total nitrogen concentrations and N/Phosphorus-ratios in foliage and litterfall, and total nitrogen concentrations and fluxes in soil water. The results also showed that the most nitrogen-affected sites with the highest nitrogen deposition to the forest floor and highest N concentrations in foliage, litterfall, runoff water and soil water showed the most pronounced decreases of TIN in runoff.

11. It can thus be concluded that long-term monitoring and research sites are reference systems for detecting long-term impacts and developing and validating ecological models. The results also indicated that complex ecosystem processes regulate the impacts, accumulation and release of the heavy metals and N compounds, and that a continuous data collection and assessment effort thus is needed.

VIII. Publications

12. A list of ICP Integrated Monitoring publications and references for the present report has been posted on the Finnish Environment Institute/ICP Integrated Monitoring website.

[13] Jussi Vuorenmaa and others, “Long-term changes in the inorganic nitrogen output in European ICP Integrated Monitoring catchments – an assessment of the impact of internal nitrogen-related parameters and exceedances of critical loads of eutrophication”.