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## Economic Commission for Europe

Executive Body for the Convention on Long-range Transboundary Air Pollution

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

**Working Group on Effects**

**Eighth joint session**
Geneva, 12–16 September 2022
Item 2 (c) (iii) of the provisional agenda
**Progress in activities in 2022 and further development of effects-oriented activities:**
**air pollution effects on materials, the environment and crops:**
**air pollution effects on waters and integrated monitoring of air pollution effects on ecosystems**

# 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 consideration by the eighth 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 both the workplans for the implementation of the Convention on Long-range Transboundary Air Pollution for 2021 and 2022 (ECE/EB.AIR/144/Add.2, items 1.1.1.7 and 1.1.1.8 and ECE/EB.AIR/148/Add.1, items 1.1.1.11 and 1.1.1.12) and the revised mandate for the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (Executive Body decision 2019/15).

The report is a progress report on activities, including a summary of the discussion and results presented at the thirty-eighth 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 jointly with the thirtieth meeting of the Task Force of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (Miraflores de la Sierra, Spain, 10–12 May 2022).

# 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 submitted for consideration by the eighth 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 both the workplans for the implementation of the Convention on Long-range Transboundary Air Pollution for 2021 and 2022 (ECE/EB.AIR/144/Add.2, items 1.1.1.7 and 1.1.1.8 and ECE/EB.AIR/148/Add.1, items 1.1.1.11 and 1.1.1.12) and the revised mandate for the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (Executive Body decision 2019/15).[1] The report is a progress report on activities, including a summary of the discussion and results presented at the thirty-eighth meeting of the ICP Waters Task Force, held jointly with the thirtieth meeting of the Task Force of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring) (Miraflores de la Sierra, Spain, 10–12 May 2022).

2. The lead country of the ICP Waters Task Force is Norway. The Programme Centre of ICP Waters is hosted by the Norwegian Institute for Water Research. ICP Waters national focal centres 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 – a joint body of the World Health Organization (WHO) European Centre for Environment and Health and the Executive Body for the Convention on Long-range Transboundary Air Pollution.

3. The ICP Waters monitoring network is tailored to monitor effects of air pollution on surface waters and currently consists of more than 500 sites in acid-sensitive areas in more than 20 countries in Europe and North America. Rivers and lakes are sampled regularly under national monitoring programmes. The data series often start during the 1990s, while some sites have over 30 years' worth of data. Data calls are issued regularly, and the data are used in assessments of trends and spatial patterns.

4. The thirty-eighth meeting of the ICP Waters Task Force was also the fifth joint meeting with the ICP Integrated Monitoring Task Force. It was a hybrid meeting, held in Miraflores de la Sierra, Spain, and attended by 71 experts from 19 Parties to the Convention. Currently, 26 countries participate in one or more of the activities of ICP Waters. The ICP Waters Task Force considered progress reports from the Programme Centre and the national focal centres on the results on trends, nitrogen, acidification and biological status. The presentations are available from the ICP Waters home page[2] and are summarized in the minutes.[3] Highlights from the presentations and discussions at the meeting are presented in section VI below.

# II. Outcomes and deliverables during the reporting period

5. During the reporting period, ICP Waters produced or contributed to the following publications and reports:

(a) The 2021 joint progress report on policy-relevant scientific findings of the EMEP Steering Body and the Working Group on Effects (ECE/EB.AIR/GE.1/2021/3−ECE/EB.AIR/WG.1/2021/3). The report contains information on data, activities and results generated by ICP Waters;

[1] All Executive Body decisions referred to in the present document are available at https://unece.org/decisions.

[2] See www.icp-waters.no.

[3] The minutes of the Task Force meetings, which include the agenda, list of participants and workplan, are available at www.icp-waters.no/meetings.

(b) A report on progress in activities by ICP Waters (ECE/EB.AIR/GE.1/2021/12–ECE/EB.AIR/WG.1/2021/5);

(c) The update of the EMEP Steering Body and the Working Group on Effects strategies with respect to the Long-term Strategy of the Convention on Long-range Transboundary Air Pollution (postponed until 2022);

(d) The report on the review of the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol);

(e) The reports on the thirty-fifth chemical intercomparison,[4] the twenty-fifth biological intercalibration[5] and the two nitrogen reports (2020–2021 workplan item 1.1.1.7). The work on trends in nitrogen species based on data from the ICP Waters database was started in 2020. At the thirty-sixth Task Force meeting of ICP Waters (online, 11–12 May 2020), it was decided to extend the scope of the report to include topics relevant to the revision of the empirical critical loads for nitrogen and include a literature review and a data analysis on the effects of reactive nitrogen on freshwater biology.[6] This work continued through 2020 and 2021. Two reports on reactive nitrogen have been produced: focusing on biological effects (2021)[7] and on trends in nitrogen (2022);[8]

(f) Contribution to the report on the review and revision of the critical loads of nitrogen for surface waters issued by the Coordination Centre for Effects, in particular through the work with the reports on reactive nitrogen but also leading the chapter on inland waters in the Coordination Centre for Effects report.

