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Recent results and updating of scientific and technical knowledge

Effects of air pollution on rivers and lakes

Report by the Programme Coordinating Centre of the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Waters

I. Introduction

1. The work of the Programme Coordinating Centre of the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Waters (ICP Waters) has recently focused particularly on the following key topics: (a) mercury (Hg) in aquatic ecosystems; (b) effects of nitrogen (N) deposition to nutrient poor aquatic ecosystems; and (c) revision of the ICP Waters Programme Manual. The results are presented here in accordance with item 3.3 of the 2010 workplan for the implementation of the Convention (ECE/EB.AIR/99/Add.2), adopted by the Executive Body at its twenty-seventh session in December 2009.

II. Workplan items common to all programmes

A. Targets and ex post application

2. Modelling lake chemistry data for 990 statistically selected lakes in Norway showed that the increased acid neutralizing capacity (ANC) in surface waters observed since 1990 could be expected to continue to increase slightly through 2020, if the planned emission reductions of the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol) and other legislation were implemented. Assuming no further emission reductions after 2020, ANC would increase very little, due to

slow build-up of soil base cations. The results also indicated that many surface waters in southernmost Norway would continue to be acidified, i.e., the critical loads would continue to be exceeded, unless sulphur (S) and N depositions were further reduced, more than required in the Gothenburg Protocol. Assuming maximum technically feasible emission reductions, ANC would continue to increase in most lakes throughout the country. The results from this scenario showed that potential remained for additional increases in ANC, if deposition was reduced more that required in the Gothenburg Protocol.

B. Robustness

3. There is generally good agreement between exceedance of critical load for acidity and the ANC in surface waters. Exceptions are found at sites with significant time delays between changes in S and N deposition and response in water chemistry. These time delays are well explained by known processes acting in catchments and waters and can be modelled by dynamic models.

C. Links with biodiversity

4. The major effect from S and N depositions on aquatic ecosystems is the loss of biodiversity. There has been extensive documentation of lost fish populations, and about 10,000 stocks of brown trout, roach, arctic char and perch have recently disappeared from Fennoscandian lakes. A major part of the invertebrate fauna was also lost in many Norwegian rivers due to acidification. This loss of biodiversity is especially true for many groups of insects, which are an important source of food for fish. Recovery of the biodiversity has begun in many regions, but lags behind chemical recovery.

D. Trends in selected monitored/modelled parameters

5. Long-term records of surface water chemistry show that surface waters are recovering due to a decrease in S emissions in Europe and North America. The results up to 2004 show increases in ANC, alkalinity and pH. A regional increase in total organic carbon (TOC) was also recorded, possibly as a response to reduced S deposition, but may also be related to climatic changes. Biological recovery, recorded as changes in invertebrates, was slow and not widespread.

III. Acidification

6. The trend assessment on acidification in aquatic ecosystems up to 2004 by ICP Waters showed that acidification remained a problem in some parts of Europe, although its effects were decreasing in Western Europe. Results from Norway showed that the positive trend in recovery from acidification in aquatic ecosystems is continuing, although at a slower rate in the period 2000–2008 as compared with 1990–1999.

7. Several areas in Europe will never achieve good (non-acidified) water quality with current legislation. Future reductions of both S and N deposition would be necessary to achieve biological recovery not influenced by acidification. A return to pre-industrial biodiversity is unlikely in most cases, because original species are extinct, new species have been introduced and biological processes are complex.

IV. Nutrient nitrogen

8. Atmospheric N deposition leads to enhanced leaching of N species to surface waters in natural and semi-natural ecosystems. The reigning paradigm of freshwater primary productivity is limitation by phosphorus (P), which suggests that additional N does not affect growth of algae and other organisms. A literature review shows that increased availability of N, related to N deposition, in nutrient-poor boreal and arctic lakes has effects on freshwater biology. Lake sediment studies (paleolimnology) show changes in algal communities and increases in algal growth related to higher N concentrations. Regional surveys in boreal lakes show higher chlorophyll concentrations per unit P areas with higher N deposition. Experimental nutrient additions in lakes (mesocosm studies) show that N and P limitation of algal growth may vary seasonally. Additionally, numerous studies indicate N limitation is common when N availability is low, while lakes with higher N availability are usually P-limited. Data availability of effects of N on water plants and invertebrates in oligotrophic waters is scarcer than for algae. Some species of water plants may increase their growth substantially upon slight increases of N availability.

V. Heavy metals

9. A report by ICP Waters on Hg in freshwater, lake sediments and fish showed that concentrations of Hg in fish in northern boreal lakes are increasing. Levels in fish in Europe and North America are frequently above thresholds advised for human consumption. Lake sediment data, however, indicate reduced Hg deposition since the 1990s.

VI. Cross-cutting issues

10. The revised and updated ICP Waters Programme Manual is still being updated. The Task Force meeting suggested including new chapters in it.