NIVA REPORT SNO 7657-2021

ICP Waters Report 145/2021

Proceedings of the 37th Task Force meeting of the ICP Waters Programme, held on-line, April 28-29, 2021

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
Økernveien 94
NO-0579 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 Proceedings of the 37th Task Force meeting of the ICP Waters Programme, held on-line, April 28-29, 2021	Serial number 7657-2021 ICP Waters report 145/2021	Date 06.10.2021
Author(s) Øyvind Garmo, Ingvild Skumlien Furuseth and Kari Austnes (editors)	Topic group Acid rain	Distribution Open
	Geographical area Europe and North America	Pages 37 + appendix

Client(s) Norwegian Environment Agency United Nations Economic Commission for Europe (UNECE)	Client's contact person Gunnar Skotte
Client's publication: ICP Waters report	Printed NIVA Project number 10300

Summary

Proceedings of the 37th Task Force meeting of the ICP Waters Programme held on-line, April 28-29, 2021. National contributions from Italy.

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:

Øyvind Garmo	*Kari Austnes*	*Sondre Meland*
Main Author	Quality Assurance	Research Manager

ISBN 978-82-577-7393-9
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 37th Task Force meeting of the ICP Waters Programme, held on-line April 28-29, 2021

Prepared at the ICP Waters Programme Centre
Norwegian Institute for Water Research
Oslo, October 2021

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 37th Task Force meeting of the ICP Waters programme, held on-line, April 28-29, 2021.

Kari Austnes

ICP Waters Programme Centre
Oslo, October 2021

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 on-line, April 28-29, 2021 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.

National Emissions Ceiling (NECD) and monitoring

- Spanish NECD and ICP Waters monitoring programs (Manuel Velasco, Spain)
- Introduction and discussion on monitoring under the NEC Directive (Kari Austnes, ICP Waters programme centre)

Biology – trends and assessment

- An update on chemical and biological responses of acidified waters in the UK to long-term deposition reductions (Don Monteith, UK)
- Lakes Paione (NW Italy): temporal and spatial trends of macroinvertebrates and acidification indices (Angela Boggero, Italy)
- Ecological status assessment in the Debed River basin using hydrobiological and inorganic nitrogen indicators (Vardan Karyan, Armenia)
- Suggestion towards a Nordic classification system for acidification (Jens Fölster, Sweden)
- ICP Waters call for contributions: Assessment of biological responses to reduced acidification (Gaute Velle, ICP Waters Programme Sub-centre)

Water chemistry trends

- Impacts of COVID-19 lockdown on sulphur and nitrogen deposition and surface water chemistry over an alpine area (Michela Rogora, Italy)
- Surprising long-term changes in water chemistry in 1000 Norwegian lakes - evidence of climate change impacts? (Øyvind Garmo, Norway)
- Long-term response of water chemistry to reduced acid deposition and climate warming of the Kola Arctic region (Tatiana Moiseenko, Russia)
- Brownification on hold: What conventional analyses miss in extended water quality records (Jens Fölster, Sweden)
- Long-term (years) use of continual water chemistry probe for DOC, pH and conductivity - what we miss compared to regular sampling? (Jakub Hruška, Czech Republic)
- Impact of climate change on the release of base cations from soils to surface waters (Daniel Houle, Canada)

Nitrogen

- ICP Waters 2021 report on nitrogen: Plans, results, discussion (Kari Austnes, Jan-Erik Thrane, ICP Waters Programme Centre)

2 Lakes Paione (NW Italy): macroinvertebrates temporal and spatial trend and applicability of acidification indices

Boggero A.[1], Fornaroli R.[1], Zaupa S.[1], Paganelli D.[1], Dumnicka E.[2], Rogora M.[1]
[1]CNR – Water Research Institute, Largo Tonolli 50, 28922 Verbania, Italy
[2]Institute of Nature Conservation, Polish Academy of Sciences, 31-120 Krakow, Poland

2.1 Introduction

Alpine lakes are important sources of water and biodiversity for the lowland areas. Therefore, their monitoring is fundamental to understand how their food web works, which abiotic parameters affect their status, and which anthropogenic stressor has the greatest impact on their biota. These fragile ecosystems, with small and steep catchments usually characterised by bare rocks and sparse vegetation, could show a high variation of physical and chemical conditions on a local scale, that support the peculiar biodiversity typical of the alpine area.

In 2019, the National Emission Ceilings Directive (NECD - 2016/2284/EU) was launched by the European Union to set national emission reduction commitments for Member States of the most relevant air-borne pollutants. For the first time, EU countries were asked to monitor the effects of the reduced emissions on both freshwater and terrestrial ecosystems.

Here, we present the results of the first analysis on the macroinvertebrates of lakes Paione superiore and inferiore, two small high altitude lakes in the Alps belonging to the ICP Waters network, with the aim to show how this dataset has been structured in order to organise data in a systematic and coherent way and to apply several acidification indices to try to highlight any effect on freshwater macroinvertebrates or any recovery from acidification.

Lakes Paione and their streams are among the most studied high altitude environments in Italy, and they are the subject of long-term and multi-disciplinary research, including also macroinvertebrates (Marchetto et al. 2004).

Lakes Paione were first studied in the 1940s to characterize their morphometry, local meteorology, and water chemistry (Tonolli 1949). Subsequently, they were included in several projects on Alpine lakes financed by the European Community. In these projects, these lakes were used, together with other remote lakes, as indicators of atmospheric pollutants deposition or of climate change. They are indeed characterized by a low buffer capacity due to the acidic rocks present in their catchments. In the ‘90s, thanks to the reduction of acid deposition, the lakes began to recover chemically, showing increasing pH and alkalinity values, and a reduction in aluminium concentrations, particularly evident in Lake Paione Superiore. Subsequently, signs of biological recovery were also observed, with the reappearance of some acid-sensitive benthic species (Marchetto et al. 2004). More recently, Lakes Paione, together with other lakes in the Ossola and Sesia Valleys, were used to analyse the possible effects of climate warming on water chemistry (Rogora et al. 2013). Unfortunately, while it is clear that long-term and continuous data exists for water chemistry, only a reduced and fragmentary series of biological data on macroinvertebrates is available since the ‘90s.

2.2 Study area

Lakes Paione are located in the Bognanco Valley, a side valley of the Ossola Valley in the Central Alps (NW, Italy). The three lakes (superiore - LPS, medio - LPM and inferiore - LPI), constitute a cascade system of glacial cirque lakes (Figure 1) characterized by huge steps shaped by ice. The Valley is not affected by any direct anthropogenic impact or exploitation of the territory. The geolithology is mainly formed by orthogneiss and gneiss, and the vegetation consists of restricted alpine meadow-pasture surrounded by bare rock and debris.

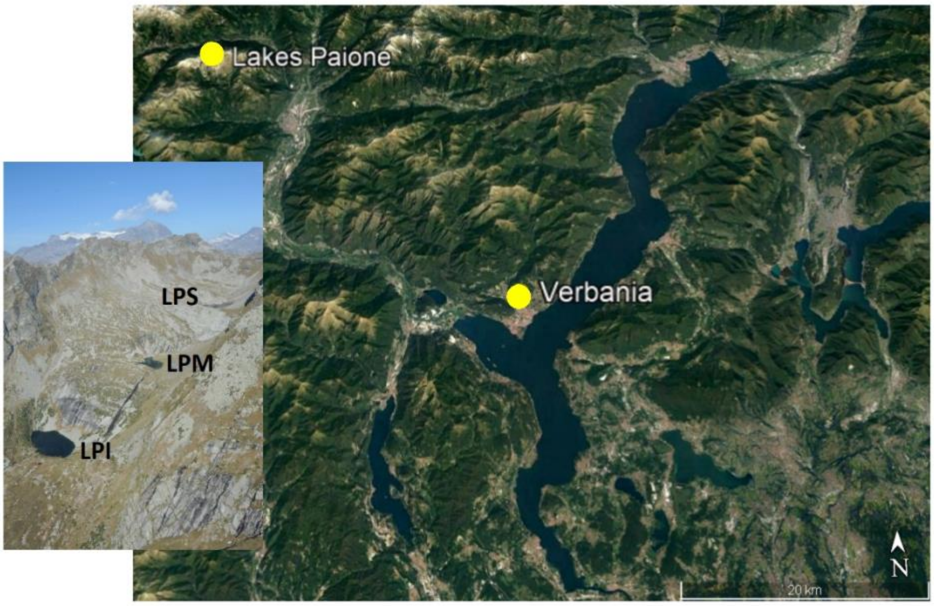

Figure 1. Location of Lakes Paione in the surroundings of Verbania (Lake Maggiore watershed, NW Italy)

2.3 Sampling design and laboratory methods

Macroinvertebrates sampling was performed following the ICP WATERS Manuals (ICP Waters Programme Centre 1996, 2010). Semi-quantitative macroinvertebrate samples were taken, during the ice-free season and before insect diapause through a disturbance-removal sampling after 2-5 min handle-netting the substrate (250 µm mesh size) complementary with sampling for water chemistry. Different habitats were considered (gravel, pebbles, boulders, rock faces) on ≥ 0.5-meter-wide littoral- or river-reaches. The samples were then fixed with 80% alcohol and transported to the laboratory. Sorting was performed at genus/species level; identification involves the use of specific taxonomic keys in use at national and at European levels: several guides related to macroinvertebrates in general (AA.VV. 1977-1985); Timm (2009) and Schmelz and Collado (2010) for oligochaetes; Andersen et al. (2013) for Chironomids.

Temporal trends of macroinvertebrate metrics were explored on autumn samples. Invertebrate metrics were modeled as a smoothed response over time through GAMs via the gam function in the "mgcv" package (Wood 2011). For this, cubic splines were implemented, and a Gaussian distribution was modeled. Then, residual diagnostics were inspected for each optimal GAM to ensure the assumptions of homogenous variances and normal distributions were met; where these criteria were satisfied, the significance of the time smoothing parameter was obtained. In addition, periods when invertebrate responses significantly increased or decreased were explored by the first derivatives of each GAM using the method of finite differences derived from 200 equally spaced time points over the study period (Monteith et al. 2014). When residual checks revealed that the assumptions of GAMs were not valid, temporal changes were visualized through a "LOcally Estimated Scatterplot Smoothing" (LOESS) function.

Table 1. Full information linked to the data set on lakes Paione with variables, their definitions, Darwin Core Thesaurus identifier, units, storage type.

Variables	Description	Univocal references	Units	Storage type
ID_Code	Unique identifier for the record within the dataset	catalogNumber		Integer
Kingdom	Full scientific name of the kingdom in which the taxon is currently classified (2020)	kingdom		String
Phylum	Full scientific name of the phylum in which the taxon is currently classified (2020)	phylum		String
Class	Full scientific name of the class in which the taxon is currently classified (2020)	class		String
Order	Full scientific name of the order in which the taxon is currently classified (2020)	order		String
Family	Full scientific name of the family in which the taxon is currently classified (2020)	family		String
Taxon	Full scientific name at the lowest taxonomic resolution available in which the taxon is currently classified (2020)	Taxon		String
GBIF_Code	Unique identifier for the record within GBIF database	taxonID		Integer
Quantity_Type	Data format in which the frequency of occurrence is provided	organismQuantityType		String
Frequency	Number of individuals in each sample	organismQuantity	No. Individuals/sample	Numeric
Sample_Code	Unique identifier for the sample within the dataset	eventID		String
Lake_Code	Unique identifier for the lake within the dataset	locationID		String
Sampling_Date	Date-time when the event was recorded expressed as yyyy/mm/dd	eventDate		String
Substrate	Substratum sampling type			String
Zone	Lake layer sampled			String
Lake	Lake name	waterBody		String
Datum	Spatial Reference System (SRS) to locate geographical water bodies or their habitats	geodeticDatum		String
Longitude	Geographic longitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of a location	decimalLongitude	Decimal degrees	Numeric
Latitude	Geographic latitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of a location	decimalLatitude	Decimal degrees	Numeric
Altitude	Explicit elevation above sea level of the sampled lake or river	verbatimElevation	Meters	Numeric
Raddum_1988	Acidity score of each taxon within Raddum index (Raddum et al. 1988)			Numeric
Raddum_1990	Acidity score of each taxon within Raddum index (Fjellheim & Raddum 1990)			Numeric

Variables	Description	Univocal references	Units	Storage type
NIVA	pH-tolerance class index of each taxon within NIVA index (Bækken & Kjellberg 2004)			Integer
$AWIC_{fam}$_taxon	Family name to be used to estimate AWIC index (Davy-Bowker et al. 2003, 2005)			String
$AWIC_{fam}$	Family level acid-sensitivity scoring system (Davy-Bowker et al. 2003, 2005)			Integer
$AWIC_{sp}$_taxon	Species name to be used to estimate AWIC index (Davy-Bowker et al. 2003)			String
$AWIC_{sp}$	Species level acid-sensitivity scoring system (Davy-Bowker et al. 2003)			Integer
Braukmann	Class-sensitivity to acidity of each taxon (Braukmann & Biss 2004)			Integer
LAMM_Sk	Acid-sensitivity score of each taxon (McFarland et al. 2010)			Numeric
LAMM_Wk	Indicator-weight of each taxon (McFarland et al. 2010)			Numeric
TL	Tolerance-Limit to acidity of each taxon (Hämäläinen & Huttunen 1990)			Numeric

2.4 Results

The set of data available at CNR-IRSA on benthic invertebrates belonging to lakes Paione inferiore and superiore (IT01, IT03), have been organized in a dedicated dataset. The database allows the storage and export of much information relating to different spatial scales, from the type of substrate sampled to the lake or the lake-reach sampled. During the dataset development, taxonomy was updated and uniformed to allow comparisons with data collected in other geographical areas. The checklist presents a total of 93 samples and 1852 records prepared in 2020 according to Fauna Europaea classification (de Jong et al. 2014). A detailed description of the information included in the dataset is shown in Table 1. For the analysis of the effects of acidification on the fauna of lakes and their river network several metrics can be applied, some of them consider the whole macroinvertebrate community, some other use specific taxon. Data covered mostly the 1991-2020 period, and their variation over time has also been assessed.

