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Item 4 of the provisional agendas
Progress in activities in 2018 and further development of effects-oriented activities

The current extent of surface water acidification in Europe and North America

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

Summary

The present report will summarize the available information on the current extent of surface water acidification, which remains an environmental problem in many countries of Europe and North America.

A combination of maps of areas potentially at risk of acidification, monitoring data and country reports is used in order to assess the current status of surface water acidification. There is widespread evidence of a gradual reduction in the acidity of acid-sensitive waters in response to recent reductions in acid deposition. However, in countries with sufficient monitoring data from water bodies in acid-sensitive regions, a significant proportion of the monitored water bodies (from 1 to 45 per cent) remains acidified (e.g. has an acid-neutralizing capacity below a critical limit of 20 µeq/l) and biological communities often remain impoverished when compared with those in acid-sensitive waters in low deposition regions. In other countries, the risk of acidified surface waters is apparent but cannot be substantiated because monitoring data are lacking. Current national monitoring schemes vary in their ability to assess the spatial extent of acidification and the recovery responses of individual acidified sites.

Monitoring and reporting in Europe under the European Commission's Water Framework Directive is currently an ambiguous and limited source of information on the impact of air pollution on surface water. Monitoring requirements under the European Union's National Emission Ceilings Directive could address some of the shortcomings of the current monitoring programmes and reverse the recent decline in the number of monitoring sites in some countries

I. Introduction

1. The present report was prepared by the experts of the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters) for consideration by the Working Group on Effects and the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) at their fourth joint session, to be held in Geneva on 10-14 September 2018. The present report is a summary for policy purposes of a recent ICP Waters report by Ms. Kari Austnes and others.[1]

II. Background and key questions

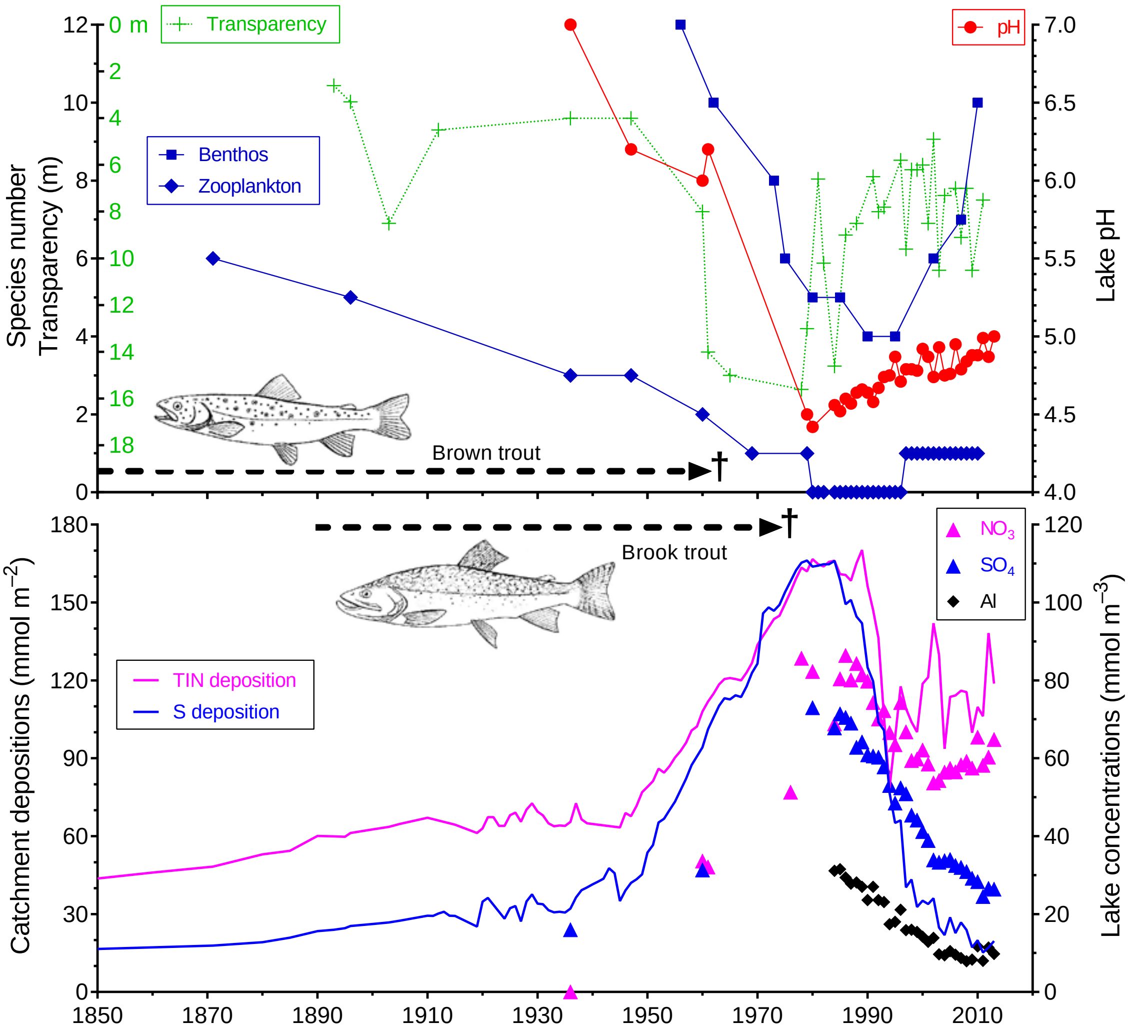
2. Is surface water acidification still an environmental problem in Europe and North America? What data are available? These questions are addressed in the 2018 report. The acidification of surface waters was one of the major environmental impacts of air pollution in the lead-up to the signing of the United Nations Economic Commission for Europe (ECE) Convention on Long-range Transboundary Air Pollution in 1979. The resulting reduction in nitrogen, and particularly sulphur deposition, resulted in a gradual decline in acidification levels and in the extent of surface water acidification. However, there is a lag in chemical, and particularly biological, recovery as illustrated in Figure I (using the example of a lake in Czechia): despite low sulphur deposition, recovery of water pH and benthos has been modest and the fish have yet to re-establish.

