United Nations ECE/EB.AIR/GE.1/2017/15–ECE/EB.AIR/WG.1/2017/8

Economic and Social Council

Distr.: General
08 September 2017

English only

Economic Commission for Europe

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

Third joint session
Geneva, 11-15 September 2017
Item 3 of the provisional agenda
Progress in activities in 2017 and further development of effects-oriented activities

Integrated monitoring of air pollution effects on ecosystems*

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

Summary

The present report is being submitted for the consideration by the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe and the Working Group on Effects at their third joint session in accordance with the request of the Executive Body for the Convention on Long-range Transboundary Air Pollution in the 2016-2017 workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.2, items 1.1.1.13, 1.1.1.14 and 1.1.1.23) and the informal document approved by the Executive Body for the Convention at its thirty-fourth session, "Basic and multi-year activities in the 2016-2017 period" (items 1.1.1-1.1.3, 1.1.5-1.1.7 and 1.8.1-1.8.3)

* The present document is being issued without formal editing.

GE.17-15687(E)
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The report of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems presents the results of the activities undertaken since its 2016 report and details, in particular, work on the connections between the exceedance of site-specific critical loads for nitrogen and empirical impact indicators, and long-term trends in the retention and release of sulphur and nitrogen compounds in the catchments.

I. Introduction

1. The present report of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring) is being submitted for the consideration by the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) and the Working Group on Effects in accordance with the request of the Executive Body for the Convention on Long-range Transboundary Air Pollution in the 2016-2017 workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.2, items 1.1.1.13, 1.1.1.14 and 1.1.1.23). The report presents the results of the activities undertaken between May 2016 and May 2017 and details, in particular, work on the connections between the exceedance of site-specific critical loads for nitrogen and empirical impact indicators, and long-term trends in the retention and release of sulphur and nitrogen compounds in the catchments.

2. The programme Task Force is led by Sweden, while the Programme Centre is hosted by the Finnish Environment Institute in Helsinki. The Programme involves some 150 scientists in 16 countries.

3. During the reporting period, ICP Integrated Monitoring held two meetings, the twenty-fourth Task Force meeting and a scientific workshop (Asker, Norway, 24-26 May, 2016), and twenty-fifth Task Force meeting and scientific workshop (Uppsala, Sweden, 9-11 May, 2017). Both meetings were joint task force meetings with the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters).

4. Key topics discussed at the most recent task force meeting included the status of the ICP Integrated Monitoring database, reports to be prepared according to 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 two Programmes (see section IV below regarding ICP Integrated Monitoring topics). The minutes of the meetings are available on the ICP Integrated Monitoring website.[1]

II. Outcomes and deliverables in the reporting period

5. In 2016-2017, ICP Integrated Monitoring produced or contributed to the following reports:

(a) The 2016 joint progress report on the activities of the International Coordinated Programmes and the Joint Task Force on the Health Aspects of Air Pollution (ECE/EB.AIR/GE.1/2016/3–ECE/EB.AIR/WG.1/2016/3);

(b) Integrated monitoring (the 2016 technical report of ICP Integrated Monitoring to the Working Group on Effects) (ECE/EB.AIR/GE.1/2016/15–ECE/EB.AIR/WG.1/2016/8);

(c) *25th Annual Report 2016* of ICP Integrated Monitoring;

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

(d) A progress report on dynamic vegetation modelling at ICP Integrated Monitoring sites;[2]

(e) A scientific paper on sulphur and nitrogen mass balances at ICP Integrated Monitoring sites in Europe in 1990-2012;[3]

(f) A report on trend assessment for bulk deposition, throughfall and runoff water chemistry and climatic variables at ICP IM sites. [4]

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

6. In the second half of 2017 and in 2018, ICP Integrated Monitoring is going to contribute to or produce the following deliverables indicated in the workplan:

(a) The 2017 joint progress report on the activities of the International Coordinated Programmes and the Joint Task Force on the Health Aspects of Air Pollution (ECE/EB.AIR/GE.1/2017/3−ECE/EB.AIR/WG.1/2017/3);

(b) A report on mercury in the aquatic environment; a joint report together with ICP Waters (workplan item 1.1.1.8, in 2018);

(c) A scientific paper on dynamic modelling on the impacts of future deposition scenarios on soil and water conditions in ICP Integrated Monitoring catchments (workplan item 1.1.1.14, in 2018);

(d) A scientific paper on long-term trends in atmospheric deposition and runoff water chemistry of sulphur and nitrogen compounds at ICP Integrated Monitoring catchments in relation to changes in emissions and hydrometeorological conditions (workplan item 1.1.1.13, in 2018);

(e) The twenty-seventh annual ICP Integrated Monitoring report (covering activities in 2017-18).

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

7. ICP Integrated Monitoring has established useful collaboration with the following bodies under the Working Group on Effects: the International Cooperative Programme (ICP) on Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends (on critical load calculations); the Joint Expert Group on Dynamic Modelling (on changes in biodiversity); the ICP on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes; and the ICP on Assessment and Monitoring

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[2] Maria Holmberg and Thomas Dirnböck, "Progress report on dynamic vegetation modelling at ecosystem monitoring and research sites" in Sirpa Kleemola and Martin Forsius, eds., 25th Annual Report 2016, pp. 27-33.