Generic metrics related to diversity, richness and functional aspects were applied to all macroinvertebrates or to specific taxon: 1) total number of taxa (Ofenböck et al., 2004); 2) number of taxa, families and relative abundance of Ephemeroptera, of Plecoptera, of Trichoptera, and of the whole EPT (Böhmer et al. 2004; Ofenböck et al. 2004); 3) number of taxa and relative abundances of Diptera Chironomids and Oligochetes (Wiederholm 1980); 4) Shannon diversity index (Shannon & Weaver 1948).

Specific metrics based on the occurrence or on the relative abundance of taxa sensitive to acidification effects (see Tab. 1 for references): 1) Raddum index 1988, and expanded Raddum index 1990; 2) NIVA index; 3) $AWIC_{sp}$ and $AWIC_{fam}$ indices; 4) Braukmann index; 5) LAMM index; 6) TL index.
The same indices will also be applied to the other Alpine lakes sampled in 2019 and 2020 within the NEC activities.

Data relating to the macroinvertebrates of lakes Paione allowed to analyse the temporal evolution of the assemblage structure over a period of almost thirty years. Figure 2 shows the richness and the $AWIC_{sp}$ index trends applied to the littoral habitats of both lakes.

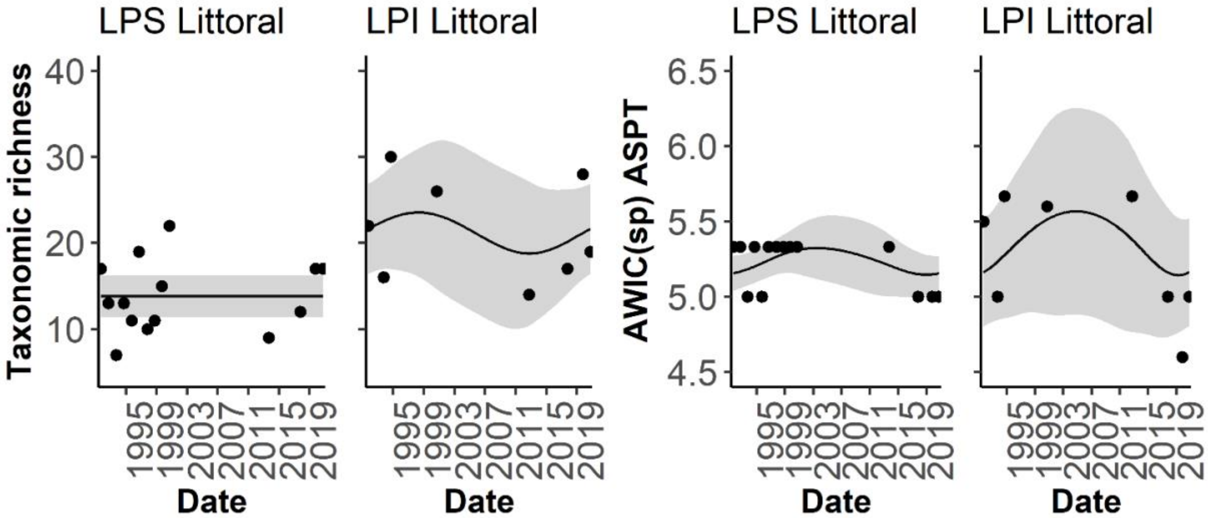

Figure 2. Richness and AWICsp index temporal trends applied to the macroinvertebrate assemblages of lakes Paione littorals during Autumn.

AWIC$_{sp}$ index variability is much lower than the total number of taxa and stands at values just over 5, corresponding to environments with pH always >5.5. Lake Paione Inferiore has a greater biodiversity than Lake Paione Superiore, possibly due both to the more favourable geographical position (lower altitude) and to a lower impact of acidification, as suggested by the higher values of the AWIC$_{sp}$ index. The same indices applied to outlet streams (Figure 3) show again that AWIC$_{sp}$ index variability is much lower than the total number of taxa and is often >5.5, corresponding to environments with pH >6. The assemblages structure present in the two streams do not allow to highlight any significant difference within them, but they are generally richer in taxa than the lake littorals, especially in Lake Paione Superiore.

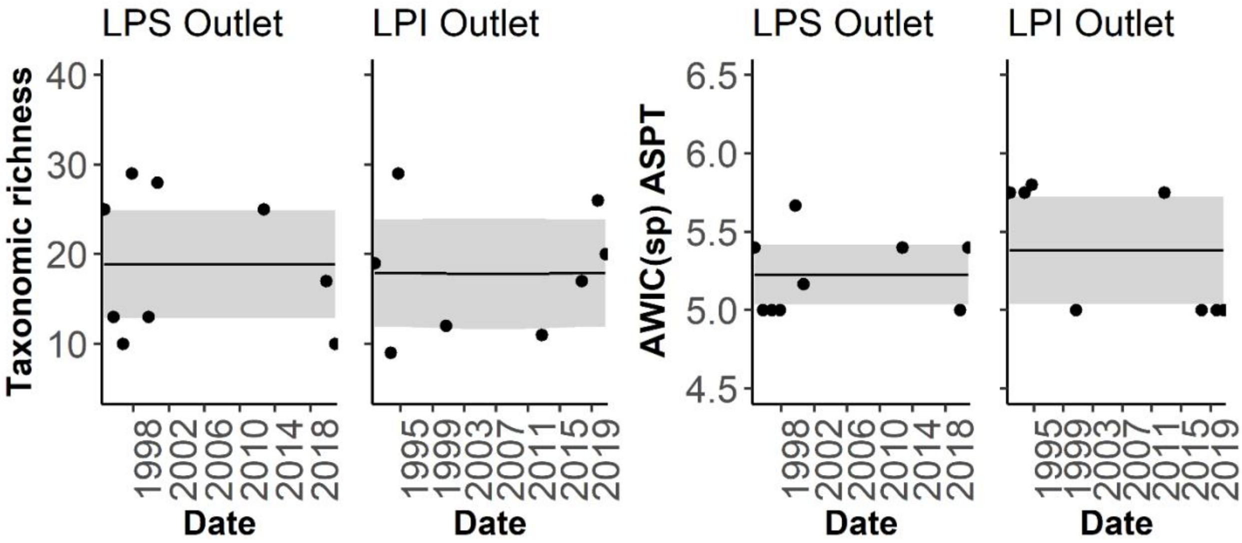

Figure 3. Richness and AWICsp index temporal trends applied to the macroinvertebrate assemblages of lakes Paione outlets during Autumn.

No significant temporal trend was identified for any of the studied relationships, probably due in part to the high variability of taxonomic richness and to the very low variability of AWIC$_{sp}$ ASPT.

2.5 Reference

Andersen T., Cranston P.S., Epler J.H. (eds). 2013. Chironomidae of the Holarctic Region: Keys and diagnoses. Part 1 - Larvae. Insect Systematics and Evolution Supplements (formerly Entomologica Scandinavica Supplement), 66: 573 pp.

Bækken T, Kjellberg G. 2004. Classification of acidity and assessment of acidification in running waters based on the presence of macroinvertebrates. Classification system developed for humic rivers and brooks in Eastern Norway. Report 4923, Norwegian Institute for Water Research (NIVA), Oslo, Norway: 13 pp.

Bohmer J., Rawer-Jost C., Zenker A., Meier C., Feld C.K., Biss R., Hering D. 2004. Assessing streams in Germany with benthic invertebrates: Development of a multimetric invertebrate based assessment system. Limnologica, 34: 416-432.

Braukmann U., Biss R. 2004. Conceptual study - An improved method to assess acidification in German streams by using benthic macroinvertebrates. Limnologica, 34: 433-450.

Davy-Bowker J., Furse M.T., Murphy J.F., Clarke R.T., Wiggers R., Vincent H.M. 2003. Development of the Acid Water Indicator Community (AWIC) macroinvertebrate family and species level scoring systems. Monitoring acid water Phase I. R&D Technical Report P2-090/TR1. Bristol, UK. Environment Agency.

Davy-Bowker J., Murphy J.F., Rutt G.P., Steel J.E.C., Furse M.T. 2005. The development and testing of a macroinvertebrate biotic index for detecting the impact of acidity on streams. Arch. Hydrobiol., 163: 383-403.

de Jong Y., Verbeek M., Michelsen V., Bjørn P., Los W., Steeman F., Bailly N., Basire C., Chylarecki P., Stloukal E., Hagedorn G., Wetzel F., Glöckler F., Kroupa A., Korb G., Hoffmann A., Häuser C., Kohlbecker A., Müller A., Güntsch A., Stoev P., Penev L. 2014. Fauna Europaea - all European animal species on the web. Biodivers. Data J., 2: e4034.

Fjellheim A., Raddum G.G. 1990. Acid precipitation: biological monitoring of streams and lakes. Sci. Total Environ., 96: 57-66.

Hämälainen H., Huttunen P. 1990. Estimation of Acidity in Streams by Means of Benthic Invertebrates: Evaluation of Two Methods. In: Kauppi P, Anttilla P., Kenttamies K. (eds), Acidification in Finland, Springer Verlag, Berlin Heidelberg: 1051-1070.

ICP Waters Programme Centre. 1996. Programme manual. NIVA report SNO 3547-96.

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

Marchetto A., Mosello R., Rogora M., Manca M., Boggero A., Morabito G., Bettinetti R. 2004. The chemical and biological response of two remote mountain lakes in the Southern Central Alps (Italy) to twenty years of changing physical and chemical climate. J. Limnol., 63: 77-89.

McFarland B., Carse F., Sandin L. 2010. Littoral macroinvertebrates as indicators of lake acidification within the UK. Aquat. Conserv., 20: 105–116.

Monteith D.T., Evans C.D., Henrys P.A., Simpson G.L., Malcolm I.A. 2014. Trends in the hydrochemistry of acid-sensitive surface waters in the UK 1988-2008. Ecol. Indic., 37: 287-303.

Mosello R., Marchetto A., Brizzio M.C., Tartari G.A., Rogora M. 1999. Pluriannual evolution of the hydrochemistry of two alpine lakes (Lake Paione Inferiore and Lake Paione Superiore, Ossola Valley) in relation to atmospheric loads. J. Limnol., 58: 43-49.

Ofenböck T., Moog O., Gerritsen J., Barbour M. 2004. A stressor specific multimetric approach for monitoring running water in Austria using benthic macro-invertebrates. In: Hering D., Verdonschot P.F.M., Moog O., Sandin L. (eds), Integrated assessment of running waters in Europe. Kluwer Academic Publisher, the Netherlands. Hydrobiologia, 516: 251-268

Raddum, G.G., Fjellheim A., Hesthagen T. 1988. Monitoring of acidification by the use of aquatic organisms. Verh. int. Ver. Limnol., 23: 2291-2297.

