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

Working Group on Effects

Second joint session*
Geneva, 13–16 September 2016
Item 13 of the provisional agenda
Progress in activities in 2016 and further development of effects-oriented activities

Effects of air pollution on rivers and lakes

Report by the Programme Centre of the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes

Summary

The present report is submitted for the consideration by the second joint session 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 accordance with the request of the Executive Body for the Convention on Long-range Transboundary Air Pollution in the 2014–2015 workplan for the implementation of the Convention (ECE/EB.AIR/122/Add.2, item 1.1.15), the 2016–

* The Executive Body to the Convention agreed that, as of 2015, the Working Group on Effects and the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe should meet jointly, to achieve enhanced integration and cooperation between the Convention's two scientific subsidiary bodies (ECE/EB.AIR/122, para. 47 (b)).

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2017 workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.1, items 1.1.8, 1.1.9 and 1.1.24, 1.4.1, 1.4.2 and 1.5.1), 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, 1.1.6, 1.1.7 and 1.8.1–1.8.3) and the Long-term Strategy for the Convention (ECE/EB.AIR/106/Add.1, decision 2010/18, annex).

The report presents a summary of the discussions at and results from thirty-first and thirty-second meeting of the Task Force of the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes held from 6 to 8 October 2015 at Monte Verita, Italy and from 24 to 26 May 2016 at Asker, Norway, respectively. The thirty-second meeting was held jointly with the Task Force of International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems.

Contents

I. Introduction

1. The present report of the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters) is being submitted for the consideration of the second joint session of 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 2014–2015 workplan for the implementation of the Convention (ECE/EB.AIR/122/Add.2, item 1.1.15), the 2016–2017 workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.1 items 1.1.8, 1.1.9 and 1.1.24, 1.4.1, 1.4.2 and 1.5.1) and the Long-term Strategy for the Convention (ECE/EB.AIR/106/Add.1, decision 2010/18, annex). The report presents a summary of the discussions at and the results from thirty-first and thirty-second meetings of the Task Force of the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes held from 6 to 8 October 2015 at Monte Verita, Italy and from 24 to 26 May 2016 at Asker, Norway, respectively. The thirty-second meeting was held jointly with the Task Force of International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring). The ICP Waters Task Force meeting was moved from October, when it was traditionally held, to spring. From 2016 onwards, the ICP Waters Task Force meeting will be held in the spring season.

2. The lead country of the Task Force of ICP Waters is Norway. The Task Force is hosted by the Norwegian Environment Agency and the Programme Centre is located at the Norwegian Institute for Water Research. National Focal Centres of ICP Waters contribute with data and present national results related to assessment and monitoring of air pollution effects on surface waters. ICP Waters collaborates with all the International Cooperative Programmes under the Working Group on Effects as well as the Joint Task Force on the Health Aspects of Air Pollution.[1]

3. The thirty-first meeting of the Task Force of ICP Waters was attended by 30 experts from 11 Parties to the Convention. The thirty-second meeting was attended by 46 experts from 14 Parties of the Convention. The thirty-second meeting was held jointly with ICP Integrated Monitoring to improve collaboration between subsidiary bodies under the WGE (ECE/EB.AIR/133/Add.1 item 1.4.2). At present, 25 countries participate in one or more of the activities of ICP Waters. The Task Force considered progress reports from the Programme Centre and the National Focal Centres on the results on trends in water chemistry and biology, heavy metals, dynamic modelling and critical loads, and climate change impacts. The presentations can be found on the ICP Waters web page and in the proceedings from the 2015 Task Force meeting,[2] and are summarized in the respective minutes.[3] A similar report containing Task Force proceedings will be produced from the 2016 Task Force meeting. A summary of the presentations and discussions at the meeting is presented below (section II).

[1] The Task Force is a joint body of the World Health Organization European Centre for Environment and Health and the Executive Body for the Convention.

[2] Heleen de Wit, Salar Valinia and Sandra Steingruber, eds., *Proceedings of the 31st Task Force meeting of the ICP Waters Programme in Monte Verita, Switzerland 6–8 October, 2015*, ICP Waters report 126/2016. Oslo. Norwegian Institute for Water Research. Available from http://at www.icp-waters.no/Publications/Reports/tabid/122/Default.aspx.

