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Working Group on Effects

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Progress in activities in 2018 and further development of effects-oriented activities

Integrated monitoring of 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 the 2018-2019 workplan for the implementation of the Convention (ECE/EB.AIR/140/Add.1, items 1.1.1.27-1.1.1.30) and as mandated in the informal document submitted to the Executive Body for the Convention at its thirty-seventh session entitled “Draft revised mandates for scientific task forces and centres under the Convention”.

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 2017 report and, in particular, the work on dynamic modelling of the impacts of deposition and climate change scenarios on soil and water quality; and climate variables and long-term (1990–2015) trends in bulk deposition, throughfall and runoff water chemistry and fluxes.

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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 as requested by the Executive Body for the Convention on Long-range Transboundary Air Pollution in the 2018-2019 workplan for the implementation of the Convention (ECE/EB.AIR/140/Add.1, items 1.1.1.27–30). The report presents the results of the activities carried out between May 2017 and May 2018, and particularly the work on dynamic modelling of the impacts of deposition and climate change scenarios on soil and water quality; and long-term (1990-2015) trends in climate variables, bulk deposition, throughfall and runoff water chemistry and fluxes

2. The Programme, which involves some 150 scientists in 16 countries, has a Task Force led by Sweden and a Centre hosted by the Finnish Environment Institute in Helsinki.

3. During the reporting period, ICP Integrated Monitoring held two meetings: the twenty-fifth Task Force meeting and scientific workshop (Uppsala, Sweden, 9–11 May 2017) and the twenty-sixth Task Force meeting and scientific workshop (Warsaw, 7–9 May 2018). Both Task Force meetings were organized jointly 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 2018 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 two Programmes (see section IV below). The minutes of the meetings are available from the ICP Integrated Monitoring website.[1]

II. Outcomes and deliverables during the reporting period

5. In 2017–2018, ICP Integrated Monitoring produced or contributed to the following reports:

(a) The 2017 joint progress report on policy-relevant scientific findings: Note prepared by the Chairs of 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, in cooperation with the secretariat (ECE/EB.AIR/GE.1/2017/3–ECE/EB.AIR/WG.1/2017/3);

(b) 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 (2017 technical report to the Working Group on Effects) (ECE/EB.AIR/GE.1/2017/15–ECE/EB.AIR /WG.1/ 2017/8);

(c) The 2017 annual report of ICP Integrated Monitoring;[2]

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

[2] Sirpa Kleemola and Martin Forsius, eds., *26th Annual Report 2017: 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. 24 (Helsinki, 2017), available at http://hdl.handle.net/10138/212199.

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(d) A report on the relationship between critical load exceedances and empirical impact indicators at ICP Integrated Monitoring sites;[3]

(e) A scientific paper on long-term changes (1990–2015) in the atmospheric deposition and runoff water chemistry at ICP Integrated Monitoring sites;[4]

(f) A report on concentrations of heavy metals in important forest ecosystem compartments;[5]

(g) A report on mercury in the aquatic environment; prepared jointly with ICP Waters.[6]

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

6. In the second half of 2018 and in 2019, ICP Integrated Monitoring will contribute to or produce the following deliverables as indicated in the workplan:

(a) The 2018 joint progress report on policy-relevant scientific findings: Note prepared by the Chairs of 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, in cooperation with the secretariat (ECE/EB.AIR/GE.1/2018/3–ECE/EB.AIR/WG.1/2018/3);

(b) A scientific paper on dynamic modelling of the impacts of future deposition scenarios on soil and water conditions in ICP Integrated Monitoring catchments (item 1.1.1.29 of the workplan, to be completed in 2018);

(c) A scientific paper on the relationship between critical load exceedances and empirical ecosystem impact indicators (item 1.1.1.31 of the workplan, to be completed in 2019);

(d) The twenty-eighth annual ICP Integrated Monitoring report (covering activities in 2018-19), forthcoming in August 2019.

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

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[3] Maria Holmberg and others, “Relationship between critical load exceedances and empirical impact indicators at IM sites” in Kleemola and Forsius, pp. 29–35.

[4] Jussi Vuorenmaa and others, “Long-term changes (1990-2015) in the atmospheric deposition and runoff water chemistry of sulphate, inorganic nitrogen and acidity for forested catchments in Europe in relation to changes in emissions and hydrometeorological conditions”, in *Science of the Total Environment* 625 (2018) 1129-1145.

[5] Staffan Åkerblom and Lars Lundin, “Report on concentrations of heavy metals in important forest ecosystem compartments” in Kleemola and Forsius, pp.35-42.

[6] Norwegian Institute for Water Research, Spatial and temporal trends of mercury in freshwater fish in Fennoscandia (2965–2015), ICP Waters report 132/2017. Available at https://www.drive.google.com/file/d/0B_DU7Rk3lFWYaGdfczRsODBGNlU/view

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 International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes; 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 (EMEP).

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

8. The twenty-third ICP Integrated Monitoring Task Force meeting and scientific workshop was held in Minsk from 6 to 8 May 2015. The scientific paper on dynamic modelling prepared for the meeting and workshop[7] included an evaluation of data from a site in Serbia.