Rogora M., Colombo L., Lepori F., Marchetto A., Steingruber S., Tornimbeni O. 2013. Thirty years of chemical changes in alpine acid-sensitive lakes in the Alps. Wat. Air Soil Pollut., 224: 1746.

Shannon C.E., Weaver W. 1948. The mathematical theory of communication. University of Illinois Press, Urbana: 132 pp.

Tonolli V. 1949. Gli alti laghi della Val Bognanco. Parte II. Mem. Ist. Ital. Idrobiol., 5: 39-93.

Wiederholm T. 1980. Use of benthos in lake monitoring. Water Pollution Control Federation, 52: 537-547.

Wood S.N. 2011. Fast stable restricted maximum likelihood and marginal likelihood estimation of semiparametric generalized linear models. J. R. Stat. Soc. Series B, 73(1): 3-36.

3 Impacts of COVID-19 lockdown on sulphur and nitrogen deposition and surface water chemistry over an alpine area

M. Rogora, P. Giacomotti, A. Orru’, A. Marchetto, R. Mosello, G. Tartari – CNR Water Research Institute (IRSA), Verbania Pallanza, Italy
S. Steingruber - Dipartimento del Territorio del Canton Ticino, Bellinzona, Switzerland

3.1 Introduction

The possible effects of COVID-19 lockdown on deposition and surface water chemistry in an area South of the Alps were investigated by analysing long-term data from the Italian and Swiss deposition and surface water monitoring networks. Atmospheric deposition is monitored at several sites in the area of Lake Maggiore’s watershed, Southern Alps, since the 1980s (Figure 4) in the framework of research on acidification and nitrogen deposition effects on surface water. Atmospheric deposition sampling sites are located both in the Italian (Piedmont region) and Swiss (Canton Ticino) part of the watershed and cover both a latitudinal and altitudinal range (Tab. 1). Wet-only collectors are used at all sites. Samples are collected weekly at all sites except the Pallanza station, where sampling is performed on an event basis. Samples are analysed for the main chemical variables by the water chemistry laboratories of the CNR Water Research Institute (CNR IRSA) in Verbania, Italy, and of the Territory Department of Canton Ticino in Bellinzona, Switzerland. Monthly and annual deposition are calculated as volume weighted average on precipitation volume. Details on sampling and analyses can be found in Rogora et al. (2016).

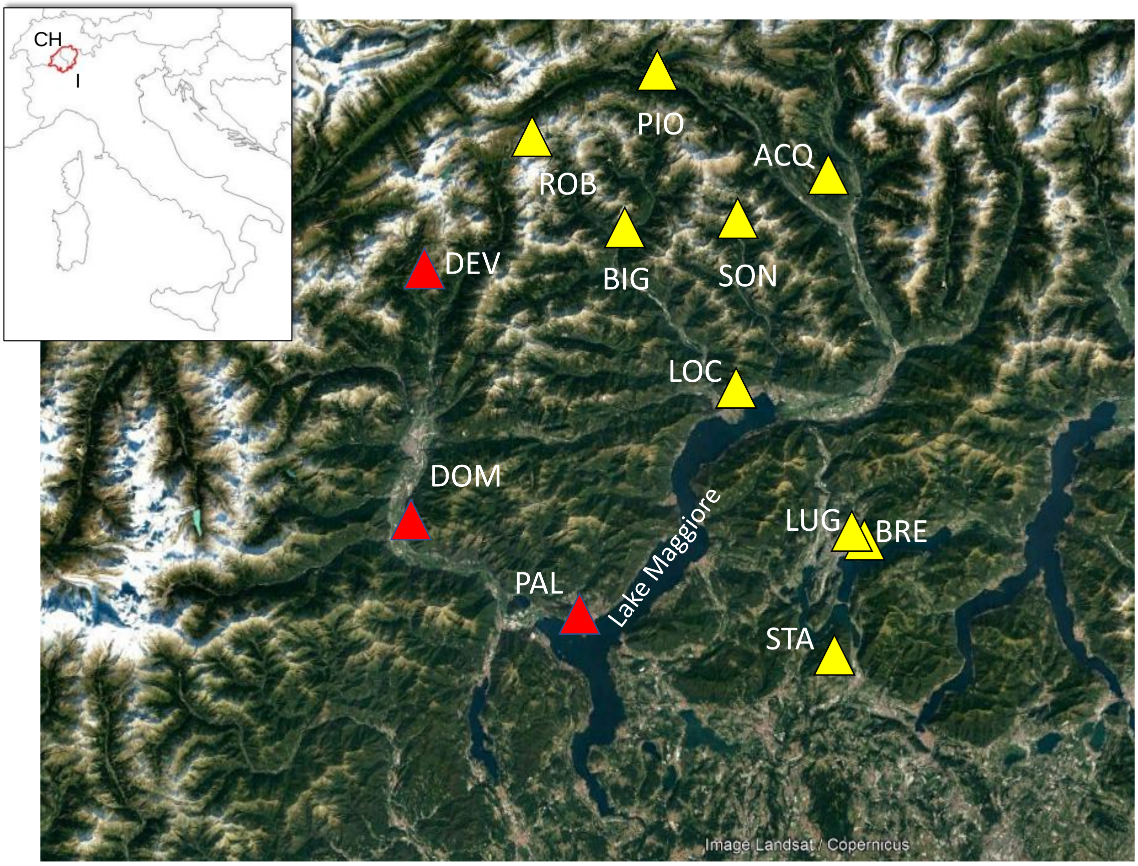

Figure 4. The study area (Piedmont, Italy, and Canton Ticino, Switzerland) with the location of the atmospheric deposition sampling sites.

Table 2. Atmospheric deposition sampling sites in the Italian and Swiss part of Lake Maggiore watershed.

STATION	ACRONYM	COUNTRY	ALTITUDE (m a.s.l.)	DATA SINCE
Pallanza	PAL	I	208	1975
Domodossola	DOM	I	270	1986
Devero	DEV	I	1634	1996
Locarno	LOC	CH	367	1982
Lugano	LUG	CH	350	1982
Piotta	PIO	CH	1007	1990
Acquarossa	ACQ	CH	575	1990
Stabio	STA	CH	353	1990
Monte Bre’	BRE	CH	925	1995
Robiei	ROB	CH	1890	1996
Bignasco	BIG	CH	443	2001
Sonogno	SON	CH	918	2001

3.2 Results

Long-term deposition data of the main chemical variables revealed that the deposition of S and N compounds have stabilised since 2010; however, in 2020 deposition values were clearly below the average values of the previous period for SO_4 and NO_3 (Figure 5).

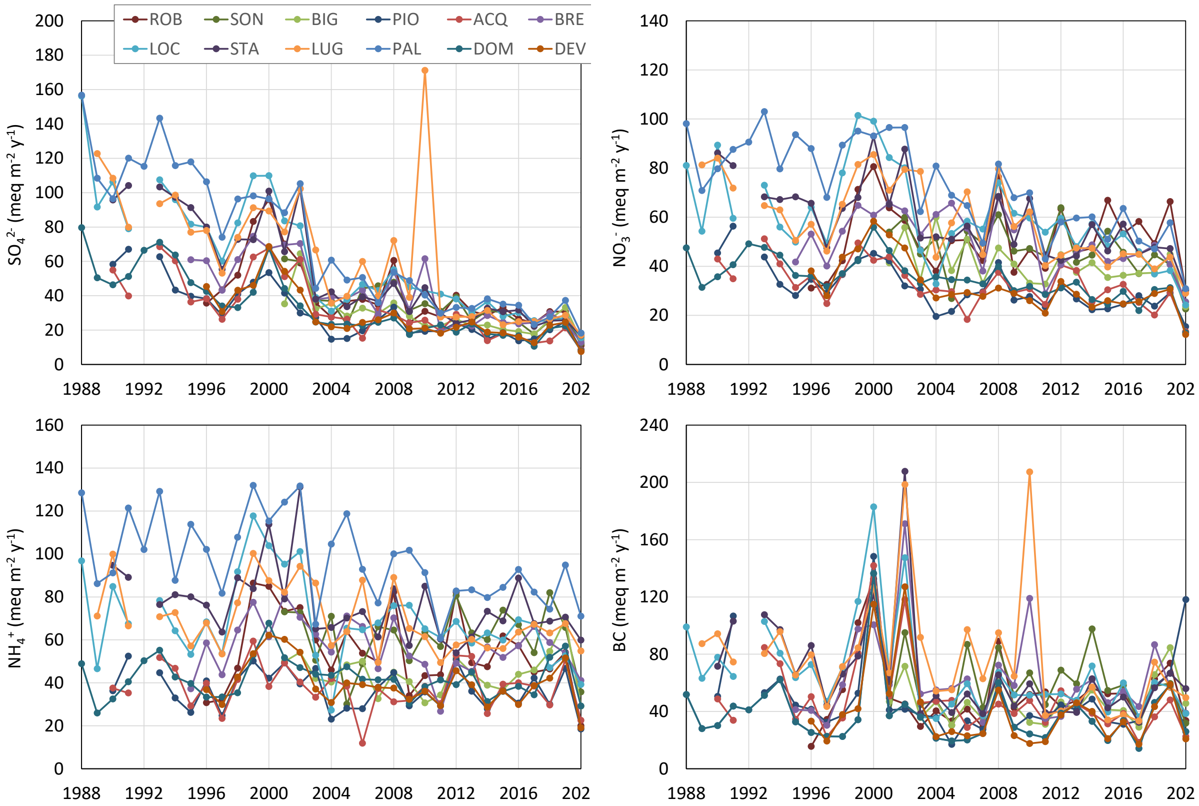

Figure 5. Yearly deposition values of the main chemical compounds at the study sites within 1988-2020. Acronyms as in tab. 1.

For both SO_4 and NO_3, the deposition value in 2020 was the lowest of the whole study record. NH_4 deposition in 2020 was also lower than average at some sites, but the effect was much less evident than with respect to NO_3. No evident changes were observed in the case of base cation (BC) deposition (Figure 5). Precipitation amount showed a high interannual variability at the study sites; however, no significant trend emerges from the data and precipitation amount in 2020 was just slightly below average at most of the sites. From the comparison of monthly deposition in 2020 at two study sites (PAL and DEV) with the values of the previous period (2010-2019) (Figure 6), it can be seen that 2020 data were below the reference values for SO_4 and NO_3 especially during spring and summer. The difference was more evident at the northern and higher altitude site (DEV). NH_4 deposition in 2020 was not different from the reference period at the southern site (PAL), while it was below average at DEV for most of the year (Figure 6).