3. In various countries, monitoring data continue to document recovery. However, a regional assessment of current surface water acidification status is needed. In the present report, the regions potentially at risk of surface water acidification are identified and the acidification status is documented where data are available. Weaknesses in the availability of data on acidification status, which is relevant for air pollution policies (the Convention, the European Union National Emission Ceilings (NEC) Directive and the United States of America’s Clean Air Act), are identified.

[1] Austnes, Kari, and others (2018). *Regional assessment of current extent of acidification of surface waters in Europe and North America*. ICP Waters Report 135/2018.

Figure I

Long-term changes in biota, lake chemistry and atmospheric deposition: Černé Lake, Bohemian Forest, Czechia



Source: Vrba, Jaroslav, and others, “Constraints on the biological recovery of the Bohemian Forest lakes from acid stress”, *Freshwater Biology*, vol. 61 (2016), pp. 376-395.

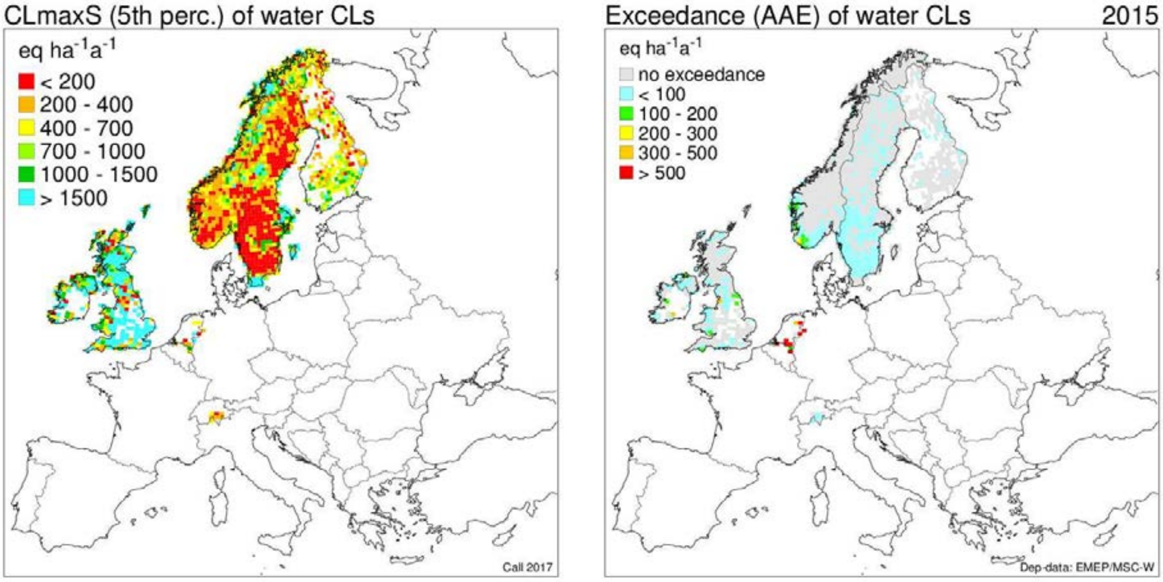
III. Identification of acid-sensitive regions

