NIVA REPORT SNO 7437-2019

ICP Waters Report 139/2019

Proceedings of the 35th Task Force meeting of the ICP Waters Programme in Helsinki, June 4-6, 2019

Photo: Hubert Schulte-Bisping

International Cooperative Programme on Assessment and Monitoring Effects of Air Pollution on Rivers and Lakes

Convention on Long-Range Transboundary Air Pollution

Norwegian Institute for Water Research

REPORT

Main Office
Gaustadalléen 21
NO-0349 Oslo, Norway
Phone (47) 22 18 51 00

NIVA Region South
Jon Lilletuns vei 3
NO-4879 Grimstad, Norway
Phone (47) 22 18 51 00

NIVA Region East
Sandvikaveien 59
NO-2312 Ottestad, Norway
Phone (47) 22 18 51 00

NIVA Region West
Thormøhlensgate 53 D
NO-5006 Bergen Norway
Phone (47) 22 18 51 00

NIVA Denmark
Njalsgade 76, 4th floor
DK 2300 Copenhagen S, Denmark
Phone (45) 39 17 97 33

Internet: www.niva.no

Title	Serial number	Date
Proceedings of the 35th Task Force meeting of the ICP Waters Programme in Helsinki, June 4-6, 2019	NIVA 7437/2019 ICP Waters report 139/2019	10.12.2019
Author(s)	**Topic group**	**Distribution**
Øyvind Garmo, Kari Austnes and Jussi Vuorenmaa (editors)	Acid rain	Open
	Geographical area	**Pages**
	Europe and North America	49

Client(s)	Client's reference
Norwegian Environment Agency (Miljødirektoratet) United Nations Economic Commission for Europe (UNECE)	
Client's publication:	Printed NIVA
ICP Waters report 139/2019	Project number 10300

Summary

Proceedings of the 35th Task Force meeting of the ICP Waters Programme in Helsinki, June 4-6, 2019. National contributions from Russia.

Four keywords		Fire emneord	
1.	Monitoring	1.	Overvåkning
2.	Freshwater	2.	Ferskvann
3.	Air pollution	3.	Luftforurensning
4.	ICP Waters	4.	ICP Waters

This report is quality assured in accordance with NIVA's quality system and approved by:

Kari Austnes — Project Manager

Heleen de Wit — Research Manager

ISBN 978-82-577-7172-0
NIVA-report ISSN 1894-7948

CONVENTION OF LONG-RANGE TRANSBOUNDARY AIR POLLUTION

INTERNATIONAL COOPERATIVE PROGRAMME ON ASSESSMENT AND MONITORING EFFECTS OF AIR POLLUTION ON RIVERS AND LAKES

Proceedings of the 35th Task Force meeting of the ICP Waters Programme in Helsinki, June 4-6, 2019

Prepared at the ICP Waters Programme Centre
Norwegian Institute for Water Research
Oslo, December 2019

Preface

The International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters) was established under the Executive Body of the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) in July 1985. Since then, ICP Waters has been an important contributor to document the effects of implementing the Protocols under the Convention. ICP Waters has prepared numerous assessments, reports and publications that address the effects of long-range transported air pollution.

ICP Waters and its Programme Centre is chaired and hosted by the Norwegian Institute for Water Research (NIVA), respectively. A programme subcentre is established at NORCE (previously known as Uni Research), Bergen. ICP Waters is supported financially by the Norwegian Environment Agency and the Trust Fund of the UNECE LRTAP Convention.

The main aim of the ICP Waters programme is to assess, on a regional basis, the degree and geographical extent of the impact of atmospheric pollution, in particular acidification, on surface waters. More than 20 countries in Europe and North America participate in the programme on a regular basis.

An important basis of the work of the ICP Waters programme is the data from existing surface water monitoring programmes in the participating countries, collected through voluntary contributions. The ICP Waters site network is geographically extensive and includes long-term data series (more than 25 years) for many sites. The programme conducts annual chemical intercomparison and biological intercalibration exercises.

At the annual ICP Waters Task Force meeting, national ongoing activities in many countries are presented. This report presents national contributions from the 35th Task Force meeting of the ICP Waters programme, held in Helsinki, Finland, June 4-6, 2019.

Øyvind Aaberg Garmo

ICP Waters Programme Centre
Oslo, December 2019

Table of contents

1 Introduction

The International Cooperative Programme on Assessment and Monitoring of Rivers and Lakes (ICP Waters) is a programme under the Working Group on Effects of the Convention on Long-Range Transboundary Air Pollution. The main aims of the programme are:

- To assess the degree and geographic extent of the impact of atmospheric pollution, in particular acidification, on surface waters;
- To collect information to evaluate dose/response relationships;
- To describe and evaluate long-term trends and variation in aquatic chemistry and biota attributable to atmospheric pollution.

The national contributions on ongoing activities that were presented during the ICP Waters Task Force meeting in Helsinki, Finland, June 4-6, 2019 were grouped thematically. A short summary of each presentation is given in the Minutes (Chapter 4). Two presenters contributed more extensive reports on their presentations to the Proceedings.

Acidification and recovery

- Is there a need for a revision of the chemical acidification criteria in the Nordic countries? (Jens Fölster, Sweden)
- Contrasting responses of two neighboring lake ecosystems in the English Lake District to acid deposition. (Don Monteith, UK)
- Migration of chemical elements in the system: Atmospheric precipitation - lysimetric waters – lake waters in the Valday region. (Dimitry Baranov, Russian Federation)
- Trends in surface water chemistry. The upcoming trend report - preliminary results. (Øyvind Garmo, ICP Waters Programme Centre)
- Long term water chemistry trends in small boreal lakes in southern Finland relative to sulphur and nitrogen deposition. (Lauri Arvola, Finland)

Climate change and land use

- Forest disturbance effect on soil nutrients and lake chemistry - Plešné Lake. (Filip Oulehle, Czech Republic)

Heavy metals and POPs

- Trends and source apportionment of atmospheric heavy metals in Finland. (Katriina Kyllönen, Finland)
- Archived invertebrate samples show LT-decline in Hg: caused by decline in S deposition? (Heleen de Wit, ICP Waters Programme Centre)
- Trends in elements speciation in Imandra lake and small lakes of the Kola Peninsula. (Marina Dinu, Russian Federation)
- Estimating the re-emission of Hg from soil to atmosphere in ICP IM catchments. (Karin Eklöf, Sweden)

Biodiversity

- Major disturbances test resilience at a long-term boreo-nemoral forest monitoring site (James Weldon, Sweden)
- A preliminary study of functional diversity in streams. (Gaute Velle, ICP Waters Programme Sub-centre)

- N deposition and bryophyte responses in boreal background forests. (Maija Salemaa, Finland)

NEC Directive
- NEC directive introductory presentation. (Kari Austnes, ICP Waters Programme Centre)
- The National Emission Ceilings Directive: Insights from Italy. (Michela Rogora, Italy)

Critical loads and modelling
- CCE and ICP M&M common vision and future activities. (Alice James, France, and Thomas Scheuschner, Germany)

Nitrogen and element budgets
- Water quality on Georgian rivers and lakes. (Marine Arabidze, Georgia)
- Air Quality Monitoring and Information Dissemination in Armenia. (Arpine Gabrielyan, Armenia)
- Response from call for data on ICP IM. (Jussi Vuorenmaa, Finland)

2 Trends in elements speciation in Imandra Lake and small lakes of the Kola Peninsula

Dinu M.I.
Vernadsky Institute of Geochemistry and Analytical Chemistry, Russia

Speciation of metals in natural waters gives important information about the level of toxicity. According to numerous published data, heavy metals (except mercury) are most toxic in ionic form. However, the study of the metal speciation in each water body requires extensive physical-chemical work.

Understanding the patterns of element distributions in surface waters and the reasons for increasing concentrations of these elements at the regional and global scale is very important. Metal enrichment of surface waters is the result of both natural processes and human activities. The anthropogenic contribution to the release of trace elements to the environment has increased dramatically over the last century. This is associated with the ever-increasing volumes of extracted metals and their dispersal in the environment.

The aim of our research was to investigate the distribution of the metal species in lakes on the Kola Peninsula under different anthropogenic loading.

<u>Expeditionary work:</u>

The Kola lakes include more than 200 lakes, but 100 were selected for the experimental determination of the metal species and mathematical calculation of equilibrium concentrations. The Imandra Lake sampling was in the Yokostrovskaya and Monche parts. In addition, we used existing data for the period 1990 – 2018 (T. Moiseenko and Kola scientific center date). In total, data from more than 15 points on the lake were used.

<u>Methods and equipment:</u>

We used ion-exchange technologies and membrane filtration systems to evaluate labile and non-labile forms of the investigated elements (**Figure 2-1**). General chemical parameters (analysis on the first day after sampling) were measured at the Kola Science Center; the content of trace elements was determined using ICP techniques.

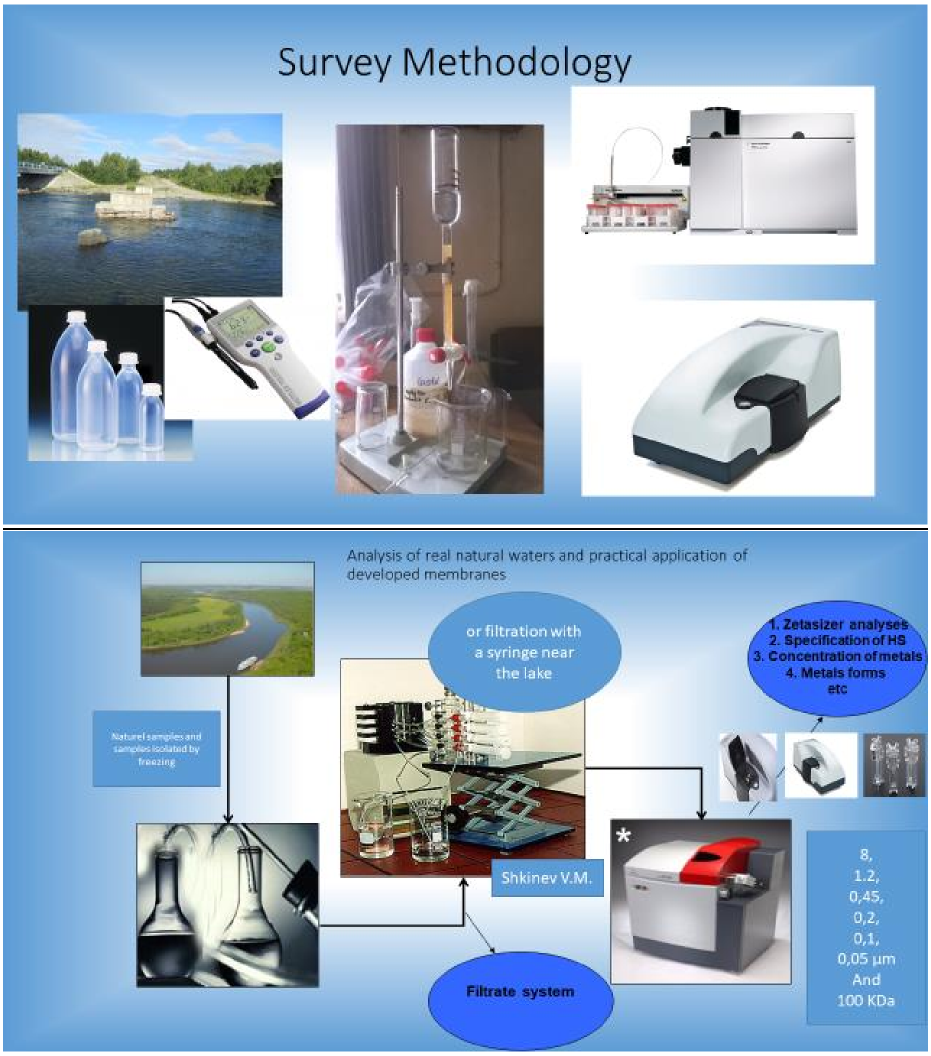

Figure 2-1. Equipment used for sampling and analysis in this study.

Some results:

Samples of lakes near industrial sites were selected near the mining processing complex in Kovdor and from Lake Monche (Lovozero) near the copper-nickel manufacture. Natural waters were characterized by high alkalinity and pH about 7. Speciation of iron at such pH values is more in the form of hydroxy compounds compared with aluminum. Under conditions of high anthropogenic loads, chromium ions are characterized by sufficient complexing capacity, which may be due to concentrations of the metal which are several times higher as compared with lakes without direct sources. Manganese in such conditions has a high capacity to form suspensions. The complexation of heavy metals (Cd, Pb, Cu, Zn) is modified as follows: as for lakes without a direct source of pollution, zinc is complexed by more than 50%, copper also forms complexes with organic matter actively due to a significant increase in concentration. Depending on the type of copper coming from the wastewater, copper may form sorption units and low-molecular inorganic compounds.

Forms of nickel in natural waters with a direct source of pollution range from units to sorption complexes with organic matter. A significant increase in metal concentration shifts the equilibrium in the system towards formation of high-molecular compounds. An interesting feature of the distribution of elements on the different forms is the increasing complexation with organic matter for the elements of the lanthanide series in such natural waters. Lanthanide elements is associated elements of many rocks of the Kola Peninsula, which explains the increase in their concentration in the areas near the plant. The affinity of these elements to an organic substance as follows: Fe>Al>Zn>Ni>Cu>Pb>La>Ce>Co.

High content of technogenic elements – Ni, Cu - create conditions for competition for organic ligands and the other formation of charge. Zeta potential change occurs dynamically and not smoothly. Middle waters (25 samples between the polluted area and the background) are characterized by 2 maxima of zeta potential. The color of the solution does not change. Turbidity and pH vary widely.