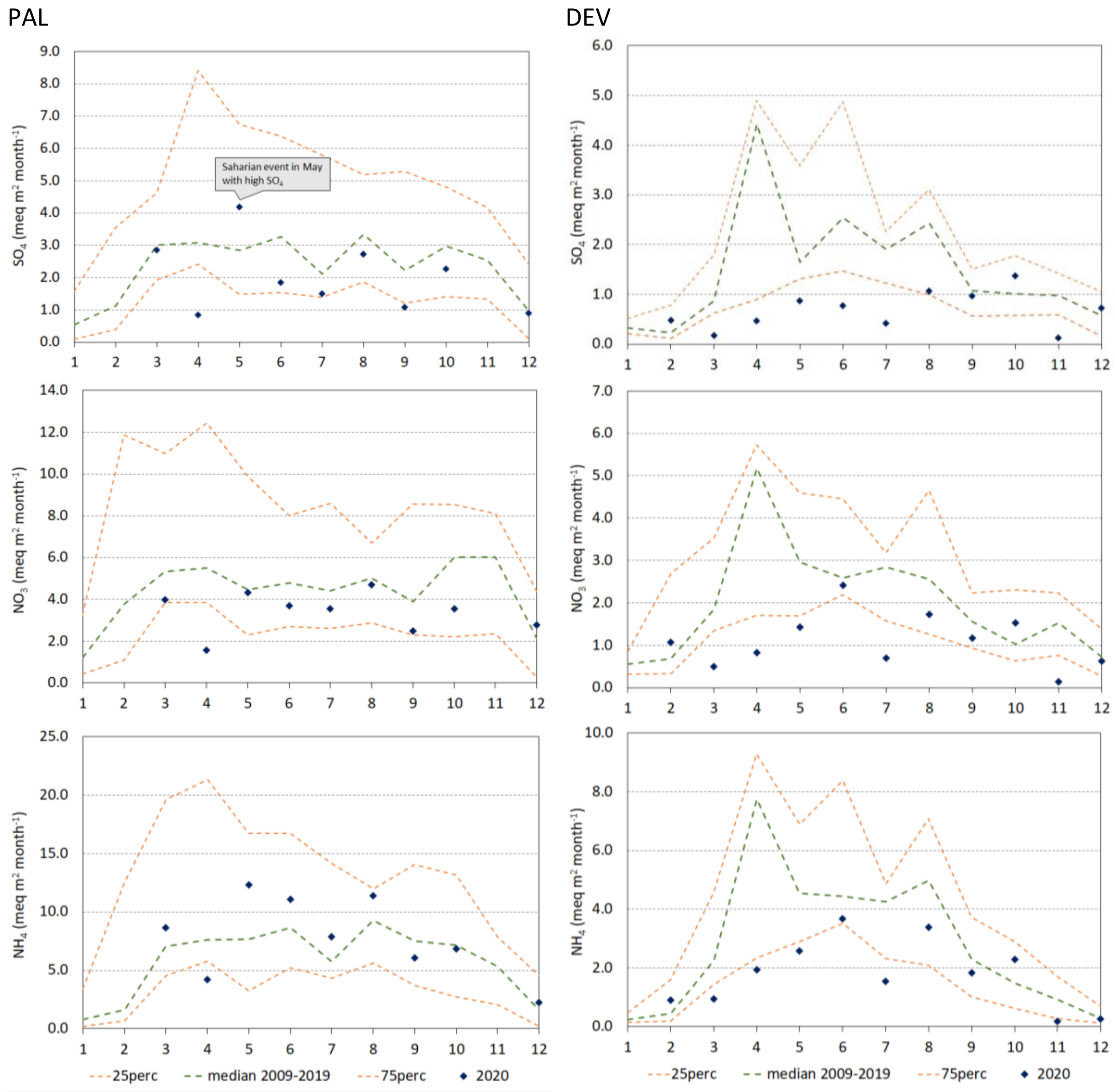

Figure 6. Monthly deposition of SO$_4$, NO$_3$ and NH$_4$ in 2020 compared to the median and 25 and 75 percentiles values of the period 2010-2019 at two monitoring sites in Italy: PAL on the left and DEV on the right

As a whole, the estimated decrease of deposition in 2020 with respect to the previous decade was between 23 and 42% for SO$_4$ and between 22 and 47% for NO$_3$, while the difference in the case of NH$_4$ deposition was rather limited and not evident at all sites.

The lower than average deposition of NO$_3$ recorded in 2020 can be related to the decrease of NOx air concentrations consequent to the COVID-19 lockdown, as recorded by monitoring stations for air quality both in Northern Italy and Southern Switzerland. As an example, Figure 7 reports the NOx air concentrations during the spring lockdown of 2020 in some monitoring stations of the Canton Ticino area, clearly showing the decrease of concentrations in March and April. In Northern Italy, in the area of the Po Plain, it was estimated that NOx emission decreased by up to 40% with respect to the values prior to the lockdown (data from the LIFE project PREPAIR: https://www.lifeprepair.eu). Several studies put in evidence the marked effect that lockdown had on atmospheric composition, in particular through massive traffic reductions, particularly for short-lived atmospheric compounds such as NO$_2$ (Menut et al., 2020; Shi et al., 2021; Liu et al., 2021). On the other hand, monitoring data showed that

NH_3 emissions did not change, as agricultural activities have not stopped during the lockdown (Lovarelli et al., 2020). Our data confirmed the lack of a significant change in NH_4 deposition in 2020, which seemed to be slightly lower in 2020 only at a few, less impacted sites.

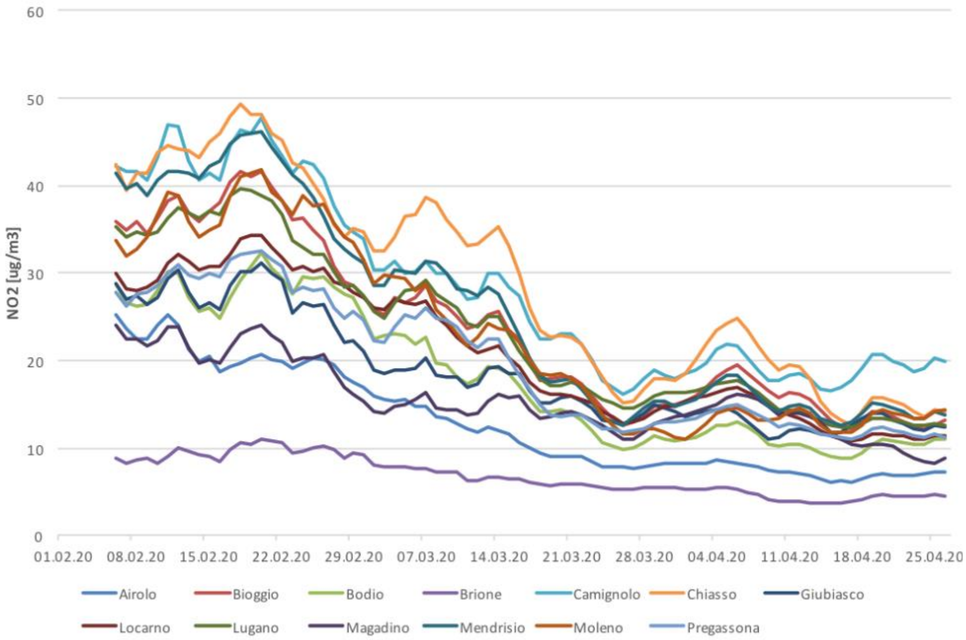

Figure 7. NOx air concentrations during the spring lockdown (16.3-11.5.2020) in Canton Ticino, Southern Switzerland (*https://www4.ti.ch/area-media/comunicati/dettaglio-comunicato/?NEWS_ID=187709)*

Remote freshwater sites, such as high-altitude alpine lakes, have shown rapid response to changing atmospheric deposition (Rogora et al., 2013). Therefore, we used long-term data available at these sites to trace a possible response to the decreasing NO_3 deposition in 2020. In particular, we compared the NO_3 concentrations measured in the 2020 field campaign in a set of 16 high altitude lakes, partly belonging to the ICP WATERS network, with the values of the previous period (2010-2019). Data collected in the autumn period, at the end of the ice-free period, were considered. It can be clearly seen than the data of 2020 were lower than those of the reference period in all lakes. At some sites (VaI, VaM, VaS, PaS) extremely low concentrations were measured, which had no precedent in the data record for these sites. A possible dilution effect due to rainfall prior to the sampling can be excluded because no major precipitation event occurred in September 2020 before the field campaign. The same comparison using SO_4 concentrations showed that values in 2020 were just slightly below those of the reference period, possibly because SO_4 in these lakes have reached an almost stable status after the sharp decrease of SO_4 deposition occurred in the 1980s and 1990s (Rogora et al., 2013). On the other hand, NO_3 concentrations in freshwater and N deposition are still quite high in the study area and there is still margin for a further decrease in response to emission change. It must be emphasised that these observations on freshwater chemistry are still preliminary and need to be confirmed by further analyses. In particular, meteorological and hydrological conditions in 2020 with respect to previous years and their possible effects on deposition and water chemistry need to be properly assessed.

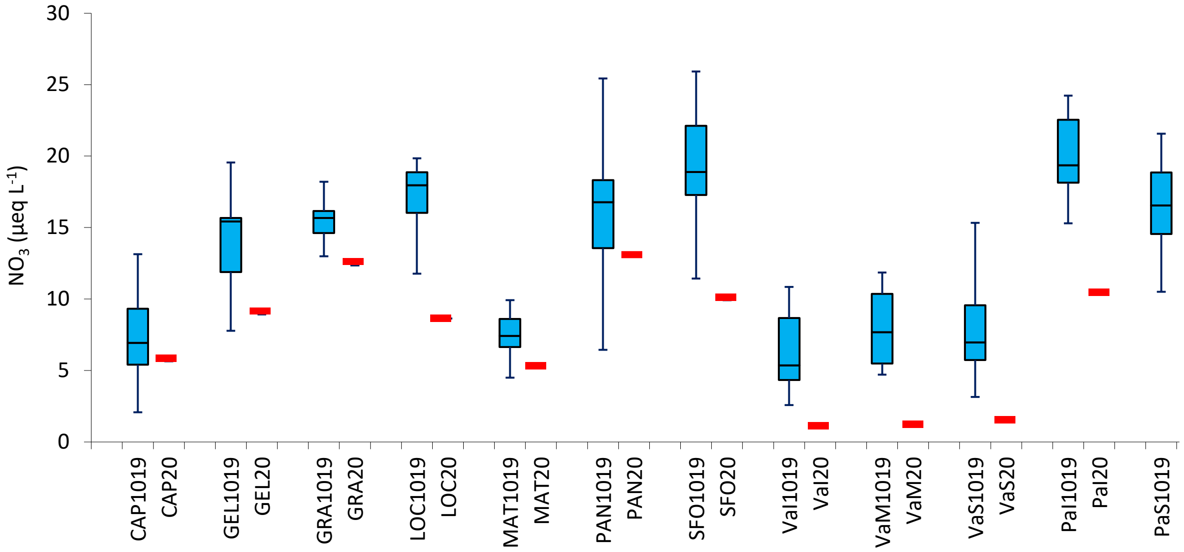

Figure 8. Measured NO_3 concentrations in a set of high-altitude lakes in the Alps in 2020 (red dashes) compared with values for the same lakes within 2010-2019 (box plots). Data refer to the autumn samplings.

3.3 Conclusions

Monitoring data from Northern Italy and Southern Switzerland showed a decrease in 2020 of SO_4 and NO_3 deposition, mainly deriving from the use of fossil fuels. On the other hand, no significant changes were observed in the deposition of NH_4, mainly related to agricultural and zootechnical activities, and for BC. These changes are in agreement with the reduced emissions of NOx consequent to the lockdown both in Italy and Switzerland, and the absence of significant effects of the lockdown on NH_3 emission. Data on freshwater chemistry at high altitude lakes confirmed the effects of NO_3 deposition reduction.

In our opinion the COVID-19 lockdown represented an interesting case study to investigate the effects on deposition and possibly freshwater chemistry of a sharp and rapid change in emission. Long-term data on both atmospheric deposition and surface water from monitoring networks such as ICP WATERS represent an invaluable asset in such evaluation. Data to be collected in 2021 will be essential to better investigate the decrease in deposition as well as the potential effects on freshwater ecosystems. Further investigations on the role of meteorology and hydrology in the patterns observed are also needed.

3.4 References

Liu, F., M. Wang, M. Zheng. 2021. Effects of COVID-19 lockdown on global air quality and health. Science of The Total Environment, 755: 142533. https://doi.org/10.1016/j.scitotenv.2020.142533

Lovarelli, D., C. Conti, A. Finzi, J. Bacenetti, M. Guarino. 2020. Describing the trend of ammonia, particulate matter and nitrogen oxides: The role of livestock activities in northern Italy during Covid-19 quarantine. Environmental Research, 191: 110048. https://doi.org/10.1016/j.envres.2020.110048

Menut, L., B. Bessagnet, G. Siour, S. Mailler, R. Pennel, A. Cholakian. 2020. Impact of lockdown measures to combat Covid-19 on air quality over western Europe. Science of The Total Environment, 741: 140426. https://doi.org/10.1016/j.scitotenv.2020.140426.

Rogora M., L. Colombo, A. Marchetto, R. Mosello, S. Steingruber. 2016. Temporal and spatial patterns in the chemistry of wet deposition in Southern Alps. Atm. Envir. 146: 44-54.

Rogora M., L. Colombo, F. Lepori, A. Marchetto, S. Steingruber & O. Tornimbeni. 2013. Thirty years of chemical changes in alpine acid-sensitive lakes in the Alps. Water Air Soil Pollut. 224:1746.

Shi, Z., Song C., Liu B., Lu G., Xu J., Van Vu T., Elliott R.J.R., Li W., Bloss W.J., Harrison R.M. 2021. Abrupt but smaller than expected changes in surface air quality attributable to COVID-19 lockdowns. Sci Adv. 13;7(3):eabd6696. DOI: 10.1126/sciadv.abd6696

4 Minutes of the 37th Task Force meeting of the ICP Waters programme held on-line, April 28-29, 2021

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 37th meeting of the Programme Task Force of ICP Waters, virtual meeting, 28-29 April 2021

KEY MESSAGES OF ICP WATERS 2021 TASK FORCE MEETING

Trends in water chemistry
Major indices of acidification such as acid neutralizing capacity (ANC), pH and toxic aluminium indicate waters demonstrate a process of recovery, based on the ICP Waters dataset that includes records since 1990, from circa 500 lakes and rivers in Europe and North America. The observed trends are a response to reduced deposition of acidifying substances, but changes in climate as well as land use are becoming more important as drivers of change. Major perturbances such as wildfires and insect outbreaks are often climate-related and can result in re-acidification of surface waters.

