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Proceedings of the 38th meeting of the ICP Waters Programme in Miraflores de la Sierra, Spain, and on-line, May 10-12, 2022

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

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Summary

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2. Freshwater	2. Ferskvann
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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 38th meeting of the ICP Waters Programme in Miraflores de la Sierra, Spain, and on-line, May 10-12, 2022

Prepared at the ICP Waters Programme Centre
Norwegian Institute for Water Research
Oslo, September 2022

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, Bergen. ICP Waters is supported financially by the Norwegian Ministry of Climate and Environment 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 38th Task Force meeting of the ICP Waters Programme, held in Miraflores de la Sierra (Spain) and on-line, May 10-12, 2022.

Kari Austnes
ICP Waters Programme Centre

Oslo, December 2022

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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 were grouped thematically. The meeting was held jointly with ICP IM in Miraflores de la Sierra (Spain) and on-line, May 10-12, 2022. A short summary of each presentation is given in the Minutes (Chapter 5). Three presenters contributed more extensive reports on their presentations to the Proceedings in Chapter 2, 3 and 4 respectively. The following presentations were given during the Task Force meeting:

Acidification, thresholds, and recovery

- Air quality in Spain: challenges for the conservation of ecosystems, Rocío Alonso, Spain
- Monitoring of the effects of air pollution on aquatic ecosystems in Spain under the NEC Directive and the ICP Waters Programme, Juan Alández, Alfredo Corrochano, Manuel Toro Velasco, Spain
- Expected and unexpected long-term changes in Norwegian lakes, Heleen de Wit, Norway
- Recent trends in surface water chemistry of high-altitude Alpine lakes, Sandra Steingruber, Switzerland
- A new approach to modelling DOC trends, Don Monteith, U.K
- Suggestion of a harmonized acidification criteria for Nordic countries, Jens Fölster, Sweden
- Mixed drops from the Czech ICP Waters sites (Sulfur budgets, Ca and Mg isotopes, DOC trends), Jakub Hruška, Czechia
- Physiochemistry of the Lysina stream: What can we learn from high-frequency monitoring? Katherine X. Pérez Rivera, Czechia

Nitrogen

- Nitrogen in surface waters: time trends and geographical patterns explained by deposition levels and catchment characteristics, ICP Waters report 2022, Øyvind Kaste, Norway
- Impact of nitrogen on the Sevan catchment area, Alina R. Zurnachyan, Armenia
- Nitrogen budgets and the link to carbon sequestration in Nordic forest ecosystems, Martin Forsius, Finland
- Impact of forecasted deposition and climate changes on the N balance - local results at the IM station and plans for a national scale analysis, Rafał Ulańczyk, Poland
- Long-term N addition effects on DOC trends, Daniel Houle, Canada (online)

NEC directive

- The NEC network in Italy: new developments and projects, Alessandra De Marco, Italy
- NECD- what to expect from the reporting 2022/2023, Salar Valinia (online)
- Biodiversity, biological indices, and recovery
- The 2022 thematic report on biological recovery, Gaute Velle, Norway
- Extended ICP IM- development of the program, Salar Valinia (online)

- Environmental monitoring at Sierra de Guadarrama National Park, Ignacio Granados, Spain

Dynamic modelling

- Update on CDM activities, Filip Moldan, Sweden (online)
- DAEMONS modelling, Martyn Futter, Sweden (online)

2 Monitoring aquatic ecosystems in the Sierra de Guadarrama National Park

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Keywords: mountain rivers, ecological status, mountain lakes, eutrophication, fish eradication, anthropogenic pressures, recreational activities, climate change, Sierra de Guadarrama National Park.

2.1 Introduction: Sierra de Guadarrama National Park

The Sierra de Guadarrama National Park covers about 340 km^2 of the Spanish Central System mountain range, about 50 km north of the city of Madrid (Figure 2.1). A river and a high mountain lake in the national park were in June 2021 included in the ICP-Waters monitoring programme (Toro et al., this Proceedings). This article provides limnological information about these two ICP-Waters sites, describing the main characteristics of the aquatic ecosystems of the Sierra de Guadarrama, and the monitoring work carried out in recent years.

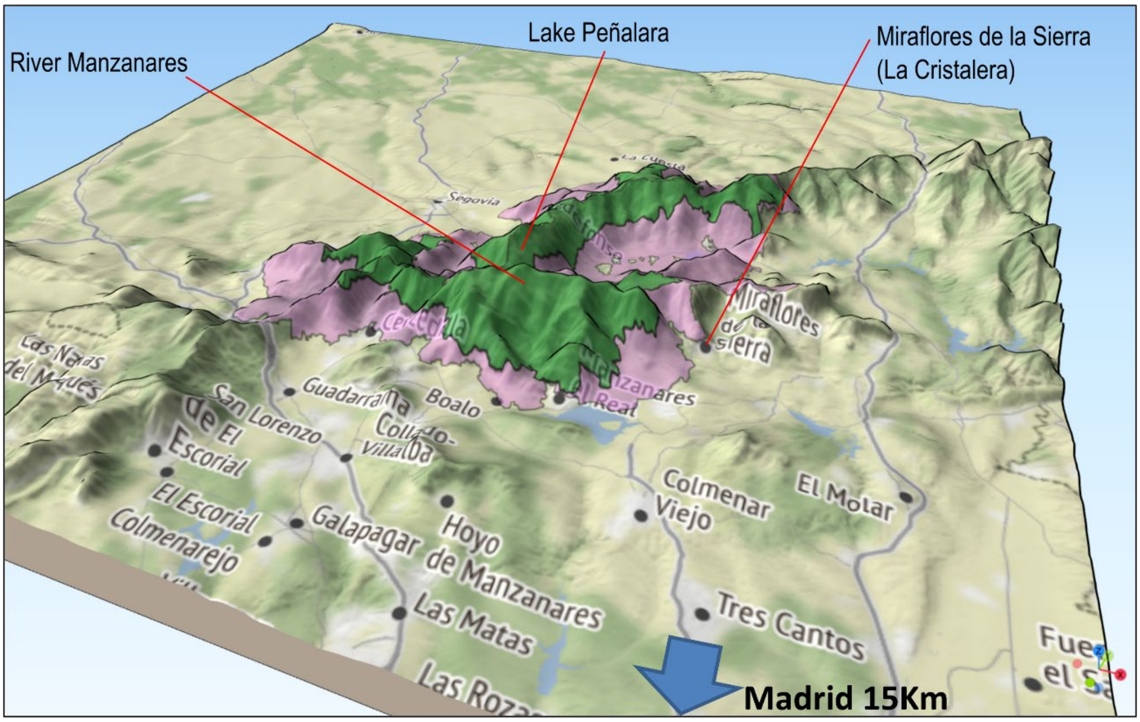

Figure 2.1. Location of the Sierra de Guadarrama National Park (dark green) and its Peripheral Protection Zone (pink), with the two ICP-Waters sites (River Manzanares and Lake Peñalara). Also shown is Miraflores de la Sierra, where the 38th meeting of the Programme Task Force of ICP Waters was held. Sources: Map tiles by Stamen Design, under CC BY 3.0; Data by OpenStreetMap, under ODbL.

The park lies on siliceous bedrock (orthogneisses, granites), and consist mainly of Mediterranean high mountain ecosystems: i.e., Scots pine woods (Pinus sylvestris), Pyrenean oak woods (Quercus pyrenaica), sclerophyllous scrubs, high-mountain grasslands, and rock vegetation communities. There are more than 330 small mountain ponds and lakes, most of them shallow and less than 500 m2 in surface. Despite their small size, they are an important contribution to the park's biodiversity, maintaining a high richness of aquatic species. There are also 170 km of creeks and rivers in the southern slope of the Sierra de Guadarrama, a few of them are intermittent.

2.2 River monitoring

The Sierra de Guadarrama National Park administration monitor the ecological status (WFD) of the main water courses (Rubio-Romero and Granados 2019). The 26 sampling stations of their monitoring network lay between 965 and 1 510 meters of altitude, well below the monitoring station for the ICP-Waters (i.e., River Manzanares at 1 710 m a.s.l.). Nearly all permanent streams (85.2%) have high or good ecological status, although temporary rivers (14.8%) appear to be in worse conditions (Figure 2.2). This is probably due to the biological index design that has some difficulties to evaluate the real ecological condition of temporary rivers.

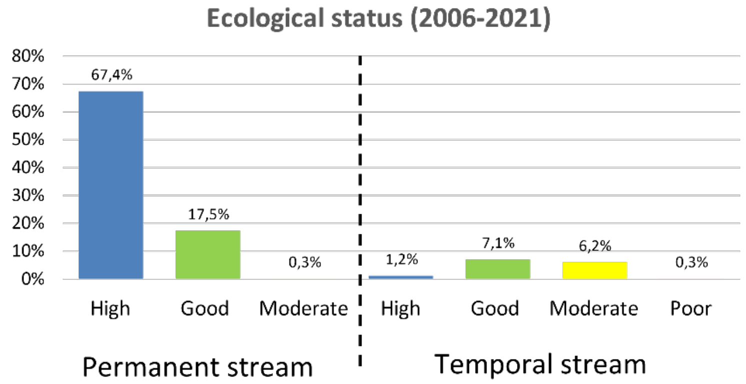

Figure 2.2. Ecological status of Sierra de Guadarrama rivers according to the Water Frame Directive (WFD) (modified from Rubio-Romero and Granados, 2015).

Rubio-Romero and Granados (2019) indicate that the biological indices are influenced by altitude and seasonality, as well as the existence of lowland vegetation and livestock, in addition to other less relevant factors and impacts (e.g., bank disturbance, recreational activities). Moreover, altitude is a limiting factor for biodiversity of fluvial macroinvertebrates at the most elevated stations. It is thus expected that the ICP-Waters site in River Manzanares will have lower macroinvertebrate biodiversity compared to the other sampling stations located at lower altitudes.

2.3 Lake monitoring

Past impacts and lake recovery

Between 1970 and 1990, the ICP-Water site Peñalara lake was affected by several direct anthropogenic pressures. A ski resort was built in the vicinity and an alien fish species (*Salvelinus fontinalis*) was introduced to the lake. The increased recreational pressure caused lake eutrophication and shore erosion. From 1990, swimming in the lake and camping in the area were banned. The lake was fenced off to prevent trampling by visitors and livestock, and the eroded shoreline were revegetated. Between 1999 and 2002 the ski resort was completely dismantled (Granados et al. 2014), and the non-indigenous fish species was eradicated (Toro et al. 2020). As a result, trophic state (Figure 2.3), erosion levels and invertebrate community (Figure 2.4) recovered to their previous characteristics of a nearly natural lake.

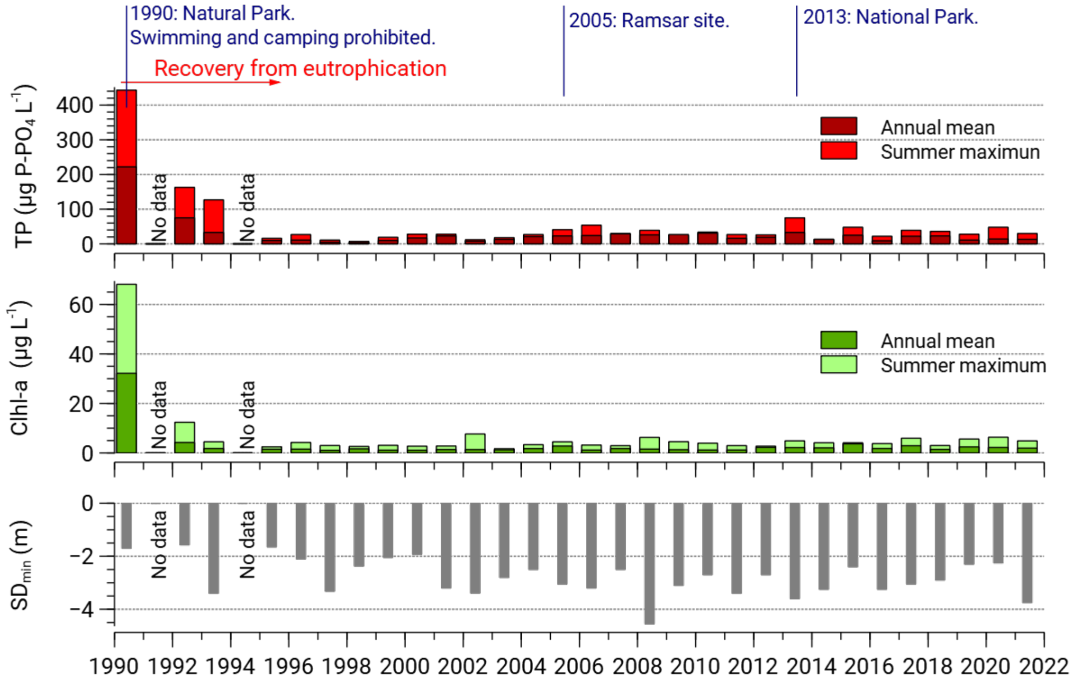

Figure 2.3. Main trophic variables (i.e., total phosphorous (TP), Chlorophyll a (Chl-a), and Secchi disk transparency) (SD)) showing the lake recovery after swimming and camping was prohibited in 1990 (modified from Granados, 2022).

