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Working Group on Effects

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Progress in activities in 2017 and further development of effects-oriented activities

Effects of air pollution on rivers and lakes

Report of 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 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 2016-2017 workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.1, items 1.1.1.8, 1.1.1.9, 1.1.1.24, 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 discussion and other results from the thirty-third meeting of the Task Force under the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (Uppsala, Sweden, 9-11 May 2017). The meeting was held jointly with the Task Force of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems.

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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 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.1, items 1.1.1.8, 1.1.1.9, 1.1.1.24, 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 discussion and other results from thirty-third meeting of the ICP Waters Task Force (Uppsala, Sweden, 9-11 May, 2017).

2. Norway is the lead country of the ICP Waters Task Force. The Task Force is hosted by the Norwegian Environment Agency and the Programme Centre is located at the Norwegian Institute for Water Research in Oslo. National focal centres of ICP Waters contribute 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 and the Joint[1] Task Force on the Health Aspects of Air Pollution.

3. The thirty-third meeting of the ICP Waters Task Force was attended by 50 experts from 16 Parties to the Convention. It was held jointly with International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring), as was the thirty-second meeting, to improve collaboration between bodies under the Working Group on Effects (2016-2017 workplan, item 1.4.2). At present, 25 countries participate in one or more of the activities of ICP Waters. At the meeting, the Task Force considered progress reports from its 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 Integrated Monitoring website[2] and in the report on the proceedings of the 2017 Task Force meeting, which will be produced before September 2017[3] and are summarized in the minutes.[4] A summary of the presentations and discussions at the meeting is presented below.

II. Ongoing activities — report from the 2017 Task Force meeting

4. *Mercury*: The outline for the 2017 ICP Waters report on mercury in aquatic ecosystems was presented (workplan, item 1.1.1.8). The aim of the analysis is to assess spatial patterns and temporal trends in mercury (Hg) in fish, and evaluate if changes in emissions of Hg have affected Hg in the aquatic environment. In remote areas with no local Hg pollution sources, long-range transported atmospheric Hg is the main source of Hg

[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] See http://www.syke.fi/en-US/Research__Development/Ecosystem_services/Monitoring/Integrated_Monitoring/ICP_IM_Meetings.

[3] Heleen de Wit, Øyvind Garmo and Jens Fölster, eds., *Proceedings of the thirty-third Task Force meeting of ICP Waters in Uppsala, Sweden,* ICP Waters report (in preparation).

[4] 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 from http://www.icp-waters.no/

contamination. Here, long-term accumulation of Hg in soils has been found, and Hg leaches from soils into surface waters and accumulates in freshwater food webs. Emissions of the pollutant Hg are regulated and/or monitored through work under international conventions, agreements and programmes (e.g., the Arctic Monitoring and Assessment Programme, the European Union Water Framework Directive and the Minamata Convention on Mercury[5] (Minamata Convention)). Documentation of spatial patterns and temporal trends in Hg levels in ecosystems is therefore highly opportune. The database on Hg in fish in Finland, Norway and Sweden, with some data from the Kola Peninsula, consists of over 50,000 observations of Hg in fish covering the period 1965 to 2015. The database is the most extensive database of its kind. Lakes with known local pollution sources and lakes with only air pollution as a source of Hg were treated separately. More than 40 per cent of the almost 2,800 lakes in the database have fish Hg levels that exceeding 0.5 milligrams per kilogram (mg/kg), which is a threshold used to classify fish suitable for human consumption. There were no uniform changes observed for temporal trends in fish Hg concentrations from lakes with sufficient historical records (over five years of data). The report will be delivered by September 2017, in time for the first meeting of the Conference of the Parties to the Minamata Convention (Geneva, 24-29 September 2017).