Effects of COVID-19 pandemics detected in ICP Waters sites
Long-term data sets of environmental monitoring of alpine and subalpine sites in Italy and Switzerland revealed a distinct reduction in deposition of S and oxidized N in 2020 that deviated from the long-term trend. These deviations result most likely from lower emission of N oxides to the atmosphere because of reduced vehicle traffic during the COVID-19 pandemic. Some improvements in water chemistry were also noted, especially for nitrate, which suggests that alpine, acid-sensitive sites are extremely well-suited for monitoring freshwater responses to rapid changes in atmospheric chemistry.

Biological responses to less acidic waters
Monitoring data from the UK demonstrate biological changes consistent with a response to chemical recovery in several, but not all, recovering acidified waters, while data from high alpine lakes in Italy do not show clear trends. In the UK, the extent of biological change does not show clear relationship with threshold levels of ANC commonly used to define “critical limits”.
Factors that drive the rate of biological recovery are not well understood and it is not always clear which organisms are most acid sensitive. The environments of ICP Waters sites are not only recovering from acidification but are more enriched with reactive nitrogen and becoming warmer as a consequence of climate change. The post-acidification biological community assemblies may be very different from the pre-acidification state.

Nitrogen
The deposition of nitrogen has declined less than sulphur and major questions remain concerning the chemical and biological effects thereof. Climate and catchment properties are important determinants of nitrogen leaching, linking air pollution and effects of reactive nitrogen in surface waters.
Although nitrogen is an essential nutrient, phosphorus is often the dominant control of freshwater productivity. However, there is increasing evidence that N derived from N deposition can influence freshwater productivity in nutrient-poor lakes. Leaching of nitrogen deposited from air to surface waters, and downstream to marine ecosystems, can also contribute to marine eutrophication because nitrogen is the limiting nutrient in marine waters. Source attribution of nitrogen in water bodies (i.e., to deposition, agriculture or other source) is important for effect-evaluation of policy to reduce emissions of nitrogen to the environment.

Monitoring networks of surface waters under various policy instruments (LRTAP, NECD, WFD) benefit each other mutually
In many European countries, surface water monitoring networks deliver data to support several policy instruments, such as the LRTAP Convention, the NEC Directive and the WFD. In some countries, the NECD monitoring network is more extensive than the national monitoring network delivering data to ICP Waters, while in other countries, the networks are largely identical. Under

the WFD, the suggested minimum lake size is 0.5 km^2, which is larger than that of many headwater lakes reported to ICP Waters. Small headwater lakes and streams that are not confounded by local pressures, such as agriculture or point source pollution, are pivotal for the assessment of regional scale pressures (air pollution, climate change) such as under the LTRAP Convention and the NEC Directive. However, such water bodies should also be of value to WFD assessments in providing information on the ecological status of sites that are minimally affected by local pressures.

Differences between national classification systems for surface water acidification may limit robust national comparisons of ecological status under the WFD. The physico-chemical definition of the important threshold between good and moderate (i.e. acceptable/non-acceptable) state of water body acidification differs between Norway, Sweden and Finland. A Nordic dataset on chemistry and biology has been used to propose an ANC-based system that can be used to harmonize classification systems.

The meeting of the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters) was held remotely via Microsoft Teams. It was attended by 46 experts from the following 18 Parties to the Convention on Long-range Transboundary Air Pollution (CLRTAP): Armenia, Canada, Czech Republic, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Norway, Poland, Russia, Spain, Sweden, Switzerland, United Kingdom and United States of America. A complete list of participants can be found **Annex I.**

Opening and introductions

1. Ms. Kari Austnes (Head of ICP Waters Programme Centre) opened the meeting.
2. A round of the table was held.
3. The agenda for the meeting was adopted.
4. There were no objections from the participants to the recording of the meeting.
5. Ms. Isaura Rábago (Chair WGE) gave a status report on behalf of the Working Group on Effects. Some activities were delayed due the COVID-19 pandemic. The draft WGE-EMEP scientific strategy will be circulated this spring and further discussed at the joint WGE-EMEP session in September. As a result of ICP participation in the ecosystem monitoring sub-group under the NEC Directive it was noted that WGE has one of the best monitoring networks, but this is not sufficiently well known by policy makers and the general public.
6. Mr. Ulf Grandin (Co-chair ICP IM) presented current activities and plans for ICP IM. Three scientific papers listed in the 2020/2021 work plan are about to be completed. One paper presents a eutrophication effect on the forest bryophyte community in Europe. Another paper reports of a strong delay in recovery in the epiphytic lichen community after the decrease in S deposition, which concludes that epiphytic lichens may not be good indicators of recovery from large-scale air pollution. Another important activity was the finalisation of the “IM light” initiative, extending ICP IM to increase the number of IM sites, while allowing less intensive monitoring than the full monitoring scheme. ICP IM has also contributed to the review of the Gothenburg Protocol by responding to questions from e.g. WGSR. Due to change of staff, the international IM database has been migrated from SYKE in Finland to SLU in Sweden. SYKE has also announced that they will end their hosting of the ICP IM Programme Centre after more than three decades. A process for finding a new host has started.
7. Mr. Aherne (Canada) asked which bryophyte species were impacted by the N deposition, and whether any of them correspond to those used in ICP Vegetation. Mr. Grandin answered that they can be found in the referenced article[1]. Mr. Aherne asked whether grassland is considered for the new ICP IM Light. Mr. Grandin answered that they will not set up their own monitoring sites, it is up to the countries. Mr. Velle (ICP Waters Sub-Centre) asked whether the endpoint of the recovery is a reference state or a new state. Mr. Grandin answered that the return to a pre-industrial state depends on the migration ability from Northern to Southern Scandinavia. In practice one cannot expect a full return to the pre-industrial state. The ‘ICP IM Light’

---

[1] Weldon et al. submitted MS.

announcement generated a discussion whether new sites would be from existing monitoring networks or not. For new sites it is valuable to co-locate with existing sites, e.g. ICP Waters sites.

8. Mr. Kai Schwärzel (Chair ICP Forests) gave an overview of current research activities and news from the ICP Forests programme. He highlighted the results of a study on heavy metals in forest floors and topsoils of ICP Forests Level I plots[2]. The aims of the study were (i) to explore spatial patterns and hotspots of heavy metal (HM) concentrations and stocks in forest floors (FF) and forest topsoil across Europe; (ii) to investigate if there is a significant temporal change between the data sampled during the first (S1) and second (S2) soil survey; (iii) to evaluate whether the HM concentrations and stocks exceed contamination or pollution levels, and (iv) to compare the observed forest soil concentration levels with reference databases and maps of HM in soil or in mosses at the European scale. Mr. Schwärzel discussed data availability and data quality issues. He showed that due to financial support from the EU in the frame of the Biosoil project significantly more countries participated in the second soil survey than in the first. Problems with data quality were observed, especially in the first soil survey, because there was little or no harmonization among countries in the late 1980s and early 1990s regarding the depth of soil samples and the methods used. Since the 1990s, ICP Forests has done a great deal to harmonize sampling and analytical methods through the development of manuals. This work was very important and meaningful to improve data quality, as the results of the second soil survey show. Mr. Schwärzel also presented what approaches were tested in the study to assess soil contamination and pollution by heavy metals. There was more exceedance compared to baseline levels for Pb, Cd and Zn compared to Ni, Cr and Cu. Based on the results of this study, background concentrations of HM in European forests were derived and presented in the above-mentioned report. 56% (S1) and 70% (S2) of the observed plots show background concentrations for all heavy metals in their forest floors. All in all, it can be concluded that HM specific variation patterns in forest floors and topsoils are found within countries, biogeographical regions and Europe. Regional hotspots of elevated HM concentrations are clearly visible on maps and can be linked to local pollution sources and well-known contaminated areas. Large-scale differences in HM concentrations can be partly explained by soil group and humus form. Compared to the mineral topsoil, heavy metals accumulate significantly more in the humus layer. With soil pollution indices comparing top-soil and sub-soil one does not need to define critical levels. Finally, Mr. Schwärzel presented the latest publications of the Programme Co-ordinating Centre (PCC) of ICP Forests and gave an overview of upcoming events organized by the PCC.

9. Ms. Felicity Hayes (Chair ICP Vegetation) presented status and activities in ICP Vegetation. This included some findings regarding the effect of ozone on vegetation, e.g. that higher ozone exposure leads to less nitrogen uptake by plants and potentially higher leaching, and that DOC and DON concentrations in soil water have been found to be higher when zone is higher. She also presented findings on microplastic accumulation in mosses. She invited other ICPs (including ICP Waters) to a joint workshop on microplastics in the environment and microplastic analysis.

---

[2] The study was carried out by Tine Bommarez, Nathalie Cools and Bruno De Vos from the Research Institute for Nature and Forest (INBO) and ICP Forests Soil Co-ordinating Centre (FSCC) in Belgium, and can be downloaded from http://icp-forests.net/

10. Ms. Austnes (Head of ICP Waters Programme Centre) asked whether there are other participants working on microplastic and encouraged them to contact her or Ms. Hayes. Several participants responded that they focus on microplastic and were interested in the workshop, among which Mr. Velle, Mr. Grandin and Mr. Aherne. Mr. Aherne (Canada) suggested that the ICPs should aim for harmonized methods regarding monitoring of microplastics. He also asked whether ozone may affect lichens. Ms. Hayes answered that lichens are difficult to study for ozone effects, but some lichens are definitively affected by ozone.

11. Ms. Christin Loran (CCE) presented the ICP Modelling and Mapping plans and progress of activities in 2020-2021 on behalf of ICP M&M, the Coordination Centre for Effects (CCE) and the Centre for Dynamic Modelling (CDM). She informed that the 37th Task Force Meeting, 28th CCE Workshop, and 2nd CDM Meeting had taken place online from 20th-22nd April 2021 with a special focus on the Gothenburg Protocol review process. She presented the main ongoing CDM activities and the launching of its new webpage (www.wge-cdm.se) informing on the current review of the dynamic modelling work under the Convention. Ms. Loran also listed the ongoing work under the CCE, mainly the updated background database for critical loads for eutrophication and acidification for European terrestrial ecosystems as well as the ongoing update of the empirical Critical Loads for Nitrogen. Finally, she presented the proposals for the future workplan 2022/23 of ICP M&M which include (1) the continuation of the review and revision process for empirical critical loads for nitrogen, (2) a project to update the harmonized receptor map for Europe (which is used by other ICPs as well), (3) the organization of an international workshop on critical levels of ammonia, (4) the organization of an expert workshop on modelling interactions between air pollution and climate change (N and C), and (5) a report on the development of methodologies for modelling impact of air pollution on biodiversity in 2030 and beyond.

12. Ms. Kari Austnes (Chair ICP Waters) presented status, current issues and plans for ICP Waters, including the work plan and review of the Gothenburg Protocol.

NEC Directive and monitoring

13. Mr. Manuel Toro Velasco (Spain) presented the Spanish NEC Directive and ICP Waters monitoring programs. The NECD network in Spain consists of 10 lakes and 15 rivers, covering the 3 biogeographical regions of the Iberian Peninsula (Alpine, Atlantic, Mediterranean), and representing 7 different WFD lake types and 11 river types. These have been selected among WFD reference sites. For the new ICP Waters monitoring network, 3 sites (1 lake and 2 rivers) in acid-sensitive small catchments in National Parks have been selected and will operate at Level 1 (monthly sampling). They have nearby meteorological and atmospheric deposition sampling stations, and are protected from future changes since they are in protected areas. Because there is currently no Mediterranean representation in the ICP W network, these sites will add value extending the study of the response of aquatic ecosystems to LRTAP in South Europe. In the near future, the ICP Waters network in Spain will be expanded with sites from NECD-network and National Parks.