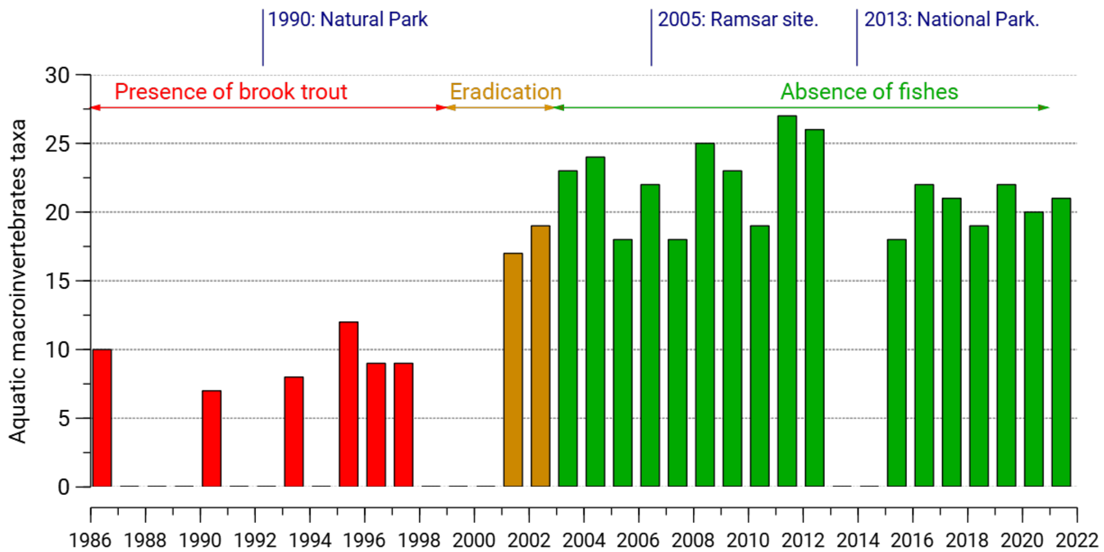

Figure 2.4. Aquatic macroinvertebrate taxa richness in Lake Peñalara before, during and after alien fish eradication (modified from Toro et al. 2020).

Limnological monitoring

A monitoring programme was set up to follow the recovery of Lake Peñalara after the restoration in 1990 (Toro and Granados 2002). Monthly measurements are conducted of the ice cover, water level, Secchi disk depth, temperature, oxygen, conductivity, pH and hydrochemistry (alkalinity, some ions, reactive and total phosphorus, nitrate, nitrite, ammonia, total nitrogen, and chlorophyll a). Sedimentation rate is measured with sediment traps. Zooplankton, phytoplankton, and benthic invertebrates are also sampled and analyzed.

2.4 Current pressures

Recreational activities

The national park receives 2.3 million visitors yearly. This poses a challenge for the park management regarding their conservation of its natural habitats and species. To reduce this recreational pressure certain regulations are imposed on the more vulnerable areas. The daily number of visitors to the Peñalara Massif is limited to 945, and at Lake Peñalara the perimeter fence is maintained around the lake to keep visitors and livestock away from the shoreline.

Climate change

Long-term (1945-2021) monitoring data from the weather station at Puerto de Navacerrada (1 890 m a.s.l., 7 km from Lake Peñalara) provides clear indication of climate warming: i.e., +2.17°C between 1980-1989 and 2010-2019 (Figure 2.5). Regional modelling (AdapteCCa 2020) suggests that the annual mean maximum temperature anomaly (relative to the 1971-2000 period) will be between 3.0 and 6.0°C during the last five years of the 21st century following the RCP 4.5 and RCP 8.5 emission scenarios, respectively. Likewise, the mean minimum temperature anomaly will be between 2.1 and 4.2°C, respectively.

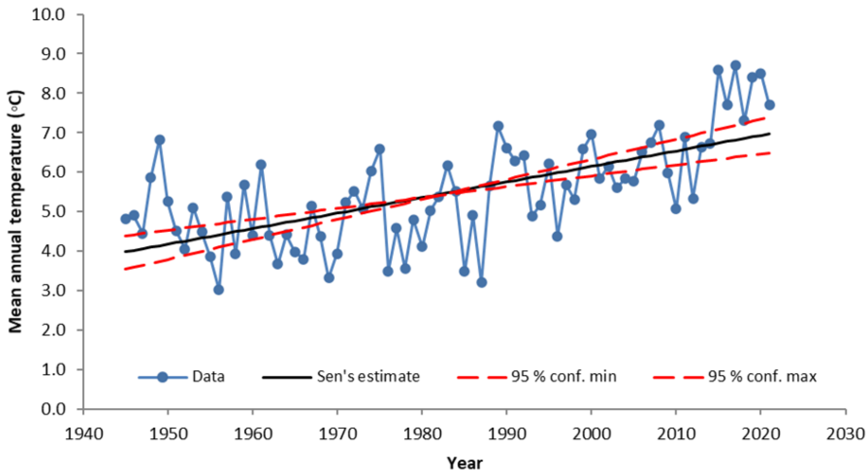

Figure 2.5. Mean annual air temperatures trend close to Lake Peñalara. Data source: AEMET (2022).

Atmospheric pollution

Recent modelling studies of the atmospheric deposition of nitrogen (N) in Spain point to the Sierra de Guadarrama as one of the areas in which the critical loads estimated for alpine ecosystems included in the Natura 2000 Network are being exceeded (García-Gómez et al. 2014). An estimated 67% of the park area is at risk of effects due to atmospheric N deposition (García-Gómez et al. 2017). The national park is also exposed to chronic tropospheric ozone pollution, above the threshold for vegetation damage (Elvira et al. 2016). These ozone levels cause delayed amphibian larval development and enhance the lethal effect of chytridiomycosis (Bosch et al. 2020).

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3 Physicochemistry of the Lysina stream-What can we learn from high-frequency monitoring?

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Keywords: high-frequency monitoring, fluorescent dissolved organic matter, hydrological events, toxic aluminum

3.1 Introduction

Long-term monitoring of stream water chemistry aids our understanding of ecosystem processes by disclosing changes over time as a response to environmental pressures or recovery from disturbances such as freshwater acidification. However, how frequent samples are taken can make a difference in what can be assessed or interpreted. Sampling frequency can play a key role in deciphering biogeochemical processes, particularly if those are dependent or influenced by flow conditions. In general, solute concentrations during changes in flow conditions (increase or deacrease) may exhibit dilution, negligible change (chemostasis) or enrichment (Lloyd et al. 2016, Godsey et al. 2019). Regular weekly streamwater chemistry monitoring at Lysina has been conducted for 32 years. These measurements have been used for tracking changes ensuing acidification and more recent ecosystem recovery. In 2019, a multi-probe sonde was installed at Lysina to measure in-situ pH, conductivity, and fluorescent dissolved organic matter (fDOM) at high-frequency. Here, we compared the monitoring approaches (regular and high frequency), based on these parameters along with discharge, for the water years of 2020 and 2021.

3.2 Study site and methods

Eight sites from the Czech Republic are currently in the ICP Waters network: six lakes and two streams, including the Lysina stream (CZ07). Two Czech sites are part of the ICP Integrated Monitoring network, one of them is the Lysina catchment (CZ02). The Lysina catchment (27.3 ha, 50°01′ N, 12°39′ E, 829-949 m a.s.l.) is situated in the Slavkov Forest, western Bohemia, Czech Republic, and is part of the Czech GEOMON network of small forest catchments (Oulehle et al. 2021). It has a granitic regolith and is forested by dense Norway spruce (*Picea abies*) plantations (Hruška et al. 2002, Krám et al. 2012, Zheng et al. 2021). Stream hydrochemical analyses of major anions and cations, trace metals, and dissolved nutrients were conducted as as described by Krám et al. (2009, 2012). Sensor data were compiled with continuous discharge measurements in order to assess the role of flow conditions on chemical parameters. The virtues of regular and high-frequency monitoring results were examined to address relevance of incorporating in-situ measurements to aid our understanding of stream water chemistry changes in 2020 and 2021.

3.3 Results and discussion

During the first half of the 1990's, atmospheric acid deposition was inconpletely neutralized in the drainage waters at Lysina due to low weathering rates (Krám et al. 2012). Lysina streamwater thus exhibited low pH and correspondingly extremely high mean concentrations of potentially toxic inorganic monomeric aluminum (Ali) (0.7 mg L^{-1}) in stream water (Fig. 1) (Krám et al. 2009, Krám and Kleemola 2019). Concentrations of Ali were usually above the toxic level for benthic macroinvertebrates (above 0.14 or 0.3 mg L^{-1} for different species). Moreover, macroinvertebrate biodiversity was very low in the Lysina stream (Traister et al. 2013, Horecký et al. 2013) compared to Czech forested sites with higher streamwater pH values.

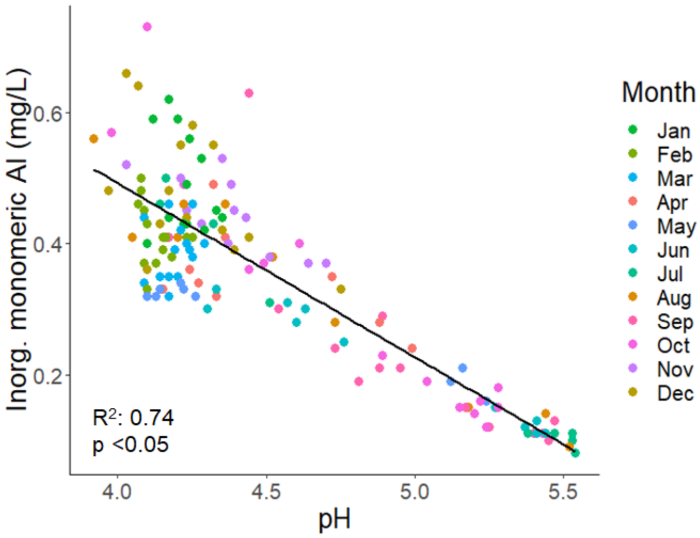

Figure 3.1. Inorganic monomeric Al (labile Al) relationships with streamwater pH.

Data from regular monitoring show notable variability relative to seasonal fluctuations in flow conditions, with unstable levels for all parameters. Similarly, to another studied sites (Pérez Rivera et al. 2022) the changes in flow conditions at Lysina exert control on the concentration of solutes and parameter dynamics. There is a clear increase in concentrations of dissolved organic carbon and proton (H^+), as well as increases in conductivity as flow levels increase. However, when compared to high frequency data, it is clearly documented that regular weekly sampling regularly miss important episodic discharge events (Fig. 2). This results in misinterpretation of processes and leads to underestimation of the impact of short-term hydrological events (Fig. 3). Therefore, having high frequency measurements compliment and substantially aid our assessment of signals that can be missed by regular sampling. The high-frequency data has the potential for improving our calculation of element fluxes, nutrient levels, and their bioavailability in streams, as well as assessment of biogeochemical processes.

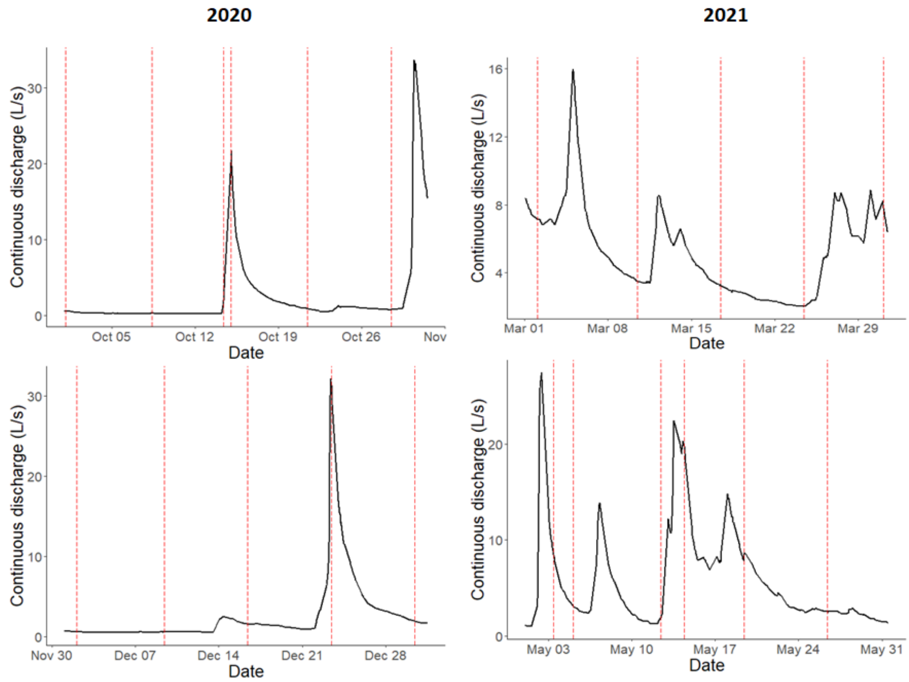

Figure 3.2. Continuous discharge at Lysina for selected months in 2020 and 2021. Red vertical dashed lines show when weekly samples were collected. Relevant flow events could often be missed in regular sampling campaigns.