5. *Regional assessment of acidification*: The outline for the 2018 ICP Waters report with the working title "A Regional Assessment of Surface Water Acidification" was presented (workplan item 1.1.1.8). The report is intended to be a policy-friendly add-on to the assessment of exceedance of critical loads of acidity, reflecting the present-day conditions of acid-sensitive surface waters. ICP Waters sites are suitable for temporal trend analysis, but spatial coverage is limited. The aim is to assess the current spatial extent of surface water acidification with output that is relevant on a nationwide scale. A request for information was sent to national focus centres to gain an overview of available information that can be used in this exercise, which 11 centres have answered. The following issues were addressed: identification of acid-sensitive areas, acidification criteria and overlap with the European Union Water Framework Directive reporting. A tentative outline for the report was presented. There are clear benefits of this report with regard to providing guidance on surface water monitoring under the European Union National Emission Ceilings Directive.[6] The Programme Centre will aim to deliver relevant products adapted to the timeline of deadlines under the National Emission Ceilings Directive. The final report will be delivered to the 2018 Task Force meeting.

6. *Biological and chemical recovery*: Substantial decreases in sulphur deposition have occurred in large parts of the world, largely through international cooperation on emission reductions. The reduction of sulphur deposition has led to significant chemical recovery of surface waters, but not a return to preindustrial 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. Furthermore, climate change can interfere with chemical and biological recovery processes. For instance, in a study of high altitude lakes in the southern Alps in Switzerland it was found that release of sulphur and base cations from melting permafrost affected long-term trends in acidity. Similar observations have been done in high altitude lakes in North America, which were also explained by melting permafrost. A study of the recovery of benthic algal assemblages from acidification in Czechia showed that episodic low pH continues to affect the biota and that episodes are

[5] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for the Community action in the field of water policy, O.J. (L 327).

[6] Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC, O.J. (L 344).

more important than long-term averages. Moreover, in the acid-sensitive region where this study was done, acidification had a greater effect than eutrophication. The Task Force applauded the work done by the national focal centres and emphasized the importance of national monitoring networks.

7. *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 for Acidification of Groundwater In Catchments (MAGIC) explored how critical loads for surface waters in Sweden might 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 Czechia, a modelling study showed that afforestation of acidified catchments may lead to a substantial re-acidification of currently recovering surface waters, through increased forest growth (associated with higher base cation uptake) and increased dry deposition. A Swedish review and modelling study on impacts of increased forest management suggested that soil base cation stores are sensitive to forest management. The base cation stores in soils are an important buffer to counteract acidification. 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.

8. *Parties in Eastern Europe, the Caucasus, and Central Asia:* Lakes in the European part of the Russian Federation are more sensitive to acidification than lakes in Siberia. Emissions differ between the European and Siberian region, but in both regions deposition of acidifying substances increases along a south-to-north transect. The Republic of Moldova conducts monitoring of air and water pollution and has an extensive network of stations, some of which have been active since the 1980s. The design and some of the results were presented at the Task Force meeting. Two of the stations for aquatic monitoring are in remote areas that could make them suitable for inclusion in the ICP Waters database. The stations are apparently not acid sensitive, but could be useful for other purposes. In the upcoming report on regional assessment of acidification an attempt will be made to produce maps displaying acid-sensitive regions in Eastern Europe, the Caucasus and Central Asia.

9. *Chemical intercomparison:* Results from the thirtieth chemical intercomparison were reported.[7] Thirty-five laboratories from 20 countries participated. The quality of results was similar to former editions of the chemical intercomparison. In total, 81 per cent of all results were acceptable. The best results were reported for the analytical variables sulphate, calcium, sodium, iron, manganese, cadmium and nickel, with an acceptance rate of 90 per cent or higher. Alkalinity and pH are typically the parameters with the worst performance, which is partly related to different methodologies for measurement of pH (stirring, non-stirring) and alkalinity (different titration endpoints). For pH, only 56 per cent of the reported results fulfilled the acceptance criteria. The chemical intercomparison is a valuable tool for quality assurance of laboratory analyses.

[7] Carlos Escudero-Oñate, *ICP Waters report 129/2016, Intercomparison 1630: pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn*, Norwegian Institute for Water Research (NIVA) report No. 7081-2016 (Oslo, NIVA, 2016). Available from http://www.icp-waters.no/

10. *Biological intercalibration:* Results from the twentieth biological intercalibration of invertebrates were reported.[8] The goal was to evaluate the quality and harmonize the taxonomic work. Only two laboratories participated in 2016, but they showed excellent taxonomic work. More participating laboratories are expected in the coming intercalibration exercises.