Trends 1990-2014-2018 for small lakes:

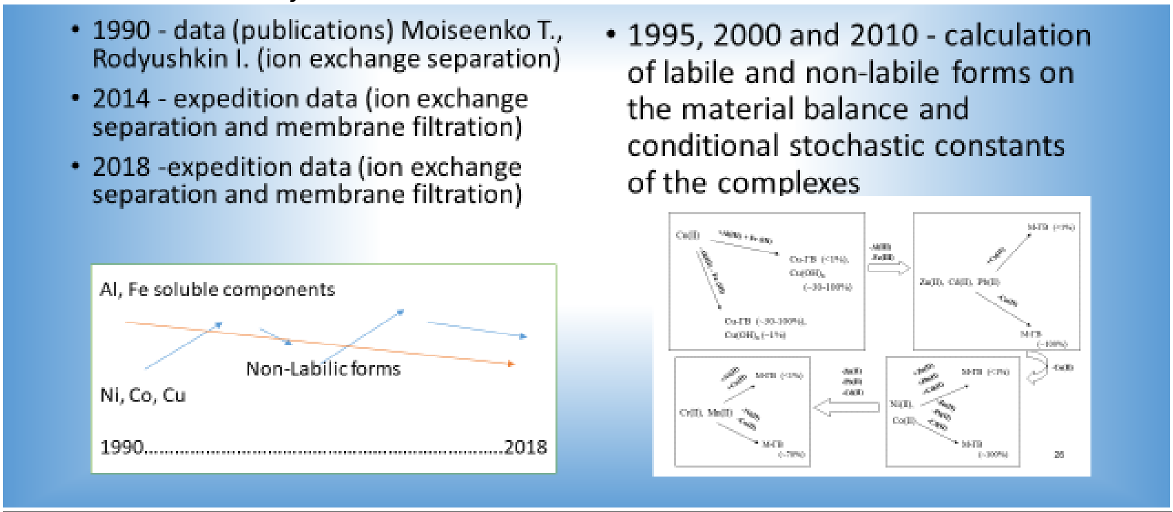

Figure 2-2. Trends 1990-2018 for small lakes

Non-labile forms of nickel and cobalt are changing dynamically from 1990 to the present and this fact directly depends on episodes of maximum pollution and turbidity. The proportion of the soluble part of the iron and aluminum compounds is also reduced.

Trends 1990-2014-2018 for Imandra lake:

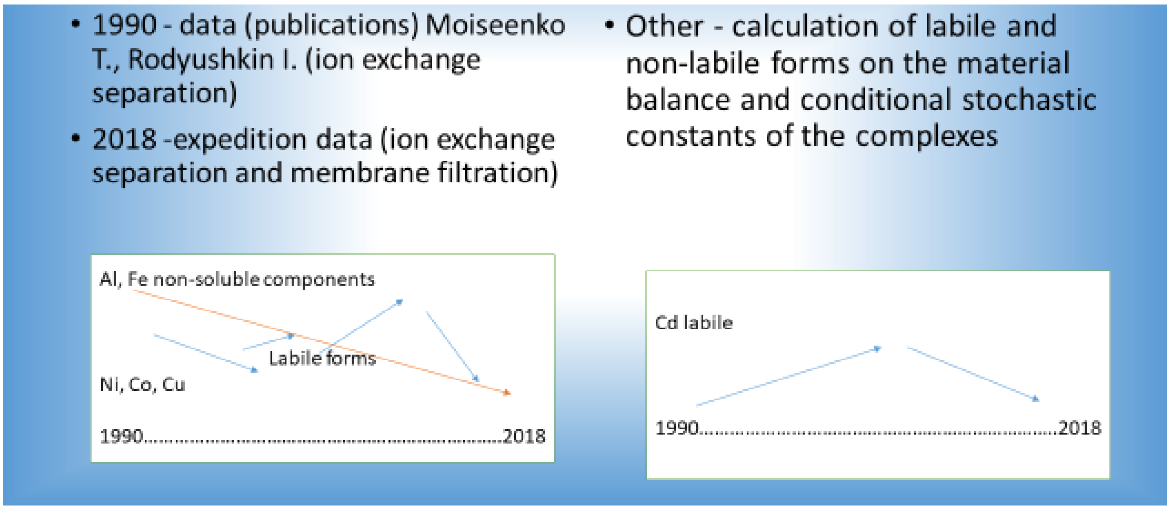

Figure 2-3. Trends 1990-2018 for Imandra lake

The change in the labile forms of nickel, cobalt, and copper also fluctuates and is associated with competitive processes in Lake Imandra in certain years. It was in this lake that the highest labile cadmium contents were found in the middle of the study period.

This work was supported by a grant from the Russian Foundation for Basic Research 18-05-60012.

3 Migration of chemical elements in the system: atmospheric precipitation - lysimetric water

Baranov D.
Vernadsky Institute of Geochemistry and Analytical Chemistry, Russia

Environmental pollution is a modern problem. Most of the investigations are currently carried out in industrials regions. Despite the high interest in objects in these regions, the background regions are also important to study as indicators of transboundary transfers. The chemical composition of atmospheric precipitation is a sensitive indicator of air pollution. But elements migration in the atmospheric precipitation-lysimeter waters system is an informative model for comprehensive assessment of the pollution influence.

Study area:
The Valday region is located in the north-western part of the Russian continental plateau. Sedimentary rocks are exposed moraine and drift deposits and block crystalline basement. The region is characterized by hilly and ridge-back topography. Podzolic soils are composed of clay and sodic (sodium-rich) sediments and spread throughout the investigation region. The Valday region is part of the subzones of the middle and southern taiga, as well as in the zone of mixed forests. Wetlands are widespread in the research region.

Materials and methods:
Three experimental places for collecting precipitation and lysimetric waters were selected. The precipitation collectors were located in the forest (Figure 3-1) between the trees (background area) and in Valday city (open place). One lysimeter was located in the city, and the other 6 in the forest (fig 1), some distance from the city.

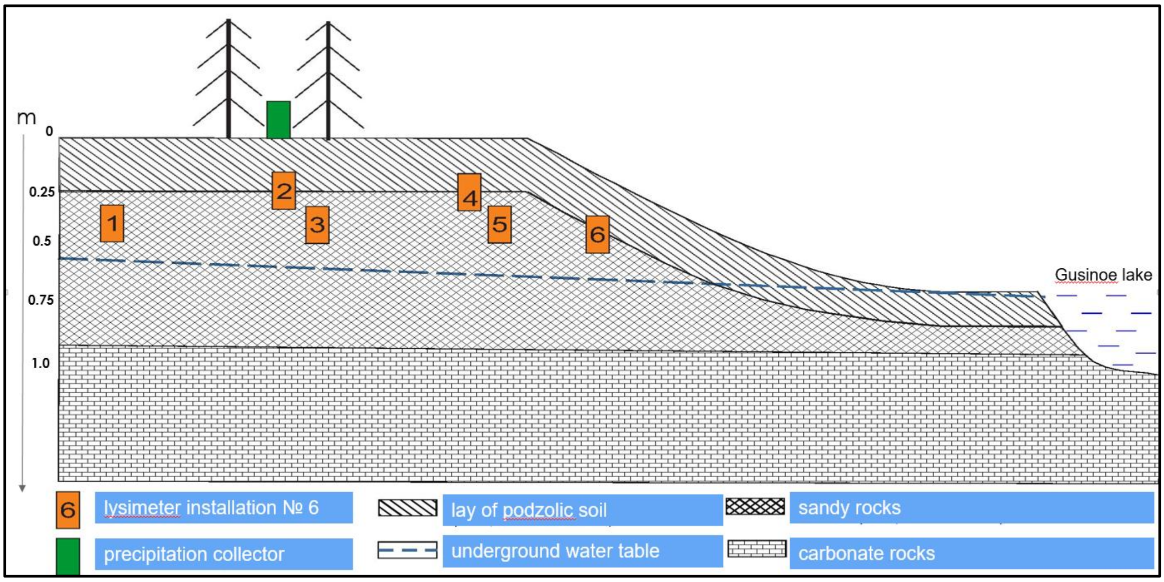

Figure 3-1. Scheme of locations of lysimeters and precipitation collectors in the forest

To collect atmospheric precipitation a 5-litre bottle and a funnel with a diameter of 0.25 m was used. The lysimeters consist of a 2-litre bottle, a deriving tube and the same plastic funnel. Sampling is systematically carried out in the spring-summer-autumn period. Analyses were carried out immediately after sampling, by the Laboratory of State Hydrological Institute. The measured parameters were temperature, pH, conductivity, redox potential and determination of cations and anions. Concentrations of trace elements were analyzed by ICP-MS and ICP-AES.

Results and discussion:
The quantity of precipitation increased from year to year during the study period.
pH of inter-crown sediments is lower than the pH of the precipitations of open areas (Figure 3-2). The lowest pH values in the sub-crown precipitation were observed in the summer (minimum value pH =5.0) due to the leaching of organic matter from the foliage. The precipitation in the open area was neutral or slightly alkaline. Anthropogenic acidification is absent in the research area.

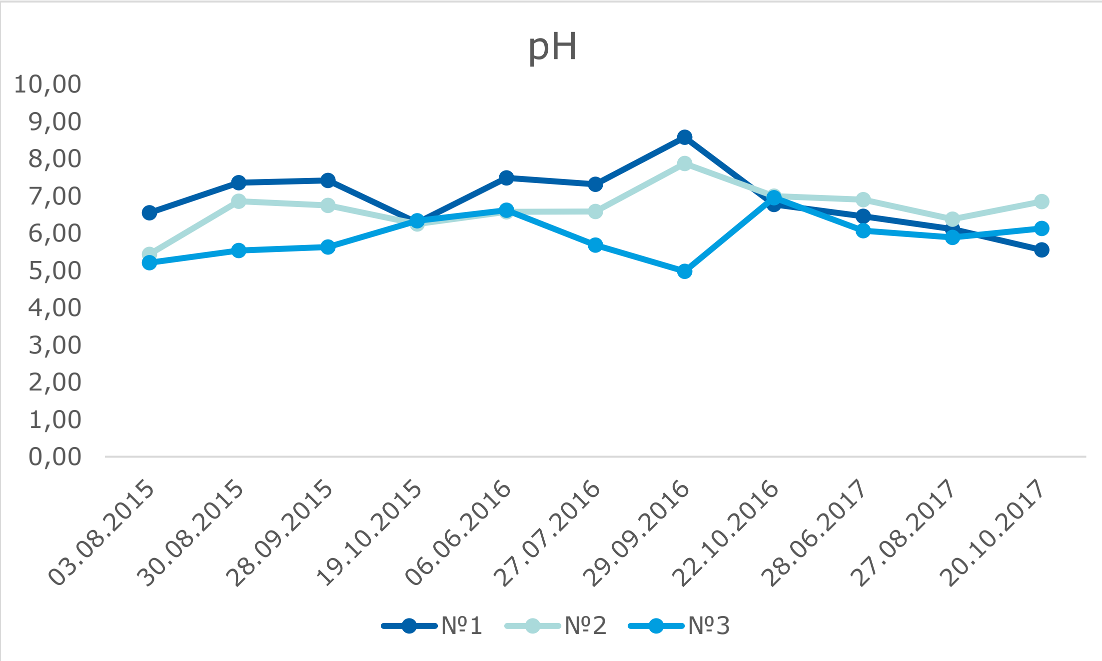

Figure 3-2. Dynamics of pH in precipitation collectors. №1 – precipitation collector in an open place far from the city (> 3 miles); №2 – in an open place near the city (< 2 miles); №3 – in the forest (>15 miles from the city).

The sulfate concentrations indicate anthropogenic influence in the research area (Figure 3-3), and the highest sulfate concentration was found in precipitation collector №1.

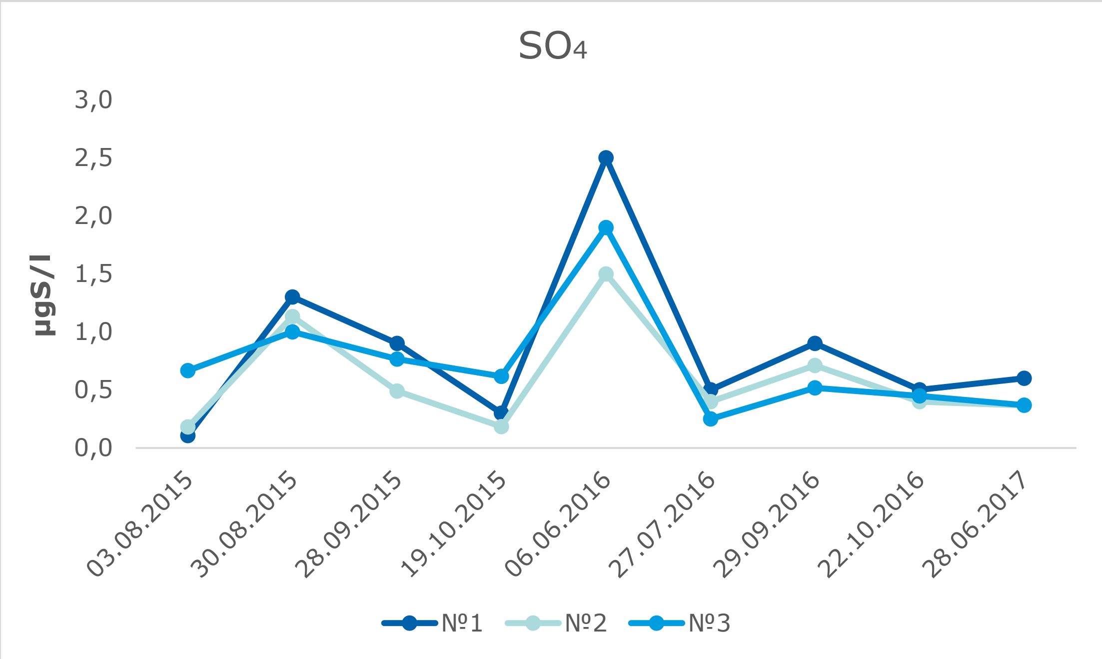

Figure 3-3. Dynamics of SO4 in precipitation collectors. №1 – precipitation collector in an open place far from the city (> 3 miles); №2 – in an open place near the city (< 2 miles); №3 – in the forest (>15 miles from the city).