4. Acidification of surface waters occurs when the chemical buffering capacity of the catchment soils is insufficient to balance the level of acid deposition. Mapping of these factors is used to identify regions with potentially acidified surface waters. This is particularly important where local surface water chemical and/or biological data are rare or unavailable. Critical load is a well-established indicator of the acid sensitivity of surface waters (the amount of acid deposition that an ecosystem can tolerate in the long term without being harmed). However, information on critical loads is only available for Finland, Ireland, Netherlands, Norway, Sweden, Switzerland and the United Kingdom of Great Britain and Northern Ireland (Figure II) and for the United States of America. In order to provide a

consistent overview, maps of potential acid sensitivity for Europe and North America were produced using available bedrock geology maps. These maps can provide only a crude indication of acid sensitivity, which is also governed by factors other than bedrock geology (such as soil characteristics). Nevertheless, the geology-based acid sensitivity maps agree reasonably well with the critical loads maps at the broad regional level.

Figure II

Critical loads (sulphur deposition; left) and exceedance of critical loads (right) for acidification of surface waters in some European countries.



Source: Coordination Centre for Effects, International Cooperative Programme on Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends (ICP M&M)

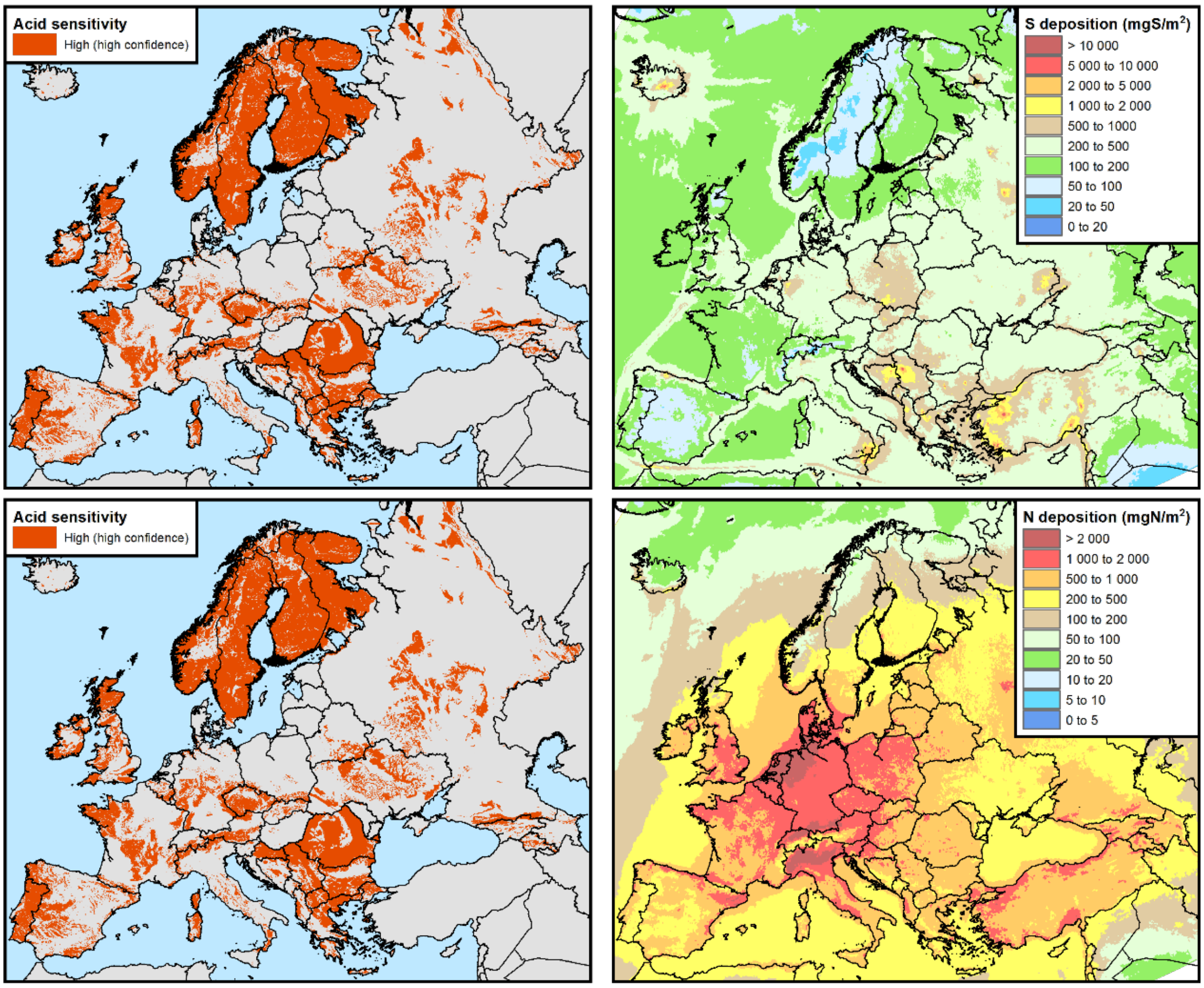
IV. Risk of surface water acidification

5. Where estimates of critical loads are available, the risk of surface water acidification can be expressed as the exceedance of the critical loads, calculated using deposition data. Areas of critical load exceedance (i.e. where levels of deposition currently exceed critical loads) occur in all the countries for which critical load estimates are available; this indicates that surface water acidification remains an environmental issue in parts of these countries. Acidification may also occur even when the critical loads are no longer exceeded because the original buffering capacity has not yet been restored. In addition, biological recovery may take much longer than chemical recovery.