6. During the reporting period, ICP Waters participated in the following meetings under the Convention: the seventh joint session of the Steering Body to EMEP and the Working Group on Effects (Geneva (online), 13–16 September 2021); the Extended Bureaux meeting of those two bodies (Geneva (online), 21–24 March 2022); the thirty-eighth meeting of the Task Force 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) (online, 3–5 May 2022); and the thirty-eighth meeting of the Task Force of the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) (online, 2–3 June 2022). ICP Waters also contributed to the Ad hoc group on Marine Protection, which presented inputs to the Convention, to consider marine eutrophication in the review and possible revision of the Gothenburg Protocol. Moreover, ICP Waters participated in the Expert Workshop on Empirical Critical Loads for Nitrogen (Bern, 26–28 October 2021).

## III. Expected outcomes and deliverables for the next reporting period and in the longer term

7. In the second half of 2021, ICP Waters carried out, and will continue to carry out in 2022, the following activities, in accordance with the 2022–2023 workplan (ECE/EB.AIR/148/Add.1) for the Convention and with the decisions taken at the thirty-eighth meeting of the Task Force:

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[4] Tina Bryntesen, "Intercomparison 2135: pH, Conductivity, Alkalinity, $NO_3$-N, Cl, $SO_4$, Ca, Mg, Na, K, TOC, Tot-P, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn", ICP Waters Report No. 147/2021 (Oslo, Norwegian Institute for Water Research (NIVA), 2021). Available at www.icp-waters.no/publications/.

[5] Christian Lucien Bodin and others, "Biological intercalibration: Invertebrates 2021", ICP Waters Report No. 148/2021 (Oslo, NIVA, 2021). Available at www.icp-waters.no/publications/.

[6] Minutes of the thirty-sixth meeting of the Task Force of ICP Waters, para. 36. Available at www.icp-waters.no/icp-waters-task-force-meetings/.

[7] Jan-Erik Thrane, Heleen de Wit and Kari Austnes, "Effects of nitrogen on nutrient-limitation in oligotrophic northern surface waters", ICP Waters Report No. 146/2021 (Oslo, NIVA, 2021). Available at www.icp-waters.no/publications/.

[8] Kari Austnes and others, "Nitrogen in surface waters: time trends and geographical patterns explained by deposition levels and catchment characteristics", ICP Waters Report No. 149/2022 (Oslo, NIVA, 2022). Available at www.icp-waters.no/publications/.

(a) Preparation of the thematic report on biological recovery and responses to changing water chemistry (2020–2021 workplan item 1.1.1.8; 2022–2023 workplan item 1.1.1.11): this report had originally been scheduled to be published in 2021, but, at the thirty-sixth Task Force meeting of ICP Waters, it was decided to postpone publication to 2022, due to the expansion of the workplan item 1.1.1.7 report.[9] The content was discussed at the thirty-seventh Task Force meeting of ICP Waters (online, 28–29 April 2021), a call for data and contributions was issued, and preliminary results were presented and discussed at the thirty-eighth Task Force meeting;

(b) Discussion of the planned report for 2023 on base cations (2022–2023 workplan item 1.1.1.12): chemical recovery of surface waters implies a decline in base cations alongside declines in strong acid anions, but recent data analyses have indicated some unexpected patterns. Very low base cation levels can add to ecological damage of aquatic organisms, while the balance between base cations and acid anions is key to assessing acidification status of surface waters. High base cation concentrations may be attributed to mineral weathering or base cation exchange at the soil exchange complex but can also be impacted by atmospheric inputs from Saharan dust. This topic will be further explored in 2022 to prepare for the work in 2023;

(c) Discussion of a possible joint analysis of nitrogen trends and levels with ICP Forests, ICP Integrated Monitoring and EMEP;

(d) Contribution to the 2022 joint report Scientific information for the review of the Gothenburg Protocol (ECE/EB.AIR/GE.1/2022/3–ECE/EB.AIR/WG.1/2022/3);

(e) Contribution to the finalization of the EMEP and the Working Group on Effects strategies (ECE/EB.AIR/GE.1/2022/18–ECE/EB.AIR/WG.1/2022/11, postponed until 2022) with respect to the Long-term strategy for the Convention on Long-range Transboundary Air Pollution for 2020–2030 and beyond (Executive Body decision 2018/5); report on activities to the eighth joint session of the Steering Body to EMEP and the Working Group on Effects;

(f) Attending meetings inside and outside the Convention, for instance, to support development of monitoring guidance under the European Union National Emissions reduction Commitments Directive,[10] the European Long-term Ecosystem Research (eLTER) network and the Minamata Convention on Mercury.