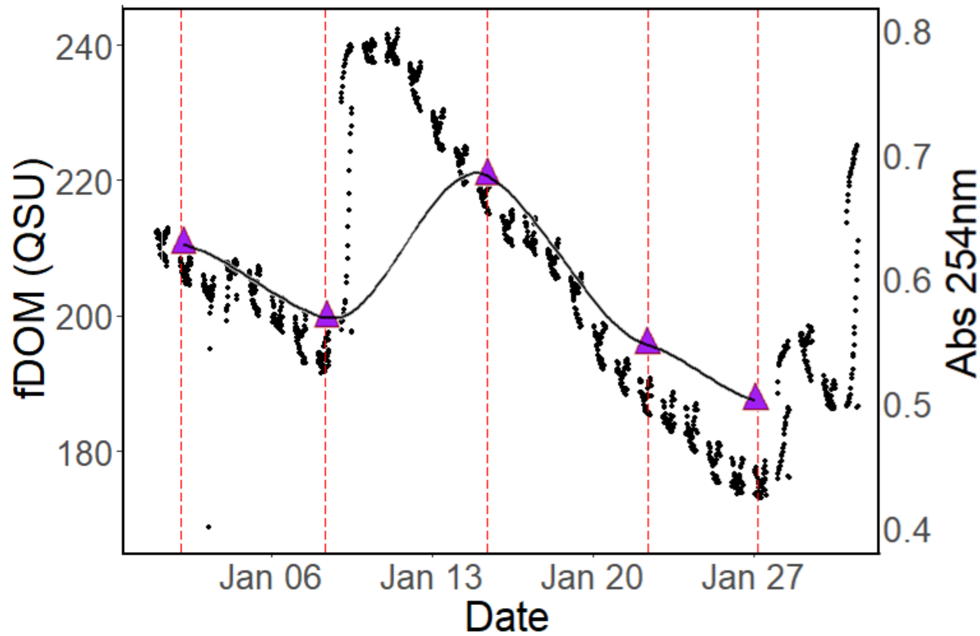

Figure 3.3. Comparison between high-frequency fluorescent dissolved organic matter (fDOM) measurements and regular water sampling for absorbance at 254 nm (Abs 254) at Lysina. Vertical dash-red lines show days when grab samples were collected. Black data points are fDOM measurements from in-situ sensor, and purple triangles data points for Abs 254.

3.4 Acknowledgements

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4 Monitoring of the effects of air pollution on aquatic ecosystems in Spain under the NEC Directive and the ICP-Waters programmes

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4.1 Introduction

The Convention on Long-Range Transboundary Air Pollution (LRTAP) and the National Emission Ceilings Directive (NECD) in Spain are the responsibility of the Sub-Directorate-General for Clean Air and Industrial Sustainability (Ministry of Ecological Transition and Demographic Challenge; MITERD). The monitoring of aquatic ecosystems under the LRTAP and NECD (ICP-Waters) is coordinated and funded by the Directorate General for Water under MITERD. Within the framework of the NECD, and in accordance with Article 9, Spain reported to the European Commission (EC) in 2018 a network for monitoring the effects of air pollution on ecosystems. The Spanish REFCON Project aims to establish new and revised reference conditions under the Water Framework Directive (WFD) for rivers and lakes, assess the effects of climate change on these reference sites, and monitor the impacts of air pollution on aquatic ecosystems within the framework of the NECD.

Spanish participation in the ICP-Waters monitoring programme began in June 2021, including three sites located in National Parks, devoid of any impacts of local pollution sources, and with nearby meteorological and atmospheric deposition monitoring stations. These sites are the only Mediterranean climate sites in the ICP-Waters Programme, and they are operating at Level 1 (monthly sampling for chemistry and annual for biota) according to hierarchy of the ICP-Waters programme (2010), thanks to the logistical support of National Parks personnel.

Although the main objective of the ICP-Waters and NECD programs is to monitor the effects on aquatic ecosystems of atmospheric pollution related to acidification, heavy metals, and persistent organic pollutants (POPs), as well as other potential atmospheric pollutants, such as dust intrusions from Africa, have become relevant in recent years.

4.2 Location of monitoring sites

The NECD monitoring network in Spain consists of 15 river stations, including 11 different WFD typologies, and 10 lake stations, encompassing 9 different WFD typologies (Figure 4.1), covering a wide geographical gradient (lat., long., alt.).
The ICP-Waters monitoring network in Spain currently consist of 3 sites located in 2 National Parks (Figure 4.1 and 4.2). These are the lake Peñalara and river Manzanares, in the National Park of Sierra de Guadarrama (Chapter 2), and the river Estena in the National Park of Cabañeros. During 2023 it is planned to extend the network to a maximum of 10-12 stations in other representative national parks in Spain.

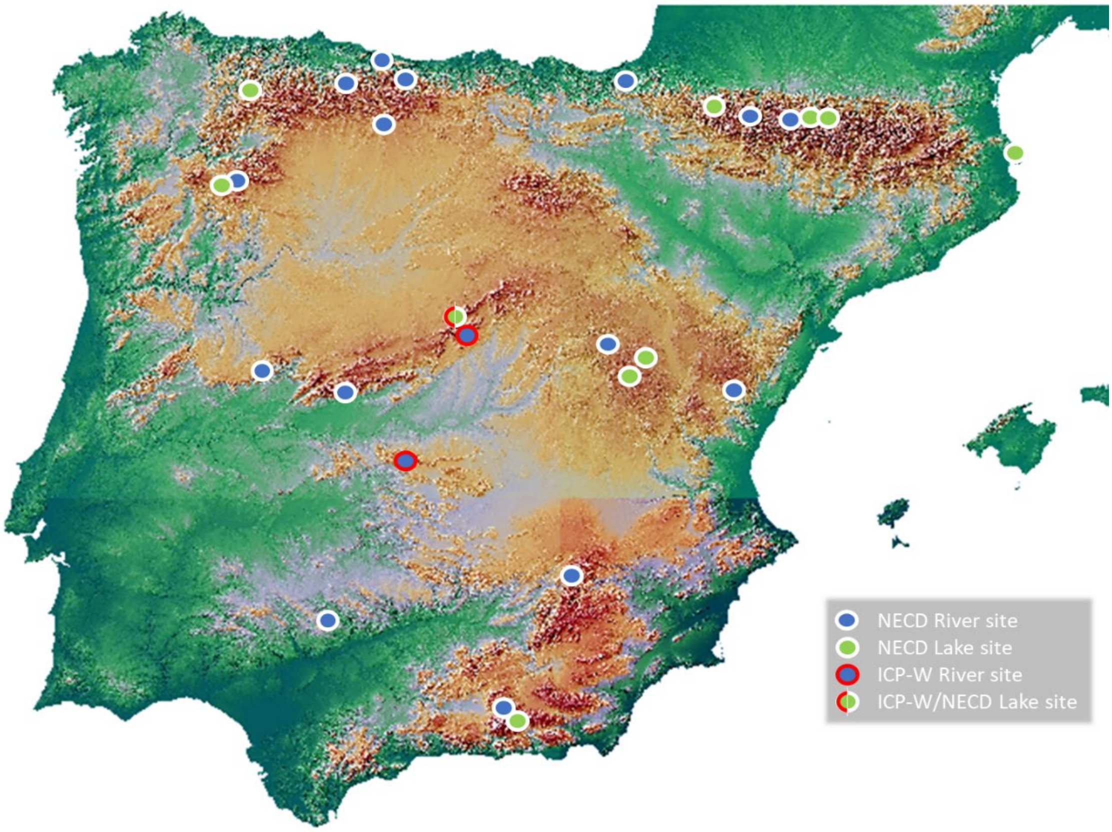

Figure 4.1 Location of NECD and ICP-Waters monitoring sites in Iberian Peninsula (Spanish territory). Source of data: Directorate General for Water and CEDEX (Ministry of Ecological Transition and Demographic Challenge; MITERD). Source of map image: Cartography Service of the Autonomous University of Madrid (SCUAM). Source of altitude data: IGN Spain: http://guiadigital.uam.es:8080/geoserver/Relieve_P_IBERICA/wms?

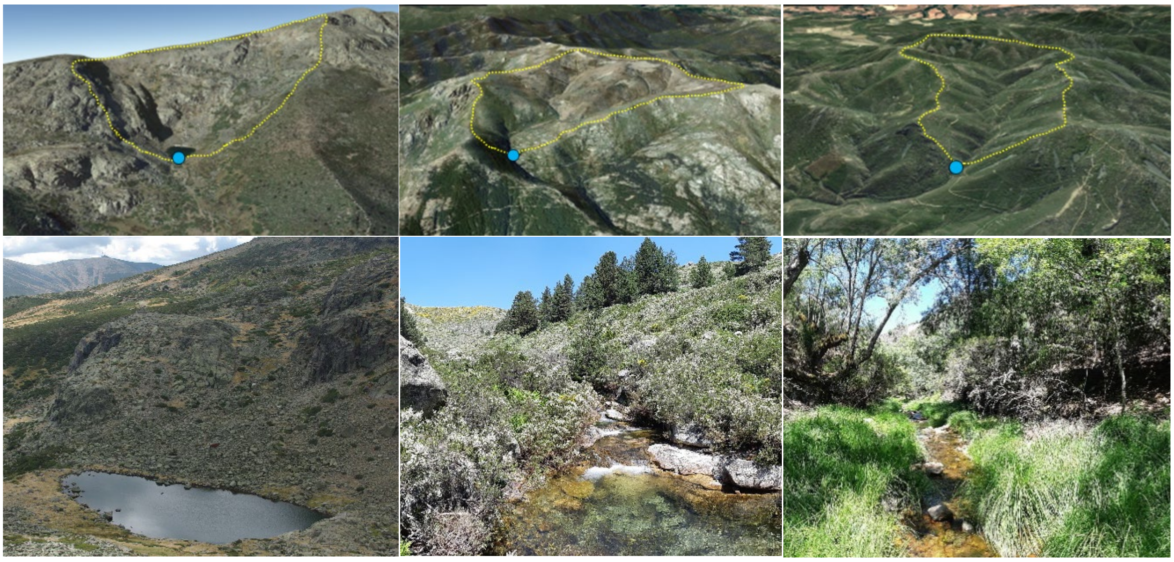

Figure 4.2. ICP-Waters monitoring sites in Spain and their watersheds: Left) lake Peñalara; Middle) river Manzanares; Right) river Estena. Sources: Aerial photos (top row) from Google Earth 3D viewer © 2022 CNES / Airbus (Image Landsat / Copernicus. Data SIO, NOAA, U.S. Navy, NGA, GEBCO); terrestrial photos (bottom row) photographed by Manuel Toro.

4.3 Methodology

At the NECD network lake stations, samples are collected twice a year for physicochemical and phytoplankton analysis, and once a year for persistent organic pollutants (POPs), macroinvertebrate and macrophyte analysis. The rivers are sampled monthly for physicochemical analysis and annually for analysis of POPs, phytobenthos, macroinvertebrates, macrophytes and fish. In the ICP-Waters network sites (lake and rivers), samples are taken monthly for physicochemical, twice a year for POPs (in June and December), and once a year for macroinvertebrate and phytobenthos analysis. Wet and dry deposition samples are collected weekly or biweekly at the meteorological and air pollution monitoring station at Puerto de Cotos (Sierra de Guadarrama National Park) for chemical analysis. Water chemistry and POPs include all mandatory and optional parameters, and analysis methodologies are carried out according to the ICP-Waters Manual (ICP Waters Programme Centre, 2010). Identification of taxa in all biological groups is done at genus or species level. Air quality data are provided by the Air Quality Network of Regional Government of Madrid (http://gestiona.madrid.org/azul_internet/run/j/AvisosAccion.icm).

