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Progress in activities in 2014 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 of 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, items 1.1.10, 1.1.11 and 1.1.15) 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 twenty-ninth meeting of the Task Force under the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (Český Krumlov, Czech Republic, 1–3 October 2013).

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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 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, items 1.1.10, 1.1.11 and 1.1.15) 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 twenty-ninth meeting of the Task Force of ICP Waters that was held in Český Krumlov, Czech Republic, from 1 to 3 October 2013.

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 twenty-ninth meeting of the Task Force of ICP Waters was attended by 29 experts from 11 Parties to the Convention on Long-range Transboundary Air Pollution. At present, 29 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, biological responses, heavy metals and dynamic modelling, ecosystem services and biodiversity. The presentations from the meeting are included in a recent ICP Waters report.[2,3] A summary of the presentations and discussions at the meeting is presented below (sect. II).

II. Ongoing activities — report on the 2013 Task Force meeting

4. *Biodiversity:* Key results from the 2013 report, *Biodiversity in freshwaters: temporal trends and response to water chemistry*,[4] were presented. The Task Force was impressed by the extensive data analysis. Monitoring data from acid-sensitive lakes and rivers on water- and sediment-dwelling insects, paired with water chemical records, were analysed statistically. The results showed significant increases in the biodiversity of these organisms in the past 30 years, coinciding with improvements in water chemistry as a result of reduced sulphur deposition. Thus, reduced sulphur emissions have resulted in improved biodiversity of acid-sensitive waters. The Task Force urged continued monitoring of

[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, Bente M. Wathne and Jakub Hruška, eds., *Proceedings of the 29th Task Force meeting of the ICP Waters Programme in Český Krumlov, Czech Republic, 1–3 October 2013*, ICP Waters report 117/2014 (Oslo: Norwegian Institute for Water Research, 2014). Available from http://www.icp-waters.no/Publications/tabid/62/Default.aspx.

[3] The minutes of the Task Force meeting, which include the agenda, the list of participants and the workplan, is available on the ICP Waters website from http://www.icp-waters.no/Publications/TaskForceminutes/tabid/80/Default.aspx.

[4] Gaute Velle and others, ICP waters report 114/2013 (Oslo: Norwegian Institute for Water Research, 2013). Available from http://www.icp-waters.no/Publications/tabid/62/Default.aspx.

biodiversity, by various metrics, in acid-impacted waters recovering from chronic acid deposition.

5. *Ecosystem services:* The main findings of the 2013 report, *Effects of long range transported air pollution (LRTAP) on freshwater ecosystem services*,[5] were presented. Through ecosystem service valuation, different environmental effects and their societal impacts can be evaluated in monetary and non-monetary values. In the initial phases of the Convention, non-monetary values were crucial, but recently monetary valuation of ecosystem services has received more attention, although not for freshwaters. Sports fishing is the freshwater ecosystem service that is most affected by acidification, resulting in large monetary losses. The Task Force noted that the concept of "ecosystem services" has been included in international environmental policy and recommended that ICP Waters continue to contribute to further quantification and assessment of ecosystem services rendered by acid-sensitive aquatic ecosystems.

6. *Nitrogen:* The Task Force noted that observed trends in inorganic nitrogen species in surface waters may be related to forest health and growth in some Czech catchments, as presented by Czech Task Force members. A possibly climate-induced bark beetle attack reversed declining trends in inorganic nitrogen species. The insect attack may be linked to extreme drought in previous years, illustrating climate as a confounding factor for recovery from acid deposition.

7. *Biological recovery*: Czech Task Force members documented some biological recovery based on monitoring records in the Czech Republic related to improved water chemical conditions. Acidification in the Czech Republic is still severe compared with other acidified regions in Europe, and surface waters remain strongly acidified. Despite large reductions in sulphur deposition, chemical and biological recovery in acidified waters of the Czech Republic are expected to suffer from long delays, related to severe depletion of base cation stores. The Task Force noted with satisfaction the extensive regional coverage of ICP Waters sites, which allow detection in differing recovery rates related to acid deposition history and soil characteristics.

8. *Dynamic modelling/critical loads:* Task Force members from Italy and Switzerland presented past and future water chemistry of several ICP Waters sites in Switzerland and Italy described with a dynamic model using several emission scenarios. They concluded that water chemistry of these lakes could be critical in the future, despite considerable reduction of emissions of sulphur and nitrogen compounds. The Task Force concluded that the work demonstrated the benefits of achieving the emission reductions for both sulphur and nitrogen, as agreed under the Protocol to Abate, Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol).[6]

9. *Parties in Eastern Europe, the Caucasus and Central Asia:* The National Focal Point from Armenia presented the status of water chemical monitoring data from the Debed River in Armenia where increases in sulphate concentrations are occurring, possibly related to emissions from industrial activity in Armenia and its surroundings. Deposition stations in background areas are not established, limiting the assessment of effects of air pollution in Armenia. The presentation illustrated current challenges facing countries in Eastern Europe, the Caucasus and Central Asia in relation to monitoring effects of air pollution. 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.