VI. Scientific and technical cooperation activities with relevant international bodies

9. ICP Integrated Monitoring cooperates closely with the Long-Term Ecosystem Research (LTER) in Europe network[8] and many sites are common to both bodies. A European Long-Term Ecosystem and socio-ecological Research Infrastructure (eLTER) project was launched in June 2015 with funding from the European Union Horizon 2020 programme.

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 negotiation of effect-based Protocols to the Convention. However, because the critical load concept is based on steady-state approach dynamic models are needed in order to assess the timescale of impacts and recovery from changes in air pollutant emissions. Interaction with changes in climate variables is also of key importance. Current climate warming is expected to continue in the coming decades and the current high levels of nitrogen (N) deposition may stabilize, in contrast to the clear decrease in sulphur (S) deposition. These pressures have distinctive regional patterns and their impact on soil conditions is modified by local site characteristics. A chain of models with a VSD+ soil dynamic model in the centre was applied to a combined dataset from ICP Integrated Monitoring, ICP Forests and

[7] Maria Holmberg and others, "Modelling study of soil C, N and pH response to air pollution and climate warming using European LTER site observations", in *Science of the Total Environment*, November 2018 (forthcoming), available online as from 31 May 2018 at www.sciencedirect.com/science/article/pii/S004896971831951X?via%3Dihub.

[8] www.lter-europe.net.

LTER-Europe[9] sites. Most of these sites are forested; located in the Mediterranean, forested alpine, Atlantic, continental and boreal regions; and provide high-quality long-term data on ecosystem response. The single-layer VSD+ soil model accounts for organic carbon (C) and N turnover, as well as charge and mass balances of elements, cation exchange and base cation weathering. VSD+ was calibrated at 26 ecosystem study sites throughout Europe using observed conditions and simulated key soil properties: soil solution pH (pH), soil base saturation (BS) and soil organic carbon and nitrogen ratio (C:N) under projected N and S deposition and climate change until 2100. Simulated future soil conditions improved under a projected decrease in deposition and current climate conditions: higher pH, BS and C:N at 21, 16 and 12 of the 26 sites, respectively. When climate change projections were included, pH increased in most of the cases and BS and C:N increased in about half of them. Hardly any climate warming scenarios led to a decrease in pH; however, BS and C:N decreased in roughly a third of the cases. The study illustrates the value of long-term monitoring sites for applying models that can predict soil, vegetation and species responses to multiple environmental changes. The study will be continued by extending the VSD+ applications to include vegetation impacts using the Probability of Occurrence of Plant Species (PROPS) model in order to study deposition and climate change impacts on biodiversity metrics. This will also allow impact assessments at the relevant spatial scales in support of related processes such as European Union policy-making on air pollution, nature and biodiversity;[6]

(b) Long-term (1990–2015) trends for climate variables, bulk deposition, throughfall and runoff water chemistry and fluxes were evaluated in 25 forested catchments in Europe under the ICP Integrated Monitoring programme.[4] Most of the sites are also part of the LTER-Europe network. Trends were evaluated for monthly concentrations of non-marine (anthropogenic fraction, denoted as x) sulphate (xSO_4) and base cations x (calcium and magnesium (Ca+Mg)), hydrogen ion (H^+), inorganic N (nitrate and ammonium – NO_3 and NH_4) and ANC (Acid Neutralizing Capacity) and their respective fluxes into and out of the catchments and for monthly precipitation, runoff and air temperature. A significant decrease in xSO_4 deposition resulted in significantly decreased concentrations and fluxes of xSO_4 in runoff at 90 and 60 per cent of the sites, respectively. Bulk deposition of NO_3 and NH_4 decreased significantly with 60-80 per cent (concentrations) and 40-60 per cent (fluxes) at the sites. Concentrations and fluxes of NO_3 in runoff decreased at 73 and 63 per cent of the sites, respectively, and NO_3 concentrations decreased significantly at 50 per cent of the sites.

11. It can thus be concluded that concentrations and deposition fluxes of xSO_4, and consequently acidity in precipitation, have decreased substantially in ICP Integrated Monitoring areas. Total inorganic nitrogen (TIN) deposition has decreased in most of the Integrated Monitoring areas, but to a lesser extent than for xSO_4. Substantially decreased xSO_4 deposition has resulted in decreased concentrations and output fluxes of xSO_4 in runoff, and decreasing TIN concentrations in runoff – particularly for NO_3 – are more common than increasing trends. Moreover, these decreasing trends appear to have strengthened for emission reductions over the past 25 years. TIN concentrations in runoff have, on the whole, decreased and while trends in output fluxes have been more variable, the trend slopes have decreased. The ICP Integrated Monitoring network covers important deposition gradients in Europe and these results confirm that although decreasing trends for S and N emissions and deposition reduction responses in runoff water chemistry have tended to be more gradual since the early 2000s, emission abatement actions are having their intended effect on precipitation and runoff water chemistry in the course of successful emission reductions in various regions of Europe.

[9] Ibid.

12. It is anticipated that the effects of climatic drivers on trends in SO_4 losses in catchment soils, together with internal SO_4 sources, will become increasingly important as atmospheric SO_4 deposition has declined. The combined effect of climate variability/change and N deposition is also a potential source of concern as many TIN retention and release processes are sensitive to changes in climatic variables.[4]

VIII. Publications

13. A list of ICP Integrated Monitoring publications and references for the present report are posted on the ICP Integrated Monitoring website.[1]