The highest average concentrations of Zn and Cu in sub-crown precipitation was observed in summer (Figures 3-4 and 3-5). We found the highest concentrations of elements in precipitation collector №3-is located under the crown of the trees. It is probably connected with enrichments by leaching of elements from the tree crowns.

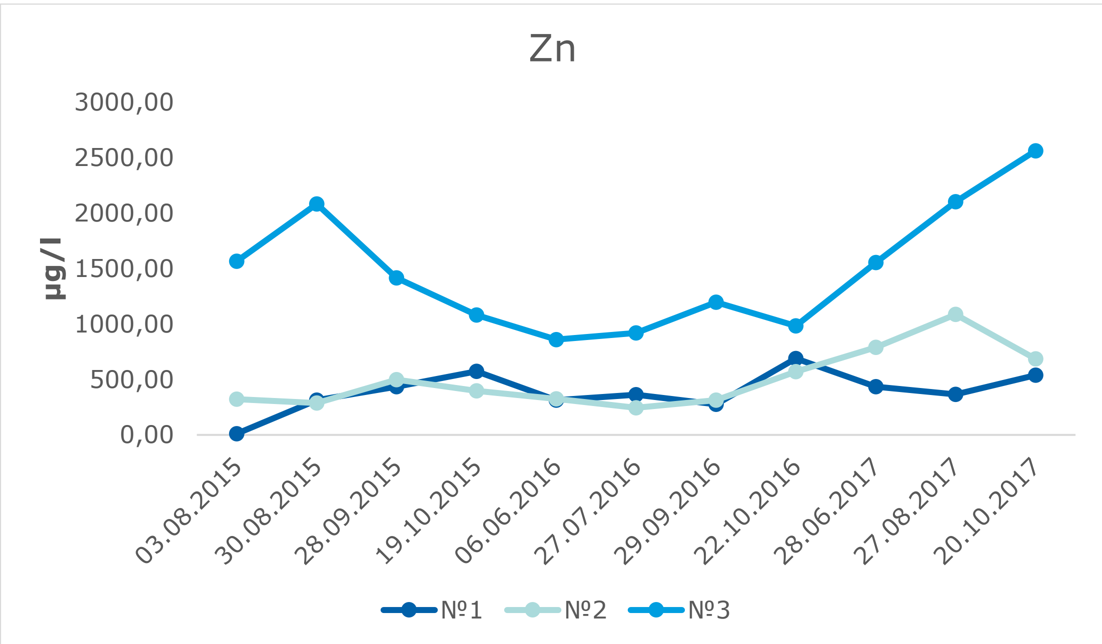

Figure 3-4. Dynamics of Zn in precipitation collectors. №1 – precipitation collector in an open place far from the city (> 3 miles); №2 – in an open place near the city (< 2 miles); №3 – in the forest (>15 miles from the city).

Concentrations of copper and zinc in the open area were the same during the period of research.

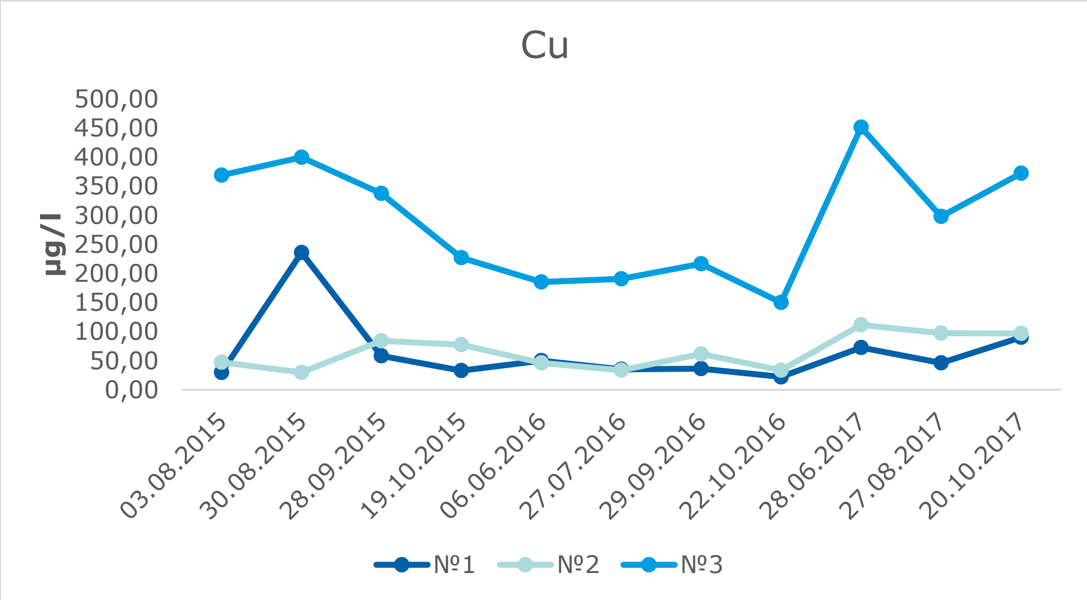

Figure 3-5. Dynamics of Cu in precipitation collectors. №1 – precipitation collector in an open place far from the city (> 3 miles); №2 – in an open place near the city (< 2 miles); №3 – in the forest (>15 miles from the city).

Conclusions:

1. The quantity of precipitation is increased from 2015 to 2017.
2. Concentration of Cu, Zn and pH values are high in forest (under crown) precipitation.
3. Higher concentration of SO4 in precipitation in the open areas may indicate anthropogenic load

This article was financially supported by RFBR grant 18-17-00184

4 Minutes of the 35th Task Force meeting of the ICP Waters programme held in Helsinki, Finland, June 4-6, 2019

CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

Working Group on Effects

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

MINUTES

of the 35th meeting of the Programme Task Force of ICP Waters, and the 4th Joint ICP IM and ICP Waters TF meeting, Helsinki, Finland, 4-6 June 2019

KEY MESSAGES OF ICP WATERS 2019 TASK FORCE MEETING

Policy developments regarding air pollution:

Monitoring of air pollution effects on freshwaters, semi-natural habitats and forest ecosystems is mandatory under the updated EU National Emission Ceilings (NEC) Directive. Member states submitted monitoring programmes in 2018 and the first data will be reported by 1 July 2019. National Focal Centres informed at the Task Force meeting that reporting procedures were somewhat lacking in detail and clarity, which may result in a lower quality of reported data than optimal for assessing the effect of the NEC Directive on ecosystems. Relevant expertise for improving the reporting procedures is available in the WGE.

A Nordic project that aims to harmonize systems for acidification assessment based on physico-chemical parameters provided a relevant example of challenges and benefits of harmonization procedures to increase consistency in international environmental assessments.

Acidification and recovery

Trend analysis of monitoring data (1990-2016) from Europe and North America showed a decrease in sulphate and base cations, while ANC, pH and DOC increased at many of the sites. In Europe, most change points (i.e. breaks or changed slope) in time series for sulphate, base cations and ANC appeared just before year 2000, while most change points in DOC appeared almost a decade later. A study of two neighbouring lakes in the Lake District of the UK highlights the importance of buffering capacity for the recovery from acidification. However, changes in sulphur deposition and DOC levels may have affected diatom communities even in the relatively well-buffered lakes.

Climate change and land use

Natural disturbances such as bark beetle infestations, the frequency of which can be affected by climate change and forestry practices, can affect nutrient and base cation stores in the soil, and thereby recovery in severely acidified systems. Forestry practices can also affect surface water chemistry more directly through its influence on soil chemistry.

Biodiversity

Linking water quality to functional biodiversity can provide further insight into the effects of air pollution in surface waters. The functional traits have direct consequences for ecosystem health and for ecosystem services, such as litter breakdown, water filtering and nutrient. Data from Norwegian rivers spanning over the last 30 years showed an increase in filterers and predators over time, and a decrease in shredders. Most of the changes were correlated to acid deposition.

Mercury

The fish mercury (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. 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 of the Minamata Convention on Mercury (September 2017). A general recommendation for monitoring of mercury in freshwater fish was to include repeated sampling of the same water body over time.

The meeting of the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters) organized jointly with the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution Ecosystems (ICP Integrated Monitoring), was attended by 55 experts from the following 20 Parties to the Convention on Long-range Transboundary Air Pollution (CLRTAP): Armenia, Austria, Canada, Czech Republic, Estonia, Finland, France, Georgia, Germany, Italy, Latvia, Lithuania, Norway, Poland, Russian Federation, Spain, Sweden, Switzerland, United Kingdom and United States of America. A complete list of participants can be found **Annex I.**

Introductions

1. Ms. de Wit (Chair ICP Waters) and Mr. Grandin (Co-Chair ICP IM) opened the meeting and welcomed the representative from the ICP IM, Martin Forsius.

2. Mr. Forsius (ICP IM Programme Centre) welcomed the parties on behalf of the Finnish Ministry of Environment, the Environment Institute and ICP IM.

3. Ms. De Wit and Mr. Grandin thanked Mr. Forsius for the warm and welcoming words and asked whether the agenda could be adopted.

4. The agenda for the meeting was adopted.

5. Mr. Vuorenmaa and Ms. Kleemola (ICP IM Programme Centre) gave brief practical information about meals and the excursion to Suomenlinna and the Helsinki archipelago.

6. Mr. Olendrzyński (Secretariat of the CLRTAP) gave a talk, via video link, about the structure of the Convention and recent and planned activities of relevance. He started by giving a brief overview of the history of the Convention. It now contains targets for sulphur, nitrogen, heavy metals, as well as particulate matter, including black carbon. He went through the organizational chart of the Convention. In the last years, amendments to the 3 most recent protocols have been approved at the sessions of the Executive body. The convention has been extended by eight protocols. He went through the review process for the amended Gothenburg Protocol and described the role of WGE. He finished by going through the 2018 and 2019 developments concerning capacity building. Next December the Convention is 40 years. A global forum on clean air will be launched.

7. Ms. de Wit asked if the CLRTAP should now be called the Clean Air Convention. Mr. Olendrzyński answered that CLRTAP is still the appropriate term.

8. Mr. Forsius (ICP IM Programme Centre) presented ongoing activities in the WGE and the Bureau. He gave an overview of the most significant meetings that have taken place during the last year, and the main topics that were discussed at these meetings. There is a suggestion by Sweden to transform former JEG-DM to a center under the Convention, but no decision has been reached yet.

9. Mr. Valinia (Co-Chair ICP IM) presented the work with a new WGE portal, via video link. A new web page is under development, which will include a data portal. A request has recently been sent out to provide data by June 1st.

10. Mr. Grandin (Co-Chair ICP IM) presented current issues, achievements and priorities for ICP IM. He gave a brief introduction of the ICP IM, its key tasks, monitoring network and activities. The network has increased by 5 reopened Polish stations since last year. He provided

highlights from recent studies and described work in progress. The ICP IM intend to cooperate more closely with LTER Europe in the future.

11. Ms. de Wit (Chair ICP Waters) presented current issues from ICP Waters. She introduced Ms. Austnes as the new leader of the Programme Centre. She welcomed new Focal Centres in Armenia, Georgia and Spain. She thanked ICP IM for good collaboration and organization of joint meetings. She gave an overview of participation in the various activities of the ICP Waters Programme. She reminded the attendants about the aims of the programme and described the work plan and went on to describe recent and planned reports. Current issues include: Data portal and open access, trend assessment, NEC Directive cooperation with other bodies under the Convention. She finished by introducing possible topics for future reports.

Acidification and recovery

12. Mr. Fölster (Sweden) and Mr. Garmo (ICP Waters Programme Centre) presented results from a Nordic project on harmonization of systems for assessment of (chemical) acidification. The systems in Norway, Sweden and Finland are quite different and several potential reasons for this were suggested. The Norwegian system focuses on calcium poor, clear waters. An exercise where recent data from a selection of sites across all three countries were classified according to the different systems showed marked differences, especially for brown waters. The Norwegian system tends to classify fewer water bodies as “moderate” or worse than the Swedish and Finnish system (the latter is only defined for running waters). Mr. Fölster went on to present results showing how different physicochemical parameters are correlated to changes in the benthic macrofauna. Overall, ANC corrected for organic acids appears to be the most promising individual parameter.

13. Mr. Monteith (UK) asked how to distinguish between acidified water bodies and naturally acidic lakes. Mr. Fölster answered that modelling of the reference state was necessary. One work package that will focus on time series might also provide useful information.

14. Mr. Monteith (UK) gave the presentation “Contrasting responses of two neighboring lake ecosystems in the English Lake District to acid deposition”. One of the lakes had better buffer capacity than the other, which has resulted in different water chemistry trajectories during the acidification period. Sediment cores and sediment traps show different responses in the diatom community from pre-industrial times and up to now in the two lakes. Even the diatom community in the lake that was not very acidified could indirectly be affected by sulphur deposition because of changes in DOC level.