[3] The minutes of the Task Force meetings, which include the agenda, the list of participants and the workplan, is available on the ICP Waters website http://www.icp-waters.no/.

II. Ongoing activities — report on the 2015 and 2016 Task Force meetings

4. *Biodiversity and climate*: Key results from preliminary version of the report "*Biodiversity of macro-invertebrates in acid-sensitive waters: trends and relations to water chemistry and climate"*[4] (2014–2015 workplan, item 1.1.15.b) were presented. Reduced deposition of sulphur is often found to have positive effects on aquatic organisms in acid-sensitive surface waters due to improved water chemical status. Here we aimed to test if 1) biological recovery was also reflected in increased biodiversity, 2) if current trends of climate change strengthen or reduce ongoing biological recovery. The database consisted of macro-invertebrate recordings (bottom-dwelling aquatic organisms) of circa 100 sites in the Czech Republic, Germany, Latvia, Norway, Sweden, and in the United Kingdom of Great Britain and Northern Ireland, with associated water chemistry (sulphate, acid-neutralizing capacity) and climate (temperature and precipitation) records. The time periods for the sites varied between 12 and 29 years. Increases in species diversity were found at 90 per cent of the lake sites and 95 per cent of the river sites, where 30 and 21 per cent were significant trends, respectively. With almost no exception, significant decreases in sulphate concentrations were found. Few significant trends in temperature and precipitation were found, on the contrary. Increasing diversity correlated best with sulphur and acid-neutralizing capacity (water chemical parameters), which is a strong indication that reduced sulfur deposition has a positive impact on biodiversity of aquatic invertebrates. In most acidified sites, additional correlations were found with temperature and precipitation, where especially precipitation had a strong effect. The changes in precipitation may affect species diversity indirectly, through impacts on water chemistry, or more directly, through changes in hydrology. Probably because trends in climate were small compared to trends in deposition and associated water chemistry, climate appeared to have limited effects on invertebrates in this analysis. However, environmental changes in the near future are expected to become less distinct for deposition and more distinct for climate, suggesting that aquatic invertebrate communities may experience stronger impacts from climate in the year to come. Further monitoring of acid-sensitive surface waters is necessary for further study of climate effects on biodiversity. The main conclusions of this report are that biological recovery is indeed associated with increased biodiversity, and that biodiversity will continue to increase when acid deposition decreases. For the studied period, impacts from climate change appear to be secondary.

5. *Mercury:* The outline for the 2016 ICP Waters report on Mercury in aquatic ecosystems was presented (2016–2017 workplan, item 1.1.8). The aim of the analysis is to assess distribution and effects of long-range transported mercury in the aquatic environment, with special focus on fish. In remote areas with no local mercury pollution sources, long-range transported atmospheric mercury is the main source of mercury contamination. Here, long-term accumulation of mercury in soils has been found, and mercury leaches from soils into surface waters and accumulates in freshwater foodwebs. In northern surface waters, elevated concentrations of mercury in fish have been found, often exceeding critical limits for human consumption and environmental quality standards, and

[4] Gaute Velle, Richard J. Telford, Jens Arle, Chris Curtis, Lars Eriksson, Arne Fjellheim, Marina Frolova, Jens Fölster, Natalja Grudule, Godtfred A. Halvorsen, Alan Hildrew, Andreas Hoffmann, Jakub Hruška, Iveta Indriksone, Lenka Kamasová, Jiří Kopáček, Stuart Orton, Pavel Krám, Shad Mahlum, Don T. Monteith, Takaaki Senoo, Ewan M. Shilland, Evžen Stuchlík, Lenka Ungermanová, Magda-Lena Wiklund, Heleen de Wit. *Biodiversity of macro-invertebrates in acid-sensitive waters: trends and relations to water chemistry and climate.* ICP Waters report xxx/2016, in preparation; Oslo, Norwegian Institute for Water Research, 2016. Planned availability in September 2016 at: http://www.icp-waters.no/.

with potential harmful effects on organisms. Recently, signs of increasing levels of mercury in fish were observed. However, so far few attempts have been made to describe and analyze spatial patterns and temporal trends of mercury in fish across gradients of climate, land cover and deposition. In this report, we aim to collate data on mercury in fish from Norway, Sweden and if possible also from Canada, Finland and the Russian Federation and Canada, potentially spanning a circumpolar region. The report could contribute to a planned Arctic Monitoring and Assessment Programme (AMAP) report on mercury in pan-arctic environments. The report will be written in collaboration with ICP Integrated Monitoring, and will be presented at the ICP Waters Task Force meeting in spring of 2017.