4.4 Preliminary results of NECD and ICP-Waters monitoring networks in Spain

NECD network

Figure 4.3 shows the main descriptive statistics of main chemical parameters in the lake sites for 2021. Seasonal patterns and natural levels for each parameter at each site will be established when more annual series become available. This will make it possible to discern inputs of atmospheric pollutants which could cause alterations in the parameter concentrations at these sites and have possible effects on biota.

No POPs concentrations above the detection limits were detected in the water and fish muscle tissue samples obtained at the NEC monitoring network sites. Mercury was detected in all the ichthyofauna samples analysed, with wet weight concentrations between 0.03 and 0.07 mg/kg, except for one case that showed a concentration of 0.28 mg/kg (i.e., Arroyo de Nueva, in Asturias). The Spanish Environmental Quality Standards (EQS) (Royal Decree 817/2015) has set a maximum concentration of 0.02 mg/kg wet weight for mercury in biota (in line with the EU EQS Directive 2013/39/EU). All samples thus had mercury concentrations exceeding this limit.

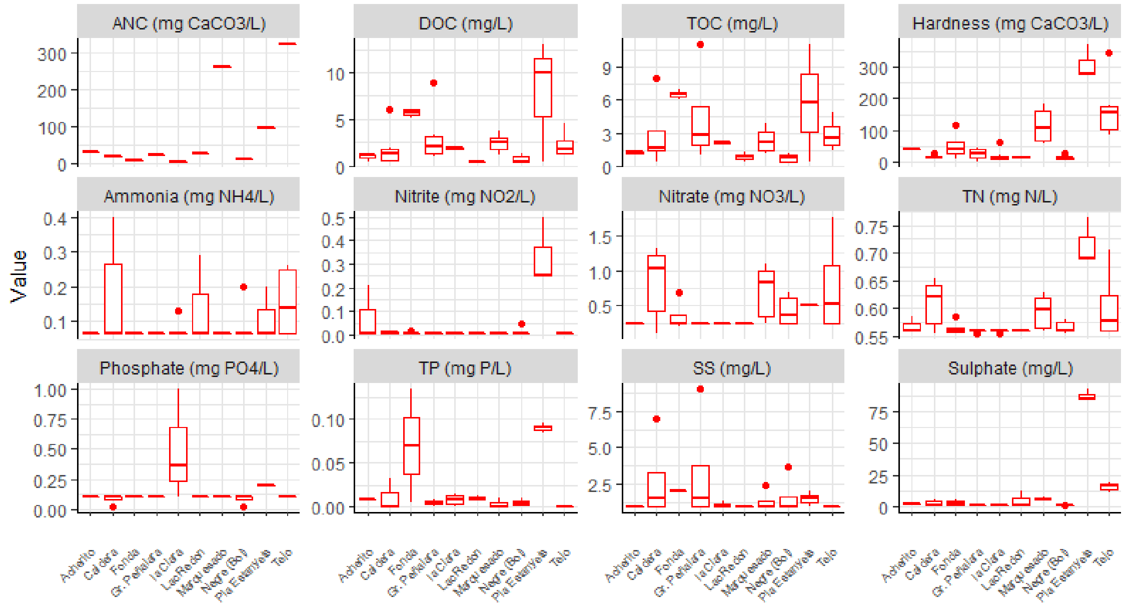

Figure 4.3. Results of the analysis of the main chemical parameters in the lakes of the NECD network in Spain during 2021. Box plot shows Max and Min values (whiskers lines), Median (horizontal line within the box), interquartile range 25-75% (lower and upper edges of the box), and outliers (dots). There is only one ANC datum for each lake in 2021. ANC is measured by electrometry (50 mg of $CaCO_3$/l = 1 meq/l).

ICP Waters network

The results of chemical analyses of samples from the three ICP-Waters sites from the first year of sampling are shown in Figures 4.4 and 4.5. The three sites have very low solute concentrations and alkalinity, although the river Estena shows slightly higher values. The river Manzanares has elevated values of nitrate, whose possible atmospheric origin will have to be investigated. Trace metals concentrations are also low, with slightly higher values in the river Estena and lower levels in the river Manzanares, especially for iron, zinc, and manganese. Only 7 POPs were detected in lake Peñalara (6) and the river Estena (4), and these had very low concentrations. No POPs were detected in the river Manzanares (Table 1). Future analyses will determine whether this is a single contamination of these substances or if there is a continuous deposition of these substances via the atmosphere.

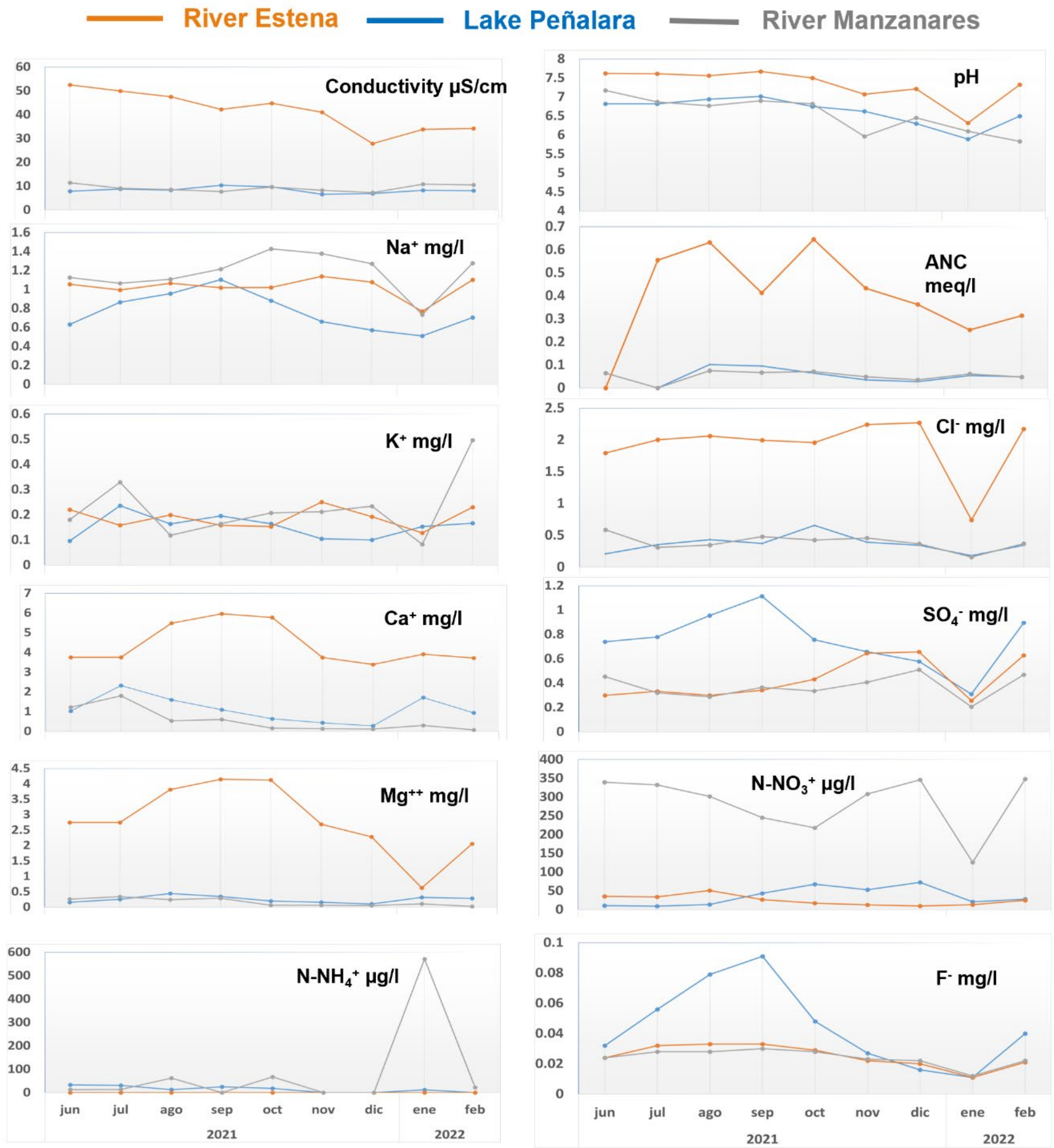

Figure 4.4. Results of the analysis of the main chemical parameters in the sites of the ICP-Waters network in Spain during the first year of sampling[1].

[1] Limits of quantification, where available: Na 0.10 mg/l, K 0.04 mg/l, Cl 0.1 mg/l, Ca 0.10 mg/l, SO_4 0.2 mg/l, Mg 0.04 mg/l, NO_3 11.3 µg N/l, NH_4 11.6 µg N/l, F 0.01 mg/l.

Figure 4.5. Results of the analysis of the trace metals in the sites of the ICP-Waters network in Spain during the first year of sampling[2].

Table 4.1. Results of the analysis of POPs in the sites of the ICP-Waters network in Spain during the first year of sampling (only detected compounds are shown).

Methodology: CG/MS high resolution (ORBITRAP)	Lake Peñalara 100621	River Manzanares 090621	River Estena 160621	Lake Peñalara 141221	River Manzanares 131221	River Estena 141221
	ng L-1	ng L-1	ng L-1	ng L-1	ng L-1	ng L-1
PCB 101	ND	ND	ND	ND	ND	0.032
PCB 153	ND	ND	ND	0.339	ND	ND
PCB 180	ND	ND	ND	0.512	ND	ND
PAH, Acenaphthene	0.0243	ND	0.113	ND	ND	ND
PAH, Acenaphthylene	0.014	ND	0.066	ND	ND	ND
PAH, Phenanthrene	ND	ND	ND	1.676	ND	ND
Naphthalene	0.024	ND	1.344	ND	ND	ND

Saharan dust intrusions

Northern Sahara and the Sahel in Africa are sources of dust to the NECD and ICP watersheds. The magnitude and nature of the dust deposition is governed by the anthropogenic activity (e.g., land use), climate and hydrological aspects in the desert region (Ginoux *et al.*, 2012). During past decades, there

[2] Limits of quantification: Al 1 µg/l, As 3 µg/l, Cd 1 µg/l, Cr 1 µg/l, Fe 5 µg/l, Hg 0.01 µg/l, Pb 3 µg/l, Zn 3 µg/l, Cu 1 µg/l, Mn 1 µg/l, and Ni 1 µg/l.

has been an increase in the frequency and intensity of African dust outbreaks over the Iberian Peninsula and western Mediterranean basin (Salvador *et al*., 2022).

On March 14th a very strong intrusion of Saharan dust reached the Iberian Peninsula, creating an exceptional situation of very high dust deposition and poor air quality. The aerosol concentrations during this event were the highest on record based on measurements from several stations in Spain. The Copernicus Atmosphere Monitoring Service (CAMS) regional ensemble analysis over Spain shows concentrations reaching up to 650 µg/m^3, while some of the individual regional models in the ensemble gave values near 2 000 µg/m^3. Figure 4.6 shows a snapshot of the evolution of the dust intrusion on March 14th. CAMS is run by the European Centre for Medium-Range Weather Forecasts (ECMWF) on behalf of the European Commission.