15. Mr. Baranov (Russian Federation) gave the presentation «Migration chemical elements in the system: atmospheric precipitation – lysimetric waters – lake waters in Valday region». The Valday region is located in Reserve National Park. The area is not affected by direct sources of pollution, and Valday is considered a background region for assessment of transboundary migration. A total of 7 lysimeters and 3 precipitation collectors were installed. Lysimeters were installed in the forest area and in the open place (in Valday city). Sulphate, heavy metals and pH were determined in precipitation and lysimetric waters. The amount of precipitation was also measured. The results showed that pH of the forest precipitation is lower than the pH of precipitation in open areas due to the leaching of organic matter from leaves. Sulphate predominates in the precipitation of the city. The amount of precipitation increased year by

year (2015-2017). The concentration of Cu and Zn was higher in precipitation samples from the forest than those from the open area, and Ni and Pb concentrations were quite variable.

16. Ms. de Wit asked about the sources of the heavy metals. Ms. Dinu (Russian Federation) commented that a fraction of the metals was believed to come from industrial sources, some of it possibly quite far away.

17. Mr. Garmo (ICP Waters Programme Centre) presented preliminary results from the upcoming report on trends in surface water chemistry. The initial analysis focused on time series for the period 1990-2016 from 231 stations sampled seasonally (lakes) or monthly (rivers/streams), and with fewer than 25% of the values between 1995 and 2011 missing. Sulphate and base cations had decreased while ANC, pH and DOC increased at many of the sites. Trends for nitrate was more mixed. Bayesian change point analysis was used to find change points in the median time series. In Europe most change points in time series for sulphate, base cations and ANC were detected just before year 2000, while most change points in DOC appeared almost a decade later. For North America there was no clear pattern across all regions. Trends in annual medium and minimum ANC and pH were compared. Interesting contrasts between regions with different exposure to sea salts were displayed, indicating that change in annual minimum pH did not necessarily reflect the increase in annual median ANC and pH. The report will include a chapter reviewing effects of changes in land use on recovery from acidification. Mr. Garmo asked for input on types of land use change that should be considered, and if any of the parties had data to contribute or knew country-wise statistics concerning changes in forested area caused by afforestation or overgrowing, insect attacks/forest dieback, forest fertilization, differences in forestry practices (e.g. whole tree harvest versus stem-only harvest) or total volume harvested per year.

18. Mr. Arvola (Finland) presented long-term water chemistry trends in small boreal lakes in southern Finland relative to sulphur and nitrogen deposition. Water chemistry data from 35 lakes for the period 1990-2018. The study area is approximately 10 km^2 with coniferous and mixed forest. The trajectories of major ions such as calcium and magnesium as well as color and iron have shown diverse responses as sulphur deposition has declined. Lakes have been impacted by forestry and there are indications that it has caused increase in e.g. color. However, beaver activity is a confounding factor because the animal might impact the water chemistry.

Climate change and land use

19. Mr. Oulehle (Czech Republic) gave a presentation of bark beetle disturbance effect on soil nutrients and lake chemistry in a glacial catchment (Plešné Lake). He started the talk by pointing out that dry conditions over the last years has had an impact on water chemistry. The lake has been monitored for water chemistry since 1984. He presented whole ecosystem nutrient (N, Ca, Mg, K) mass balances in the forested catchment of the lake, which has undergone transient changes linked to the recovery from anthropogenic acidification and to the forest disturbances caused by severe infestations by the bark beetle (Ips typographus). Measured fluxes and storage of nutrients in the lake-catchment ecosystem were used to constrain the process-oriented biogeochemical model MAGIC. Simulated lake water chemistry and changes in soil nutrient pools fitted observed data and revealed that i) the ecosystem N

retention declined, thus nitrate leaching increased for 10 years following the bark beetle disturbance, with transient adverse effects on the acid-base status of lake water, ii) the kinetics of nutrient mineralisation from decaying biomass coupled with nutrient immobilization in regrowing vegetation constrained the magnitude and duration of ecosystem losses of N, Ca and Mg, iii) the excess of mineralized base cations from decomposing biomass replenished the soil cation exchange matrix, which led to increased soil base saturation, and iv) the improvement of the catchment soil acid-base status led to an increase of lake water pH and acid neutralizing capacity. The results show that in this natural forest ecosystem protected from human intervention, disturbances together with natural post-disturbance vegetation recovery have temporally positive effects on the nutrient stores in the soil.

Heavy metals and POPs

20. Ms. Kyllönen (Finland) gave the presentation "Trends and source apportionment of atmospheric heavy metals in Finland". Mercury concentrations in air are higher in the north than in the south, which is opposite of several other heavy metals. Levels of heavy metals show large seasonal variation and a decline over time, while Hg has remained virtually constant over time. Sources of HM as well as SO4 and NO3 have been apportioned to various sources, including long range transport, the Kola industry, and natural sources using positive matrix factorization. No statistically significant increasing trends were observed.

21. It was asked how one could distinguish between Kola and other sources of long-range transport. Ms. Kyllönen said that it had to do with the wind direction.

22. Ms. de Wit (Chair ICP Waters) gave a presentation entitled "Archived invertebrate samples show LT-decline in Hg: caused by decline in S deposition?". Mercury in fish has declined, but it is not clear why. Potential causal explanations include a decline in Hg deposition, browning of waters, declining sulphur deposition, and ecological changes affecting fish populations. Hg has increased in surface sediment since the 70s while Hg in chironomids has showed a fivefold decrease. Ms. de Wit proposed that declining Hg methylation, due to reduced availability of sulphate, and increased affinity of DOM for Hg could explain the results, referring to a manuscript she had coauthored and submitted to Environmental Science and Technology.

23. Mr. Ulańczyk (Poland) asked whether any mass balance estimates have been done. Ms. de Wit answered no. Mr. Stoddard (USA) asked if one would not expect more methylation because of higher DOC concentrations. Ms. de Wit answered that increasing DOC had not necessarily caused a large increase in labile DOM.

24. Ms. Dinu (Russian Federation) presented "Trends in elements speciation in Imandra lake and small lakes of the Kola Peninsula", showing results from lakes affected by emissions from smelters to a varying degree. She described the separation of metal fractions according to mass and charge in water samples from the Kola Peninsula (more than 100 small lakes and Imandra Lake). Speciation of metals in natural waters gives important information about toxicity. The most dangerous form of migration of heavy metals (except mercury) is considered to be the ionic form. However, the study of metals distribution forms in each water object is a task that requires a huge physical-chemical work. A decrease in soluble forms of aluminum and iron from 1990 to 2018, as well as an uneven change in the quantity of copper and nickel complexes with organic matter, was found in the small lakes. In Imandra

Lake, in the part near Monche, the maximum concentration of labile cadmium was found in the 2000s.

25. Ms. Eklöf (Sweden) gave a presentation on mercury mass-balance in Swedish ICP IM sites. She is interested in effects of perturbations on Hg biogeochemistry. Mercury mass-balances were measured from the Swedish ICP IM sites, Anneboda, Gårdsjön and Kindlahöjden, between 1997 and 2016. Stream runoff was 2% (Kindlahöjden), 5% (Gårdsjön) and 9% (Anneboda) of total Hg deposited in each catchment. The remaining 91-98% of the deposited Hg were suggested to either be retained in the catchments or re-emitted to atmosphere. In well drained podzols Hg re-emission was suggested to be low and it was believed that most Hg was retained in catchments soils. The long time series of Hg in soils could be used to estimate the soil retention by calculating the annual change of soil storage. These numbers were predicted to correspond to the difference in total Hg deposition and the Hg runoff. However, the annual increase of Hg in soils were higher than the total Hg deposition. Possible explanations for the deviation between the Hg soil retention estimated by total Hg deposition and Hg in runoff, and the one estimated from the soil Hg time series were discussed.

Biodiversity

26. Mr. Weldon (Sweden) gave the presentation “Major disturbances test resilience at a long-term boreal forest monitoring site”. A Swedish ICP IM site subject to intense combined storm and bark beetle damage beginning in 2005 provided an opportunity to investigate the post-disturbance development of the vegetation community, which was of particular interest as a shift from spruce (*Picea abies*) to beech (*Fagus sylvatica*) domination was considered to be possible. Areas impacted by the disturbances showed altered community composition and increased taxonomic and functional diversity, while in refuge areas the vegetation community has remained substantially unchanged. Despite an increase in deciduous tree species (particularly beech) in disturbed areas, spruce has shown strong post-disturbance regeneration, recolonizing from unaffected areas. These results were interpreted as an indication of a resilient spruce forest.

27. Mr. Forsius (ICP IM Programme Centre) asked what would happen if the dead wood had been removed. Mr. Weldon was not quite sure but believed that the recovery of spruce was helped by the non-removal of deadwood.

28. Mr. Velle (ICP Waters sub-centre) presented a “A preliminary study of functional biodiversity in streams”. He used data on benthic invertebrates and water chemistry from Norwegian rivers spanning over the last 30 years to find whether the functional group composition has changes as the sites recover from acidification. The data showed an increase in filterers and predators over time, and a decrease in shredders. An increase in filterers could be linked to water browning and suggest increased rates of particle removal, resulting in more clear water. An increase in predators could cause increased biomass turnover, while the decrease in shredders may cause decreased rates of decomposition of organic matter. Most of the changes were correlated to acid deposition.

29. Mr. Monteith (UK) asked if the data was detrended. Mr. Velle answered no. Mr. Stoddard (USA) asked why the percentage functional groups did not add up to 100 %. Mr. Velle

answered that not all species had been identified. He also added that not all plots were shown in the presentation.

30. Ms. Salemaa (Finland) gave the presentation “Nitrogen deposition and bryophyte responses in boreal background forests”. She had investigated the relation between N deposition and the total concentration of N in moss. She compared levels inside and outside of forests. Bulk deposition and throughfall deposition of nitrogen increases from the north to the south of Finland. Levels were higher inside forests than outside. Data indicate that it is possible to estimate N deposition from N in moss, but forest mosses apparently approached saturation at deposition levels of 3-4 kg N/ha/yr.

31. Mr. Forsius asked whether N saturation harmed bryophytes. Ms. Salemaa answered no but added that it was important to consider the effects on the whole ecosystem.

NEC Directive

32. Ms. Austnes (ICP Waters Programme Centre) gave an introductory presentation about the NEC Directive, focusing on Article 9, 10 and Annex V. She mentioned the Commission’s draft report reviewing the monitoring network resulting from the stations that the Member States have suggested. She pointed out problems with the template that the Member States are supposed to use for data reporting to comply with the July 2019 deadline, related to e.g. selection and description of parameters, calculation of biological indices and simply how to fill in the template. She asked whether there is a need to revise ICP Waters’ Programme Manual, as the NECD guidance document and the reporting template refer to the manual.

33. Ms. Rogora (Italy) presented insights gained in Italy concerning the NEC Directive. A network of sites (NEC Italy) has been developed in Italy over the last few months, in order to comply with the requirements of the NEC Directive and specifically with Article 9 - monitoring of the impacts of air pollution upon ecosystems. The process of NEC Italy was guided by the Ministry for Environment, Land and Sea and several government and research institutions. The monitoring sites and parameters were presented and the first implications of the NEC Directive application in Italy discussed. The focus was on freshwater sites and on the monitoring activities foreseen for the next period. She went through the rationale behind Italy’s selection of freshwater sites. Monitoring of chemical and biological parameters have been restarted at some sites as a response to the NECD.

34. Mr. Grandin (Co-chair ICP IM) commented that the start of the work with the reporting template had been good, but that a change of staff working with the NECD in the Commission had derailed the process somewhat.

35. Mr. Monteith (UK) mentioned that he had been involved in data reporting from the UK. He asked whether the reporting could be revised later. (Answer: yes)

36. Mr. Forsius (ICP IM Programme Centre) asked whether the COM wants time series data. (Answer: yes)

37. Ms. Djukic (Austria) mentioned that she had been involved in reporting for Austria. They had tried to follow the reporting template and struggled. She also commented that the timing of the NECD is not aligned with WFD. NEC data is supposed to be submitted every 4 years while

reporting under WFD is every 6 years. This could hamper the use of data collected from monitoring of WFD stations for NECD purposes.

38. Ms. de Wit (chair ICP Waters) asked what ICP Waters and ICP IM could do to help make the NECD more useful. Mr. Grandin pointed out that representatives from ICP IM and Waters had made it clear that they were not entirely satisfied with the process so far. There seemed to be consensus that further (constructive) criticism of the process initiated by the NECD should be conveyed by the WGE.

39. Mr. Forsius suggested that there should be an evaluation of the overlap between suggested sites in NEC and ICP sites. (This has been done in the draft report mentioned by Ms. Austnes).

40. Mr. Scheuschner (Germany) Mr. Scheuschner (Germany) said that they intended to convey to the Commission that they considered the reporting template difficult to use for its purpose and offered to send a copy of their feedback to the commission to ICP Waters.

Critical loads and modelling

41. Ms. Alice James (France, Chair ICP M&M) and Mr. Thomas Scheuschner (Germany, CCE) presented "CCE and ICP M&M common vision and future activities". Ms. James has replaced Ms. Anne Christine Le Gall as chair of ICP M&M, which is still located at INERIS in France. CCE has moved from the Netherlands to UBA, Dessau-Roßlau in Germany. They gave an overview of the transition process and presented the workplans for 2019. They are working on automation of data importation and exportation processes. A new development is that calls for data now include biodiversity. Ms. James went through items that will go in the revised mandate. An important point is that JEG might become the Centre for Ecosystem Dynamics hosted under the umbrella of ICP M&M. The most urgent scientific questions concern steady-state modelling, gap filling processes and cross-border harmonization. Methods for calculating empirical critical loads and biodiversity critical loads are also hot topics. ICP M&M and CCE are looking forward to fruitful collaboration with ICP IM and ICP Waters.