6. *Biological and chemical recovery*: Substantial decreases in sulphur deposition have occurred in large parts of world as a result of international cooperation on emission reductions. The reduction of sulphur deposition has led to significant chemical recovery of surface waters, but not yet to a return to pre-industrial conditions. Associated biological recovery proceeds more slowly than chemical recovery. In some regions, the deposition of nitrogen has become more important than sulphur for surface water acidification, and delays chemical and biological recovery. Further reduction of deposition of sulphur and nitrogen are important to further enhance protection of acid-sensitive aquatic ecosystems. The Task Force applauded the work done by the National Focal Centres, and emphasized the importance of national monitoring networks.

7. *Dissolved organic carbon:* A large water chemistry database for Europe and North America shows that concentrations of dissolved organic carbon (DOC) continue to rise, with hardly any signs of levelling off. The primary driver appears to be the reduction in sulfur deposition, while seasalt deposition also add to changes in surface water DOC. Climatic drivers, in particular precipitation strongly affect interannual variation of DOC. More DOC in surface waters leads to higher expenses in providing clear drinking water in regions that depend on surface waters as raw water source. Also, surface water productivity and mercury contamination of aquatic foodwebs may be impacted.

8. *Land use, acidification and critical loads:* Climate mitigation policies may lead to national initiatives for afforestation, or increased forestry for production of biofuels, with potential impacts on critical loads for acidification and surface water acidification. A modelling exercise with the Model of Acidification of Groundwater in Catchments (MAGIC) in Sweden explored how critical loads for surface waters in Sweden may be affected by forestry, which is predicted to become more intensive in the future as the need for forest-based biofuels may increase as a climate mitigation measure. Forestry and critical loads are linked through uptake of base cations in biomass. Future forest management may impact ecosystem critical loads in countries with acid-sensitive surface waters where biofuels are considered as an option to mitigate climate change. In the Czech Republic, a modelling study showed that afforestation of acidified catchments may lead to a substantial re-acidification of currently recovering surface waters. A modelling study using scenarios of future forest cover and a dynamic model indicates that increased forest growth (associated with higher base cation uptake) and increased dry deposition will lead to future acidification, even under future reductions in sulphur deposition. The results of these studies are relevant for other regions where substantial changes in forest cover and forest management are expected, for instance where afforestation is used to mitigate climate change.

9. *Assessment of surface water acidification under the Water Framework Directive:* Under the European Union Water Framework Directive,[5] ecological status of surface waters is assessed with respect to pressures that potentially affect individual water bodies. In Norway, acidification is currently the second-most important pressure for surface water

[5] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

quality. Detailed criteria for assessment of ecological status, using biology and chemistry, have been developed as the result of a fruitful collaboration between monitoring networks, where monitoring data and research under the Convention proved highly valuable. There is significant added value in combining data and methods from monitoring networks designed for monitoring air pollution effects and for the Water Framework Directive.

10. *Parties in Eastern Europe, the Caucasus and Central Asia:* Aquatic ecosystems in Armenia and the Russian Federation are strongly impacted by atmospheric deposition. In lakes in the Kola Peninsula in the Russian Federation, the forms and complexes in which metals are present in lakes is affected by anthropogenic deposition. In Armenia, hardly any policy instruments to abate atmospheric pollutions have been implemented. Mining and release of household and industrial waste into rivers are other major sources of surface water pollution in Armenia. The Task Force urged the ICP Waters Programme Centre to continue its efforts to further include Parties in that subregion in the activities of the Programme Centre.

11. *Chemical intercomparison:* Results from the twenty-ninth chemical intercomparison were reported.[6] Thirty-nine laboratories from nineteen countries participated. The quality of results was similar to that in former years. In total, 88 percent of all results were acceptable. The chemical intercomparison is a valuable tool for quality assurance of laboratory analyses.

12. *Biological intercalibration:* Results from the seventeenth biological intercalibration of invertebrates were reported.[7] The goal was to evaluate the quality and harmonize the taxonomic work. Four laboratories participated and showed excellent taxonomic work. Ten laboratories have participated on a regular basis in the intercalibration.