14. Ms. Austnes (Head of ICP Waters Programme Centre) asked whether all NECD sites could be used as ICP Waters sites. Mr. Velasco (Spain) answered that not all NECD sites are monitored on a

monthly basis, which is preferable for ICP Waters – lakes are only monitored annually. Ms. Austnes suggested that these sites with lower sampling frequency could the included as trends sites. Mr. Velle (ICP Waters Sub-Centre) encouraged the Spanish team to take part in the 2021 call for biology data.

15. Ms. Kari Austnes (ICP Waters Programme Centre) introduced a discussion on monitoring in general and under the convention and EU Directives (NECD and WFD). She raised four questions: 1) What is the state of monitoring (of air pollution impacts on freshwaters) in your country? (Chemistry/biology) 2) Are you familiar with national NECD/WFD monitoring? 3) Has the NECD and/or WFD impacted the national monitoring? How? 4) How can we improve the guidance in the ICP W manual? Mr. Aherne (Canada) suggested to reach out to those countries reporting under NECD which are not part of ICP Waters. Mr. Monteith (UK) commented that monitoring under the WFD and ICP Waters in the UK have always been quite separated, probably because of the small lake size used in ICP Waters. Many WFD sites are not so suitable. He suspected that much WFD monitoring on acidification is done in larger water bodies. In the UK there is a desire to continue to provide data to these directives, although the UK is no longer part of the EU. Mr. Hruska (Czech Republic) commented that the Czech Republic use ICP networks as the base for NECD monitoring. This was also the case for Italy, according to Ms. Rogora (Italy), which use the ICP Waters and ICP Forests network as the base for the NECD monitoring. According to Mr. Vuorenmaa (Finland), Finland uses ICPs (Waters, IM, Forests) and some national-based sites for NECD monitoring, and also some WFD-sites, but those belong to ICP W/IM as well. Several participants were under the impression that the NECD does not include smaller lakes. Ms. Rábago (Chair WGE) clarified that the NECD has not excluded any water bodies, but for the first reporting there was not enough time to establish new sites. So, Member States would only send what they had at the time, so smaller lakes could be included if they already were monitored. Ms. Boggero (Italy) commented that they highlight the importance of monitoring the smaller high-altitude lakes, which are not considered separate water bodies under WFD. There are many such lakes, and they cannot all be monitored. Mr. Aherne suggested that it should be stressed in the criteria for selection of lakes that smaller lakes should be included. They are also ideal for analysing the climate change. Ms. Rogora agreed with Mr. Aherne that it would be very important to stress that, especially for those countries where WFD sites are not suitable to monitor atmospheric pollution effects.

Biology – trends and assessment

16. Mr. Don Monteith (UK) gave an update on chemical and biological responses of acidified waters in the UK to long-term deposition reductions. The UK Upland Waters Monitoring Network (formerly known as the Acid Waters Monitoring Network) has been monitoring the chemical, biological and physical characteristics of a range of acid-sensitive lakes and streams since 1988. The 30 years of data show that the water quality of all but the least sensitive sites, exposed historically to significant levels of acid deposition, has improved monotonically. Non-marine sulphate concentrations at sites in the least affected sites in the north and west appear to have flattened out at background levels, while concentrations in most sites further south have continued to decline, but at progressively lower rates. These changes have been accompanied by

very large reductions in labile aluminium concentrations in the historically most acidified waters, and progressive increases in water pH, Gran Alkalinity, Acid Neutralising Capacity (ANC) and Dissolved Organic Carbon (DOC). For most waters, ANC has now reached, and in some cases substantially surpassed, the 20 µeq/L critical limit used to set critical loads for waters. Over the past 5-6 years, several sites have shown surprisingly rapid increases in alkalinity, the reason for which is currently being investigated. Epilithic diatom and macroinvertebrate communities in most sites recovering from acidification have undergone directional changes in species composition. In the majority, but not all, cases, these changes are consistent with changes in metrics summarising the acidification status of the biological community, thus providing a clear indication that the ecology of these waters is benefitting from the chemical improvements. Metrics for a minority of highly acidified sites have not changed significantly, possibly because chemical recovery has been relatively modest to date, but a range of other factors could be restricting recovery in these systems. In the remaining sites, positive changes in the biological metrics are observed in almost all cases where ANC is increasing, but change does not seem to be dependent on current ANC level.

17. Mr. Aherne asked whether the marked increase in alkalinity could be due to sea salt or dust storms. Ms. Rogora (Italy) asked whether there is an acidification index for diatoms, to which Mr. Monteith answered that he was not aware of such an index. Mr. Velle (ICP Waters Sub-Centre) asked whether the biology is lagging chemical recovery. Mr. Monteith answered that they found some sites in which both pH and some biology indicators are levelling off, but he could not generalize based on their findings. Mr. Bodin asked whether they did functional diversity assessment on the datasets. Mr. Monteith answered no, but that they are considering it. They have looked at functional diversity in previous studies which indicated a shift from acid generalist species to specialist grazing, and more predatory species.

18. Ms. Angela Boggero (Italy) gave a presentation on temporal and spatial trends of macroinvertebrates and acidification indices in Lakes Paione. Alpine lakes are important sources of water and biodiversity for the lowland areas. Their monitoring is therefore of fundamental importance to understand how their food web works, which abiotic parameters contribute to the status assessment of lake waters, and which anthropogenic stressor has the greatest impact on their biota. These fragile ecosystems, with small and steep catchments, usually consisting of bare rock and sparse vegetation, can show a greater degree of diversity of physical and chemical conditions on a local scale, such as to support a typical biodiversity for the alpine area. In 2019 the National Emission Ceilings (NEC) Directive was launched by the European Union to set national emission reduction commitments for Member States of the most relevant air-borne pollutants. For the first time, EU countries were asked to monitor the effects of the reduced emissions on both freshwater and terrestrial ecosystems. Here, the results obtained from a first statistical analysis of the dataset of Lakes Paione were presented. The lakes are high altitude lakes in the Alps belonging to the ICP Waters network, and they proved to be a useful case study to organize the data in a systematic and coherent way to highlight the macroinvertebrates assemblages that characterize the two lakes and their streams, and to apply several acidification indices developed at European level to highlight any effect on freshwater macroinvertebrates or any recovery from acidification.

19. Mr. Velle (ICP Waters Sub-Centre) commented that they have used many of the same indices for acidification in high altitude- and clear water sites Norway, resulting in poor situation for many sites although the chemistry indicates that the water quality is perhaps good enough. He suggested that this may be due to a naturally low diversity and thin population of invertebrates in such sites, so that the indices do not necessarily work there. Mr. Velle also asked whether they got similar results in the littoral zone as in the outlet. Ms. Boggero answered that they did not find any trends at all, and different situation from lower Paione lakes and higher Paione lakes. For the moment she said they were not able to find any trend, also in the rivers, even though they tried many alternatives. Mr. Velle asked whether pH or acidification could be a limiting factor for the invertebrates in these sites. Ms. Boggero answered that she thought so but probably have a different assemblance structure than the Norwegian. She would like to find out which are the sensitive species in their freshwaters (if there are).

20. Mr. Karyan (Armenia) presented results from an ecological status assessment in the Debed river basin. The Debed river originates in Armenia, in the Lori province and is formed at the confluence of the Dzoraget and Pambak rivers. Much of the catchment is mountainous. The river runs to Georgia where it feeds into the Khrami, a tributary of Kura. Mr. Karyan showed results for 4 reference sites and 6 sites affected by local metal mining industry or wastewater emission. The monitoring programme comprised hydrological, biological and chemical parameters (pH, nutrients, ions, trace metals). Nutrients, metal concentrations and sulphate levels were very high in the polluted parts of the river compared to the reference sites. The pollution caused negative effects on biota and reduced ecological status, according to the Armenian classification system.

21. Mr. Jens Fölster (Sweden) presented a suggestion towards a Nordic classification system for acidification. The classification system for acidification in the Nordic countries are different, both in how they are constructed and how sensitive they are. This causes problems in reporting to both WFD and LRTAP. The Swedish and Norwegian authorities thus funded a project for suggesting a common classification system that could be used for all countries or at least used for harmonisation between the systems. The work was done on a joint Nordic dataset including water chemistry, macroinvertebrates and fish in 165 lakes and 100 rivers. The analysis showed that ANC was a better predictor for biological quality elements than pH. A preliminary suggestion for a classification system was suggested based on class boundaries from a Swedish index for macroinvertebrates and the statistical analysis of the joint dataset (gradient forest analysis). This suggestion is now being developed by constructing a common Nordic macroinvertebrate index that can be used for setting the class boundaries for ANC.

22. Mr. Gaute Velle (ICP Waters sub-centre) presented the planned ICP Waters report on assessment of biological responses to reduced acidification. He outlined the aims of the report and ideas for content. The report will include a section on analysis of a joint international dataset, as well as national chapters. The aims of the report will be to (1) assess current status of region/country-wise influence of acidification on the biota, (2) assess temporal trends in biological responses to acidification, and (3) compare response among regions/countries. For the international dataset of the report, Mr. Velle suggested to include one or several of the following aspects: A) Biological diversity: Is the diversity still increasing; B) Analyse biota in relation to change in chemistry: What is driving the biotic change? Is the recovery synchronous or are there lags and leads? (dose-

response) C) Assemblage change: Is the recovery directional or are the assemblages moving towards a new and unpredictable state? D-E) Change in functional groups (feeding mode and locomotion): Has the ecosystem processes changed during the recovery? F) Regional indices for acidification (transformed into a comparable scale): Is the fauna still damaged by acidification? Present an overview of different indices with principles and recommendations. For the national sections of the report, Mr. Velle suggested to include the following aspects: i) Acid sensitivity - Focusing on biology, describe the extent and degree of acid sensitivity; ii) Monitoring and assessment approach: Describe biological acidification monitoring in the country, describe methods used to derive the biological monitoring data, describe biological index/ indices for acidification; iii) Acidification status: Assessment of acidification/ ecological status based on the biological indicator organism, describe the correlation between biological and chemical recovery, including potential delays in biological recovery. Examples of recent development from time series or aggregated time series – are the biological communities still improving or are they levelling off? The plan is to upscale information from sites to region or country.

Water chemistry trends

23. Ms. Rogora (Italy) presented impacts of COVID-19 lockdown on Sulphur and nitrogen deposition and surface water chemistry over an alpine area. The possible effects of COVID-19 lockdown on deposition and surface water chemistry in an area south of the Alps were investigated by analysis of data from the Italian and Swiss monitoring networks. Atmospheric deposition has been monitored at several sites in the area of Lake Maggiore watershed since the 1980s. These long-term data revealed that the deposition of S and N compounds have stabilised since 2010; however, in 2020 deposition vales were significantly below the average values of the previous period for sulphate and nitrate. No evident change was observed for NH4 and base cations deposition. Both concentrations and precipitation amount in 2020 were below the average values of the previous years, in contrast with the general pattern of an inverse relationship between concentrations and precipitation volume. It was hypothesized that the low deposition of SO4 and NO3 recorded in 2020 can be related to the lower-than-average NOx concentrations in the air, as recorded by monitoring stations for air quality both in Northern Italy and Southern Switzerland. Some effects on the chemistry of remote freshwater sites were also noticed, with NO3 concentrations in 2020 clearly below the long-term values. Ms. Michela Rogora stated that the COVID-19 lockdown represented an interesting case study to investigate the effects of a sharp and rapid emission decrease. Data to be collected in 2021 data will be essential to better investigate the decrease in deposition as well as the potential effects on freshwater ecosystems. Further investigations on the role of meteorology and hydrology in the patterns observed are also needed, according to Ms. Rogora.

24. Mr. Velle (ICP Waters Sub-Centre) asked about the source of nitrogen. Ms. Rogora pointed to emission from vehicles. Mr. Aherne (Canada) asked if ammonia had been used to correct for meteorological effects. The answer was no. Mr. Monteith (UK) asked if the monitoring included biology. Ms. Rogora (Italy) said that this had not been done but mentioned that it might be possible to study the biological response when emissions return to normal levels.

25. Mr. Øyvind Garmo (ICP Waters Programme Centre) presented results from the Norwegian 1000 lake survey. He explained the background of the survey and gave an overview of expected as well

as more surprising results. In the former category were substantial decreases in sulphate, nitrate and labile aluminium combined with increasing alkalinity, pH and DOC. Surprises included higher concentration of silicic acid as well as higher C:N ratios of DOM. Interactions between deposition and climate must probably be invoked to explain these observations. Mr. Houle (Canada) suggested doing a comparison of changes in temperature and chemistry. He also said that other criteria for grouping lakes than just proximity could be tried. Mr. Monteith (UK) said that it was important to check the observations against long time series from stations monitored more frequently. Mr. Garmo agreed. Mr. Moldan asked how acidified the most affected regions were (i.e., how far from the estimated pre-acidification state). Ms. Austnes (Head of ICP Waters Programme Centre) answered that she had looked at this in an evaluation of MAGIC model predictions and critical loads using data from the 1000 lake survey. Very few lakes were classed as acidified according to the Norwegian WFD criteria (which are based on ANC, pH and LAL).