42. Ms. Holmberg (Finland) asked about the procedure for updating the empirical critical loads. Ms. James replied that it was last done in 2010.

Nitrogen and element budgets

43. Ms. Arabidze (Georgia) gave a presentation on the water quality in Georgian rivers and lakes. Among various natural resources, Georgia is rich in terms of water resources, with their 26,000 rivers and 850 lakes. Monitoring of water quality is the National Environmental Agency's responsibility. During the last years the Agency significantly increased the number of monitoring points. The laboratory for analyses of atmospheric air, water and soil is located in a new building and equipped with modern analytical equipment. The main pressures on surface water resources come from the household sector due to the discharges of untreated urban wastewater into the surface water bodies. Agriculture and industry also pose challenges to Georgia's water resources. To ensure good qualitative and quantitative status of surface and groundwater bodies as well as coastal waters, the Government of Georgia approved "Third National Environmental Action Programme of Georgia, 2017-2021.

44. Ms. de Wit (chair ICP Waters) asked about monitoring of air pollution and acidification. Ms. Arabidze mentioned stations for monitoring air pollution (concentrations in air). Readings are published online at air.gov.ge/en. Ms. Austnes asked if there was any aquatic monitoring in remote (reference) sites in Georgia. Ms. Arabidze answered that there was some, but so far not very extensive.

45. Ms. Gabrielyan (Armenia) gave the presentation "Air Quality Monitoring and Information Dissemination in Armenia". She described the network and parameters that are measured in air and gave some information about the QA/QC procedures. She gave an overview of the assessment of surface water quality in 2018. The monitoring of ambient air pollution in the Republic of Armenia is supervised through the hybrid survey network. It consists of 16 main stationary active sampling and automated Observation stations, where monitoring is performed daily, and of 211 mobile passive sampling observation points (weekly samples).

Armenia has participated in the European monitoring and evaluation program (EMEP) since September 2008.

46. Ms. Austnes (ICP Waters Programme Centre) asked about the classification system for water. Ms. Gabrielyan answered that water quality is classified as good, moderate, poor and bad. Ms. de Wit asked about monitoring of reference stations in water. Ms. Gabrielyan could not give an overview off the cuff.

47. Mr. Vuorenmaa (ICP IM Programme Centre) presented the response from a call for data on nitrogen. The processing is hard. It is done in the ICP IM Programme Centre. The trend analysis shows that nitrogen deposition and inorganic N in deposition and runoff is still declining. Trends in fluxes are more variable. A manuscript will be drafted after the summer holidays.

48. This was followed by a discussion on nitrogen as a potential topic for ICP IM/Waters collaboration. Ms. de Wit started by pointing out the difference in spatial extent and difference in heterogeneity between ICP Waters stations and ICP IM stations (Forested sites, mainly coniferous). Mr. Forsius said that they at the ICP IM Programme Centre intended to write up the started work, but suggested cooperation on a report on reactive nitrogen.

49. Ms. de Wit suggested a tour de table about the most relevant nitrogen related questions.

50. Ms. Djukic (Austria) pointed out that missing data was a problem. Mr. Oulehle (Czech Republic) commented that nitrogen trends in waters are still very variable and said that it was important not to look exclusively at N trends, but also other elements that might elucidate relevant catchment processes. Mr. Stoddard (US) observed that nitrogen in water could increase and decrease, but the cause is often unclear. He said that a trend report on N could be boring. Could we rather contribute to the work on estimating empirical critical loads?

51. This spurred a discussion about nitrogen as a limiting factor for primary production. The effect of nitrogen is often subtle in headwaters. It might have higher impact further downstream.

52. Ms. Forsius suggested that a synthesis approach could be useful for the Convention.

53. Mr. Stoddard (US) proposed trends in N saturation as a potential topic that to his knowledge, had not been covered by others. Effects of N will be larger downstream than in headwaters. We could try to quantify export of N to ecosystems downstream and describe the threshold above which one could expect effects. Mr. Oulehle said that looking at lowland rivers might work in Scandinavia but would be harder elsewhere more affected by agriculture. Ms. de Wit said that this varies between countries. Mr. Monteith said that this had been discussed in UK and pointed out that collection of N data from lowland waters would be necessary.

54. Mr. Weldon (Sweden) suggested that cooperation with ICP Forests on nitrogen could be interesting.

55. There was a discussion about involvement in work concerning national budgets for N export. Sweden and others are working on this, and Mr. Valinia (Co-chair ICP IM) pointed out that this will become mandatory if/when the revised Gothenburg protocol enters into force.

56. Ms. Djukic suggested that the NEC directive could be useful for coordinating work on N budgets.

Issues common for both ICPs

57. Mr. Valinia (co-chair ICP IM) gave a presentation on the long-term strategy and the potential review of the Gothenburg protocol, via video link. The strategy sets out a vision for the convention for the period 2020-2030. Remaining challenges mentioned include lead, mercury, nitrogen, and several other topics of relevance to ICP IM and Waters. Sulphur is however not mentioned among the challenges. He encouraged the participants to have a look at the strategy. ICPs have played an important role in the review of the Gothenburg protocol. Our recommendations to the WGSR (The Working Group on Strategies and Review) and EB (Executive Body) on work concerning ecosystem effects.

58. Mr. Forsius (ICP IM Programme Centre) commented that one of the points in the strategy seemed to be relevant for cooperative work between ICP IM and Waters on nitrogen.

59. Mr. Velle (ICP Waters sub-center) gave a presentation on the annual biological intercalibration. He has taken over the intercalibration from Mr. Anker, who has retired. Mr. Velle described the reason for having an intercalibration and exemplified this by showing an example from a Norwegian version, where results were somewhat discouraging. There were 4 participants in the 2018 version of ICP Waters' biological intercalibration. The average quality was acceptable, but some laboratories had problems with some of the taxonomic groups, i.e. quality index lower than 80 %. He showed some interesting trends of participation and quality over time and suggested potential causes for this.

60. Ms. Gundersen (ICP Waters Programme Centre) presented the results from the annual chemical intercomparison. She has taken over the intercomparison from Mr. Escudero and will be the new contact person for this activity. The overall results from 2018 were good (acceptance higher than 80%), but poor for total phosphorous. She finished with an outlook and future plans. The samples for 2019 are about to be distributed. It is still possible to participate if you move quickly.

61. Mr. Fölster (Sweden) asked if work has been considered on correcting for differences between methods, e.g. for alkalinity. (It has).

62. Ms. Austnes (ICP Waters Programme Centre) gave an overview of future plans for ICP Waters. One topic for consideration is if more data on catchments should be requested. The work plan for 2020-2021 includes contribution to WGE/EMEP activities and a new topical report, possibly on nitrogen. In 2021 calcium limitation or recovery of fish populations from acidification are possible topics for reports.

63. Mr. Grandin (co-chair ICP IM) gave an overview of future plans for ICP IM. This includes strengthening cooperation with other ICPs and LTER, publishing papers on N enrichment in forest vegetation, impacts of internal catchment related N parameters to TIN leaching, relationship between CL exceedances and empirical ecosystem impact indicators, HM trends and more.

Separate ICP Waters TF meeting

64. Ms. Austnes (ICP Waters Programme Centre) went through the mandate and workplan of the Task Force.

65. Ms. Austnes gave a report of status and progress since the last meeting.

66. Current and planned reports. There was a discussion on how to proceed with the trend report. It was agreed that median time trends should be analysed for an extended number of sites, applying less strict criteria for sampling frequency. The change point analysis should if possible be applied to deposition as well on a site-by-site or region-by-region basis. If possible, measured data should be used, alternatively model estimates. It was also suggested that the report could include maps showing spatial trends in sulphate concentrations, possibly corrected for precipitation. Then the discussion turned to more technical details concerning how to correct for the marine contribution of ions. We could either restrict the correction to the regions most affected by sea salt or use a method based on distance from the sea and/or chloride concentration.

67. A possible topic of the 2020 thematic report is reactive nitrogen. Ms. de Wit (chair ICP Waters) presented some ideas about the report. It is often difficult to show effects of nitrogen as a nutrient on biology, and many existing studies were already reviewed in the 2010 ICP Waters report. Another option is to look at nutrient trends, nitrogen saturation and soil stoichiometry. Effects of disturbances and contribution of nitrogen deposition to marine waters via rivers are also interesting topics. Ms. Austnes suggested that the Nordic database might be worth considering for looking at biological effects. Mr. Monteith (UK) suggested that looking at links between nitrogen and the macrophyte community could be interesting. Another possibility is to look more at geochemistry and stochiometry trends than links with biology. Do we need to gather more catchment information and if so, would that be easy to do? This question spurred a lively discussion. Obtaining data on e.g. vegetation cover was tried for the 2007 DOC work, but it did not work very well. If another attempt is to be made, we should look at what was done in 2007 and make sure that we do not repeat the same. Some types of catchment information e.g. size) might be easier to obtain than others (e.g. vegetation types). Mr. Fölster (Sweden) added that it was important to keep track of changes in methodology, e.g. for total nitrogen, which is one of the optional parameters to submit to the database. The transportation of N from the uplands to the sea is an interesting angle. Mr. Stoddard (US) substantiated this by referring to papers by Eshleman et al. (2016) [1] on the effects of reduced N transport from upland waters on the restoration of Chesapeake Bay. This could be a topic for a session at the next TF meeting.

68. A possible topic for the 2021 report is decline in calcium. Ms. Austnes asked about possible angles for exploring this. Calcium trends, trends in e.g. plankton communities, literature review, liming as a counter measure to low calcium, subtle effects in catchments that are not very calcium poor are possible lines of enquiry. Mr. Velle (ICP Waters sub-centre) mentioned that there would be data on zooplankton in lakes. Ms. Rogora mentioned a paper that could be relevant in this context. Mr. Stoddard pointed out that calcium was coming down from

[1] Eshleman, K.N., Sabo, R.D., 2016. Declining nitrate-N yields in the Upper Potomac River Basin: What is really driving progress under the Chesapeake Bay restoration? Atmospheric Environment, Acid Rain and its Environmental Effects: Recent Scientific Advances 146, 280–289.

high levels as acidification has declined. What are the true background levels of calcium? This is not easy to estimate given the uncertainties pertaining to e.g. weathering rates. Mr. Velle claimed that the calcium requirements of some groups of biotas are relatively well known.

69. Another possible topic for the 2021 report is recovery of fish populations. Effects on fish was considered very important in the early days of research on acidification. However, it was claimed that there is a lack of recent data on fish recovery and thresholds of different species and life stages. Mr. Velle commented that this could potentially involve a lot of work. Mr. Monteith mentioned that there was some recent work in UK on this that could be of relevance[2].

70. Mr. Velle reminded the attendants that it was possible to do a report on trends in functional diversity (see separate presentation above), a topic that was also considered during the 2018 Task Force meeting in Warsaw.

71. Mr. Sample (ICP Waters Programme Centre) presented news about the database and homepage. One recurring issue is the question of online availability of data. This would make it possible for the Programme Centre to download data themselves and would also be convenient to refer when other parties ask for data. Ms. de Wit asked about the online availability of data in the various countries. It appears that it is only in Sweden that this is working so far. Mr. Sample mentioned that NIVA now has a Jupyterhub, which could be of interest for everyone working with ICP Waters data in Julia, Python or R. The ICP Waters data exploration page need to be done in a new system because Google is terminating the service that the data exploration is built on. Basic metadata for the stations will be reported to the WGE portal. Ms. Austnes asked whether it is possible to provide more detailed EUNIS codes for the ICP Waters sites. Contact Mr. Sample or Ms. Furuseth (ICP Waters Programme Centre) with details on published papers and reports. The annual call for data will possibly be sent out later this month. Ms. de Wit asked if it was necessary to have a call for data every year. No one voiced strong opposition to this suggestion. It was agreed that less frequent calls for data can be considered for the future.

72. Mr. Velle asked if it should be possible to participate in the biological intercalibration without submitting data to ICP Waters. This can be considered but should possibly involve payment of a fee by the prospective participant.

73. Topics related to the NEC Directive was raised. Ms. Austnes asked if we should we be more specific about how to determine e.g. biological indices in the ICP Waters manual. Mr. Monteith mentioned that it would be good to know what the European Environment Agency wanted to do with the data. He also raised the question whether it is possible to find common biological indices that can be used.

74. Ms. Nelson (Canada) gave a presentation on atmospheric transport of microplastic to four lake catchments in Ireland. Microfibers were observed in all samples. The results suggest that there is (long-range) atmospheric transport of microfibers.

[2] Malcolm, I.A., Bacon, P.J., Middlemas, S.J., Fryer, R.J., Shilland, E.M., Collen, P., 2014. Relationships between hydrochemistry and the presence of juvenile brown trout (Salmo trutta) in headwater streams recovering from acidification. Ecological Indicators 37, Part B, 351–364.

75. Ms. Austnes asked if anyone wanted to contribute to the proceedings. If so, send it to Ms. Furuseth before August 1.

76. Evaluation of the meeting. Mr. Fölster suggested that the cooperation could be flexible, e.g. ICP IM one year, ICP M&M another year.