13. *Access to data/information*: The current ICP Waters homepage will be moved to a new platform and content and form will be evaluated and updated. The database will be visualized with maps and metadata will be presented (2016–2017 Workplan item 1.4.1).

14. *Participation in other groups under the Working Group on Effects:* Representatives of the ICP Waters Programme Centre participated in the meetings of the Task Forces of other ICPs i.e. the ICP Integrated Monitoring, the ICP on Effects on Materials including Historic and Cultural Monuments (ICP Materials) and the ICP on Modelling and Mapping of Critical Loads and Levels and Air Pollution Effects, Risks and Trends (ICP Modelling and Mapping), as well as the Joint Expert Group on Dynamic Modelling.

15. *Exploration of ways to combine activities of ICPs:* ICP Waters and ICP Integrated Monitoring organized a joint Task Force meeting in May 2016 (2016–2017 Workplan item 1.4.2). The Task Force of ICP Waters supported another joint Task Force meeting in 2017. Possibilities for joint work on thematic reports were discussed.

[6] Carlos Escudero-Oñate, *Intercomparison 1529: pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn.* ICP Waters report 123/2015, Oslo. Norwegian Institute for Water Research. Available from http://www.icp-waters.no/.

[7] Arne Fjellheim, Arne Johannessen and Torunn Svanevik Landås, *Biological intercalibration: Invertebrates 1915.* ICP Waters report 124/2015, Oslo. Norwegian Institute for Water Research. Available from http:// www.icp-waters.no/.

III. Workplan items common to all International Cooperative Programmes

A. Further implementation of the Guidelines for Reporting on the Monitoring and Modelling of Air Pollution Effects

16. An overview of the monitoring effects reported by ICP Waters, according to the Guidelines for Reporting on the Monitoring and Modelling of Air Pollution Effects (ECE/EB.AIR/2008/11) was provided in the 2015 document ECE/EB.AIR/GE.1/2015/13–ECE/EB.AIR/WG.1/2015/6.

B. Enhanced involvement of countries in Eastern and South-Eastern Europe, the Caucasus and Central Asia, and cooperation with activities outside the Convention

17. With regard to the involvement of countries in Eastern and South-Eastern Europe, the Caucasus and Central Asia, the following countries participate in ICP Waters activities: Armenia, Belarus and the Russian Federation. The Russian Federation delivered data for the ICP Waters database for the first time in 2016. Collaboration with regard to the mercury report is being discussed with Russian partners.

C. Cooperation with programmes and activities outside the region

18. The Arctic Monitoring and Assessment Programme contributed to the Working Group on Effects trends report.[8] A Norwegian expert on monitoring under the Water Framework Directive was invited to the 2016 Task Force meeting to present how ecological status with regard to acidification is treated in the Norwegian monitoring under the directive. Monitoring data and expertise developed under the Working Group on Effects have contributed strongly to the development of the Norwegian monitoring system under the directive. The outline for the 2016 ICP Waters report on mercury (workplan item 1.1.8) will be presented at an AMAP meeting in 2016 to evaluate a possible contribution to an AMAP assessment report on mercury.

D. Contribution to the joint annual report by the Working Group on Effects

19. ICP Waters contributed to the 2015 joint progress report on policy-relevant scientific findings to the Working Group on Strategies and Review and to the Executive Body (workplan item 1.1.11) (see ECE/EB.AIR/GE.1/2015/3–ECE/EB.AIR/WG.1/2015/3).

[8] Heleen A. de Wit, Jean-Paul Hettelingh and Harry Harmens, eds., Trends in ecosystem and health responses to long-range transported atmospheric pollutants, ICP Waters report No. 125/2015, NIVA report 6946–2015 (Oslo, Norwegian Institute for Water Research, 2015) Available from http://www.icp-waters.no/ and http://www.unece.org/env/lrtap/welcome.html.

E. Science-policy assessment (workplan item 1.5)

20. Regarding *Assess the long-term trends in air pollution and its adverse effects* (workplan item 1.5.1), ICP Waters coordinated and, together with others ICPs, contributed to the trends report of the Working Group on Effects.