11. *Access to data/information*: The current ICP Waters home page has been moved to a new platform and the content and format have been evaluated and updated. The database is now visualized with maps, useful for data exploration, and metadata are presented (workplan item 1.4.1).

12. *Participation in other groups under the Convention:* Representatives of the ICP Waters Programme Centre participated in joint meetings of the EMEP Steering Body and the Working Group on Effects in September 2016, the meeting of their two Bureaux in March 2017, the meeting of the Task Force under the International Cooperative Programme on Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends and the meeting of the Joint Expert Group on Dynamic Modelling. The Programme Centre was also represented at a meeting in Brussels concerning the National Emission Ceilings Directive, together with representatives from the Working Group on Effects and other international cooperative programmes.

13. *Exploration of ways to combine activities of the international cooperative programmes*: ICP Waters and ICP Integrated Monitoring organized a joint Task Force meeting in May 2016 and May 2017 (workplan item 1.4.2). In 2018, a third joint meeting is planned. Possibilities for joint work on thematic reports are discussed during the Task Force meetings.

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

14. 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-ECE/EB.AIR/WG.1/2008/16/Rev.1) was provided in the 2016 report on measurements and modelling (ECE/EB.AIR/GE.1/2016/12-ECE/EB.AIR/WG.1/2016/5).

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

15. Of the countries in Eastern and South-Eastern Europe, the Caucasus and Central Asia, currently, Armenia, Belarus, the Republic of Moldova and the Russian Federation participate in ICP Waters activities. The Russian Federation delivered data for the ICP Waters database for the first time in 2016 and has contributed data to the current mercury report. The Republic of Moldova has proposed two stations that are in relatively remote

[8] Godtfred Anker Halvorsen, Arne Johannessen and Torunn Svanevik Landås, *ICP Waters report 130/2016, Biological intercalibration: Invertebrates 2016*, NIVA report No. 7089-2016 (Oslo, NIVA, 2016). Available from http://www.icp-waters.no/.

areas that could make them suitable for inclusion in the ICP Waters database. The stations are apparently not acid sensitive, but could be useful for other purposes. In the upcoming report on regional assessment of acidification an attempt will be made to produce maps displaying acid-sensitive regions in Eastern Europe, the Caucasus, and Central Asia.

C. Cooperation with programmes and activities outside the region

16. The mercury report (workplan item 1.1.1.8) will be delivered by September 2017, in time for the meeting of Conference of the Parties to the Minamata Convention (see para. 4). ICP Waters has delivered a note on the status of surface waters monitoring networks in relation to air pollution, as a response to an enquiry from the European Commission in relation to the National Emission Ceilings Directive, and has attended a meeting of the Ambient Air Quality Expert Group relating to that Directive.

D. Science-policy assessment

17. Regarding its mandate to assess the long-term trends in air pollution and its adverse effects (workplan item 1.5.1), ICP Waters coordinated and, together with other international cooperative programmes, contributed to the trend report of the Working Group on Effects.[9]

18. With regard to assessing the scientific and policy outcomes within the Convention over the past few decades (workplan item 1.5.2), ICP Waters contributed to the Convention's 2016 scientific assessment report.[10]

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

A. 2017 report on mercury in aquatic ecosystems

19. Progress on the mercury report (workplan item 1.1.1.8) is described in paragraph 4.

B. Assess regional extent of lakes impacted by acidification

20. Progress on the thematic report with the working title "A Regional Assessment of Surface Water Acidification" (workplan item 1.1.1.9) is reported in paragraph 5. The final report will be delivered to the 2018 Task Force meeting.

[9] Heleen A. de Wit, Jean-Paul Hettelingh and Harry Harmens, eds., *ICP Waters report 125/2015, Trends in Ecosystem and Health Responses to Long-range Transported Atmospheric Pollutants*, NIVA report No. 6946-205, revised 21 April 2016 (Oslo, NIVA, 2016). Available from: http://www.unece.org/environmental-policy/conventions/envlrtapwelcome/publications.html.

