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Working Group on Effects

Fourth joint session
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Item 4 of the provisional agenda
Progress in activities in 2018 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 by the fourth 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 2016-2017 workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.1 items 1.1.8-9, 1.1.24, 1.4.1-2 and 1.5.1), the 2018-2019 workplan for the implementation of the Convention (ECE/EB.AIR/140/Add.1 items 1.1.1.10-11, 1.1.1.34, 1.4.1 and 1.4.3) and in accordance with the activities set out 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 presents a summary of the discussion and other results from thirty-fourth

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meeting of the Task Force under the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (Warsaw, 7-9 May 2018). The thirty-fourth meeting was held jointly with the Task Force of International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems.

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 the fourth 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 2016–2017 workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.1 items 1.1.8-9, 1.1.24, 1.4.1-2 and 1.5.1), the 2018-2019 workplan for the implementation of the Convention (ECE/EB.AIR/140/Add.1, items 1.1.1.10-11, 1.1.1.34, 1.4.1, 1.4.3) and in accordance with the activities set out 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 presents a summary of the discussion and other results from thirty-fourth meeting of the Task Force under the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (Warsaw, 7-9 May 2018). The thirty-fourth meeting was held jointly with the Task Force of International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring).

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[1] Task Force on the Health Aspects of Air Pollution.

3. The thirty-fourth meeting of the Task Force of ICP Waters was attended by 46 experts from 14 Parties to the Convention. The thirty-fourth meeting was held jointly with ICP Integrated Monitoring, as was the thirty-third and thirty-second meeting, to improve collaboration between bodies under the WGE (ECE/EB.AIR/133/Add.1 item 1.4.2). At present, 24 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 and persistent organic pollutants, climate, biodiversity, nitrogen, and the European Union National Emission Ceilings Directive. The presentations are found on the ICP Integrated Monitoring homepage[2] and in the proceedings from the 2018 Task Force meeting, which will be produced before September 2018[3], and are summarized in the minutes.[4] 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] http://www.syke.fi/en-US/Research__Development/Ecosystem_services/Monitoring/Integrated_Monitoring/ICP_IM_Meetings.

[3] Øyvind Garmo, Rafal Ulanczyk and Heleen de Wit, eds., *Proceedings of the 34th Task Force meeting*

II. Ongoing activities - report from the 2018 Task Force meeting

4. *Mercury* The 2017 ICP Waters report on mercury in aquatic ecosystems was presented[5] (2016-2017 workplan, item 1.1.8). The aim of the analysis was to assess spatial patterns and temporal trends in mercury (Hg) in fish and evaluate if changes in emissions of mercury has affected mercury in the aquatic environment. Mercury emissions to the atmosphere contribute to elevated concentrations of Hg in the aquatic environment leading to elevated Hg levels in fish, even in many remote regions of the world. The database presented in the report consists of more than 50 000 measurements of Hg in fish, including 3132 individual water bodies in Fennoscandia (Finland, Norway, Sweden and the Russian part of Kola Peninsula) sampled between 1965 and 2015. The data have been analysed for spatial patterns and temporal trends, on raw and weight-adjusted data. The lakes were separated in groups that containing lakes only be impacted by atmospheric sources of Hg, and those also impacted by local, mostly historical, industrial point sources, and lakes with uncertainty related to local sources of Hg. Data on local emission sources are not readily available and pose a challenge to evaluation of data in relation to air pollution. Median lake-specific fish Hg concentrations in the vast majority of the studied Fennoscandian lakes exceeded Environmental Quality Standards for Hg in biota (0.02 part per million (ppm)) set by the European Union Water Framework Directive. Forty-six, thirty-three and twenty per cent of the fish in Sweden, Finland and Norway, respectively, exceeded the Food and Agriculture Organization/World Health Organization limit (0.5 ppm). Overall, there was a strong decline in fish Hg concentrations with time. For lakes impacted by air pollution only, no such trend was observed. For lakes with known local pollution sources, there was a strong decline in fish Hg. We attribute the contrast in trends primarily to declining impacts of local pollution sources. Spatial patterns were found in fish Hg levels, but further work is required to disentangle the effects of climate, deposition and catchment properties on fish Hg concentrations. The fish Hg database is a valuable source of information for continued monitoring of impacts of Hg in the environment. In particular, lakes that are primarily impacted by atmospheric sources of Hg will be relevant for documentation of effects of reduced air pollution on fish Hg (Convention). The entire database has a large potential for evaluation of effectiveness of past and future policy to reduce Hg in the environment, including the global Minamata Convention on Mercury (entered into force in August 2017. Results from the report were contributed to Chapter 7 (Mercury concentrations in biota) of the Global Mercury Assessment Draft Report, which was presented at the first Conference of the Parties (COP-1) of the Minamata Convention on Mercury (September 2017). A general recommendation for monitoring of mercury in freshwater fish was to focus on repeated sampling of the same water body.