# IV. Cooperation with other groups, task forces and subsidiary bodies, including with regard to synergies and possible joint activities

8. ICP Waters has focused on synergies with other bodies and groups under the Working Group on Effects. The Task Force meeting was held jointly with ICP Integrated Monitoring in four consecutive years (Asker, Norway, 24–26 May 2016; Uppsala, Sweden, 9–11 May 2017; Warsaw, 7–9 May 2018; and Helsinki, 4–6 June 2019), followed by two online ICP Waters-only Task Force meetings during the coronavirus disease (COVID-19) pandemic. Joint Task Force meetings with IPC Integrated Monitoring were reinstated in 2022. There was regular collaboration on thematic reports with ICP Integrated Monitoring and other bodies under the Convention. Nitrogen was also seen as a natural topic for collaboration with other bodies under the Convention.

9. The involvement of countries of Eastern and South-Eastern Europe, the Caucasus and Central Asia in ICP Waters work includes the participation of Armenia, Belarus, Georgia, the Republic of Moldova and the Russian Federation. Armenia was present at the thirty-eighth meeting of the Task Force of ICP Waters and presented its work. The Republic

[9] Minutes of the thirty-sixth meeting of the Task Force of ICP Waters, para. 36.

[10] 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, *Official Journal of the European Union*, L 344 (2016), pp. 1–31.

of Moldova took part in the chemical intercomparison in 2021. The Russian Federation was present at the Task Force meeting in 2021 and participated in the chemical intercomparison.

# V. Scientific and technical cooperation with relevant international bodies

10. The Programme Centre of ICP Waters has been taking an active part in the work of the Ecosystem Monitoring subgroup under the European Union National Emissions reduction Commitment Directive and was represented at three online webinars held in June 2021, October 2021 and January 2022, where a contractor for the European Commission presented revised guidance for the next round of reporting. ICP Waters provided feedback on the reporting template, parameters and protocols. ICP Waters will continue to be active in contributing expertise and activities in the work to implement the Directive.

11. ICP Waters has followed and contributed to the development of the document Guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention[11] and status reports from the online meetings of the Ad hoc Technical Expert Group on Effectiveness Evaluation.

12. ICP Waters has been following the ongoing development of eLTER, a feature of the European Strategy Forum on Research Infrastructures road map since 2018. Since 2020, the preparation for and development of the eLTER Research Infrastructure (RI) as a European Research Infrastructure Consortium has been supported by two European Union-funded 5-year projects involving 27 countries. Several ICP Waters sites around Europe are associated with the eLTER network, and ICP Waters supports and encourages the national focal centres to explore how their countries can interact with the upcoming eLTER RI. ICP Waters contributed to a letter on collaboration between the Working Group on Effects and eLTER RI.

# VI. Highlights of the scientific findings: policy-relevant issues

13. *Chemical recovery from acidification.* Surface water quality shows widespread chemical recovery as a result of reduced emissions of acidifying substances. Acid deposition has, in many regions, declined to such an extent that other factors, in particular climate-related factors, are beginning to have detectable impacts on concentrations as well as fluxes of acid anions, base cations and organic acids and thus on acidification status of surface waters.

14. *Long-term monitoring essential for differentiating between drivers of acidification and recovery*. There is growing evidence that some catchments are highly sensitive to climatic factors; an insight that is crucial for differentiating between water chemical responses to air pollution and to climate. Catchments with changing cryospheric features (thawing permafrost, retreating glaciers) show changes in sulfate and in base cations from weathering and release from soils. Additionally, the length of the growing season is increasing almost without exception, and this might increase vegetation demand for nitrogen and reduce nitrate leaching from soils. Also, external disturbances related to climate, such as insect outbreaks, can confound responses to air pollution. Since changes in strong anions and base cations are strong controls of acid neutralizing capacity (ANC), and reflect acidification status of waters, climate change may lead to quicker, or delay in recovery from, acid deposition of surface waters. Additionally, nutrient status of surface waters can be affected due to changed retention of nitrogen and phosphorus in catchments. Continued monitoring of surface waters in catchments that are sensitive to air pollution and in catchments that are sensitive to climate factors is highly recommended.