[5] Silje Holen, Richard F. Wright and Isabel Seifert, *Effects of long range transported air pollution (LRTAP) on freshwater ecosystem services*. ICP Waters Report 115/2013 (Oslo: Norwegian Institute for Water Research, 2013). Available from http://www.icp-waters.no/Publications/tabid/62/Default.aspx

[6] Available from http://www.unece.org/env/lrtap/multi_h1.html.

10. *Heavy metals:* National Focal Points of Sweden and Canada presented national data on mercury levels in freshwater fish. Mercury levels in freshwater fish in Canada and Sweden exceed limits advised for consumption by humans. Some fish species have significant increases in mercury over time. Reductions in mercury emissions do not result in declines of mercury in fish. Factors driving trends in mercury in aquatic biota are speculated to be related to reduced sulphur deposition, increased concentrations of dissolved organic carbon and global warming.

11. *Chemical intercomparison:* Results from the twenty-seventh chemical intercomparison were reported.[7] Sixty laboratories from 28 countries participated. The quality of results was similar to that in former years. In total, 76 per cent of all results were acceptable. The chemical intercomparison is a valuable tool for quality assurance of laboratory analyses.

12. *Biological intercalibration:* Results from the sixteenth biological intercalibration of invertebrates were reported.[8] The goal was to evaluate the quality and harmonize the taxonomic work. Four laboratories participated and showed good taxonomic work. Ten laboratories have participated on a regular basis in the intercalibration.

13. *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 International Cooperative Programmes (ICPs), i.e., the ICP on Integrated Monitoring of Air Pollution Effects on Ecosystems and the ICP on Modelling and Mapping of Critical Loads and Levels and Air Pollution Effects, Risks and Trends, as well as the Joint Expert Group on Dynamic Modelling.

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 (workplan item 1.1.10 (a))

14. Regarding further implementation of guidelines for reporting under the Convention (workplan item 1.1.10 (a)), ICP Waters, together with others ICPs, contributed to the review and revision by the European Union of the National Emission Ceilings Directive.[9] The contribution was compiled by the Coordination Centre for Effects.

[7] Carlos Escudero-Oñate, *Intercomparison 1327: pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni and Zn*, ICP Waters report 116/2013 (Oslo: Norwegian Institute for Water Research, 2013). Available from http://www.icp-waters.no/Publications/tabid/62/Default.aspx.

[8] Arne Fjellheim, Arne Johannessen and Torunn Svanevik Landås, *Biological intercalibration: Invertebrates 1713*, ICP Waters report 118/2014 (Oslo: Norwegian Institute for Water Research, 2014). Available from http://www.icp-waters.no/Publications/tabid/62/Default.aspx.

[9] See Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants.

B. Enhanced involvement of countries in Eastern and South-Eastern Europe, the Caucasus and Central Asia, and cooperation with activities outside the Convention (workplan item 1.1.10 (b))

15. With regard to the involvement of countries in Eastern and South-Eastern Europe, the Caucasus and Central Asia in ICP Waters work (workplan item 1.1.10 (b)), currently, only Armenia, Belarus and the Russian Federation participate in ICP Waters activities (see para. 9 above).

C. Cooperation with programmes and activities outside the region (workplan item 1.1.10 (c))

16. In terms of cooperation with programmes and activities outside the United Nations Economic Commission for Europe (ECE) region (workplan item 1.1.10 (c)), there are three countries — Indonesia, Japan and Thailand — that participate in the chemical intercomparison coordinated by ICP Waters.

D. Contribution to the joint annual report by the Working Group on Effects (workplan item 1.1.11)

17. ICP Waters contributed to the joint annual report by the Working Group on Effects on recent scientific findings and their implications for policy, containing clear policy-relevant messages and recommendations to the Working Group on Strategies and Review and to the Executive Body (workplan item 1.1.11) (see ECE/EB.AIR/WG.1/2014/3).

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

A. Identification of the state of surface water ecosystems and their long-term changes (workplan item 1.1.15 (a))

18. Concerning the identification of the state of surface water ecosystems and their long-term changes with respect to regional variation and the impact of selected air pollutants, including effects on biota (workplan item 1.1.15 (a)), a trend analysis on chemical water records is ongoing. The analysis will be presented in a report in 2014, with the tentative title “Trends in surface water chemistry and biology up to 2011: ecosystem response to emission reductions”.

B. Identification of changes in biodiversity and climate in surface water ecosystems (workplan item 1.1.15 (b))

19. Work to identify changes in biodiversity and climate in surface water ecosystems (workplan item 1.1.15 (b)) is ongoing. An analysis will be presented in a report in 2015.