5. *Regional assessment of acidification.* The draft 2018 ICP Waters report with the title "*A regional assessment of surface water acidification*" was presented (2016-2017 workplan, item 1.1.8, 2018-2019 workplan, item 1.1.10). 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. The results are expected to be relevant for activities under the National Emission Ceilings Directive. The aim is to assess the current spatial extent of surface water acidification in Europe and North

of the ICP Waters Programme in Warsaw, Poland, 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/..

[5] Braaten, H.F.V., Åkerblom, S., de Wit, H.A. et alt. 2017. *Spatial and temporal trends of mercury in freshwater fish in Fennoscandia (1965-2015).* ICP Waters report 132/2017. https://drive.google.com/file/d/0B_DU7Rk3lFWYaGdfczRsODBGNlU/view.

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America. A call for data and for national assessments of surface water acidification was answered by 13 countries. A map indicating potentially acid sensitive regions in Europe and North America based on bedrock geology, was used, alongside deposition maps, to identify regions with potentially acidified surface waters where no information was available from national contributions and critical loads/exceedance maps. Monitoring data from water bodies in acid-sensitive regions indicate that a significant proportion of acid-sensitive lakes remains acidified (i.e., has an acid-neutralizing capacity (ANC) below the critical limit) in North America and in European countries, despite considerable reductions in sulphur deposition. However, there is considerable variation between countries. In some countries where no water chemical monitoring data were available, a potential risk of acidified surface waters was indicated but could not be substantiated because of the lack of monitoring data. Some ongoing national monitoring programs are supplying sufficient information for a reliable assessment of acidification, while other countries appear to lack suitable monitoring programs for surface water acidification status. Monitoring and reporting under the Water Framework Directive in Europe is currently not a reliable source of information on air pollution effects on surface waters.

6. *National reports of acidification and chemical recovery*: Several countries reported on national data on acidification status and recovery. In Poland, 12.5 per cent of its area was categorized as potentially sensitive to acidification. In some areas, monitoring of acid-sensitive water bodies is ongoing but the monitoring system is not representative with regard to acid-sensitive surface waters. For a limited number of sites, chemical and biological recovery is documented but most of the sites remain acidified. In Sweden, an extensive monitoring dataset was presented that documented reduced sulphate concentrations and increases in ANC. However, there was also a substantial number of sites with decreases in ANC. Climate is presently a strong control of water chemistry in Sweden, in addition to deposition. In the Italian Alps, evidence of chemical recovery was shown from a recent survey, and ANC is now close to, or over the critical limit. Nitrate is now the main acidifier rather than sulphate in these sites, and climate variability is an important control of surface water acidification status. The lakes remain vulnerable to acidification. In Western Siberia in the Russian Federation, oil and gas extraction lead to emissions of sulphur, chloride and nitrogen to the atmosphere, and low pH in precipitation. However, only part of the area is acid-sensitive. In Eastern Russian Federation, there are also some large emissions of acidifying components to the atmosphere. In both regions, there are areas where critical loads for acidification are exceeded. In the United Kingdom of Great Britain and Northern Ireland, long-term monitoring data show strong decreases in sulphate concentrations in acid-sensitive lakes and streams. Even in recent years, the decline continues. Increases in dissolved organic carbon can be explained by changes in ionic-strength which are a consequence of changes in atmospheric chemistry. In conclusion, the national reports complement and support the findings in the regional assessment of acidification report (2016-2017 workplan, item 1.1.8, 2018-2019 workplan, item 1.1.1.10).

7. *Nitrogen:* Long-term trends of inputs and outputs of reactive nitrogen in ICP Integrated Monitoring sites indicate a decline in nitrogen deposition and nitrogen run-off in most sites, and a strong catchment nitrogen retention. Mechanisms that drive relationships between deposition, retention and run-off are not well understood, however. There is continued need for monitoring of catchment-internal nitrogen cycling indicators such as litterfall, throughfall, soil and soil solution. Several catchments in ICP Integrated Monitoring sites have extensive data on nitrogen cycling which makes them suitable case-studies for modelling of the climate impacts on nitrogen. Assessment of nutrient nitrogen impacts on surface waters is suggested as a theme for the 2019 ICP Waters report (2018-2019 workplan, item 1.1.1.11). A preliminary analysis indicates co-limitation of nitrogen and phosphorus on freshwater algal productivity, as found previously. However, algal data in combination with water chemical data are scarce for oligotrophic, acid-sensitive lakes which limits the possibility for this data analysis. It was concluded that the theme itself is of high relevance for the work under the convention but that a report will be postponed,

needing to ensure that enough relevant data are accessible.