6. For countries where critical load estimates are not available, a comparison of the geology-based map of potential acid sensitivity with atmospheric deposition data (Figure III) suggests that acidification may be an issue, particularly in the Pyrenees; the border regions of Belgium, Luxembourg, France and Germany; the border regions of Czechia, Germany and Austria; the Tatra mountains; the Italian Alps; northern Croatia; parts of Bosnia and Herzegovina and Serbia; western Albania; parts of western Russian Federation; and central Armenia.

Figure III

Left: Areas with potentially high acid sensitivity of surface waters (the top and bottom images show the same map). Right: Sulphur deposition (top) and nitrogen deposition (bottom) in 2015.



Sources: Original bedrock map: Jörg Hartmann and Nils Moosdorf, "The new global lithological map database GLiM: A representation of rock properties at the Earth surface", *Geochemisty, Geophysics, Geosystems*, vol. 13, No. 2 (December 2012), p. 5. Deposition data: EMEP/Meteorological Synthesizing Centre-West

V. Documentation of the current status of surface water acidification using surveys

7. While the risk of acidification may be assessed as described above, the actual presence of surface water acidification can only be confirmed by monitoring data. Upon request, 13 countries submitted monitoring data on their current (from 2010 onwards) acidification status for the assessment (Figure IV). The spatial coverage of the data submitted varies considerably from country to country. In general, the data represent only acid-sensitive sites or regions and cannot be extrapolated to the country as a whole. A few countries (e.g. Sweden and the United States) collect national or regional data through extensive surveys and can state with some confidence the proportion of acidified lakes and/or streams within their acid-sensitive regions; some countries monitor fewer sites in various parts of their territory (e.g. Finland

and Germany); while others focus on particularly sensitive or affected regions (e.g. Czechia and Switzerland). The United Kingdom survey was based only on sites where critical loads had previously been found to be exceeded, while the data from the Netherlands represent a particularly sensitive habitat type. Care must be taken in comparing the summary results for such different data sets. The 13 countries, as well as Spain and Latvia, also provided separate country reports with a more detailed overview of acid sensitivity and acidification status, frequently including other monitoring or modelling data representing the entire country.