V. Policy relevant issues, findings and recommendations

20. *Mercury still on the agenda:* Methyl mercury levels in freshwater fish in boreal areas (North America, Nordic countries) continue to exceed limits advised for human

consumption and are still of great concern in these areas. Reductions in mercury emissions have so far not resulted in declines of mercury in fish. Factors driving present trends in methyl mercury in aquatic biota are hypothesized to be related to reduced sulphur deposition, increased concentrations of dissolved organic carbon and climate warming (see para. 10).

21. *Biodiversity of acid-sensitive waters* has improved as a result of reduced sulphur emissions to the atmosphere. Continued monitoring of biodiversity in acid-impacted waters recovering from chronic acid deposition is needed to assess biodiversity related to acid deposition and climate change (see also paras. 25–26).

22. *Valuation of ecosystem services*: Ecosystem service valuation permits different environmental effects and their societal impacts to be evaluated in monetary, and not just non-monetary, terms. The Task Force noted that the concept of "ecosystem services" has been included in international environmental policy and recommended that ICP Waters continue to contribute to further quantification and assessment of ecosystem services rendered by acid-sensitive aquatic ecosystems. Other bodies under the Convention can also contribute to further quantification and assessment of ecosystem services rendered by acid-sensitive ecosystems (see also paras. 5 and 24).

23. *Parties in Eastern Europe, the Caucasus and Central Asia:* The Task Force urged the ICP Waters Programme Centre to continue its efforts to further include Parties in Eastern Europe, the Caucasus and Central Asia in the activities of the Programme Centre (see para. 9).

VI. 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

24. 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.

VII. Relevant scientific findings: highlights

25. *Ecosystem services*: Acid deposition affects the services provided by freshwater ecosystems. The loss of sport fisheries is by far the most important ecosystem service affected. Both inland fisheries (such as brown trout) and anadromous fish (such as Atlantic salmon) are sensitive to acidification. Damage and loss of fish populations has large ramifications for other ecosystem services, such as tourism, biodiversity, aesthetic value and cultural value. Ongoing work in both Europe and Canada indicates significant improvements in the ability to value in monetary terms the numerous potential benefits and costs of acid deposition abatement. There are still large gaps in understanding of the nature and value of acid deposition impacts. Despite the fact that some economic evaluation modelling capacity currently exists, economic evaluation models for acid deposition do not adequately account for environmental benefits resulting from abatement.[10]

[10] Silje Holen, Richard F. Wright and Isabel Seifert, ICP Waters Report 115/2013.

26. *Biodiversity*: Trends in biological diversity of benthic invertebrates from acid-sensitive lakes and rivers, sampled between 1982 and 2011 in the Czech Republic, Germany, Latvia, Norway, Sweden and the United Kingdom of Great Britain and Northern Ireland, were investigated. The results indicate an overall increase in species diversity during the study period, especially in the rivers. The increase in biodiversity is correlated with declining sulphate concentrations in surface waters, which in turn are related to reduced atmospheric deposition of sulphur. The changes in biodiversity could be related to chemical recovery of surface waters, where reduced sulphate concentrations are associated with increased pH[11] and lowered aluminium concentrations. Apart from the increasing species diversity seen in most sites, the biological recovery trends varied among sites. As a consequence of increased species diversity, the aquatic ecosystems are likely to have a higher resilience against future threats. An analogous increase can be expected in species diversity for comparable sites elsewhere. The improved biodiversity in acid-sensitive waters is in contrast to the worldwide trend of decreasing freshwater species diversity. ICP Waters results suggest that international policies to reduce sulphur emissions have promoted a positive development in species diversity of invertebrates in acid-sensitive surface waters.[12]

27. *Chemical recovery of acid-sensitive waters:* Acidification of lakes and rivers is still an environmental concern despite reduced emissions of acidifying compounds. Trends in surface water chemistry of 173 acid-sensitive sites from 12 regions in Europe and North America were analysed. In 11 of 12 regions, non-marine sulphate declined significantly between 1990 and 2008 (−15 to −59 per cent). In contrast, regional and temporal trends in nitrate were smaller and less uniform. In 11 of 12 regions, chemical recovery was demonstrated in the form of positive trends in pH and/or alkalinity and/or acid neutralizing capacity. The positive trends in these indicators of chemical recovery were regionally and temporally less distinct than the decline in non-marine sulphate and tended to flatten after 1999. From an ecological perspective, the chemical quality of surface waters in acid-sensitive areas in these regions has clearly improved as a consequence of emission abatement strategies, paving the way for some biological recovery.[13]

VIII. Publications

28. For a list of ICP Waters publications and references for the present report, please visit the ICP Waters website.[14]

[11] In chemistry, pH is a measure of the acidity or basicity of an aqueous solution.

[12] Gaute Velle and others, ICP waters report 114/2013.

[13] Øyvind A. Garmo and others, 2014. “Trends in Surface Water Chemistry in Acidified Areas in Europe and North America from 1990 to 2008”, *Water Air & Soil Pollution*, vol. 225 (February 2014), p. 1880. Available from http://rd.springer.com/article/10.1007/s11270-014-1880-6,

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