8. *Parties in Eastern Europe, the Caucasus, and Central Asia:* In Western Siberia in the Russian Federation, oil and gas extraction lead to emissions of sulphur, chloride and nitrogen to the atmosphere, and low pH in precipitation. However, only part of the area is acid-sensitive. In the European part of the Russian Federation, some large emissions of acidifying components to the atmosphere occur. In both regions, there are areas where critical loads for acidification are exceeded and there is evidence of acidified lakes. In addition, there is evidence of enhanced concentrations of nickel and copper in lakes that are located in proximity of smelters on the Kola Peninsula. In Armenia, elevated atmospheric concentrations of nitrogen and sulphur-oxides are found, where the likely sources are industrial plants, for instance a copper smelter. The atmospheric concentrations pose a health risk to the population, as suggested by national statistics on lung cancer mortality.

9. *National Emission Ceilings Directive:* The principles of the National Emission Ceilings Directive and the guidance for ecosystem monitoring, to which ICP Waters and ICP Integrated Monitoring contributed, were presented. The ecosystem monitoring that is proposed under the Directive is similar to the monitoring systems under the Convention. The national focal centres confirmed that they had had contact with national ministries or agencies regarding the development of the national monitoring system under the Directive. Discussions and presentations reflected that the current surface water monitoring programs under ICP Waters are well-suited to monitor air pollution effects on surface waters. The need for biological monitoring was highlighted.

10. *Chemical intercomparison:* Results from the thirty-first chemical intercomparison were reported.[6] Thirty-eight laboratories from twenty-one countries participated. The quality of results was similar to former editions of the chemical intercomparison. In total, 76 per cent of all results were acceptable. Accuracy in determination of major ions, trace metals and total organic carbon (TOC) was very good (> 80 per cent had target accuracy < 20 per cent). Accuracy for alkalinity, nitrate (NO_3_N), nitrogen dioxide (NO_2_N) and total phosphorous was poor (32 per cent or less had acceptable target accuracy). Strict acceptance criteria, differences in methodology, sample instability at low nutrient levels or high limits of detection can all contribute to the relatively poor results for alkalinity and concentrations of nitrate and total phosphorous. The chemical intercomparison is a valuable tool for quality assurance of laboratory analyses.

11. *Biological intercalibration:* Results from the twenty-first biological intercalibration of invertebrates were reported.[7] The goal was to evaluate the quality and harmonize the taxonomic work. Four laboratories participated in 2017. The average quality index was excellent for two laboratories, acceptable for one laboratory, and not acceptable for one laboratory. The biological intercalibration is an important tool to maintain high taxonomic quality.

12. *Access to data/information*: The current ICP Waters homepage has been moved to a new platform and content and form has been evaluated and updated. The database is now visualized with maps, useful for data exploration, and metadata are presented (2018-2019 workplan, item 1.4.3).

13. *Participation in other groups under the Convention:* Representatives of the ICP Waters Programme Centre participated in third joint session of the Steering Body to EMEP and the Working Group on Effects in September 2017 and the Bureaux meeting of the two

[6] Escudero-Oñate, C. 2017. Intercomparison 1731: pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. ICP Waters report 134/2017. Available from http://www.icp-waters.no/.

[7] Halvorsen, G.A., Johannessen, A., Svanevik, T. 2017. Biological intercalibration: Invertebrates 2017. ICP Waters report 133/2017 Available from http://www.icp-waters.no/.

bodies in February 2018, the Task Force meeting of the International Cooperative Programme on Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends (ICP Modelling and Mapping), and the meeting of the Joint Expert Group on Dynamic Modelling (November 2017 and April 2018, respectively). 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 the other ICPs (October 2017).

14. *Exploration of ways to combine activities of ICPs* ICP Waters and ICP Integrated Monitoring organized a joint Task Force meeting for the third consecutive time, in May 2018 (2018-2019 workplan item 1.4.1). In 2019, a fourth 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

15. 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 ECE/EB.AIR/GE.1/2017/12–ECE/EB.AIR/WG.1/2017/5.

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

16. With regards to the involvement of countries in Eastern and South-Eastern Europe, the Caucasus and Central Asia in ICP Waters work, currently, Armenia, Belarus, Moldova and the Russian Federation participate in ICP Waters activities. Scientists from the Russian Federation has contributed with data to the 2017 mercury report (see para. 4). Republic of Moldova has proposed two stations that are in relatively 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 (see para. 5), a map for potential risk for acidification of surface waters, based on bedrock geology, includes Armenia, Georgia and the European part of the Russian Federation.