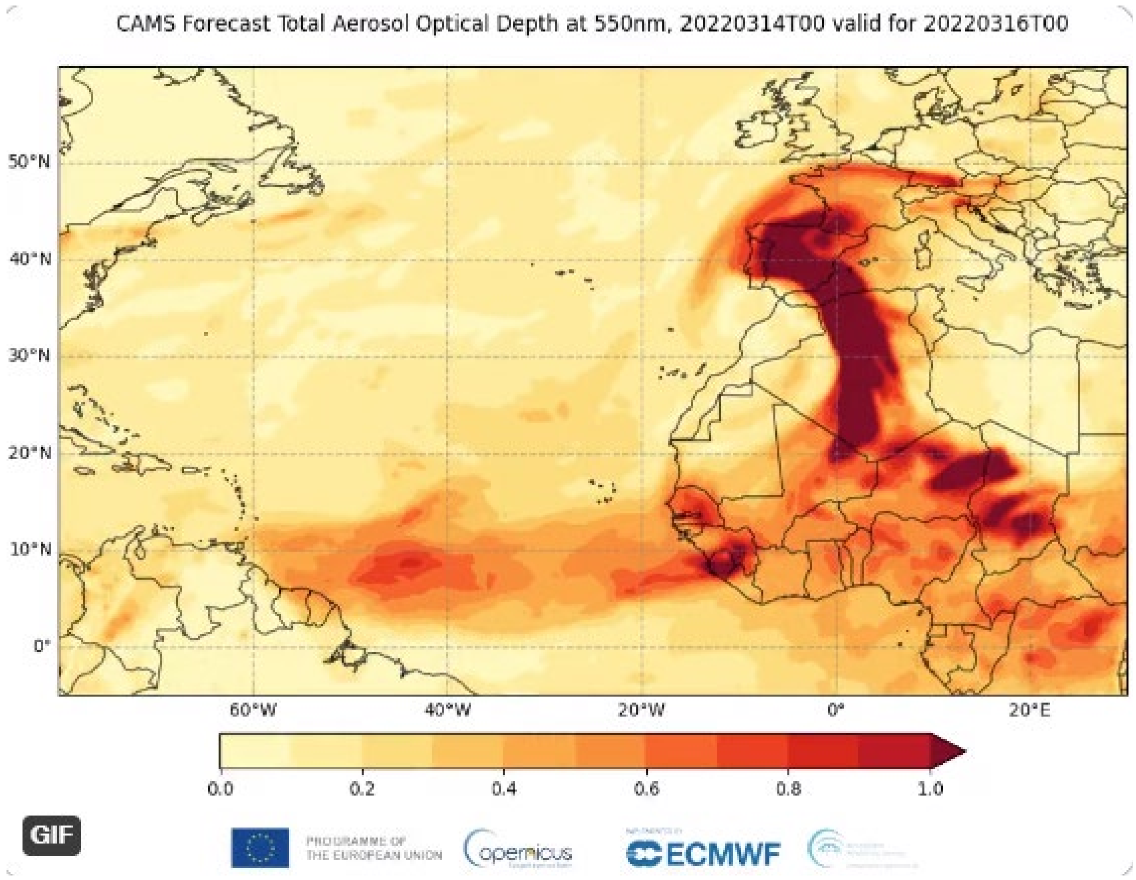

Figure 4.6. Snapshot of dust intrusion based on CAMS aerosol optical depth analyses between 14-16 March 2022. Source: CAMS/ECMWF website (https://atmosphere.copernicus.eu/copernicus-cams-monitors-saharan-dust-transport-across-western-and-central-europe).

The air quality monitoring station at Puerto de Cotos (National Park of Sierra de Guadarrama) registered exceptional peaks in the concentration of particles during the dust intrusions (Figure 4.7). Chemical analyses of the bulk deposition collected at this station during the dust storm showed unusual high values for ammonium, nitrate, iron, aluminium and phosphorous. Alkalinity was also exceptionally higher than usual. Clearly in remote unpolluted areas, such as the ICP watersheds, these dust storm events represent an important source of some chemicals, such as metals, nitrogen, phosphorus, and alkalinity. The effects on water chemistry of the input of atmospheric deposition associated with the Saharan dust storms are being studied at ICP-Waters stations in Spain.

Figure 4.7. Air quality and bulk deposition data recorded at Puerto de Cotos (Sierra de Guadarrama National Park) monitoring station during the strong intrusion of Saharan dust in March 2022. Air quality data source: http://gestiona.madrid.org/azul_internet/run/j/AvisosAccion.icm.

4.5 Acknowledgements

The collaboration of the staff of the National Park of Sierra de Guadarrama (Ignacio Granados and Ángel Rubio) and National Park of Cabañeros (Pablo Pozo and Ángel Gómez) in the collection of samples at the ICP-Waters Network sites is gratefully acknowledged. Chemical analyses were carried out in the Water Quality Laboratory of the Centre for Hydrographic Studies (CEDEX).

4.6 References

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Salvador, P., J. Pey, N. Perez, X. Querol and B. Artíñano. 2022. Increasing atmospheric dust transport towards the western Mediterranean over 1948–2020. *npj Climate and Atmospheric Science,* 5:34. https://doi.org/10.1038/s41612-022-00256-4

5 Minutes of the 38th meeting of the Programme Task Force of ICP Waters held in Miraflores de la Sierra, Spain, and on-line, May 10-12, 2022

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 38th meeting of the Programme Task Force of ICP Waters, and the 5th Joint ICP IM and ICP Waters TF meeting, Miraflores de la Sierra, 10-12 May 2022

KEY MESSAGES OF ICP WATERS 2022 TASK FORCE MEETING

Chemical recovery from acidification.

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

Long-term monitoring essential for differentiating between drivers of acidification and recovery

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

Harmonisation of chemical thresholds for biological recovery

Countries use different approaches for assessing biological acidification status with water chemical data, under the Water Framework Directive. Experts have proposed a new classification system based on relationships between macroinvertebrate species composition and acid neutralising capacity in Nordic waters. This new system has potential for further refinement of the critical loads of acidity under the LRTAP Convention. The work is a good example of integration of scientific work under different policy instruments of environmental legislation.

Nitrogen

Concentrations of nitrate and trends in nitrate in surface waters, as demonstrated by the extensive ICP Waters monitoring records across Europe and North America, are partly controlled by nitrogen deposition and are thus linked to nitrogen emissions to the atmosphere. Variation in concentrations and trends is also controlled by vegetation and soil processes, for which high-quality data are difficult to obtain. Collaboration with other bodies under the Convention with spatially extensive datasets could provide valuable insights on controls of ecosystem trends and levels of reactive nitrogen. The present data from ICP Waters do not suggest that N saturation is occurring now, but ambient loads of nitrogen deposition might still exceed long-term sustainable levels. Future climate- and land use-related ecosystem disturbances might also result in elevated nitrogen leaching from nitrogen-enriched soils to surface waters.

Nitrogen is a limiting nutrient in some oligotrophic surface waters. The review and revision of the empirical critical loads of nitrogen presents updated knowledge on effects of nitrogen deposition on surface waters and further substantiates the basis for empirical critical loads of nitrogen for surface waters, in particular for oligotrophic softwater lakes, dystrophic lakes and dune slack pools.

ICP Waters and other policy aimed to protect surface waters – mutual benefits

In many European countries, surface water monitoring networks deliver data to support several policy instruments, such as the Convention, the NEC Directive and the Water Framework Directive. In several countries, the NEC Directive monitoring network is being developed and is more extensive than the national monitoring network delivering data to ICP Waters, while in other countries, the networks are largely identical. National Focal Points are urged to consider whether new sites are relevant for inclusion in the ICP Waters monitoring network. Such sites should be small headwater lakes and streams that are not confounded by local pressures, such as agriculture or point source pollution.

Continuation of existing long time series is essential, but relatively new monitoring activities initiated by the requirements of the NEC Directive can be of great value for improving spatial cover and diversity of sites, especially in the Mediterranean area. New guidance clarifies how to report biological data under the NEC Directive which will promote the quality of biological data, a theme that ICP Waters continually works on in particular through biological intercomparisons and trend assessments of biological recovery.

Atmospheric deposition and the carbon cycle

Increased concentrations and export of dissolved organic matter (DOM) is promoted by reduction in sulfur deposition, as shown by repeated assessments of temporal change in water chemistry in ICP Waters sites. Societal concerns of higher DOM are found with drinking water providers that need to remove DOM in the resource-demanding process of safe drinking water production. Additionally, increased DOM may present an important pathway for terrestrial cycling of atmospheric CO_2, relevant to Earth System Models.

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 65 experts from the following 20 Parties to the Convention on Long-range Transboundary Air Pollution (CLRTAP): Armenia, Austria, Denmark, Canada, Czech Republic, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Lithuania, Norway, Poland, Russia, Spain, Sweden, Switzerland and United Kingdom. A complete list of participants can be found **Annex I.**

Opening and introductions

1. Ms. de Wit (Chair of ICP Waters) and Mr. Grandin (Co-chair of ICP IM) opened the meeting and thanked the hosts and sponsors.
2. Ms. María José Alonso, Directorate General of Environmental Quality and Assessment, Spanish Ministry of Ecological Transition and Demographic Challenge, welcomed the parties to Miraflores de la Sierra. She gave some background about the activities of the Ministry of relevance for the convention. She wished the parties a fruitful meeting. Ms. De Wit thanked her for the warm and welcoming words.
3. Mr. Pablo Sanjuanbenito, Director of Sierra de Guadarrama National Park, Regional Goverment of Madrid gave a description of the monitoring activities in the area.
4. The agenda for the meeting was adopted.
5. Mr. Velasco (Spain) provided general information about the meeting and excursion.
6. Ms. Alonso (Spain) gave a presentation “Air quality in Spain: challenges for the conservation of ecosystems”. The most important problems/challenges are considered to be high tropospheric ozone levels, variable proportion between dry and wet deposition, incomplete measurement programme at air quality monitoring stations for nitrogen, and increasing frequency of African dust events. Tropospheric ozone (O3) and atmospheric nitrogen (N) deposition are two of the main air pollutants affecting natural and semi-natural ecosystems in Spain. Ozone effects on vegetation have been extensively documented but effects on ecosystem hydrology and aquatic ecosystems are still poorly understood. Atmospheric deposition in the Mediterranean area presents two important particularities. The contribution of dry deposition to total deposition can be very variable and can become the dominant deposition process. Information on some pollutants (NH3, HNO3, NH4+, NO3-) that are not regularly measured in air quality monitoring stations is needed for dry deposition estimations. Also, there is an increase in the intensity and frequency of African dust outbreaks that supply nutrients (N, P) and cations to natural ecosystems. Further research is needed on air quality in Mediterranean mountain areas that concentrate a significant proportion of the very high biodiversity of this biogeographical region.
7. Mr. Alández, Mr. Corrochano and Mr. Velasco (Spain) gave a joint presentation about the monitoring of air pollution effects on aquatic ecosystems in Spain under the NEC Directive and the ICP-Waters programs. Mr. Alández introduced the REFCON project which aims to establish new and revised reference conditions under the WFD for rivers and lakes, assess the effects of climate change on these reference sites, and monitor the impacts of air pollution on aquatic ecosystems within the framework of the NEC Directive. It is financed by the General Directorate of Water (Ministry of Ecological Transition and Demographic Challenge). 10 lakes and 15 rivers have been selected from the REFCON project for the NECD network in Spain where physicochemical parameters are monitored monthly in rivers and twice a year in lakes, including POPs, and

biological elements. Mr. Corrochano gave an overview of the Spanish NEC monitoring network and the data that are collected there. Mr. Velasco described the Spanish ICP Waters monitoring activities. Spanish participation in the ICP Waters monitoring programme began in June 2021, including three sites located in National Parks, without the impact of local pollution sources, and with nearby meteorological and atmospheric deposition sampling stations. These sites are the only Mediterranean climate sites in the ICP Waters Programme, and they are operating at Level 1 (monthly sampling for chemistry and annual for biota) according to hierarchy of the ICP-Waters programme (2010), thanks to the logistical support of National Parks personnel. Water chemistry include all mandatory and optional parameters. On March 14th a very strong intrusion of Saharan dust reached the Iberian Peninsula, creating an exceptional situation of very poor air quality and a very high dust deposition. The air quality monitoring station at Puerto de Cotos (S. de Guadarrama) registered an exceptional peak in the concentration of particles, especially large ones. Chemical analyses of the bulk deposition collected at this station showed anomalous high values for some parameters such as alkalinity, ammonium, nitrate, iron, aluminium and phosphorous. These events can represent an important source of some chemicals in remote unpolluted areas, such as metals, nitrogen, phosphorus, or alkalinity, and their effects on these aquatic ecosystems will be investigated with special emphasis in the framework of ICP Waters monitoring network.

8. Mr. Krzysztof Olendrzynski (Secretariat, online) informed about recent developments and activities under the convention, including highlights from the following meetings: the 41st session of the Executive Body, the 60th session of Working group on strategies and review. Highlights of the 7th joint session of EMEP Steering body/WGE, the Extended Bureau meeting of the EMEP Steering body and WGE. He also informed about activities categorized as capacity building, awareness raising, communication and outreach.

9. Ms. Isaura Rabago (Chair WGE) gave an update on recent activities in the Working Group of Effects and the CLRTAP, including an update of the work with the report on the Gothenburg protocol review which will inform the (potential) revision of the protocol.

10. Mr. Grandin (Co-chair ICP IM) presented current activities and plans for ICP IM. Among them are plans for extending the network to include monitoring of other ecosystems than forests, to incorporate stations with less intensive monitoring than the regular programme, and to facilitate monitoring and reporting to the NEC Directive.

11. Ms. de Wit (Chair, ICP Waters) presented current activities and plans for ICP Waters, including plans for thematic report on base cations and revision of ICP Waters' manual.

Acidification, thresholds and recovery

12. Ms de Wit (Norway) presented "Expected and unexpected long-term changes in Norwegian lakes". The results were from a representative lake survey across all of Norway, sampled in 1995 and 2019. Water chemistry demonstrated strong chemical recovery and browning, as expected, while nitrate concentrations declined. Unexpected changes were increases in silica whereas ratios of metals to DOM declined, possible a sign of changes in DOM character. Additionally, unexpected increases in Ca were found, especially in regions that were little affected by deposition. Mr. Monteith (UK) asked about interannual variation, and whether trends in silica could be explained by benthic algae. Ms de Wit replied that an annual lake survey showed similar trends as the

representative lake survey, implying that the change that was observed was part of a long-term trend and not due to interannual variation.