77. The minutes of the meeting were adopted.

Annex I: Participants at the Joint ICP IM and ICP Waters TF meeting in Helsinki, Finland, 4-6 June 2019

Armenia

Arpine Gabrielyan
Environmental Monitoring and Information Center
arpi.gabrielyan@gmail.com

Austria

Ika Djukic
Environment Agency Austria
Spittelauer Lände 5
1090 Wien
Austria
ika.djukic@umweltbundesamt.at

Canada

Sarah Nelson
Trent University
1600 West Bank Drive
Peterborough,
Canada
sanelson@trentu.ca

Czech Republic

Filip Oulehle
Czech Geological Survey
Klarov 3
118 21 Prague 1, CZ
Czech Republic
filip.oulehle@geology.cz

Milan Vana
Czech Hydrometeorological Institute
393 01 Kosetice,
Czech Republic
milan.vana@chmi.cz

Pavel Krám
Czech Geological Survey
Department of Geochemistry
Klarov 3
CZ-118 21 Prague 1,
Czech Republic
pavel.kram@geology.cz

Estonia

Naima Kabral
EERC
naima.kabral@klab.ee

Finland

Jussi Vuorenmaa
Finnish Environment Institute (SYKE)
P.O. Box 140
FIN-00251 Helsinki
Finland
jussi.vuorenmaa@ymparisto.fi

Sirpa Kleemola
Finnish Environment Institute (SYKE)
P.O. Box 140
FIN-00251 Helsinki
Finland
sirpa.kleemola@ymparisto.fi

Maria Holmberg
Finnish Environment Institute (SYKE)
P.O. Box 140
FIN-00251 Helsinki
Finland
maria.holmberg@ymparisto.fi

Martin Forsius
Finnish Environment Institute SYKE
P.O. Box 140
FIN-00251 Helsinki
Finland
martin.forsius@ymparisto.fi

Trond Kvitvik
Finnish Environment Institute (SYKE)
P.O. Box 140
FIN-00251 Helsinki
Finland
trond.kvitvik@ymparisto.fi

Juha-Petri Kärnä
Finnish Environment Institute (SYKE)
P.O. Box 140
FIN-00251 Helsinki
Finland
Juha-Petri.Karna@ymparisto.fi

Irina Bergström
Finnish Environment Institute (SYKE)
P.O. Box 140
FIN-00251 Helsinki
Finland
irina.bergstrom@ymparisto.fi

Martti Rask
Lammi Biological Station
University of Helsinki
Fi-16900 Lammi,
Finland
martti.rask@helsinki.fi

Sirkku Manninen
University of Helsinki
P.O. Box 65 (Viikinkaari 2a)
00014 Helsinki
Finland
sirkku.manninen@helsinki.fi

Lauri Arvola
University of Helsinki
Pääjärventie 320
FIN-00014 Hämeenlinna
Finland
lauri.arvola@helsinki.fi

Katriina Kyllönen
Finnish Meteorological Institute
P.O. Box 503,
FI-00101 Helsinki
Finland
katriina.kyllonen@fmi.fi

Maija Salemaa
Natural Resources Institute Finland (Luke)
Latokartanonkaari 9,
FI-00790 Helsinki
Finland
maija.salemaa@luke.fi

France

Alice James Casas
INERIS, French National Institute for Industrial
Environment and Risks
Rue Jacques Taffanel,
60550 Verneuil-en-Halatte
France
alice.james@ineris.fr

Georgia

Marine Arabidze
National Environmental Agency
150, David Agmashenebeli ave.,0112
Tbilisi, Georgia
arabidzemarine0@gmail.com

Germany

Hubert Schulte-Bisping
University Göttingen
Büsgenweg 2
D-37077 Göttingen
Germany
hschult1@gwdg.de

Thomas Scheuschner
German Federal Environmental Agency
Wörlitzer Platz 1
06844 Dessau-Roßlau
Germany
thomas.scheuschner@uba.de

Burkhard Beudert
Bavarian Forest National Park
Freyunger Straße 2
94481 Grafenau
Germany
burkhard.beudert@npv-bw.bayern.de

Italy

Michela Rogora
CNR Institute of Ecosystem Study
Largo Tonolli 50
I-28922 Verbania Pallanza (VB)
Italy
m.rogora@ise.cnr.it

Giancarlo Papitto
Corpo Forestali
Via. G. Carducci 5
00187 Roma
Italy
g.papitto@libero.it

Latvia

Evita Maderniece
Latvian Environmental, Geology and Meteorology Center
Maskavas Street 165,
Riga LV-1019
Latvia
evita.maderniece@lvgmc.lv

Lithuania

Algirdas Augustaitis
Forest monitoring laboratory
Faculty of forest sciences and ecology
Vytautas Magnus University
Studentu 13, Academia, Kaunas dstr.
LT-53362 Lithuania
algirdas.augustaitis@vdu.lt

Ingrida Augustaitiene
Vytautas Magnus University
iaugustaitiene@gmail.com

Vilma Bimbaite
EPA
vilma.bimbaite@aaa.am.lt

Norway

Heleen de Wit
Norwegian Institute of Water Research (NIVA)
Gaustadalléen 21
N-0349 Oslo
Norway
heleen.de.wit@niva.no

Kari Austnes
Norwegian Institute of Water Research (NIVA)
Gaustadalléen 21
N-0349 Oslo
Norway
kari.austnes@niva.no

Gaute Velle
Uni Research Environment
Nygårdsgaten 112, Blokk D
5006 Bergen
Norway
gvel@norceresearch.no

Øyvind Garmo
Norwegian Institute for Water Research (NIVA)
Sandvikavegen 59
NO-2312 Ottestad
Norway
oyvind.garmo@niva.no

Cathrine Brecke Gundersen
Norwegian Institute of Water Research (NIVA)
Gaustadalléen 21
N-0349 Oslo
Norway
cathrine.gundersen@niva.no

James Sample
Norwegian Institute of Water Research (NIVA)
Gaustadalléen 21
N-0349 Oslo
Norway
james.sample@niva.no

Ingvild Skumlien Furuseth
Norwegian Institute of Water Research (NIVA)
Gaustadalléen 21
N-0349 Oslo
Norway
Ingvild.Furuseth@niva.no

Poland

Rafał Ulańczyk
Institute of Environmental Protection
National Research Institute
ul. Krucza 5/11d, 00-548 Warszawa
Poland
Rafal.ulanczyk@ios.edu.pl

Krzysztof Skotak
Institute of Environmental Protection – National Research Institute
ul. Krucza 5/11d,00-548 Warsaw
Poland
krzysztof.skotak@ios.edu.pl

Emilia Konopka-Górna
Ministry of the Environment
emilia.konopka-gorna@mos.gov.pl

Agnieszka Sosnowska
Ministry of the Environment
ul. Wawelska 52/54, 00-922 Warszawa
Poland
agnieszka.sosnowska@mos.gov.pl

Russian Federation

Anna Kukhta
Yu.A. Izrael Institute of Global Climate and Ecology
107258, 20b, Glebovskaya street, Moscow,
Russian Federation
anna_koukhta@mail.ru

Marina Dinu
Vernadsky Institute of Geochemistry and Analytical
Chemistry of Russian Academy of Sciences
Kosygin Street 19, 119991 Moscow
Russia
marinadinu999@gmail.com

Dmitry Baranov
Vernadsky Institute of Geochemistry and Analytical
Chemistry of Russian Academy of Sciences
Kosygin Street 19, 119991 Moscow
Russia
mitya.baranov.90@bk.ru

Spain

David Elustondo
Universidad de Navarra
Irunlarrea 1
31080 Pamplona
Spain
delusto@unav.es

Sweden

Pernilla Rönnback
Swedish University of Agricultural Sciences (SLU)
P.O box 7050
75007 Uppsala
Sweden
pernilla.ronnback@slu.se

Jens Fölster
Swedish University of Agricultural Sciences (SLU)
P.O box 7050
75007 Uppsala
Sweden
Jens.Folster@slu.se

James Weldon
Swedish University of Agricultural Sciences (SLU)
P.O box 7050
75007 Uppsala
Sweden
james.weldon@slu.se

Karin Eklöf
Swedish University of Agricultural Sciences (SLU)
P.O box 7050
75007 Uppsala
Sweden
karin.eklof@slu.se

Ulf Grandin
Swedish University of Agricultural Sciences (SLU)
P.O box 7050
75007 Uppsala
Sweden
ulf.grandin@slu.se

Participated remotely:
Salar Valinia
Swedish Environmental Protection Agency
106 48 Stockholm
Sweden
salar.valinia@naturvardsverket.se

Switzerland

Luca Colombo
University of Applied Sciences of Southern
Switzerland
Trevano - Blocco C
Via Trevano, 6952 Canobbio
Switzerland
luca.colombo@supsi.ch

Sandra Steingruber
Ufficio dell’aria, del clima e delle energie rinnovabili
Diupartimento del territorio del Canton Ticino
via Franco Zorzi 13
6501 Bellinzona
Switzerland
sandra.steingruber@ti.ch

UNECE

Participated remotely:
Krzysztof Olendrzynski
Environmental Affairs Officer
Transboundary Cooperation Section United Nations
Economic Commission for Europe
UNECE- Palais des Nations Avenue de la Paix 8-14
1211 Geneva 10
Switzerland
krzysztof.olendrzynski@unece.org

United Kingdom

Don Monteith
Centre for Ecology & Hydrology
Lancaster Environment Centre
Library Avenue
Bailrigg, Lancaster
LA1 4AP, United Kingdom
donm@ceh.ac.uk

USA

John Stoddard
U.S. Environmental Protection Agency
200 SW 35th Street
Corvallis, OR 97333, USA
stoddard.john@epa.gov

Annex II: Agenda for the joint ICP IM and ICP Waters Task Force meeting in Helsinki, Finland, 4-6 June 2019

1. **Opening of the joint meeting and introductions (**Chairs ICP IM and ICP Waters**)**
2. **Meeting welcome by the hosts and organisers** (Martin Forsius, SYKE, ICP IM)
3. **Adoption of the agenda** (Chairs ICP Waters and ICP IM)
4. **General information about the meeting and excursion** (Sirpa Kleemola, Jussi Vuorenmaa)
5. **Reports**

   a. Structure of the Convention and recent CLRTAP activities (Krzysztof Olendrzynski, Secretariat)
   b. Reports from Working Group on Effects and the Bureau (Martin Forsius)
   c. The new WGE web portal, status report (Salar Valinia)
   d. Current issues ICP IM (Chair ICP IM)
   e. Current issues ICP Waters (Chair ICP Waters)

6. **Thematic sessions**

   a. Acidification and recovery

      i. Is there a need for a revision of the chemical acidification criteria in the Nordic countries? Jens Fölster, Sweden
      ii. Contrasting responses of two neighbouring lake ecosystems in the English Lake District to acid deposition, Don Monteith, UK
      iii. Atmospheric depositions - lysimetric waters - waters of a lake in the Valdai Hills, Dimitry Baranov, Russian Federation
      iv. Trends in surface water chemistry. The upcoming trend report - preliminary results. Øyvind Garmo, Norway
      v. Long term water chemistry trends in small boreal lakes in southern Finland relative to sulphur and nitrogen deposition. Lauri Arvola, Finland

   b. Climate change and land use

      i. Forest disturbance effect on soil nutrients and lake chemistry - Plešné Lake, Filip Oulehle, Czech Republic

c. Heavy metals and POPs

   i. Trends and source apportionment of atmospheric heavy metals in Finland, Katriina Kyllönen, Finland
   ii. Archived invertebrate samples show LT-decline in Hg: caused by decline in S deposition? Heleen de Wit, Norway
   iii. Trends in elements speciation in Imandra lake and small lakes of the Kola Peninsula, Marina Dinu, Russian Federation
   iv. Estimating the re-emission of Hg from soil to atmosphere in ICP IM catchments – Karin Eklöf, Sweden

d. Biodiversity

   i. Major disturbances test resilience at a long-term boreo-nemoral forest monitoring site, James Weldon, Sweden
   ii. Functional diversity of benthic invertebrates, Gaute Velle, Norway
   iii. N deposition and bryophyte responses in boreal background forests, Maija Salemaa, Finland

e. NEC Directive

   i. Introductory presentation, Kari Austnes, Norway
   ii. The National Emission Ceilings Directive: Insights from Italy. Michela Rogora, Italy
   iii. Discussion

f. Critical loads and modelling

   i. CCE and ICP M&M common vision and future activities. Alice James, France, and Thomas Scheuschner, Germany

g. Nitrogen and element budgets

   i. Water quality on Georgian rivers and lakes, Marine Arabidze, Georgia
   ii. Air Quality Monitoring and Information Dissemination in Armenia, Arpine Gabrielyan, Armenia
   iii. Response from call for data on Nitrogen, ICP IM, Jussi Vuorenmaa, Finland
   iv. Discussion on N issues and potential ICP IM/Waters collaboration

7. **Common sessions of ICP Waters and ICP Integrated Monitoring for report and discussion of work plan items**
   a. Adoption of the new Long-term strategy and what does it mean? Salar Valinia, Sweden
   b. Chemical and biological intercalibration
      i. Biological intercalibration – Gaute Velle, Norway
      ii. Chemical intercomparison – Cathrine Gundersen, Norway
   c. Thematic reports of common interest
      i. Future plans ICP Waters – Kari Austnes
      ii. Future plans ICP IM – Martin Forsius/Ulf Grandin

8. **Next Task Force meeting**

9. **End of joint TF meeting**

Separate Task Force meetings followed immediately after the ending of the joint meeting.