26. Ms. Tatiana Moiseenko (Russia) presented results from a study of long-term response of water chemistry in 75 lakes in the Kola arctic region to reduced acid deposition and climate warming. The monitoring was carried out once every 4–5 years in 1990–2018, with analysis for major anions and cations, DOC and heavy metals (Ni and Cu). Analysis of weather data showed that a there has been a systematic temperature increase over the past 28 years. There was a decrease in anthropogenic sulphate and increase in the ANC over the same period. Lake water was analysed in six subareas defined by the bedrock geology of the catchment areas and distances from the emission sources. The water chemistry of the lakes responded differently to a decrease in the influx of acids: in the most acid-sensitive areas, whose catchment bedrocks are granite and quartz sand, ANC did not increase, and acidification continued. The concentrations of both DOC and nutrients in the lake waters were found to increase. Simultaneously the TotP and TotN systematically increased. This can be explained by lower deposition of strong acids and climate warming. It was suggested that multiple factors result in an irreversible development in the lakes, and hence, the term recovery does not adequately reflect the processes occurring in this industrially well-developed part of the Arctic.

27. Mr. Monteith (UK) asked about the opposite trends for colour and DOC observed in some of the subareas. Mr. Aherne (Canada) commented that he had made similar observations and asked if changed complexation with iron could be involved. Ms. Moiseenko finished by saying that additional research was needed.

28. Mr. Jens Fölster gave a presentation entitled Brownification on hold: What conventional analyses miss in extended water quality records. Data of monthly samples of TOC and filtered absorbance at 420nm (AbsF) in 164 Swedish water courses with time series of 20-30 years were analysed by GAM models. GAM models fit smoothers to time series so that not just the overall change is detected, but also the dynamics. A toolbox was used for visualising results from multiple GAM models. The results show periods of extended increase in TOC in the late 1990ies and late 2000ies. Since then most sites showed no trends in TOC. For AbsF the only period with extended increases occurred in the late 1990ies. The ratio of AbsF/TOC increased in many sites during the late 1990ies, but since then negative trends have become more prevalent. This indicates that the organic matter has become less brown since 2000.

29. Ms. Austnes (ICP Waters Programme centre) asked about the AbsF/TOC ratio. Mr. Aherne (Canada) asked about the changes in colour and TOC. It was mentioned that increases in Hg concentration had been linked to decreasing colour. Mr. Monteith (UK) commented that there is a degree of subjectivity in the selection of nodes for the GAMs. Mr. Fölster mentioned the algorithm that had been used for selecting nodes.

30. Mr. Jakub Hruška (Czech Republic) gave a presentation entitled Long-term (years) use of continual water chemistry probe for DOC, pH and conductivity - what we miss compared to regular sampling? The fDOM, pH and conductivity measured by automatic sonde YSI EXO 3 was tested against lab values for three small catchments from autumn 2019 to autumn 2020. The sonde pH was measured satisfactorily in the range ca. 4.5 – 6.0. pH<4.5 was underestimated systematically, pH>7.0 were randomly distributed (probably due to pCO2 differences between in situ and lab conditions). The conductivity probe response was linear to the lab values. fDOM was a good surrogate to measured DOC in the interval of ca. 5-25 mg/L. Higher DOC concentrations (high flows) gave reduced fluorescence absorption, probably due to different nature of DOM or higher turbidity reducing fluorescence absorption.

31. Mr. Fölster (Sweden) commented that turbidity could be interfering with the fDOM measurements. Ms. Rogora (Italy) said that she had obtained unreliable results with pH sensor and asked about calibration and biofouling. The answer was that the sensors were not calibrated during the deployment and that there was some mechanism for reducing biofouling. Mr. Velasco (Spain) asked about battery changes. Mr. Garmo (ICP Waters programme centre) asked if Mr. Hruška trusted the lab measurements of low pH more than the in situ measured pH. The answer was yes.

32. Mr. Daniel Houle (Canada) gave a presentation on the impact of climate change on the release of base cations from soils to surface waters. He started by explaining various effects of climate change. He distinguished between major perturbations (fires, insect outbreaks, windfall, droughts) and more gradual responses to air temperature and amount of precipitation. He showed results from several case studies as well as model projections.

33. Mr. Monteith (UK) asked if Mr. Houle could make a guess about the relative importance of weathering rates and vegetation effects in explaining trends observed in the Norwegian 1000 lakes (see point 34-36). Mr. Houle answered that it would depend on the catchment properties and went into some detail about how he thought the various factors would play out.

Nitrogen

34. Ms. Kari Austnes and Mr. Jan-Erik Thrane (ICP Waters Programme Centre) presented results from the ongoing work with the 2021 ICP Waters report on nitrogen. The objective is twofold: 1) an exploration of trends and spatial patterns in N fractions and 2) an assessment of biological responses to nitrogen in water.

35. Mr. Monteith (UK) suggested that it would be better to use fluxes instead of concentration, if possible. Mr. Aherne (Canada) seconded this suggestion and asked if lake retention had been considered, and this was not the case. Mr. Houle (Canada) suggested that forest composition could be important. He also pointed out that the deposition in Europe and N. America had

followed different trajectories and asked if it was possible to make more out of this fact in the analysis.

36. Mr. Thrane (ICP Waters Programme Centre) presented results from the ongoing report on nitrogen, focusing on an assessment of signs of N-limitation or effects of nitrogen on phytoplankton biomass/productivity. He presented preliminary result from an analysis of the relative importance of N- vs. P on phytoplankton biomass in a large Nordic dataset, and analysis of the N:P stoichiometry in natural rivers in Norway. The results indicated that P is the main driver of autotroph biomass, but that N-limitation may be important in certain lake- and river types – particularly in low N-deposition areas.
37. Ms. Austnes proceeded to give a timeline for the work with the report and the updating of the critical loads for nitrogen. The plan is to have a draft report ready for the EMEP-WGE joint session in late August and publish after the expert workshop in October-November. For the update of critical loads draft chapters are expected by the end of June and the work will be finished in April 2022.

Task Force meeting

38. The first item on the agenda was the workplan for 2021-2022. Mr. Velle (ICP Waters Programme subcentre) revisited the plans for the 2022 report on assessment of biological responses to reduced acidification (see also point 22). Mr. Monteith mentioned that he and colleagues had observed changes in acidification metrics but not species richness in a similar analysis for UK sites. Mr. Velle answered that he had plans to analyse assemblage change as well as functional groups. Ms. Austnes said that she was interested in functional groups and even more interested if it was possible to link it to changes in acidification (chemistry). Mr. Monteith (UK) asked what was meant by “unpredictable state”, a term that Mr. Velle had used to describe the community changes. Mr. Velle explained that he was interested to find out if there was a directional change towards a predisturbance state or if it is seemingly random walk towards a new equilibrium.
39. Mr. Velle finished by giving a timeline for the work with the report. The deadline for data submission is April 2021. National contributions should be in by April 1st, 2022. The deadline for the report is July 1st, 2022. The proposed timeline was accepted. Mr. Velle asked if we should have a working group for the report. Mr. Monteith (UK), Mr. Bodin (sub-centre), Ms. Boggero (Italy), Mr. Fölster (Sweden), Ms. Kolada (Poland), Mr. Fornaroli (colleague of Ms. Boggero) and Mr. Karyan (Armenia) volunteered to be in such a group.
40. The second item on the agenda was ICP Waters’ contribution to the Gothenburg Protocol review. Ms. Austnes (ICP Waters Programme centre) repeated the main points and referred to Ms. Rábago’s presentation (see point 5). The purpose of the review is to decide if an update of the Protocol is necessary. The focus is on the sufficiency and effectiveness of current obligations and success in achieving the Protocol’s objectives. Ms. Austnes listed some questions of relevance for the review and for ICP Waters. The deadline for the final draft is February 2022 and input must be in by January 10. Ms. Austnes outlined plans and thoughts for how ICP Waters might contribute. A contribution on biological trends would be very welcome but perhaps not

compatible with the proposed timeline for the upcoming report (see point 22). Ms. Austnes asked if it was possible to get input on biological trends (i.e. national chapters) and monitoring before the proposed deadline for the 2022 report. There was no immediate response from the attendees. It will be possible to respond by email, and a reminder will be sent after the meeting.

41. The third agenda point was the work plan for 2022-2023. Ms. Austnes presented an outline. Major items in 2022 are the report on biological recovery and input to the review of the Gothenburg Protocol. The plan for 2023 is not decided. Ms. Austnes listed possible topics/items that could be included and asked if the attendees had preferences or other suggestions. Mr. Monteith (UK) wanted to pursue weathering and changes in base cation concentrations from a biogeochemical and biological perspective, if possible. Mr. Houle (Canada) commented that the fact that we have data on catchment properties (forest cover etc.) provides opportunities for a study of weathering.

42. Ms. Austnes gave an overview of some other activities that ICP Waters had been involved in since the last Task Force meeting. ICP Waters delivers input to guidance for effect-based monitoring of mercury for the Minamata convention. ICP Waters has contributed to the EMEP/WGE scientific strategy for 2020-2030 and will review the complete draft in 2021. The biological intercalibration and the chemical intercomparison are performed every year, so also in 2020. Estonia, Sweden and Norway took part in the biological intercalibration, and the results were good. Invitations for 2021 have been sent out. The chemical intercomparison comprised 21 laboratories from 13 countries. The results were good, even for pH this year. Two errors have been discovered in the report and a corrigendum will be out soon. Invitations for the 2135 version have been sent out. New person in charge is Tina Bryntesen (tina.bryntesen@niva.no). Ms. Austnes thanked everyone that had provided new data for the water chemistry database. She apologised for sometimes slow response and that new data were not yet included in the nitrogen analysis. She stressed that keeping the deadlines for data submission would improve efficiency. She also mentioned that the data template might be improved and that a short survey for this purpose might be undertaken in the autumn. Ms. Austnes went on to remind the audience about some important deadlines. These include input to review of the Gothenburg Protocol and/or empirical critical loads (May 14), list of recent publications (June 30), proceedings (July 30). The latter is an opportunity for publishing findings that have been presented during this task force meeting. It should be 2-6 pages and should be sent to ingvild.furuseth@niva.no.

43. Next Task Force meeting will be held in Riga 2022, fingers crossed. Ms. Aleksandra Ševčuka (Latvia) welcomes all parties to Latvia in 2022.