13. Ms. Steingruber (Switzerland) presented “Recent trends in surface water chemistry of high-altitude Alpine lakes”. All catchments were characterized by inputs of S and N that decreased until 2009 and stabilized afterwards. Catchments impacted by melting cryospheric features are characterized by increasing output concentrations of S and BC because of an increase of the weathering processes, that don’t however prevent alkalinity to increase. Output concentrations of S and N in catchments not influenced by melting cryospheric features decreased until 2014/2015 to then stabilize, while output concentrations of BC decreased until 2015 and then increased because of the stabilization of S and N input concentrations. As a consequence output alkalinity continues to increase. Since the upward trend of BC in these catchments is related to the stabilization of the acidifying deposition and of the released S and since the catchments have been shown to react fast to changes of deposition, it is probable that lake water concentrations of BC and alkalinity are stabilizing soon as well. Further recovery from acidification is then possible only if deposition of N decrease further. However, it is still not clear what are going to be the effects of climate change on N. Effects that lead to both an increase (> vegetation, > growing season) or a decrease (> number intense rain events -> < retention time) of the N retention are possible. Until now a trend in N retention cannot be observed.
14. Ms. de Wit asked about base cation levelling out and silica trends. Ms. Steingruber answered that there were increasing silica trends in sites located in catchments partly covered by (melting) glaciers.
15. Mr. Monteith (UK) presented “A new approach to modelling DOC trends in headwaters”. Who cares about DOC? Water companies, global carbon modellers, modellers of acidification and recovery. Trends are affected by changes in deposition and climate. He presented a model that uses the ionic strength of precipitation, antecedent air temperature and instantaneous discharge to predict short- and long-term variation in DOC concentration. The model seems to work quite well.
16. Mr. Fölster (Sweden) presented “Suggestion of a harmonized acidification criteria for Nordic countries”. A common Nordic system for classification of acidification was developed to overcome the differences in classification between the Nordic countries. The system includes a newly developed Nordic acidification index for macroinvertebrates in lakes and streams. Classification from water chemistry was made by correlating ANCo1 (ANC adjusted for strong organic acids) to the classification by macroinvertebrates, taking into account the higher sensibility for acidification at lower ANCo1. The system gives the possibility to harmonize classification between biology and water chemistry, between the Nordic countries and between classification of ecological status within the Water Framework Directive and calculation of critical loads within the air convention.
17. Ms. de Wit asked if the work was applicable for the manual and if it could be used for critical load calculations as well as WFD. Mr. Fölster answered yes.
18. Mr. Hruška (Czech Republic) presented “Mixed drops from the Czech ICP Waters sites (Sulfur budgets, Ca and Mg isotopes, DOC trends)”. The two catchments were Lysina and Uhlirska. A large decrease in runoff occurred in 2014-2018, primarily because of increased evapotranspiration. He called it the Central European drought. There had been more export than input of sulphur in recent years, especially during the drought. The systems seem to be far from steady state. Budgets

based on stable calcium isotope ratios seems to overestimate the role of calcium deposition. The drought period 2014-2019 was associated with increased DOC concentrations but decreased DOC flux.

19. Ms. Rivera (Czech Republic) presented “Physicochemistry of the Lysina stream: What can we learn from high-frequency monitoring?” The presentation provided insights into the effects of changing flow conditions on fluxes and concentrations. Ms. Rivera argued that long-term monitoring of stream water chemistry aids our understanding of ecosystem processes highlighting impacts, changes over time, and recovery. However, how frequent samples are taken can make a difference in what can be said or interpreted. Sampling frequency can play a key role in deciphering biogeochemical processes, particularly if those are dependent or influenced by flow conditions. Regular monitoring at Lysina has been conducted for over 30 years and these measurements have been important in tracking changes over time and stream water recovery from acidification. In recent years, a multi-probe sonde was installed at Lysina to measure in-situ pH, conductivity, and fDOM at a 10-minute interval frequency. The difference for these parameters was compared along with discharge for both sampling approaches (regular and high frequency) for the water years of 2020 and 2021. Changes in flow conditions, notably exert control on the concentration of solutes and parameter dynamics. The data showed enrichment of dissolved organic carbon, as well as increases in conductivity and H+ when flow conditions increase. However, when compared to the high-frequency parameters, it is well highlighted that often their grab samples miss important events (floods) during regular sampling, which can translate in overall misinterpretation of processes. Therefore, having in-situ measurements allows to compliment and aid our understanding of the signals that are often not picked up by regular sampling, which has implications for calculation of element fluxes, and conditions for biota.

Nitrogen

20. Mr. Kaste (Norway) presented “Nitrogen in surface waters: time trends and geographical patterns explained by deposition levels and catchment characteristics, ICP Waters report 2022”. NO_3 levels were mainly controlled by N deposition, which suggest a change in DOM quality over time. C/N ratios of DOM were mainly explained by TOC. Land cover, land use and climate factors do matter at site level. The results do not suggest that nitrogen saturation is occurring presently, but there is still a risk that climate change and ecosystem disturbances might cause higher N leaching in the future. Climate change can increase vegetation demand for N but might also promote increased N leaching due to more intensive rainfall, droughts and increased risk for insect attacks. Although the N deposition has been reduced in recent years, ambient loads might still exceed long-term sustainable levels and perhaps cause N saturation further into the future

21. Ms. Zurnachyan (Armenia) presented “Impact of nitrogen on the Sevan catchment area”. Lake Sevan is the largest body of water in both Armenia and the Caucasus region – a lake with many inlet rivers with high nitrogen concentrations situated in the Gegharkunik Province at an altitude of 1,900 m above sea level. There are 19 sampling points for which monitoring of the rivers water quality take place. For Lake Sevan, there are 33 sampling points with different depths. Ms. Zurnachyan presented the water annual average balance of Lake Sevan in 2021, and hydrological observations of rivers in the Sevan catchment area. Nitrogen and phosphorous emissions are significant pressures in the Sevan catchment area. The pollution sources come from agriculture

and cattle breeding, fish farming and fishing, sewage water, organic substances from submerged and coastal forest cover, precipitation and evaporation disbalance, high temperature and climate changes. Further plans include to continue research and to monitor impact of nitrogen on the Sevan catchment area, assess the nitrogen pollution sources of the lake Sevan, and preserve the environment of Lake Sevan.

22. Mr. Forsius (Finland) presented “Nitrogen budgets and the link to carbon sequestration in Nordic forest ecosystems”. Major inflows of N to the Nordic forests are atmospheric deposition and biological N fixation, and major outflows are runoff and tree harvest. The annual N budgets for forests were approximately in balance, with outflows between 70% and 130% of the N inflows, in the four countries. All four Nordic countries report substantial annual forest C accumulation to the UNFCCC (UN Framework Convention on Climate Change). The forest C accumulation is not possible without accumulation of N, but the sources of N to support the reported C accumulation have not been identified in the N budgets based on inflows and outflows. Potential explanations for the discrepancy between the available N based on inflows and outflows, according to the methodology of the CLRTAP/TFRN (Task Force on Reactive Nitrogen) and N needed to support the reported C-stock changes in UNFCCC reporting, could originate from one or a combination of several factors. The relatively large discrepancy between forest N budgets based on N flows and based on UNFCCC carbon data raises the question of the consistency between reported data on N and C flows. Mr. Forsius concluded that ICP data and related modelling activities of e.g., the CDM would be very useful for further studies on this central topic.

23. Mr. Ulańczyk (Poland) presented the modelled impact of forecasted deposition and climate changes on the N balance in one of catchments included in the ICP IM and the ICP Waters – a primarily forested area of 13 km2. The presented study was done with the use of SWAT model (Soil And Water Assessment Tool) and in addition to the current status it included two climate scenarios (RCP4.5 and RCP8.5) and three deposition scenarios based on the “Clean Air Outlook 2” (baseline, baseline with Maximum Feasible Technological Reduction of emissions and baseline with additional measures as defined in the National Air Pollution Control Programmes). Climate changes reflected in the increased precipitation and air temperature and decreased solar radiation were estimated to cause the increased outflow of N from the catchment, both by the percolation and runoff. The decreased deposition counterbalances these effects limiting the load of nitrogen at the outflow. Climate change is the main factor affecting the transport of organic and the total nitrogen and it is attributed mainly to the runoff and erosion. By contrast, the change in deposition is the main factor affecting the load of mineral N in groundwater recharge and in the outflow to surface waters. Both factors, i.e. climate and deposition can significantly decrease the content of N in soil profile available for uptake by vegetation in future. Since these estimations cannot be considered as representative at national or even regional scale in Poland it was decided that similar analysis of lower spatial resolution will be done for the entire country. The presentation included also the information about the current status of the development of a national scale model which was already applied, however, its functionality is limited to the simulation of water balance only. The inputs regarding sources of nutrients including air deposition of nitrogen are under development with a target release date of the final outcomes at the end of 2022. Ms. de Wit asked if the N model would also be used to estimate export to the Baltic sea. Mr. Ulańczyk answered yes.

24. Mr. Houle (Canada, online) presented “Long-term N addition effects on DOC trends”. Presented results from N-addition experiments that had been going on for 20 years. The response of DOC on N addition depends on tree type. No significant differences of low N depositions on DOC trends were found, suggesting no impact of N loads at current and recent past deposition.

NEC Directive

25. Ms. De Marco (Italy) presented “The NEC network in Italy: new developments and projects”. The presentation described issues and suggested solutions for improving the Italian network for the NEC directive. A new project (LIFE MODERn - New Monitoring system to Detect the Effects of Reduced pollutants emissions resulting from NEC Directive adoption) ensure funding until 2025. An intention is to include 6 new water sites in addition to the 4 (ICP Waters) sites that comprise the water network now.

26. Mr. Kelleghan (Ireland, online) suggested that there were possible synergies between activities under the Habitat directive and the NEC directive.

27. Mr. Valinia (Co-chair ICP IM, online) presented “NECD- what to expect from the second round of reporting 2022/2023”. For wetlands, grasslands, and heathlands there are no monitoring manuals (neither ICP nor EU). This makes it difficult to compare results. Suggested new aquatic parameters include total nitrogen, annual maximum and minimum pH as well as the % abundance of a various groups of species. The need for monitoring of biodiversity and other biological indicators in surface waters is emphasised - linked to WFD and habitat directive. Mr. Valinia hoped for a more balanced report. Last report was focused on waters and forests.

28. Ms. the Wit challenged the biologists to voice their views on the shift to biological indicators. Mr. Velle warned about simplifying too much. Mr. Monteith enquired about rationale for including annual maximum and minimum pH among the recommended parameters. Ms. Austnes pointed out that the requested biological indicators in water are at least clearer than in the original guidance.

Biodiversity, biological indices and recovery

29. Mr. Velle (ICP Waters Programme sub-centre) presented the 2022 thematic report on biological recovery. It is an assessment of biological recovery from reduced acidification. The aims are to assess status, temporal trends and to compare biological recovery among regions. Deadline national contributions September 2022. Deadline report: November 2022. Mr. Velle explained how he envisaged the report’s table of contents and suggested an outline for the national sections.

30. Ms. Marchetto asked if all focal centres should send info on their own biological indices for acidification, if here are any. Mr. Velle answered yes.

31. Mr. Valinia (Co-chair ICP IM, online) presented “Extended ICP IM - development of the program”. ICP IM at present focus largely on forested catchments. The Programme centre wants to include more ecosystem types. What can ICP IMs extended monitoring provide? Insert points from last slide.

32. Mr Scheuschner asked about parameters monitored in Level I and Level II. Mr. Monteith asked about links between eLTER and ICP IM sites. Should sites focus on developing as eLTER or ICP IM?

Mr, Grandin said that there should be no competition. Mr. Vuorenmaa (Finland) gave a short description of 4 new sites in Finland.

33. Mr. Granados (Spain) presented "Environmental monitoring at Sierra de Guadarrama National Park- Focus on aquatic ecosystems". The Sierra de Guadarrama National Park (340 km^2) is in the Spanish Sistema Central range, about 50 km north of the city of Madrid and is the location of the ICP meeting and excursion. Two of the ICP-Waters sites in Spain are in this national park (Lake Peñalara, River Manzanares). The main ecological characteristics, conservation values and threats of the national park were described. The ecological restoration project of Lake Peñalara, was heavily affected by recreational use between 1970 and 1990. Since then, the eutrophication process has been reversed, the erosion of the shore has been stopped and an invasive fish has been eradicated from the lake. With respect to the rivers of the Sierra de Guadarrama, they are mostly in good or excellent ecological status. The factors determining a loss of quality are altitude, seasonality, riverbank alteration and recreational uses. The prohibition of bathing in the river Manzanares allowed a gradual improvement of the ecological status at the sampling stations influenced by bathing activity. The national park carries out other environmental monitoring such as the effect of climate change, the type and number of visitors and the singular species of flora and fauna.