21. Regarding *Assess scientific and policy outcomes within the Convention over the past few decade*s (workplan item 1.5.2), ICP Waters contributed to the 2016 assessment report.[9]

IV. Workplan items specific to the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes

22. *Regional extent of lakes impacted by acidification*: A regional assessment of acidification (2016–2017 workplan 1.1.9) was presented and discussed at the 2016 Task Force meeting. The topic will be the theme of the ICP Waters thematic report in 2017. The background for choosing this topic is that the current key policy instrument for presentation of the current state of surface water acidification is the map of exceedances of critical loads. This presents a limited view on the status of acidified lakes because areas that are currently non-exceeded may still contain lakes that are acidified, and a regional assessment could thus provide additional information of the current status of lakes that are impacted by acidification. A reference group was elected and the topic will be discussed in greater detail in ICP Waters Task Force meeting in spring of 2017.

V. Expected outcomes and deliverables over the next period and the longer term

23. ICP Waters will continue to deliver policy-relevant reports to the Working Group on Effects that address the long-term strategy. At present, there are no concrete deliveries planned for the period after 2017. The Task Force meeting agreed that reactive nitrogen in surface waters is a potential topic for a future thematic report.

VI. Policy relevant issues, findings and recommendations

24. *Nitrogen and phosphorous:* While deposition of nitrogen shows widespread declines, in some sites nitrogen deposition shows increases in recent years related to increases in precipitation. Catchment nitrogen input-output budgets show that nitrogen continuous to accumulate in European catchments, while previous trend assessments of ICP Waters do not show widespread increases in inorganic nitrogen concentrations in surface waters. However, nitrogen has become a more important driver of acidification in some regions, most clearly in the Alps. Nitrogen may have impacts on freshwater productivity, especially since clear, but contrasting, trends in phosphorous concentrations in freshwaters have been observed in Sweden and the United States of America. Phosphorous is considered the principal driver of freshwater productivity. In the next call for data, phosphorous will be included to allow an overview of data availability and patterns in ICP Waters sites. The topic is suitable for between-ICP collaboration.

25. *Ground truth — the importance of long-term monitoring:* Small (lake) catchments

[9] Rob Maas and Peringe Grennfelt, eds., Towards Cleaner Air: Scientific Assessment Report 2016 (Oslo, 2016).

with intensive monitoring of deposition, hydrology and chemistry catchments are highly suitable to detect rapid response to changes in environmental change, and provide ground truth data for policy and modelling applications. Additional high frequency monitoring of climatic variables will be valuable to monitor climatic events in addition to long term changes. Examples of such sites exist in many national monitoring networks.

26. *Critical loads* Differences in critical limits for critical load calculations may lead to discontinuities in critical load maps across national borders (workplan item 1.1.24). The background for choice of critical limits is political with regard to which organisms countries choose to protect, while scientific work provides the basis for the critical limits. Further study of differences in national approaches for critical load maps calculations could lead to more consistency in international calculations of critical loads.

27. *Acidification of surface waters is still a concern in acid-sensitive ecosystems* Substantial decreases in sulphur deposition have occurred in large parts of world as a result of international cooperation on emission reductions. Sulphur reduction has led to a widespread chemical recovery in surface waters, but many waters have not returned to a pre-industrial reference condition. The subsequent biological recovery is dependent good chemical conditions and has therefore has not been as strong as the chemical. Surface water acidification is an important reason why surface water bodies do not reach 'Good Ecological Status' in accordance with the European Union Water Framework Directive. In acid sensitive areas, the deposition of nitrogen has become more important than sulphur for surface water acidification, and delays chemical and biological recovery. Further reduction of deposition of sulphur and nitrogen are important to further enhance protection of acid-sensitive aquatic ecosystems.

VII. 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

28. The ICP Waters monitoring network currently consists of approximately 200 sites in acid-sensitive areas in 16 countries in Europe and North America. The rivers and lakes are sampled regularly under national monitoring programmes. The length of the data series is mostly between 15 and 25 years. Some sites have over 30 years of data. The data are frequently used in trend assessments. Effects-related work under the Convention could benefit from joint activities on trends in ecosystem responses between various bodies and groups under the Working Group on Effects.

VIII. Relevant scientific findings: highlights

29. Highlights of recent scientific findings of ICP Waters are summarized in sections II and VI above.

IX. Publications

30. For a list of ICP Waters publications and references for the present report, reference is made to the ICP Waters website.[10]

[10] See http://www.icp-waters.no/Publications/tabid/62/Default.aspx.