44. The minutes were adopted.

Annex I: Participants at the virtual ICP Waters TF meeting, 28-29 April 2021

Armenia

Alina Zurnachyan
HYDROMETEOROLOGY AND MONITORING CENTER
46, Str. Charents, Yerevan
Armenia
alina.zurnachyan@gmail.com

Gor Khachatryan
HYDROMETEOROLOGY AND MONITORING CENTER
46, Str. Charents, Yerevan
Armenia
gor_xachatryan_9898@mail.ru

Hayk Minasyan
HYDROMETEOROLOGY AND MONITORING CENTER
46, Str. Charents, Yerevan
Armenia
h.s.minasyanc@gmail.com

Marieta Zakaryan
HYDROMETEOROLOGY AND MONITORING CENTER
46, Str. Charents, Yerevan
Armenia
zakaryan526219@gmail.com

Vardan Karyan
HYDROMETEOROLOGY AND MONITORING CENTER
46, Str. Charents, Yerevan
Armenia
vhkaryan@gmail.com

Canada

Daniel Houle
Environment and Climate Change Canada
105 McGill street, H2Y 2E7 Montreal
Canada
daniel.houle2@canada.ca

Julian Aherne
Trent University
TSE, 1600 West Bank Drive, Peterborough, Ontario
Canada
jaherne@trentu.ca

Czech Republic

Jakub Hruška
Czech Geological Survey
Klarov 3, 11821 Praha 1
Czech Republic
jakub.hruska@geology.cz

Pavel Kram
Czech Geological Survey
Klarov 3, 11821 Praha 1
Czech Republic
pavel.kram@geology.cz

Estonia

Reet Talkop
Ministry of Environment
Narva mnt 7A, 15172 Tallinn
Estonia
reet.talkop@envir.ee

Finland

Jussi Vuorenmaa
Finnish Environment Institute (SYKE)
Latokartanonkaari 11
00790 Helsinki
Finland
jussi.vuorenmaa@ymparisto.fi

Germany

Christin Loran
German Federal Environment Agency
Wörlitzer Platz 1
06844 Dessau-Roßlau
Germany
christin.loran@uba.de

Kai Schwärzel
Thünen Institute of Forest Ecosystems
Alfred-Möller-Str. 1
16225 Eberswalde
Germany
kai.schwaerzel@thuenen.de

Jens Arle
German Federal Environment Agency
Wörlitzer Platz 1
06844 Dessau-Roßlau
Germany
jens.arle@uba.de

Ireland

Wayne Trodd
Environmental Protection Agency
The Glen, Monaghan, H18 YT02,
Ireland
w.trodd@epa.ie

Italy

Angela Boggero
CNR - Water Research Institute
Largo Tonolli 50
I-28922 Verbania
Italy
angela.boggero@irsa.cnr.it

Riccardo Fornaroli
CNR - Water Research Institute
Largo Tonolli 50
I-28922 Verbania
Italy
riccardofornaroli@gmail.com

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

Latvia

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

Aleksandra Ševčuka
Latvian Environment, Geology and Meteorology Centre
Maskavas Street 165,
Riga LV-1019
Latvia
aleksandra.sevcuka@lvgmc.lv

Norway

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

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

Jan-Erik Thrane
Norwegian Institute of Water Research (NIVA)
Gaustadalléen 21
N-0349 Oslo
Norway
jet@niva.no

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

Gaute Velle
NORCE Norwegian Research Centre/University of Bergen
NORCE Nygårdsgaten 112
5008 Bergen
Norway
gvel@norceresearch.no

Christian Lucien Bodin
NORCE Norwegian Research Centre/University of Bergen
NORCE Nygårdsgaten 112
5008 Bergen
Norway
christian.lucien.bodin@gmail.com

Gunnar Skotte
Norwegian Environment Agency
Postboks 5672 Torgarden
7485 Trondheim
Norway
gunnar.skotte@miljodir.no

Poland

Agnieszka Kolada
Institute of Environmental Protection,
National Research Institute
Krucza 5/11d, 00-548 Warszawa
Poland
akolada@ios.edu.pl

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

Russia

Marina Dinu
GEOKHI RAS
119991 Moscow, Kosygin str., 19
Russia
marinadinu999@gmail.com

Tatyana Moiseenko
GEOKHI RAS
119991 Moscow, Kosygin str., 19
Russia
tatyana@aqua.laser.ru

Dmitry Baranov
GEOKHI RAS
119991 Moscow, Kosygin str., 19
Russia
mitya.baranov.90@bk.ru

Mriya Bazova
GEOKHI RAS
119991 Moscow, Kosygin str., 19
Russia

Spain

Isaura Rábago
Ciemat, Environmental Department
Avenida Complutense
Madrid 4028040
Spain
isaura.rabago@ciemat.es

Manuel Toro Velasco
Centre for Hydrographic Studies – CEDEX
Paseo Bajo Virgen del Puerto,
328005 Madrid
Spain
manuel.toro@cedex.es

Sweden

Filip Moldan
Swedish Environmental Research Institute (IVL)
Box 530 21
400 41 Gothenburg
Sweden
filip.moldan@ivl.se

Sara Jutterström
Swedish Environmental Research Institute (IVL)
Box 530 21
400 41 Gothenburg
Sweden
sara.jutterstrom@ivl.se

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

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

Switzerland

Luca Colombo
University of Applied Sciences of Southern Switzerland
SUPSI Laboratory of Applied Microbiology,
LMAVia Mirasole 22a
CH-6500 Bellinzona
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

United Kingdom

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

Felicity Hayes
UK Centre for Ecology & Hydrology
Environment Centre Wales
Deiniol Road
Bangor, Gwynedd
LL57 2UW, United Kingdom
fhay@ceh.ac.uk

USA

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

UNECE

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

Carolin Sanz Noriega
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
carolin.sanznoriega@un.org

Annex II: Agenda of the virtual ICP Waters Task Force meeting 28-29 April 2021

1. Opening, introductions, adoption of the agenda and general information about the meeting *(Wednesday 12:30-12:45 PM)*
2. **Reports** (Wednesday 12:45-2:15 PM)
    a. Report from the Working Group on Effects (Isaura Rábago, Chair WGE)
    b. Report from ICP Integrated Monitoring (Ulf Grandin, Chair ICP IM)
    c. Report from ICP Forests (Kai Schwärzel, Chair ICP Forests)
    d. Report from ICP Vegetation, including work on microplastics (Felicity Hayes, Chair ICP Vegetation)
    e. Report from ICP Modelling and Mapping (Christin Loran, CCE)
    f. Status and current issues ICP Waters (Heleen de Wit, Chair ICP Waters)
3. **Thematic sessions**
    a. NEC Directive (Wednesday 2.15-3.00 PM)
        i. Spanish NECD and ICP Waters monitoring programs (Manuel Velasco, Spain)
        ii. Introduction and discussion, NEC Directive (Kari Austnes, ICP Waters programme centre)
    b. Biology – trends and assessment *(Wednesday 3.00-5:00 PM)*
        i. An update on chemical and biological responses of acidified waters in the UK to long-term deposition reductions (Don Monteith, UK)
        ii. Lakes Paione (NW Italy): temporal and spatial trends of macroinvertebrates and acidification indices (Angela Boggero, Italy)
        iii. Ecological status assessment in the Debed River basin using hydrobiological and inorganic nitrogen indicators (Vardan Karyan, Armenia)
        iv. Suggestion towards a Nordic classification system for acidification (Jens Fölster, Sweden)
        v. ICP Waters 2022 report on biological recovery: Plans, call for contributions, discussion (Gaute Velle, ICP Waters sub-centre)
    c. Water chemistry trends (Thursday 12:30-2:30 PM)
        i. Impacts of COVID-19 lockdown on sulphur and nitrogen deposition and surface water chemistry over an alpine area (Michela Rogora, Italy)
        ii. Surprising long-term changes in water chemistry in 1000 Norwegian lakes - evidence of climate change impacts? (Heleen de Wit, Norway)
        iii. Long-term response of water chemistry to reduced acid deposition and climate warming of the Kola Arctic region (Marina Dinu, Russia)
        iv. Brownification on hold: What conventional analyses miss in extended water quality records (Jens Fölster, Sweden)
        v. Long-term (years) use of continual water chemistry probe for DOC, pH and conductivity - what we miss compared to regular sampling? (Jakub Hruška, Czech Republic)
        vi. Impact of climate change on the release of base cations from soils to surface waters (Daniel Houle, Canada)
    d. Nitrogen (Thursday 2:30-3:30 PM)
        i. ICP Waters 2021 report on nitrogen: Plans, results, discussion (Kari Austnes, Jan-Erik Thrane, Heleen de Wit, ICP Waters Programme Centre)
4. **Task Force meeting** (Thursday 3:30-5:00 PM)

a. ICP Waters contribution to the Gothenburg Protocol review
b. Work plan 2022-23 and ideas for future thematic reports
c. Update on activities
d. Next Task Force meeting
e. Adoption of the minutes

End of TF meeting *(Thursday 5:00 PM)*

Annex III: Status participation in the ICP Waters Programme as of April 2021

	Chemical data (last year with data)	Biological data (last year with data)	Participation in TF meetings 2019-2021	Participation in chemical intercomparison 2018-2020	Participation in biological intercalibration 2018-2020
Armenia	2019		●		
Austria	2018		●	●	
Belarus	2014				
Belgium				●	
Canada	2019		●	●	
Czech Rep.	2019	2017	●	●	
Estonia	2019		●	●	●
Finland	2019		●	●	
France			●	●	
Georgia			●		
Germany	2019	2019	●	●	
Ireland	2019	2016	●	●	●
Italy	2019		●	●	
Latvia	2018	2019	●		●
Lithuania			●	●	
Moldova	2017			●	
Netherlands	2014			●	
Norway	2019	2020	●	●	●
Poland	2019		●	●	
Russia	2018		●	●	
Serbia				●	
Slovakia	2019				
Spain	2013		●	●	
Sweden	2019	2019	●	●	●
Switzerland	2019	2018	●	●	
UK	2019	2015	●	●	
USA	2018		●		
Total	**21**	**8**	**21**	**21**	**5**

Annex IV: ICP Waters workplan for 2021–2023

2021

- Arrange the 37th meeting of the Programme Task Force in spring of 2021
- Prepare proceedings from the 37th Task Force meeting
- Contribute to the review of the Gothenburg Protocol
- Finalise the thematic report on nitrogen
- Start working on a thematic report on biological recovery, call for biological data and for national chapters on biological trends
- Arrange and report chemical intercomparison 2135
- Arrange and report biological intercalibration 2521
- Run the Programme Centre in Oslo and the Subcentre in Bergen
- Participation in meetings of relevance for the ICP Waters programme. Contribute to the implementation of the 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)

2022

- Arrange the 38th meeting of the Programme Task Force in spring of 2022
- Prepare proceedings from the 38th Task Force meeting
- Contribute to the review of the Gothenburg Protocol
- Finalise the thematic report on biological recovery
- Start working on the thematic report for 2023. A suggested topic is ‘base cation trends and implications’, but the GP review might also point to other topics.
- Arrange and report chemical intercomparison 2236
- Arrange and report biological intercalibration 2622
- Run the Programme Centre in Oslo and the Sub-centre 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 the 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)

2023

- Arrange the 39th meeting of the Programme Task Force in spring of 2023
- Prepare proceedings from the 39th Task Force meeting
- Finalise the thematic report
- Start working on the thematic report for 2024 (to be discussed at the TF meeting 2022/2023)
- Arrange and report chemical intercomparison 2337
- Arrange and report biological intercalibration 2723
- Run the Programme Centre in Oslo and the Sub-centre in Bergen

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., Birkeland, I.B., Johannessen, A. and Landås, T.S. 2020. Biological intercalibration: Invertebrates 2020. NIVA SNO 7556-2020. **ICP Waters report 144/2020**

Gundersen, C.B. and Bryntesen, T. 2021. Intercomparison 2034: 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 7621-2021. ICP Waters report 143/2021.

Gundersen, C.B. 2020. Intercomparison 2034: 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 7549-2020. ICP Waters report 143/2020. *Obs! This report has been revised (see ICP Waters 143/2021 above).*

Garmo, Ø., Arle, J., Austnes, K. de Wit, H., Fölster, J., Houle, D., Hruška, J., Indriksone, I., Monteith, D., Rogora, M., Sample, J.E., Steingruber, S., Stoddard, J.L., Talkop, R., Trodd, W., Ulańczyk, R.P. and Vuorenmaa, J. 2020. Trends and patterns in surface water chemistry in Europe and North America between 1990 and 2016, with particular focus on changes in land use as a confounding factor for recovery. NIVA report SNO 7479-2020. ICP Waters report 142/2020

Gundersen, C.B. 2019. Intercomparison 1933: 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 7445-2019. ICP Waters report 141/2019.

Velle, G., Birkeland, I.B., Johannessen, A. and Landås, T.S. 2019. Biological intercalibration: Invertebrates 2019. NIVA SNO 7433-2019. ICP Waters report 140/2019

Garmo, Ø., Austnes, K. and Vuorenmaa, J. (editors) 2019. Proceedings of the 35th Task Force meeting of the ICP Waters Programme in Helsinki, June 4-6, 2019. NIVA report SNO 7437-2019. ICP Waters report 139/2019

Velle, G., Johannessen, A. and Landås, T.S. 2018. Biological intercalibration: Invertebrates 2018. NIVA report 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 report 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 SNO7207-2017. 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. Intercomparison 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. 2015. 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 113/2012.

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, HCO3, NO3-N, Cl, SO4, 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, HCO3, NO3-N, Cl, SO4, 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, HCO3, NO3-N, Cl, SO4, 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, 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 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, 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 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. Intercomparison 0115: 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 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 SNO 4384-2001. 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, K25, NO3 + NO2, Cl, SO4, 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, 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 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.

NIVA

Norwegian Institute for Water Research

Økernveien 94 • NO-0579 Oslo, Norway
Telephone: +47 22 18 51 00 • Fax: 22 18 52 00
www.niva.no • post@niva.no