Other ICPs and common activities

34. Mr. Thomas Scheuschner (CCE, Germany) gave an update on ICP Modelling and Mapping/CCE. One of the things he talked about was the review of empirical critical loads for nitrogen. The report from this work will be ready soon.

35. Mr. Forsius (Finland) asked if there was a plan to compare N data in the background database and national data for N exceedance. Mr. Scheuschner answered that this has not been done yet, but the background database tends to be more sensitive to changes than picture based on national data.

36. Mr. Schwärzel (Head of the Programme Co-ordinating Centre, ICP Forests) gave an update on recent activities of ICP Forests. First, he presented publications released by the PCC. Then, he outlined how ICP Forests' work contributes to the implementation of the Convention's work plan. The ICP Forests technical report - Forest condition in Europe, the 2021 assessment - focusses among others on regular evaluations within the programme. The report includes assessments of atmospheric throughfall deposition in 2019 as well as of crown conditions in 2020 and there is a chapter to Heavy metals in the soils of the Level I plots. These topics are also relevant to the implementation of the work plan of the convention. The report is available for download at http://icp-forests.net/page/icp-forests-technical-report. In 2021, ICP Forests Brief number 5 was released. The objective of the ICP Forests Briefs is (i) to raise awareness for forest-related environmental topics, (ii) to inform stakeholder and enablers on key findings of the ICP Forests monitoring programme, and (iii) to stimulate the debate on the effects of air pollution on forest ecosystem functions and services. In Brief number 5, data on 30 years of crown condition assessment in Europe within the framework of ICP Forests are processed and visualized. The main take home message is that the proportion of fully foliated trees has significantly declined over the past 30 years. The brief can be downloaded from the ICP Forests website (http://icp-forests.net/page/icp-forests-briefs). In the period 2022 to 2023, ICP Forests will contribute to the implementation of the work plan of the air convention by providing new data and knowledge on

N deposition, heavy metals, Air pollution-related cause-effect relationships in forests and ambient ozone. As said above, Mr. Schwärzel focussed in his presentation on results related to Nitrogen. Throughfall deposition measurements have been made on ICP Forests plots since the mid-1990s. At the moment there are about 300 active plots. Gapless data are available from 64 plots since 1997. Compared to the values at the end of the 1990s, a decrease in N deposition by about 20% were observed. In recent years, however, N deposition values have stagnated at a relatively high level. In his talk, Mr. Schwärzel showed spatial patterns of throughfall deposition of nitrogen measured in 2018 and 2019. Areas with moderate and high N deposition are found mainly in Central Europe. Comparison of the 2018 and 2019 maps illustrates that the spatial patterns of N deposition are temporally stable. Another interesting feature of these maps is that we observed higher N deposition values in 2018 in comparison to 2019. This was a surprise because, after all, 2018 was a drought year and there was significantly less rainfall compared to 2019. In 2018 and 2019, nitrate-nitrogen deposition was at the same level, but ammonium-nitrogen deposition was in 2018 higher than in 2019. It is known that NH3 concentrations in the air are higher in dry years, which probably results in more dry deposition being captured by the tree canopy. Furthermore, Mr. Schwärzel presented the paper of Machetto et al. (2021) entitled 'Good Agreement Between Modeled and Measured Sulfur and Nitrogen Deposition in Europe, in Spite of Marked Differences in Some Sites'. They compared data measured by the ICP Forests/SWETHRO network with data modelled by EMEP. Machetto et al found that (i) modeled and measured results are in good agreement for sulphur and nitrate open field deposition but not so well for ammonium, (ii) modeled sulphur total deposition compares well with throughfall deposition measured in forest plots, and (iii) modeled total nitrate and ammonium deposition is higher than throughfall deposition measured in forest plots indicating the presence of relevant canopy effects.

37. Mr. John Salter (Working group for strategy and review, online) gave an update from the Task Force for International Cooperation on Air Pollution (FICAP). A new Task Force that sits under the CLRTAP. Mr. Salter presented the FICAP on behalf of the Co-chairs. FICAP has been discussed in policy circles for some time as a means to utilise the expertise and technical capabilities from across the CLRTAP to regions outside the UNECE region. The Co-chairs are keen to engage all ICPs and Task Forces across the Convention to find topics, technical knowledge, and guidance that would be applicable to other regions of the world. The co-chairs are working to a biennial workplan to engage within the Convention and externally to bring together interested parties and experts to form the steering group for the Forum, which will be open to all UN Countries and regions. The first meeting of the Taskforce (which will act as the steering group) will be in Bristol, UK, 10 – 11 October 2022. We encourage experts to engage with the co-chairs and input into the formation of the new Task Force to set the parameters and priority topics for the inaugural forum as well as sharing existing outreach and capacity building experience and capabilities within the Convention. The wider Forum will take place on 16 March (tbc) after the Saltsjöbaden Workshop in Gothenburg Sweden, which will be open to wide participation from Countries across the world, as well as NGOs, experts, and interested Parties. The Forum will run a programme for interested parties outside the UNECE region to come together with Parties in the Convention and experts to provide a space for collaboration and cooperation and mutual learning on air quality topics. In the meantime, any thoughts, info or comments from members of the ICPs is greatly appreciated. Please contact the co-chairs: John.Salter@Defra.gov.uk; Anna.Engleryd@swedishepa.se; Petra.Hagstrom@swedishepa.se.

38. Mr. Salar (co-chair, ICP IM) appreciated the initiative and suggested that we could send something.
39. Ms. Rabago suggested that it would be useful to receive information about the main air pollution problems in other parts of the world. In 2023, April 17-21, there will be an Acid rain conference in Japan. Saltsjöbaden meeting in March 2023. This could be a place to obtain useful information, at least on acidification.
40. Mr. Christian Lucien Bodin (ICP Waters Programme sub-centre) presented the results from the twenty-fifth biological intercalibration of invertebrates. The goal was to evaluate the quality of, and harmonize, the taxonomic work. Two laboratories participated in 2021. In total, 96.2 % of the species and 99.2 % of the genus were correctly identified. The mean Quality assurance index of 95.1 and 97.4. Both laboratories had a mean value well above 80.0 – the limit for acceptable taxonomic work. Results in the biological intercalibrations over time suggest that the taxonomists in the laboratories affiliated to ICP Waters hold a high standard in their taxonomic work.
41. Ms. Brecke Gundersen (ICP Waters Programme centre) presented the chemical intercomparison from 2021. The test contributes to international harmonization of monitoring practices. It is an offer, free of charge, to laboratories producing data that is reported to any of the ICPs. Other laboratories can participate for a small fee. The test is based on the “round robin” principle. Each laboratory is offered to analyse two sets of water samples: one set for ions and one set for heavy metals. The “true value” is calculated as the median of reported results after excluding extreme observations. In 2021, 30 laboratories representing 16 different countries reported results. The sample this year was challenging by having overall low parameter values. This produced an overall acceptance rate at 65%, which is poorer than the previous years. An additional contributing factor was the failure by the host laboratory (NIVA) to acidify the sample set to be analysed for metals. This led to poor acceptance, in particularly for lead (24%). However, despite the low sample concentrations, the participating laboratories performed very well for most of the major ions (~80%) and for certain of the heavy metals (Cu, Ni, Zn >70%). A systematic effect from the use of different analytical methods can be observed for certain of the parameters which is emphasised in the report. The previously described tendency of the laboratories to employ more advanced analytical methods is continuing. Contact: Tina Bryntesen, tina.bryntesen@niva.no
42. Ms. Degórska (Poland, online) informed about possibilities for two more IM stations from Poland to ICP IM.
43. Mr. Pavel Krám (Czech Republic) presented “Invisible part of the ICP Integrated Monitoring database: Hidden gem?” They evaluated the results (traditional Table 1) from 28 ICP IM Annual Reports (1995-2022) with respect of annually reported values and amount of reported subprogrammes. Frequently measured parameters (e.g. precipitation chemistry) were treated the same way as irregularly measured parameters (e.g. soil chemistry). Twenty-four countries reported data to the IM database so far (15 active, 9 already non-active). In total, 90 IM sites reported data (48 still active, 42 abandoned), which included 65 catchments (33 still active, 32 abandoned). Some sites in the abandoned category continue with monitoring just ended reporting data to the IM database. More than two thirds of the existing IM subprogrammes were reported only from 17 sites. Most of them from LV02 (21 subprogrammes), EE02 (20) and DE01 and FI01 (19). Most annual values were reported from Sweden and Italy. In total 8400 annual values from active sites and 3300 values from abandoned sites are stored in the IM database. Abandoned IM sites could be used for continuation of integrated monitoring or modelling. Their

momentarily hidden existence in the IM database for public (represented by current Tables 1) should be announced on maps and tables in the IM Annual Reports.

Dynamic modelling

44. Mr. Thomas Scheuschner (CCE, Germany) gave a summary of the 3rd meeting of CDM in Sitges on behalf of Filip Moldan (Chair, CDM). CDM builds on former JEG DM and has been in place for a little more than 2 years as a part of ICP M&M and it builds on former JEG DM. He summarised the 3rd meeting of CDM, which in line with the JEG tradition was held in Sitges. He also informed about a new EU initiative on soils.

45. Mr. Martyn Futter (Sweden, online) gave a talk on dynamic modelling in DAEMONS. Drivers and effects of modified nutrient stoichiometry from source to sea. DOC quality is changing. There has been a decline in TotP in southern Sweden. It seems like a move from P limitation to joint N and P limitation. We lack a mechanistic understanding of multi element cycling.

46. Mr. Monteith (UK) asked about the applicability of redfield-ratios to terrestrial systems and if soil solution chemistry could be useful. Mr. Futter answered that the redfield-ratio was used as a reference because it is well known, and because of lack of universally accepted alternatives. Ms. de Wit asked if there are data on changes in biomass in ICP IM or are ICP Forests more useful. Mr. Futter would like to test the hypothesis with ICP Forest data.

The eLTER-WGE letter of co-operation

47. Ms. Grandin informed that WGE and eLTER are working on a letter of cooperation.
48. Ms. de Wit informed that eLTER research infrastructure requires national funding. Ms. de Wit encouraged those influencing the process not to set the requirements too high.

Next Task Force meeting and end of joint meeting

49. Ms. Gisela Pröll announced that the next TF meeting will be held in Lunz, Austria.

Separate ICP Waters Task Force meeting

50. Ms. de Wit (Chair, ICP Waters) reminded the audience about ICP Waters' mandate and workplan. The current workplan is valid for 2022-2023. The next will be for 2024-2025.
51. Ms. de Wit went through status of participation and ongoing activities. Multi-year activities are primarily to arrange task-force meetings, conduct data calls, chemical intercomparison tests, biological intercalibration tests, exchange information with the relevant parties about the NEC Directive, the Minamata Convention and collaboration with EECCA countries. She listed the meetings where delegates from ICP Waters took part, and the most recent reports and publications. ICP Waters is contributing to the review of the Gothenburg protocol. There is strong evidence of chemical recovery. The strong correlation between acid components of the water and species diversity suggests that biodiversity will continue to increase when acid deposition decreases. The main challenges for monitoring of air pollution effects on surface waters are to secure continued funding to maintain chemical and biological monitoring of small headwater catchments that are not confounded by local pressures. ICP Waters will produce a prognosis for water chemistry under various scenarios, which is to be submitted towards the end of May. Mr. Monteith (UK) would like to see text provided by ICP Waters to the review of the GP.
52. Ms.de Wit introduced current and planned reports. General comment: Mr. Hruška (Czech Republic) encouraged the Programme centre to put more emphasis on producing scientific papers and perhaps less on writing reports. Most pressing is the thematic report on biological recovery

which must be finished by the end of 2022. Mr. Monteith enquired about the extent of the national contributions. Mr. Velle suggested 4-5 pages. National indices (if they exist) should be described in the national contributions. Deadline for national contributions September 30. Deadline for report: November. Indices/indicators does not have to be restricted to macroinvertebrates. It could be diatoms, fish, periphyton etc. Mr. Monteith suggested that for water chemistry one could refer to the latest trend report instead of elaborating in the biological report. Ms. de Wit agreed, and no objections were voiced.