C. Cooperation with programmes and activities outside the region

17. The Mercury report (2016-2017 workplan, item 1.1.8; para. 4) was delivered by September 2017, in time for the COP-1 of the Minamata Convention on Mercury (September 2017). Results from the report were contributed to Chapter 7 (Mercury concentrations in biota) of the Global Mercury Assessment Draft Report, which was presented and discussed at COP-1. A general recommendation for monitoring of mercury in freshwater fish was to focus on repeated sampling of the same water body. ICP Waters was represented at the COP-1. ICP Waters has contributed to a guidance document on ecosystem monitoring for the National Emission Ceilings Directive and has attended a meeting of the Ambient Air Quality Expert Group relating to the Directive. ICP Waters has

also supplied an expert for the subgroup on ecosystem monitoring under the Ambient Air Quality Expert Group.

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

18. ICP Waters contributed to the 2017 joint progress report on policy-relevant scientific findings (ECE/EB.AIR/GE.1/2017/3−ECE/EB.AIR/WG.1/2017/3) to the Working Group on Strategies and Review and to the Executive Body

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

A. The 2017 ICP Waters report on mercury in aquatic ecosystems (2016-2017 workplan, item 1.1.8).

19. Progress on the mercury report is described under para. 4.

B. Assess regional extent of lakes impacted by acidification (2016-2017 workplan item 1.1.9; 2018-2019 workplan, item 1.1.10)

20. Progress on the thematic report with the working title "*A regional assessment of surface water acidification*" is reported under para. 5. The final report will be delivered for the consideration by the Executive Body at its thirty-eighth session.

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. A suggested topic for the 2019 report is reactive nitrogen in surface waters, a topic that is supported by the Task Force meeting. Nitrogen is a relevant topic for the Convention as well as the European Union Water Framework Directive and possibly for the Marine Strategy Framework Directive because contribution of nitrogen deposition is not well understood. Nitrogen is also a suitable topic for collaboration between ICP Waters and ICP Integrated Monitoring. After discussions at the Task Force meeting, it was decided to postpone the report on reactive nitrogen, because of limited access to relevant data, and instead, present a trend analysis of water chemistry to assess chemical recovery of acid-sensitive surface waters. The plan is to also address changes in land use with relevance for chemical recovery and nutrient runoff.

VI. Policy relevant issues, findings and recommendations

22. *Policy developments regarding air pollution: The European Union National Emission Ceilings Directive:* In the updated National Emission Ceilings Directive, monitoring effects of air pollution on freshwaters, semi-natural habitats and forest ecosystems is made mandatory (Article 9). International Cooperative Programmes under

the Working group on Effects contributed to a guidance document on ecosystem monitoring, and with experts for the subgroup on ecosystem monitoring, under the Ambient Air Quality Expert Group of the Directive. National focal centres that currently contribute to ICP Waters have acquainted themselves with national activities for implementation of the National Emission Ceilings Directive. ICP Waters will continue to be active to contribute expertise and activities from groups under the Working Group on Effects in the work to implement the National Emission Ceilings Directive. One example of ICP Waters contributions is the assessment of the regional extent of lakes impacted by acidification.

23. *Mercury* Emissions of the pollutant mercury are regulated and included in old and new international conventions and agreements (e.g. Minamata Convention on Mercury, the Convention, Water Framework Directive, Arctic Council). Documentation of levels of mercury in freshwater fish, recipients of mercury pollution, will be important to evaluate whether regulations of emissions have their intended effect. Results presented in the ICP Waters report on mercury in fish (para. 4) was used in Chapter 7 (Mercury concentrations in biota) of the Global Mercury Assessment Draft Report, which was presented at the COP-1. A general recommendation for monitoring of mercury in freshwater fish was to focus on repeated sampling of the same water body.

24. *Current status of ICP Waters Monitoring network:* The ICP Waters Monitoring network is tailored to document responses in water chemistry to changes in atmospheric loads of air pollution. New countries start to contribute (Republic of Moldova) while several countries re-initiate their participation (Ireland, Poland and Spain,). Collaboration within the Convention has intensified through organization of joint meetings with ICP Integrated Monitoring. Reports and results that are delivered continue to be of relevance under the Convention, and outside, for instance for the Minamata Convention and for 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

25. 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. Monitoring of air pollution effects is mandatory through article 9 of the National Emission Ceilings Directive. ICP Waters has contributed to preparation of guidelines for monitoring effects on surface waters under the Directive, has nominated an expert for the Directive expert group’s sub-group on ecosystems monitoring and reporting, and will continue highlight the relevance and value of the ICP Waters network and expertise developed since the 1980s.

26. *Exploration of ways to combine activities of ICPs* The Task Force meeting was held jointly with ICP Integrated Monitoring in three subsequent years, from 2016 onwards. A fourth joined meeting is planned in 2019. Collaboration on thematic reports is done regularly, with ICP Integrated Monitoring and with other bodies under the Convention.

VIII. Relevant scientific findings: highlights

27. Highlights of recent scientific findings of ICP Waters are summarized in chapters II and VI above.

IX. Publications

28. For a list of ICP Waters publications and references for the present report, reference is made to the ICP Waters website.[8]

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