[3] Jussi Vuorenmaa and others, "Long-term sulphate and inorganic nitrogen mass balance budgets in European ICP Integrated Monitoring catchments (1990-2012)", *Ecological Indicators* 76 (2016): 15-29.

[4] Jussi Vuorenmaa and others, "Trend assessment for bulk deposition, throughfall and runoff water chemistry and climatic variables at ICP IM sites in 1990-2013" in Sirpa Kleemola and Martin Forsius, eds., 25th Annual Report 2016, pp.34-50.

of Air Pollution Effects on Forests (on long-term trends calculations on effects indicators). ICP Integrated Monitoring also uses emission scenario data of EMEP.

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

8. The twenty-third ICP Integrated Monitoring Task Force meeting and scientific workshop was held in Minsk, Belarus, 6-8 May, 2015.

VI. Scientific and technical cooperation activities with relevant international bodies

9. In terms of cooperation with international bodies, ICP Integrated Monitoring collaborates closely with the European Long-Term Ecosystem Research (LTER) network[5] and many of the sites are common to both bodies. A research infrastructure project (eLTER) received funding from the European Union Horizon 2020 programme that started in June 2015.

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

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

(a) European databases and maps of critical loads have been instrumental in the negotiations of effect-based protocols to the Convention. For testing and validation of the key concepts in the critical load calculations, it is therefore important to study the link between critical thresholds of acidification and eutrophication and empirical impact indicators. Critical loads for eutrophication and their exceedances were determined for a selection of sites in the ICP Integrated Monitoring programme. The exceedances of critical loads for nutrient nitrogen ($ExCL_{nut}N$) were calculated as differences between the level of total nitrogen deposition (N_{tot} = nitrate (NO_3) + ammonium (NH_4) and the mass balance critical loads of nitrogen ($CL_{nut}N$). Concentrations and fluxes of total inorganic nitrogen (TIN = NO_3^- + NH_4^+) in runoff were determined for the same sites, as empirical indicators of the level of eutrophication. The deposition and the empirical indicators were previously determined for the year 2000.[6] It was therefore decided to make an update using modelled deposition values for the year 2010 and empirical indicator values based on water quality observations for the years 2013-2015. For most sites, there was an improvement visible as a shift towards less exceedance and lower concentrations of total inorganic nitrogen in runoff. At the majority of the sites both the input and the output flux of total inorganic nitrogen decreased between the two observation periods 2000-2002 and 2013-2015. Data from the ICP Integrated Modelling thus provide evidence on the link between modelled critical thresholds and empirical monitoring results for fluxes of nutrient nitrogen. This increases

[5] See www.lter-europe.net

[6] Holmberg, M. et al. 2013. Relationship between critical load exceedances and empirical impact indicators at Integrated Monitoring sites across Europe. Ecological Indicators: 24:256-265.

the confidence in the European-scale critical loads mapping used in integrated assessment modelling. The results also indicate ecosystem recovery;[7]

(b) Empirical evidence based on integrated environmental monitoring is essential for evaluating the ecosystem benefits of costly emission reduction policies. Site-specific annual input-output budgets for sulphate (SO_4) and total inorganic nitrogen for 17 European ICP Integrated Monitoring sites in 1990-2012 were calculated. Temporal trends for input (deposition) and output (runoff water) fluxes and the net retention/net release of SO_4 and total inorganic nitrogen were also analysed. Large differences in the input and output fluxes of SO_4 and total inorganic nitrogen reflect important gradients of air pollution effects in Europe, with the highest deposition and runoff water fluxes at Integrated Monitoring sites located in southern Scandinavia and in parts of Central and Eastern Europe and the lowest fluxes at more remote sites in northern European regions. A significant decrease in the total (wet + dry) deposition of non-marine SO_4 and bulk deposition of total inorganic nitrogen was found at 90 per cent and 65 per cent of the sites, respectively. Output fluxes of non-marine SO_4 in runoff decreased significantly at 65 per cent of the sites, indicating positive effects of the international emission abatement actions in Europe during the last 20 years. Catchments retained SO_4 in the early and mid-1990s, but this shifted towards a net release in the late 1990s, which may be due to the mobilization of legacy sulphur pools accumulated during times of high atmospheric SO_4 deposition. Despite decreased deposition, total inorganic nitrogen output fluxes and retention rates showed a mixed response with both decreasing (9 sites) and increasing (8 sites) trend slopes, and trends were rarely significant. In general, total inorganic nitrogen was strongly retained in the catchments not affected by natural disturbances. The long-term annual variation in net releases for SO_4 was explained by variations in runoff and SO_4 concentrations in deposition, while a variation in total inorganic nitrogen concentrations in runoff was mostly associated with a variation of the total inorganic nitrogen retention rate in catchments. The net release of SO_4 from forest soils may delay the recovery from acidification for surface waters and the continued enrichment of nitrogen in catchment soils poses a threat to terrestrial biodiversity and may ultimately lead to a higher total inorganic nitrogen runoff through nitrogen saturation. Continued monitoring and further evaluations of mass balance budgets are thus needed (see footnote 4.).

VIII. Publications

11. For a list of ICP Integrated Monitoring publications and references for the present report, please visit the ICP Integrated Monitoring website.

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[7] Maria Holmberg and others, “Relationship between critical load exceedances and empirical impact indicators at IM sites - Update 2017”, in Sirpa Kleemola and Martin Forsius, eds., 26th Annual Report 2017 (in press).