Agenda – ICP Waters Task Force:

1. Mandate and workplan
2. Status and progress
3. Current and planned reports
4. Database and homepage
5. Biological intercalibration, chemical intercomparison
6. NEC Directive
7. Other issues
8. Proceedings, evaluation of the meeting
9. Adoption of the minutes

Annex III: Status participation in the ICP Waters programme as of December 2019

	Chemical data (last year with data)	Biological data (last year with data)	Participation in TF meetings 2017-2019	Participation in chemical intercomparison 2017-2019	Participation in biological intercalibration 2017-2019
Armenia	2008		●		
Austria	2012		●	●	
Belarus	2014				
Belgium				●	
Canada	2017		●	●	
Croatia					
Czech Rep.	2016	2017	●	●	
Estonia	2017		●	●	●
Finland	2017		●	●	
France			●	●	
Georgia			●		
Germany	2018	2018	●	●	●
Ireland	2017	2016	●	●	●
Italy	2017		●	●	
Latvia	2018	2018	●		●
Lithuania			●	●	
Moldova	2017		●	●	
Montenegro	2009				
Netherlands	2014			●	
Norway	2017	2019	●	●	●
Poland	2017		●	●	
Russia	2014		●	●	
Serbia			●	●	
South Africa			●		
Spain	2013		●	●	
Sweden	2016	2018	●	●	●
Switzerland	2018	2017	●	●	●
UK	2017	2015	●	●	
USA	2017		●		
Total	**21**	**8**	**24**	**21**	**7**

Annex IV: ICP Waters workplan for 2019–2021

2019

- Arrange thirty-fifth meeting of the Programme Task Force in spring of 2019
- Prepare proceedings from the 35th Task Force meeting
  - abstracts (2-6 pages) by **August 1, 2019** to ingvild.furuseth@niva.no
  - report will be delivered in September 2019
- Write new thematic report (a trend analysis of water chemistry, to assess chemical recovery of acid-sensitive surface waters), by November 2019
- Arrange and report chemical intercomparison 1933
  - Laboratories are invited in March and confirm their participation in May. Samples are sent in June. Laboratories submit results in October. Contact person is cathrine.gundersen@niva.no
  - Report will be delivered in November 2019
- Arrange and report biological intercalibration 2319
  - Report will be delivered in November 2019. Contact person is Gaute Velle (gvel@norceresearch.no).
- Prepare new thematic report for 2020 on reactive nitrogen (special attention to nitrogen saturation and influences of nitrogen downstream of headwaters)
- Contribute to the WGE portal
- Run the Programme Centre in Oslo and the Subcentre in Bergen, including:
  - maintenance of the web page
  - increasing visibility of activity of the Focal Centres on the web page
  - maintenance of databases of chemical and biological data
  - maintenance and update the manual for methods and operation
  - reporting to WGE and UNECE
- Submission of data to the Programme Centre by all Focal Centres
- Participation in meetings of relevance for the ICP Waters programme. Contribute to implementation of NEC Directive, together with other bodies under the WGE
- Cooperation with other bodies within and outside the Convention
- Consider availability of other water databases and cooperation with other water monitoring programmes (UNEP, GEMS, EEA)
- Cooperation with ECCCA countries (East Central Caucasus and Central Asian countries)

2020

- Arrange thirty-sixth meeting of the Programme Task Force in spring of 2020
- Prepare proceedings from the 36th Task Force meeting
- Write thematic report on reactive nitrogen
- Arrange and report chemical intercomparison 2034
- Arrange and report biological intercalibration 2420
- Prepare new thematic report for 2021 on biological recovery and responses to changing water chemistry (to be discussed at TF meeting 2020)
- Run the Programme Centre in Oslo and the Subcentre in Bergen
- Submission of data to the Programme Centre by all Focal Centres
- Participation in meetings of relevance for the ICP Waters programme. Contribute to implementation of NEC Directive, together with other bodies under the WGE
- Cooperation with other bodies within and outside the Convention
- Consider availability of other water databases and cooperation with other water monitoring programmes (UNEP, GEMS, EEA)
- Cooperation with ECCCA countries (East Central Caucasus and Central Asian countries)

2021

- Arrange thirty-seventh meeting of the Programme Task Force in spring of 2021
- Prepare proceedings from the 37th Task Force meeting
- Write thematic report on biological recovery (to be discussed at TF meeting 2020)
- Arrange and report chemical intercomparison 2135
- Arrange and report biological intercalibration 2521
- Prepare new thematic report for 2022
- Run the Programme Centre in Oslo and the Subcentre in Bergen
- Submission of data to the Programme Centre by all Focal Centres
- Participation in meetings of relevance for the ICP Waters programme. Contribute to implementation of NEC Directive, together with other bodies under the WGE
- Cooperation with other bodies within and outside the Convention
- Consider availability of other water databases and cooperation with other water monitoring programmes (UNEP, GEMS, EEA)
- Cooperation with ECCCA countries (East Central Caucasus and Central Asian countries)

Reports and publications from the ICP Waters programme

All reports from the ICP Waters programme from 2000 up to present are listed below. Reports before year 2000 can be listed on request. All reports are available from the Programme Centre. Reports and recent publications are also accessible through the ICP Waters website; http://www.icp-waters.no/

Velle, G., Johannessen, A. and Landås, T.S. 2018. Biological intercalibration: Invertebrates 2018. NIVA SNO 7314-2018. **ICP Waters report 138/2018**

Escudero-Oñate, C. 2018. Intercomparison 1832: pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Tot-P, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA SNO 7316-2018. **ICP Waters report 137/2018.**

Garmo, Ø., Ulańczyk, R. and de Wit, H. (eds.) 2018. Proceedings of the 34th Task Force meeting of the ICP Waters Programme in Warsaw, May 7-9, 2018. NIVA report SNO 7298-2018. **ICP Waters report 136/2018.**

Austnes, K. Aherne, J., Arle, J., Čičendajeva, M., Couture, S., Fölster, J., Garmo, Ø., Hruška, J., Monteith, D., Posch, M., Rogora, M., Sample, J., Skjelkvåle, B.L., Steingruber, S., Stoddard, J.L., Ulańczyk, R., van Dam, H., Velasco, M.T., Vuorenmaa, J., Wright, R.F., de Wit, H. 2018. Regional assessment of the current extent of acidification of surface waters in Europe and North America. NIVA report SNO 7268-2018. **ICP Waters report 135/2018**

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. NIVA report SNO 7207-2017. **ICP Waters report 134/2017**.

Halvorsen, G.A., Johannessen, A. and Landås, T.S. 2017. Biological intercalibration: Invertebrates 2017. NIVA report SNO 7198-2017. **ICP Waters report 133/2017**.

Braaten, H.F.V., Åkerblom, S., de Wit, H.A., Skotte, G., Rask, M., Vuorenmaa, J., Kahilainen, K.K., Malinen, T., Rognerud, S., Lydersen, E., Amundsen, P.A., Kashulin, N., Kashulina, T., Terentyev, P., Christensen, G., Jackson-Blake, L., Lund, E. and Rosseland, B.O. 2017. Spatial and temporal trends of mercury in freshwater fish in Fennoscandia (1965-2015). NIVA report SNO 7179-2017. **ICP Waters report 132/2017**.

Garmo, Ø., de Wit, H. and Fölster, J. (eds.) 2017. Proceedings of the 33rd Task Force meeting of the ICP Waters Programme in Uppsala, May 9-11, 2017. NIVA report SNO 7178-2017. **ICP Waters report 131/2017**.

Anker Halvorsen, G., Johannessen, A. and Landås, T.S. 2016. Biological intercalibration: Invertebrates 2016. NIVA report SNO 7089-2016. **ICP Waters report 130/2016**.

Escudero-Oñate, C. 2016. Intercomparison 1630: pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA report SNO 7081-2016. **ICP Waters report 129/2016.**

De Wit, H. and Valinia, S. (eds.) 2016. Proceedings of the 32st Task Force meeting of the ICP Waters Programme in Asker, Oslo, May 24-26, 2016. NIVA report SNO 7090-2016. **ICP Waters report 128/2016**.

Velle, G., Mahlum, S., Monteith, D.T., de Wit, H., Arle, J., Eriksson, L., Fjellheim, A., Frolova, M., Fölster, J., Grudule, N., Halvorsen, G.A., Hildrew, A., Hruška, J., Indriksone, I., Kamasová, L., Kopáček, J., Krám, P., Orton, S., Senoo, T., Shilland, E.M., Stuchlík, E., Telford, R.J., Ungermanová, L., Wiklund, M.-L. and Wright, R.F. 2016. Biodiversity of macro-invertebrates in acid-sensitive waters: trends and relations to water chemistry and climate. NIVA report SNO 7077-2016. NIVA report SNO 7077-2016. **ICP Waters report 127/2016**.

De Wit, H., Valinia, S. and Steingruber, S. 2015. Proceedings of the 31st Task Force meeting of the ICP Waters Programme in Monte Verità, Switzerland 6th –8th October, 2015. NIVA report SNO 7003-2016. **ICP Waters report 126/2015**.

De Wit, H., Hettelingh, J.P. and Harmens, H. 2015. Trends in ecosystem and health responses to long-range transported atmospheric pollutants. NIVA report SNO 6946-2015. **ICP Waters report 125/2015**.

Fjellheim, A., Johannessen, A. and Landås, T.S. 2015. Biological intercalibration: Invertebrates 1915. NIVA report SNO 6940-2015. **ICP Waters report 124/2015**.

Escudero-Oñate, C. 2015 Intercomparison 1529: pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA report SNO 6910-2015. **ICP Waters report 123/2015**.

de Wit, H., Wathne, B. M. (eds.) 2015. Proceedings of the 30th Task Force meeting of the ICP Waters Programme in Grimstad, Norway 14th –16th October, 2014. NIVA report SNO 6793-2015. **ICP Waters report 122/2015**.

Fjellheim, A., Johannessen, A. and Landås, T.S. 2014. Biological intercalibration: Invertebrates 1814. NIVA report SNO 6761-2014. **ICP Waters Report 121/2014**.

Escuedero-Oñate. 2014. Intercom¬parison 1428: pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA report SNO 6718-2014. **ICP Waters Report 120/2014**.

De Wit, H. A., Garmo Ø. A. and Fjellheim A. 2014. Chemical and biological recovery in acid-sensitive waters: trends and prognosis. **ICP Waters Report 119/2014**.

Fjellheim, A., Johannessen, A. and Landås, T.S. 2013. Biological intercalibration: Invertebrates 1713. NIVA report SNO 6662-2014. **ICP Waters Report 118/2014**.

de Wit, H., Bente M. Wathne, B. M. and Hruśka, J. (eds.) 2014. Proceedings of the 29th Task Force meeting of the ICP Waters Programme in Český Krumlov, Czech Republic 1st –3rd October, 2013. NIVA report SNO 6643-2014. **ICP Waters report 117/2014**.

Escuedero-Oñate, C. 2013. Intercomparison 1327: pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA report SNO 6569-2013. **ICP Waters Report 116/2013**.

Holen, S., R.F. Wright and Seifert, I. 2013. - Effects of long-range transported air pollution (LTRAP) on freshwater ecosystem services. NIVA report SNO 6561-2013. **ICP Waters Report 115/2013**.

Velle, G., Telford, R.J., Curtis, C., Eriksson, L., Fjellheim, A., Frolova, M., Fölster J., Grudule N., Halvorsen G.A., Hildrew A., Hoffmann A., Indriksone I., Kamasová L., Kopáček J., Orton S., Krám P., Monteith D.T., Senoo T., Shilland E.M., Stuchlík E., Wiklund M.L., de Wit, H. and Skjelkvaale B.L. 2013. Biodiversity in freshwaters. Temporal trends and response to water chemistry. NIVA report SNO 6580-2013. **ICP Waters Report 114/2013**.

Fjellheim, A., Johannessen, A. and Landås, T.S. 2013. Biological intercalibration: Invertebrates 1612. **ICP Waters Report 113/2013**.

Skjelkvåle, B.L., Wathne, B.M., de Wit, H. and Rogora, M. (eds.) 2013. Proceedings of the 28th Task Force meeting of the ICP Waters Programme in Verbania Pallanza, Italy, October 8 – 10, 2012. NIVA report SNO 6472-2013. **ICP Waters Report 112/2013**.

Dahl, I. 2012. Intercomparison 1226: pH, Conductivity, Alkalinity, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA report SNO 6412-2012. **ICP Waters report 111/2012**.

Skjelkvåle, B.L., Wathne B. M. and Moiseenko, T. (eds.) 2012. Proceedings of the 27th meeting of the ICP Waters Programme Task Force in Sochi, Russia, October 19 – 21, 2011. NIVA report SNO 6300-2012. **ICP Waters report 110/2012**.

Fjellheim, A., Johannessen, A., Svanevik Landås, T. 2011. Biological intercalibration: Invertebrates 1511. NIVA report SNO 6264-2011. **ICP Waters report 109/2011**.

Wright, R.F., Helliwell, R., Hruska, J., Larssen, T., Rogora, M., Rzychoń, D., Skjelkvåle, B.L. and Worsztynowicz, A. 2011. Impacts of Air Pollution on Freshwater Acidification under Future Emission Reduction Scenarios; ICP Waters contribution to WGE report. NIVA report SNO 6243-2011. **ICP Waters report 108/2011**.

Dahl, I and Hagebø, E. 2011. Intercomparison 1125: pH, Cond, HCO3, NO3-N, Cl, SO4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA report SNO 6222-2011. **ICP Waters report 107/2011**.

Skjelkvåle B.L. and de Wit, H. (eds.) 2011. Trends in precipitation chemistry, surface water chemistry and aquatic biota in acidified areas in Europe and North America from 1990 to 2008. NIVA report SNO 6218-2011. **ICP Waters report 106/2011**.

ICP Waters Programme Centre 2010. ICP Waters Programme manual. NIVA SNO 6074-2010. **ICP Waters report 105/2010**.

Skjelkvåle, B.L., Wathne B. M. and Vuorenmaa J. (eds.) 2010. Proceedings of the 26th meeting of the ICP Waters Programme Task Force in Helsinki, Finland, October 4 – 6, 2010. NIVA report SNO 6097-2010. **ICP Waters report 104/2010**.

Fjellheim, A. 2010. Biological intercalibration: Invertebrates 1410. NIVA report SNO 6087-2010. NIVA report SNO 6087-2010. **ICP Waters report 103/2010**.