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

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

21. ICP Waters will continue to deliver policy-relevant reports to the Working Group on Effects that address the long-term strategy and the 2018-2019 workplan (forthcoming). A suggested topic for the 2019 report is reactive nitrogen in surface waters, a topic that was supported at the 2017 Task Force meeting. Nitrogen is a relevant topic for the Convention, as well as the European Union Water Framework Directive and possibly the European Union Marine Strategy Framework Directive,[11] because the contribution of nitrogen deposition is not well understood. Nitrogen is also a suitable topic for collaboration between ICP Waters and ICP Integrated Monitoring.

VI. Policy relevant issues, findings and recommendations

22. *Policy developments regarding air pollution:* In the National Emission Ceilings Directive, monitoring effects of air pollution on fresh waters, semi-natural habitats and forest ecosystems is made mandatory (article 9). Bodies under the Working Group on Effects have been contacted by the European Commission to contribute to implementation of the Directive because of the suitability of existing monitoring networks under the Convention. National focal centres that currently contribute to ICP Waters are advised to make themselves acquainted with national activities for implementation of the National Emission Ceilings Directive. ICP Waters will contribute to preparation of guidelines for monitoring effects on surface waters under the Directive and will highlight the relevance and value of the ICP Waters network and expertise developed since the 1980s.

23. *Mercury:* See paragraph 4.

24. *Climate change: melting permafrost affects recovery from acidification:* A study of high altitude lakes in the southern Alps in Switzerland demonstrated that water chemistry (sulphate, nitrate) in most lakes reflects precipitation chemistry and shows strong signs of chemical recovery. However, there were deviating patterns in the lakes at the highest elevation. Release of sulphur and base cations from melting permafrost appeared to be the best explanation for the deviating patterns. Similar observations have been made in high altitude lakes in North America, which were also explained by melting permafrost. High altitude lakes in permafrost areas function as early warning systems for ecosystem impacts of climate change.

25. *Climate mitigation as a confounding factor:* National climate mitigation policies may take form in plans for afforestation, or increased forestry for production of biofuels, with potential impacts on critical loads for acidification and surface water acidification. In Czechia, a modelling study showed that afforestation of acidified catchments may lead to a substantial re-acidification of currently recovering surface waters, through increased forest growth (associated with higher base cation uptake) and increased dry deposition. A Swedish review and modelling study on impacts of increased forest management suggested that soil base cation stores, which are an important buffer to counteract acidification, are sensitive to forest management. 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.

26. *Current status of ICP Waters Monitoring network:* The ICP Waters Monitoring network is tailored to document responses in water chemistry to changes in atmospheric

[11] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy, O.J. (L 164).

loads of air pollution. New countries have started to contribute (Republic of Moldova) while several countries that had stopped participating have begun to participate again (Ireland, Poland and Spain). Collaboration within the Convention has intensified through the organization of joint meetings with ICP Integrating Monitoring. Reports and results that are delivered continue to be of relevance under the Convention and outside it, for instance with regard to the Minamata Convention and the European Union National Emission Ceilings Directive.

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

27. The ICP Waters monitoring network is tailored to monitor effects of air pollution on surface waters, and consists currently 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. Article 9 of the National Emission Ceilings Directive imposes an obligation to monitor air pollution effects. ICP Waters will contribute to the preparation of guidelines for monitoring effects on surface waters under that Directive and will highlight the relevance and value of the ICP Waters network and expertise developed since the 1980s.

28. *Exploration of ways to combine activities of international cooperative programmes:* The ICP Waters Task Force meeting was held jointly with ICP Integrated Monitoring (item 1.4.2) in 2016 and 2017, and it has been decided to continue this practice for the 2018 meeting. New topics for thematic reports are chosen also taking into account possible collaboration with other groups under the Convention.

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.[12]

[12] See http://www.icp-waters.no/publications/.