8. In order to determine whether a water body is acidified, a criterion is needed. The most common and generally accepted chemical indicator is acid-neutralizing capacity (ANC) with a commonly-used critical limit of 20 microequivalents per litre (µeq/l). This is based on the level above which fish and invertebrate populations are not likely to be affected by water acidity. The same critical limit is frequently used in critical load calculations.

9. Based on the submitted data, 1 to 45 per cent of the water bodies in each country have ANC < 20 µeq/l while 5 to 33 per cent of the water bodies have ANC between 20 and 50 µeq/l, indicating that they are at risk and potentially vulnerable to short-term acidification events driven by seasalt episodes or climate extremes such as droughts and snowmelt events. Although these percentages are not directly comparable, the data provides evidence that acidification remains an issue in many countries.

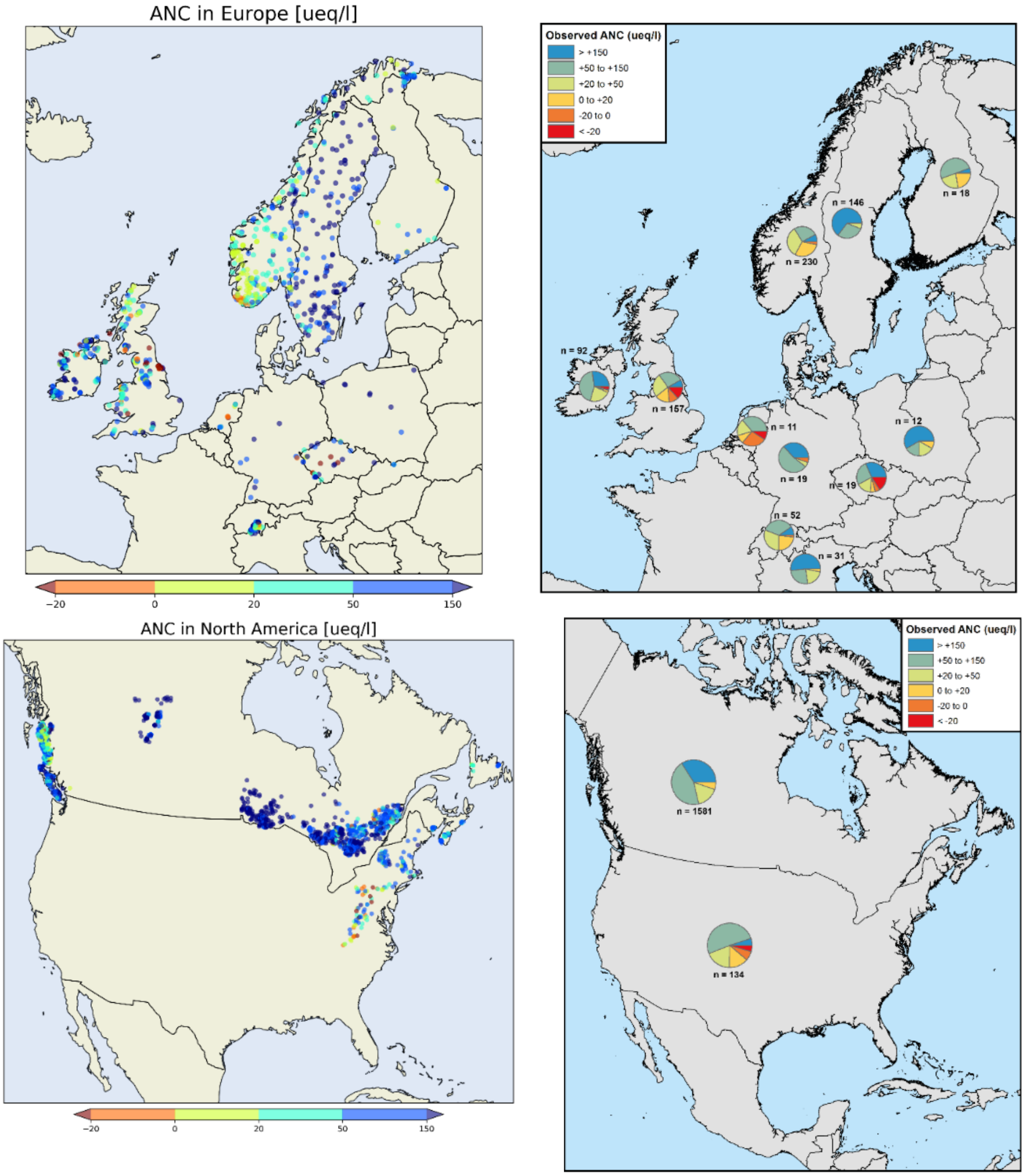
10. Thus, the submitted data and the information contained in the country reports show that acidification occurs over large regions of Canada, Norway, Sweden, the United Kingdom and the United States. In Finland, while more scattered, it occurs in large parts of the country while in Czechia, Ireland, Italy, Netherlands and Switzerland it is limited to a few smaller areas. The severity of acidification is not necessarily related to the extent of the problem; local hot spots may occur even where acidification is not a major regional issue, e.g. in Czechia, Ireland and the Netherlands. However, based on both extent and severity, Finland, Germany, Italy, Poland and, to a lesser extent, Canada and Switzerland seem closer to chemical recovery than the other countries that submitted data. Biological recovery is likely to be delayed by comparison with chemical recovery.