Hovind, H. 2010. Intercomparison 1024: pH, Cond, HCO_3, NO_3-N, Cl, SO_4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA report SNO 6029-2010. **ICP Waters report 102/2010**.

De Wit, H.A. and Lindholm M. 2010. Nutrient enrichment effects of atmospheric N deposition on biology in oligotrophic surface waters – a review. NIVA report SNO 6007 - 2010. **ICP Waters report 101/2010**.

Skjelkvåle, B.L., De Wit, H. and Jeffries, D. (eds.) 2010. Proceedings of presentations of national activities to the 25th meeting of the ICP Waters Programme Task Force in Burlington, Canada, October 19-21 2009. NIVA report SNO 5995 - 2010. **ICP Waters report 100/2010**.

Fjellheim, A. 2009. Biological intercalibration: Invertebrates 1309. NIVA report SNO 5883-2009, **ICP Waters report 99/2009**.

Hovind, H. 2009. Intercomparison 0923: pH, Cond, HCO_3, NO_3-N, Cl, SO_4, Ca, Mg, Na, K, TOC, Al, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA report SNO 5845-2009. **ICP Waters report 98/2009**.

Ranneklev, S.B., De Wit, H., Jenssen, M.T.S. and Skjelkvåle, B.L. 2009. An assessment of Hg in the freshwater aquatic environment related to long-range transported air pollution in Europe and North America. NIVA report SNO 5844-2009. **ICP Waters report 97/2009**.

Skjelkvåle, B.L., Jenssen, M. T. S. and De Wit, H (eds.) 2009. Proceedings of the 24th meeting of the ICP Waters Programme Task Force in Budapest, Hungary, October 6 – 8, 2008. NIVA report SNO 5770-2009. **ICP Waters report 96/2009**.

Fjellheim, A and Raddum, G.G. 2008. Biological intercalibration: Invertebrates 1208. NIVA report SNO 5706-2008, **ICP Waters report 95/2008**.

Skjelkvåle, B.L., and De Wit, H. (eds.) 2008. ICP Waters 20 year with monitoring effects of long-range transboundary air pollution on surface waters in Europe and North-America. NIVA report SNO 5684-2008. **ICP Waters report 94/2008**.

Hovind, H. 2008. Intercomparison 0822: pH, Cond, HCO_3, NO_3-N, Cl, SO_4, Ca, Mg, Na, K, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA report SNO 5660-2008. **ICP Waters report 93/2008**.

De Wit, H. Jenssen, M. T. S. and Skjelkvåle, B.L. (eds.) 2008. Proceedings of the 23rd meeting of the ICP Waters Programme Task Force in Nancy, France, October 8 – 10, 2007. NIVA report SNO 5567-2008. **ICP Waters report 92/2008**.

Fjellheim, A and Raddum, G.G. 2008. Biological intercalibration: Invertebrates 1107. NIVA report SNO 5551–2008. **ICP Waters report 91/2008**.

Hovind, H. 2007. Intercomparison 0721: pH, Cond, HCO3, NO3-N, Cl, SO4, Ca, Mg, Na, K, Fe, Mn, Cd, Pb, Cu, Ni, and Zn. NIVA report SNO 5486-2007. **ICP Waters report 90/2007**.

Wright, R.F., Posch, M., Cosby, B. J., Forsius, M., and Skjelkvåle, B. L. 2007. Review of the Gothenburg Protocol: Chemical and biological responses in surface waters and soils. NIVA report SNO 5475-2007. **ICP Waters report 89/2007**.

Skjelkvåle, B.L., Forsius, M., Wright, R.F., de Wit, H., Raddum, G.G., and Sjøeng, A.S.M. 2006. Joint Workshop on Confounding Factors in Recovery from Acid Deposition in Surface Waters, 9-10 October 2006, Bergen, Norway; Summary and Abstracts. NIVA report SNO 5310-2006. **ICP Waters report 88/2006**.

De Wit, H. and Skjelkvåle, B.L. (eds) 2007. Trends in surface water chemistry and biota; The importance of confounding factors. NIVA report SNO 5385-2007. **ICP Waters report 87/2007**.

Hovind, H. 2006. Intercomparison 0620. pH, K25, HCO3, $NO_3 + NO_2$, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA report SNO 5285-2006. **ICP Waters report 86/2006**.

Raddum, G.G. and Fjellheim, A. 2006. Biological intercalibration 1006: Invertebrate fauna. NIVA report SNO 5314-2006, **ICP Waters report 85/2006**.

De Wit, H. and Skjelkvåle, B.L. (eds.) 2006. Proceedings of the 21th meeting of the ICP Waters Programme Task Force in Tallinn, Estonia, October 17-19, 2005. NIVA report SNO 5204-2006, **ICP Waters report 84/2006**.

Wright, R.F., Cosby, B.J., Høgåsen, T., Larssen, T. and Posch, M. 2005. Critical Loads, Target Load Functions and Dynamic Modelling for Surface Waters and ICP Waters Sites. NIVA report SNO 5166-2005. **ICP Waters report 83/2006**.

Hovind, H. 2005. Intercomparison 0317. pH, K25, HCO3, NO3 + NO2, Cl, SO4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA report SNO 5068-2005. **ICP Waters report 82/2005**.

Raddum, G.G. 2005. Intercalibration 0307: Invertebrate fauna. NIVA report SNO 5067-2005. **ICP Waters report 81/2005**.

De Wit, H. and Skjelkvåle, B.L (eds.) 2005. Proceedings of the 20th meeting of the ICP Waters Programme Task Force in Falun, Sweden, October 18-20, 2004. NIVA report SNO 5018-2005. **ICP Waters report 80/2005**.

Fjeld, E., Le Gall, A.-C. and Skjelkvåle, B.L. 2005. An assessment of POPs related to long-range air pollution in the aquatic environment. NIVA report SNO 5107-2005. **ICP Waters report 79/2005**.

Skjelkvåle et al. 2005. Regional scale evidence for improvements in surface water chemistry 1990-2001. Environmental Pollution, 137: 165-176

Hovind, H. 2004. Intercomparison 0418. pH, K25, HCO3, NO3 + NO2, Cl, SO4, Ca, Mg, Na, K, Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA report SNO 4875-2004. **ICP Waters report 78/2004**.

Raddum, G.G. 2004. Intercalibration: Invertebrate fauna 09/04. NIVA report SNO 4863-2004. **ICP Waters report 77/2004**.

Skjelkvåle, B.L. (ed) 2004. Proceedings of the 19th meeting of the ICP Waters Programme Task Force in Lugano, Switzerland, October 18-20, 2003. NIVA report SNO 4858-2004. **ICP Waters report 76/2004.**

Raddum, G.G, et al. 2004. Recovery from acidification of invertebrate fauna in ICP Water sites in Europe and North America. NIVA report SNO 4864-2004. **ICP Waters report 75/2004.**

Hovind, H. 2003. Intercomparison 0317. pH, K25, HCO3, NO3 + NO2, Cl, SO4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA report SNO 4715-2003. **ICP Waters report 74/2003.**

Skjelkvåle, B.L. (ed) 2003. The 15-year report: Assessment and monitoring of surface waters in Europe and North America; acidification and recovery, dynamic modelling and heavy metals. NIVA report SNO 4716-2003. **ICP Waters report 73/2003.**

Raddum.G.G. 2003. Intercalibration 0307: Invertebrate fauna. NIVA report SNO-4659-2003. **ICP Waters report 72/2003**.

Skjelkvåle, B.L. (ed.) 2003. Proceedings of the 18th meeting of the ICP Waters Programme Task Force in Moscow, October 7-9, 2002. NIVA report SNO 4658-2003. **ICP Waters report 71/2003**.

Wright, R.F. and Lie, M.C. 2002.Workshop on models for Biological Recovery from Acidification in a Changing Climate. 9-11 september 2002 in Grimstad, Norway. Workshop report. NIVA report 4589-2002.

Jenkins, A. Larssen, Th., Moldan, F., Posch, M. and Wrigth, R.F. 2002. Dynamic Modelling of Surface Waters: Impact of emission reduction - possibilities and limitations. NIVA report SNO 4598-2002. **ICP Waters report 70/2002**.

Halvorsen, G.A, Heergaard, E. and Raddum, G.G. 2002. Tracing recovery from acidification - a multivariate approach. NIVA report SNO 4564-2002. **ICP Waters report 69/2002**.

Hovind. H. 2002. Intercomparison 0216. pH, K_{25}, HCO_3, NO_3 + NO_2, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA report SNO 4558-2002. **ICP Waters Report 68/2002**.

Skjelkvåle, B.L. and Ulstein, M. (eds) 2002. Proceedings from the Workshop on Heavy Metals (Pb, Cd and Hg) in Surface Waters; Monitoring and Biological Impact. March 18-20, 2002, Lillehammer, Norway. NIVA report SNO-4563-2002. **ICP Waters report 67/2002**.

Raddum.G.G. 2002. Intercalibration 0206: Invertebrate fauna. NIVA report SNO-4494-2002. **ICP Waters report 66/2002**.

Bull, K.R. Achermann, B., Bashkin, V., Chrast, R. Fenech, G., Forsius, M., Gregor H.-D., Guardans, R., Haussmann, T., Hayes, F., Hettelingh, J.-P., Johannessen, T., Kryzanowski, M., Kucera, V., Kvaeven, B., Lorenz, M., Lundin, L., Mills, G., Posch, M., Skjelkvåle, B.L. and Ulstein, M.J. 2001. Coordinated Effects Monitoring and Modelling for Developing and Supporting International Air Pollution Control Agreements. Water Air Soil Poll. 130:119-130.

Hovind, H. 2001. pH, K_{25}, HCO_3, NO_3 + NO_2, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA report SNO 4416-2002. **ICP Waters report 64/2001**.

Lyulko, I. Berg, P. and Skjelkvåle, B.L. (eds.) 2001. National presentations from the 16th meeting of the ICP Waters Programme Task Force in Riga, Latvia, October 18-20, 2000. NIVA report SNO 4411-2001. **ICP Waters report 63/2001**.

Raddum.G.G. 2000. Intercalibration 0005: Invertebrate fauna. NIVA report SNO4384-2001. **ICP Waters report 62/2001**.

Raddum, G.G. and Skjekvåle B.L. 2000. Critical Load of Acidifying Compounds to Invertebrates In Different Ecoregions of Europe. Water Air Soil Poll. 130:825-830.

Stoddard, J. Traaen, T and Skjelkvåle, B.L. 2001. Assessment of Nitrogen leaching at ICP-Waters sites (Europe and North America). Water Air Soil Poll. 130:825-830.

Skjelkvåle, B.L. Stoddard J.L. and Andersen, T. 2001. Trends in surface waters acidification in Europe and North America (1989-1998). Water Air Soil Poll.130:781-786.

Kvaeven, B. Ulstein, M.J., Skjelkvåle, B.L., Raddum, G.G. and Hovind. H. 2001. ICP Waters – An international programme for surface water monitoring. Water Air Soil Poll.130:775-780.

Wright, R.F. 2001. Note on: Effect of year-to-year variations in climate on trends in acidification. NIVA report SNO 4328-2001. **ICP Waters report 57/2001**.

Hovind, H. 2000. Trends in intercomparisons 8701-9812: pH, K_{25}, NO_3 + NO_2, Cl, SO_4, Ca, Mg, Na, K and aluminium - reactive and nonlabile, TOC, COD-Mn. NIVA report SNO 4281-2000, **ICP Waters Report 56/2000**.

Hovind, H. 2000. Intercomparison 0014. pH, K_{25}, HCO_3, NO_3 + NO_2, Cl, SO_4, Ca, Mg, Na, K, total aluminium, aluminium - reactive and nonlabile, TOC, COD-Mn. Fe, Mn, Cd, Pb, Cu, Ni and Zn. NIVA report SNO 4281-2000. **ICP Waters Report 55/2000**.

Skjelkvåle, B.L., Olendrzynski, K., Stoddard, J., Traaen, T.S, Tarrason, L., Tørseth, K., Windjusveen, S. and Wright, R.F. 2001. Assessment of trends and leaching in Nitrogen at ICP Waters Sites (Europe And North America). NIVA report SNO 4383-2001. **ICP Waters report 54/2001.**

Stoddard, J. L., Jeffries, D. S., Lükewille, A., Clair, T. A., Dillon, P. J., Driscoll, C. T., Forsius, M., Johannessen, M., Kahl, J. S., Kellogg, J. H., Kemp, A., Mannio, J., Monteith, D., Murdoch, P. S., Patrick, S., Rebsdorf, A., Skjelkvåle, B. L., Stainton, M. P., Traaen, T. S., van Dam, H., Webster, K. E., Wieting, J., and Wilander, A. 1999. Regional trends in aquatic recovery from acidification in North America and Europe 1980-95. Nature 401:575- 578.

Skjelkvåle, B. L., Andersen, T., Halvorsen, G. A., Raddum, G.G., Heegaard, E., Stoddard, J. L., and Wright, R. F. 2000. The 12-year report; Acidification of Surface Water in Europe and North America; Trends, biological recovery and heavy metals. NIVA report SNO 4208/2000. **ICP Waters report 52/2000**.

Reports before year 2000 can be listed on request.

NIVA: Norway's leading centre of competence in aquatic environments

NIVA provides government, business and the public with a basis for preferred water management through its contracted research, reports and development work. A characteristic of NIVA is its broad scope of professional disciplines and extensive contact network in Norway and abroad. Our solid professionalism, interdisciplinary working methods and holistic approach are key elements that make us an excellent advisor for government and society.

Norwegian Institute for Water Research

Gaustadalléen 21 • NO-0349 Oslo, Norway
Telephone: +47 22 18 51 00 • Fax: 22 18 52 00
www.niva.no • post@niva.no