

The Integrated Monitoring Programme in Finland

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Background

In the early 1980s, an expert group appointed by the Nordic Council of Ministers suggested that the Nordic countries should launch a joint programme for monitoring the effects of acidifying substances and heavy metals on northern coniferous forest ecosystems (Nordiska Ministerrådet 1984). Finland participated in this Integrated Monitoring Programme, establishing four monitoring areas during 1987–1988.

In 1988, the United Nations Economic Commission for Europe recommended that countries participate in the three-year Pilot Programme for Integrated Monitoring. The Pilot Programme was initiated under the Convention on Long-Range Transboundary Air Pollution at the request of the Nordic countries, and it was called the Pilot Programme of Integrated Monitoring of Air Pollution Effects on Ecosystems (Environment Data Centre 1992). Sixteen countries with 40 monitoring sites participated in the Pilot Programme. Finland used the same monitoring sites as those employed during the Nordic phase of the project. Finland also took the responsibility for handling the data generated by the programme. After a pilot phase (1989–1991), an international evaluation of the programme was carried out in 1992 (Environment Data Centre 1992).

The main conclusion of the evaluation group was that an integrated monitoring programme in small catchments should be pursued as a long-term, international co-operation project (Environment Data Centre 1992). It was also concluded that, in the short-term perspective especially, it will be possible within the programme to identify the effects of sulphur and nitrogen on processes that are important for the long-term stability of the ecosystems. It was particularly emphasized that this type of integrated monitoring enables the modelling and testing of future scenarios by performing continuous validation of dynamical mechanistic models, developed on the basis of empirical data and additional research.

In accordance with the recommendations of the evaluation group, the International Co-operative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP IM) was initiated in 1993 under the auspices of the UN/ECE Convention on Long-Range Transboundary Air Pollution. At present, 20 European countries and Canada are participating in the programme with a total of 61 monitoring sites. Finland is participating in the programme with the four intensive monitoring sites that were used earlier in the Nordic Integrated Monitoring Programme and pilot phase of the ICP IM. Finland also has the responsibility of running the ICP IM Programme Centre.

Objectives of the Programme

The main objective of the ICP IM is to observe and predict the state of and possible changes in natural ecosystems caused by transboundary air pollutants. Emphasis is placed on the fluxes and effects of acidifying sulphur and nitrogen compounds, ozone and heavy metals on ecosystems. To achieve this, a large number of physico-chemical and ecological variables are being monitored simultaneously at all the monitoring sites. An additional objective of the ICP IM is the development and validation of models for the simulation of ecosystem responses. A more detailed description of the short-term and long-term objectives of the programme was published by the Environment Data Centre (1992).

Management of the Programme in Finland

The location of the Finnish integrated monitoring areas was planned on the basis of the guiding principles laid down by the Nordic Council of Ministers (Nordiska Ministerrådet 1984). The intensive monitoring programme was started at four monitoring sites, located in Häme, North Karelia, Kainuu and Lapland. The selected sites were small, pristine forested catchments including a lake. Very strict selection criteria were applied in order to ensure that the sites were in as natural a state as possible, that they were representative of the area, and that they were not affected by local pollution sources (Bergström *et al.* 1995). Additional criteria were used for determining the natural state of the catchments.

Since 1993, the monitoring has been carried out within subprogrammes in accordance with the Manual for Integrated Monitoring, Programme Phase 1993–1996 (Environment Data Centre 1993). The subprogrammes have been designed to monitor acidifying sulphur and nitrogen compounds and heavy metals, and their effects throughout the ecosystem, from tree canopy to soil and lake communities. The manual is currently under revision and a new manual will be published in 1998. Former versions of the manuals were used during the Nordic and pilot phases of the programme. A separate manual for hydrobiological

monitoring at IM sites was published by Keskkitalo and Salonen (1994).

More than 20 subprogrammes have been implemented by designated institutes at the Finnish monitoring sites. The regional environment centres have been responsible for most of the field work and a part of the analyses. However, not all the subprogrammes have been active throughout the whole ten-year monitoring period, but instead have been carried out periodically. Some of the monitoring recommendations in the manuals of the Nordic and Pilot phases of the programme have now been deleted. For example, breeding birds were monitored at the sites only during the period 1987–1990 (Koskimies *et al.* 1995).

Analysis of the data obtained from monitoring areas

The results of the first five-year monitoring period (1987–1991; Nordic and Pilot phases) at the Finnish IM sites have been summarised in the First National Report (Bergström *et al.* 1995). The report includes a detailed description of the physico-chemical and ecological status and characteristics of the monitoring sites. However, owing to the fact that the monitoring period covers only five years, the report does not include any evaluation of temporal trends or causal relationships in the functioning of the ecosystems.

The ten-year monitoring period culminating at the end of the ICP IM phase (1992–1996) allows assessment of dose-response relationships, trends and the models calibrated with data from the IM sites. For example, an assessment of the effects of nitrogen and sulphur deposition on vegetation was carried out (Liu 1996), and the first results from a trend analysis of ICP IM data on bulk and throughfall deposition and runoff water chemistry were reported (Vuorenmaa 1997). Three dynamic models (MAGIC, SAFE, SMART) were calibrated using data from the IM sites, and the effects of several emission/deposition scenarios were assessed (Forsius *et al.* 1998).

In summary, it can be stated that ten years of intensive monitoring has produced sufficient data for modelling the effects of, e.g. the Sulphur Protocols in ecosystems, as well as to detect trends in a large number of the processes occurring in natural ecosystems.

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