VI. Acidification status for surface waters in regions not covered by the data submitted for the present report

11. Several European countries with potentially acidified surface waters did not submit data for the present report, either because there was no national focal point or because there was no recent data available. Under the European Union Water Framework Directive (WFD), however, atmospheric deposition is defined as a pressure type and both acidification status and water bodies with the impact type acidification can be reported. In principle, the WFD reporting should give a representative view of pressures and status but in practice, there are ambiguities in the definition of acidification status, the pressure type ‘atmospheric deposition’ and the impact type ‘acidification’, as well as in the manner in which data are reported. Moreover, the WFD reporting covers only larger water bodies (lakes with a surface area of over 0.5 square kilometres (km^2) and rivers with catchment areas greater than 10 km^2); it does not reflect acidification pressure on the many smaller headwater lakes and streams that are often the most geologically acid-sensitive systems.

Figure IV

Average Acid Neutralising Capacity (ANC) (microequivalents per litre (µeq/l)) per site (left) and summary of ANC data (right) for European (top) and North American (bottom) sites.



12. Owing to these ambiguities in definitions and reporting, national reports on acidification status under the WFD may not be complete; the criteria may not be comparable or relevant; acidification may be a result of pressures unrelated to acid deposition (e.g. mine drainage); and the cause of the acidification may be unclear. While several countries report water bodies with less-than-good acidification status, a number of them are reported as also having the impact type ‘acidification’ and/or the pressure type ‘atmospheric deposition’. Of the countries that did not submit data for the present report, only Belgium reported a significant proportion of water bodies as having less-than-good acidification status, the impact type ‘acidification’ and the pressure type ‘atmospheric deposition’ under the WFD (3 per cent for rivers and 17 per cent for lakes). Moreover, many countries classify very few water bodies with respect to acidification status and it is not always clear whether this is because they lack information on the matter or because acidification is not a relevant issue.

13. The comparison of the acid sensitivity and deposition maps (Figure IV) suggests that there are potentially more countries with acidified surface waters than is suggested by WFD reporting. According to the literature, acidified surface waters have previously been observed in the Vosges and Ardennes mountains in France, the Rila mountains in Bulgaria and the Retezat mountains in Romania, but no information on the current situation has been found. In the Slovakian part of the Tatra mountains, the literature confirms that many lakes are still acidified while in Austria, surface water acidification resulting from atmospheric deposition is no longer considered to be an issue. Only moderate acidification has been detected in some Pyrenean lakes, owing in part to the buffering of acid deposition by dust from North Africa. No information has been found for the West Balkan countries. Acidified lakes have been observed during surveys of the European part of the Russian Federation and in Western Siberia, but the former survey was conducted over 10 years ago. In Armenia, acidified rivers are found in parts of the country but relevant data are limited.

VII. Conclusion

14. The current status of surface water acidification in Europe and North America has been assessed using various sources of information. Despite a reduction in acid deposition, acidification is still observed in many countries; however, its extent and severity varies.