53. The suggested topic for the thematic report in 2023 is trends in base cations, potential drivers and implications for acidification status and biological recovery. Ms. de Wit asked if the delegates found the topic interesting and relevant. Mr. Velasco (Spain) was more interested in Saharan dust. Mr. Hruška (Czech Republic) said yes but mentioned that weathering was higher in Czech Republic than e.g., in Norway and therefore still largely controlled by acid deposition. Dust from Sahara could fit in the base cation topic (attribution of sources of base cations). There was a suggestion that MAGIC or existing MAGIC simulations should be included in such a report. Climate change effects could be included (Switzerland, melting of glaciers). Ms. Steingruber, Mr. Hruška, Mr. Fölster, Mr. Velasco, Mr. Monteith and Ms. Rogora volunteered to be part of a group to prepare for a base cation report before the next TF meeting. Mr. Hruška mentioned that there were more sites than the standard ICP Waters sites that could be used in such an analysis.
54. Ms. de Wit mentioned a possible collaboration on nitrogen trends with ICP Forests. Mr. Monteith and Mr Hruška found it interesting but commented on the lack of overlap of network. Mr. Hruška believed that undertaking such analysis would be hard work. Ms. Steingruber mentioned that there were sites that were not part of ICP Forests and with independent measurements of deposition that could be useful. Ms de Wit suggested that EMEP should be part. Mr. Monteith mentioned that they had a pair of forested and non-forested sites in close proximity with data on deposition. Ms. Rogora mentioned that they also had this in Italy.
55. Database and homepage. There will be a call for data up to 2020. Ms. Austnes mentioned that there are plans to improve the data delivery process for both Focal Centres and Programme Centre. She apologized that the most recent data were not used for the N report. Deadline for submission of data is **November 15**, 2022.
56. Next point on the agenda was data access and dissemination. Ms. Austnes asked about experiences with open access to data. There is increasing pressure to make the data we used publicly available. Ms. Rogora pointed out some difficulties. Mr. Fölster mentioned that Swedish data were already open source, and that data should be stored nationally. Ms. Steingruber mentioned that part of the Swiss data was also open source. Mr. Monteith mentioned that there is an obligation in the UK to make data publicly available, but it is not yet available. He also mentioned that an ICP Waters data depository would be of interest to other parties, which could lead to a "race to publish". Publishing meta data could be possible. ICP Waters does collect their own data. ICP Waters make use of data produced by Focal centres and others. Duplicate database maintenance is not the best solution.
57. Update of manual
    a. Ms Austnes presented the status of the manual, reasons for why we need to update it and suggestions on how to approach the update process. Results from the survey sent out before the TF meeting. Strong need for update of Chapters 5, 4, and 3. Less important chapters: 8, 9, 10 and 11. The 14 respondents were split in half regarding their view on the lack of guidance on biological indices relevant for acidification. More people wanted guidance on how to assess biological acidification status compared to chemical state of acidification. What should an updated manual look like? Should it look like something produced for the NEC directive? There was some confusion about the origin of the %

abundance of species group in the NECD. Mr. Fölster suggested that one could have a library of algorithms for calculating various indices. Ms. Alonso emphasised the need for good taxonomic ability in order to deliver data at species level. Should the updated manual provide guidance on how to define the reference state of acidification, i.e., pre-acidification state? Diatoms, chironomids (paleoecology), fishermen queries, modelled pre-acidification chemistry represent different approaches to this problem.

b. Ms. Austnes presented a tentative time plan: Jan/Feb 2023- review of current manual, March 2023 - Topic-wise Teams discussions. TF 2023 - present status/ findings/suggestions, opening for new volunteers. TF 2024 - revised manual ready.
c. Ms. Steingruber, Mr. Hruška, Mr. Fölster, Mr. Velasco, Mr. Monteith, Ms. Rogora, Mr. Velle and Ms. Alonso volunteered to contribute to the revision of the manual.

58. Proceedings, evaluation of the meeting. No one announced immediate interest in contributing to the proceedings from the TF meeting.
59. The minutes were adopted. Key messages will be circulated.

Annex I: Participants at the joint ICP Waters and ICP IM TF meeting, Spain, 10-12 May 2022

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Annex II: Agenda of the joint ICP IM and ICP Waters Task Force meeting in Miraflores de la Sierra, Spain, 10-12 May 2022

1. **Opening of the joint meeting and introductions (**Chairs ICP IM and ICP Waters**)**
2. **Meeting welcome by the hosts and organisers** (Manuel)
3. **Adoption of the agenda** (Chairs ICP Waters and ICP IM)
4. **General information about the meeting and excursion** (Manuel)
5. **Reports**
    a. Structure of the Convention and recent CLRTAP activities (Krzysztof Olendrzynski, Secretariat)
    b. Reports from Working Group on Effects and the Bureau (Chair WGE)
    c. Current issues ICP IM (Chair ICP IM)
    d. Current issues ICP Waters (Chair ICP Waters)

6. **Thematic sessions**
    a. Acidification, thresholds, and recovery
        i. Air quality in Spain: challenges for the conservation of ecosystems, Rocío Alonso, Spain
        ii. Monitoring of the effects of air pollution on aquatic ecosystems in Spain under the NEC Directive and the ICP Waters programmes, Juan Alández, Alfredo Corrochano, Manuel Toro Velasco, Spain
        iii. Expected and unexpected long-term changes in Norwegian lakes, Heleen de Wit, Norway
        iv. Recent trends in surface water chemistry of high-altitude Alpine lakes, Sandra Steingruber, Switzerland
        v. A new approach to modelling DOC trends, Don Monteith, U.K
        vi. Suggestion of a harmonized acidification criteria for Nordic countries, Jens Fölster, Sweden
        vii. Mixed drops from the Czech ICP Waters sites (Sulfur budgets, Ca and Mg isotopes, DOC trends), Jakub Hruška, Czechia
        viii. Physicochemistry of the Lysina stream: What can we learn from high-frequency monitoring? Katherine X. Pérez Rivera, Czechia

    b. Nitrogen
        i. Nitrogen in surface waters: time trends and geographical patterns explained by deposition levels and catchment characteristics, ICP Waters report 2022, Øyvind Kaste, Norway
        ii. Impact of nitrogen on the Sevan catchment area, Alina R. Zurnachyan, Armenia
        iii. Nitrogen budgets and the link to carbon sequestration in Nordic forest ecosystems, Martin Forsius, Finland
        iv. Impact of forecasted deposition and climate changes on the N balance - local results at the IM station and plans for a national scale analysis, Rafał Ulańczyk, Poland

v. Long-term N addition effects on DOC trends, Daniel Houle, Canada (online)

c. NEC directive

i. The NEC network in Italy: new developments and projects, Alessandra De Marco, Italy

ii. NECD- what to expect from the reporting 2022/2023, Salar Valinia (online)

d. **Biodiversity, biological indices, and recovery**

i. The 2022 thematic report on biological recovery, Gaute Velle, Norway

ii. Extended ICP IM- development of the program, Salar Valinia (online)

iii. Environmental monitoring at Sierra de Guadarrama National Park, Ignacio Granados, Spain

e. Dynamic modelling

i. Update on CDM activities, Filip Moldan, Sweden (online)

ii. DAEMONS modelling, Martyn Futter, Sweden (online)

7. **Common sessions of ICP Waters and ICP Integrated Monitoring for report and discussion of work plan items TBA**

i. ICP Modelling and Mapping/CCE, Thomas Scheuschner, Germany

ii. ICP Forests update (online), Kai Schwarzel, Germany

iii. Task Force for International Cooperation on Air Pollution (TFICAP), John Salter (online)

iv. Intercalibration of biological invertebrates, Christian Lucien Bodin, Norway

v. Chemical intercomparison, Cathrine Brecke Gundersen, Norway

vi. Possibilities to offer two more IM stations from Poland to ICP IM, Anna Degórska, Poland (online)

vii. Invisible part of the ICP Integrated Monitoring database: Hidden gem?, Pavel Kram, Czechia

8. **The eLTER-WGE letter of co-operation**

9. **Next Task Force meeting**

10. **End of joint TF meeting**

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

Agenda – ICP Waters Task Force:

1. Workplan
2. Status and progress
3. Current and planned reports
4. Database and homepage
5. NEC Directive
6. Other issues
7. Proceedings, evaluation of the meeting
   Adoption of the minutes

Annex III: Status participation in the ICP Waters Programme as of April 2022

	Chemical data (last year with data)	Biological data (last year with data)	Participation in TF meetings 2019-2021	Participation in chemical intercomparison 2019-2021	Participation in biological intercalibration 2019-2021
Armenia	2019		●		
Austria	2018		●	●	
Belarus	2014				
Belgium				●	
Canada	2019		●	●	
Czech Rep.	2019	2019	●	●	
Estonia	2019		●	●	●
Finland	2019		●	●	
France			●	●	
Georgia			●		
Germany	2019	2019	●	●	
Ireland	2019	2020	●	●	
Italy	2019	2020	●	●	
Latvia	2020	2020	●		●
Lithuania			●	●	
Moldova	2017			●	
Netherlands	2014			●	
Norway	2021	2021	●	●	●
Poland	2019		●	●	
Russia	2018		●	●	
Serbia				●	
Slovakia	2019				
Spain	2013		●		
Sweden	2019	2021	●	●	●
Switzerland	2019	2018	●	●	
UK	2019	2018	●	●	
USA	2018		●		
Total	**21**	**9**	**21**	**20**	**4**

Annex IV: ICP Waters workplan for 2022–2023

2022

- Arrange the 38th meeting of the Programme Task Force in spring of 2022
- Prepare proceedings from the 38th Task Force meeting. Deadline for submissions: July 30
- Contribute to the review and possible revision of the Gothenburg Protocol and contribute to the Science Strategy
- Finalise the thematic report on biological recovery. Deadlines: September 30 (national contributions and November 30 (report).
- Start working on the thematic report for 2023 on base cation trends and its implications for recovery.
- Discuss a possible collaboration on nitrogen trends with other bodies under the Conventions (ICP Forests, ICP Integrated Monitoring, EMEP), a possible topic for a Thematic Report in 2024
- Prepare the update of the ICP Waters Manual
- Arrange and report chemical intercomparison 2236
- Arrange and report biological intercalibration 2622
- Run the Programme Centre in Oslo and the Sub-centre in Bergen
- Call for water chemical data up to 2020, to be delivered before November 15, 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 benefits for harmonization and collaboration with other international policy instruments focused on water quality cooperation with other water monitoring programmes (NEC D, WFD, UNEP)
- Cooperation with ECCCA countries (East Central Caucasus and Central Asian countries)

2023

- Arrange the 39th meeting of the Programme Task Force in the spring of 2023
- Prepare proceedings from the 39th Task Force meeting
- Finalise the thematic report on base cation trends and its implications for recovery.
- Work with the update of the ICP Waters Manual
- Prepare the thematic report for 2024 (to be discussed at the TF meeting 2023)

- Deliver workplan for 2024 and 2025 to WGE
- Arrange and report chemical intercomparison 2337
- Arrange and report biological intercalibration 2723
- Run the Programme Centre in Oslo and the Sub-centre in Bergen
- 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 benefits for harmonization and collaboration with other international policy instruments focused on water quality cooperation with other water monitoring programmes (NEC D, WFD, UNEP)
- Cooperation with ECCCA countries (East Central Caucasus and Central Asian countries)

2024

- Arrange the 40th meeting of the Programme Task Force in the spring of 2024
- Prepare proceedings from the 40th Task Force meeting
- Finalise the update of the ICP Waters Manual
- Finalise the thematic report for 2024
- Arrange and report chemical intercomparison 2438
- Arrange and report biological intercalibration 2824
- Run the Programme Centre in Oslo and the Sub-centre in Bergen
- 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 benefits for harmonization and collaboration with other international policy instruments focused on water quality cooperation with other water monitoring programmes (NEC D, WFD, UNEP)
- Cooperation with ECCCA countries (East Central Caucasus and Central Asian countries)

Thematic reports from the ICP Waters programme

Since its establishment in 1985, the ICP Waters programme has prepared numerous assessments, reports and publications that address the effects of long-range transported air pollution, including thematic reports, chemical intercalibrations, biological intercalibrations, proceedings of Task Force meetings, and peer-reviewed articles. Reports and publications are available at the ICP Waters website; http://www.icp-waters.no/

Thematic reports from the ICP Waters Programme from 2000 up to present are listed below.

Austnes, K., Hjermann, D.Ø., Sample, J., Wright, R. F., Kaste, Ø., and de Wit, H. 2022. Nitrogen in surface waters: time trends and geographical patterns explained by deposition levels and catchment characteristics. NIVA SNO 7728-2022. **ICP Waters report 149/2022**.

Thrane, J.E., de Wit, H. and Austnes, K. 2021. Effects of nitrogen on nutrient-limitation in oligotrophic northern surface waters. NIVA report SNO 7680-2021. **ICP Waters report 146/2021.**

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**

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**

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**.

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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**.

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**.

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

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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**.

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