15. *Harmonization of chemical thresholds for biological recovery.* Countries use different approaches for assessing biological acidification status with water chemical data under the

[11] United Nations Environment Programme, document UNEP/MP/COP.4/INF/12.

European Union Water Framework Directive.[12] Experts have proposed a new classification system based on relationships between macroinvertebrate species composition and acid neutralizing capacity in Nordic waters. This new system has potential for further refinement of the critical loads of acidity under the Convention on Long-range Transboundary Air Pollution. The work is a good example of integration of scientific work under different policy instruments of environmental legislation.

16. *Nitrogen.* Concentrations of nitrate and trends in nitrate in surface waters, as demonstrated by the extensive ICP Waters monitoring records across Europe and North America, are partly controlled by nitrogen deposition and are thus linked to nitrogen emissions to the atmosphere. Variation in concentrations and trends is also controlled by vegetation and soil processes, for which high quality data are difficult to obtain. Collaboration with other bodies under the Convention with spatially extensive data sets could provide valuable insights into controls of ecosystem trends and levels of reactive nitrogen. No sign of nitrogen saturation was found in the ICP Waters monitoring records, but ambient loads of deposition might still exceed long-term sustainable deposition levels. Future climate- and land use-related ecosystem disturbances might also result in elevated nitrogen leaching from nitrogen-enriched soils to surface waters. Nitrogen is a limiting nutrient in some oligotrophic surface waters. The review and revision of the empirical critical loads of nitrogen presents updated knowledge on effects of nitrogen deposition on surface waters and further substantiates the basis for empirical critical loads of nitrogen for surface waters, in particular for oligotrophic soft water lakes, dystrophic lakes and dune slack pools.

17. *Monitoring networks of surface waters under various policy instruments (Convention, European Union National Emissions reduction Commitments Directive and Water Framework Directive) are mutually beneficial.* In many European countries, surface water monitoring networks deliver data to support several policy instruments, such as the Convention, the National Emissions reduction Commitments Directive and the Water Framework Directive. In several countries, a National Emissions reduction Directive monitoring network is being developed, which is more extensive than the national monitoring network delivering data to ICP Waters, while in other countries, the networks are largely identical. National focal points are urged to consider whether new sites are relevant for inclusion in the ICP Waters monitoring network. Such sites should be small headwater lakes and streams that are not confounded by local pressures, such as agriculture or point source pollution. Continuation of existing long-time series is essential, so relatively new monitoring activities initiated by the requirements of the National Emissions reduction Commitments Directive can be of great value for improving spatial cover and diversity of sites, especially in the Mediterranean area. New guidance clarifies how to report biological data under the National Emissions reduction Commitments Directive, which will promote the quality of biological data, a theme that ICP Waters continually works on, in particular through biological intercomparisons and trend assessments of biological recovery.

18. *Interactions between atmospheric deposition and the carbon cycle*. Increased concentrations and export of dissolved organic matter (DOM) is promoted by reduction in sulfur deposition, as shown by repeated assessments of temporal change in water chemistry at ICP Waters sites. Societal concerns regarding higher DOM are found with drinking water providers that need to remove DOM in the resource-intensive process of safe drinking water production. Additionally, increased DOM may present an important pathway for terrestrial cycling of atmospheric carbon dioxide, relevant to Earth system models.

19. *Chemical intercomparison.* Results from the thirty-fifth chemical intercomparison were reported (see para. 5 (e) above). Thirty laboratories from 16 countries participated. The water sample for 2021 was challenging to analyse because of low concentration levels. This produced an overall acceptance rate of 65 per cent, which is poorer than for previous years. ICP Waters uses water samples with a substantial inter-annual variation in concentration

[12] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, *Official Journal of the European Communities*, L 327 (2000), pp. 1–72.

levels, reflecting the variation found within the ICP Waters network. Chemical intercomparison is a valuable tool for quality assurance of laboratory analyses.

20. *Biological intercalibration.* Results from the twenty-fifth biological intercalibration of invertebrates were reported (see para. 5 (e) above). The goal was to evaluate the quality of, and harmonize, the taxonomic work. Two laboratories participated in 2021. With a mean quality assurance index of, respectively, 95.1 and 97.4, the laboratories scored well above the threshold for acceptable taxonomic work (quality assurance index 80). Results in the biological intercalibrations over time suggest that the taxonomists in the laboratories affiliated to ICP Waters have good taxonomic skills.

# VII. Publications

21. For a list of ICP Waters publications and references for the present report, see the ICP Waters website.[13]

[13] See www.icp-waters.no/publications/.