

REVIEW OF THE PAN-EUROPEAN MONITORING PROGRAMME ON FOREST ECOSYSTEMS

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SUMMARY

As part of the Forestry Strategy for Europe, a review of the European scheme for the protection of forests against air pollution (Council Regulation 3528/86) was undertaken. This report presents the results of the review, and serves as input for the discussion on the adaptation of the existing regulation.

The aim of the study was to review the development and outcome of the monitoring activities conducted under Regulation 3528/86 in view of the objectives of this Regulation, as well as, more generally, the perspectives described in the Forestry Strategy and the recommendations by the Ministerial Conferences on the Protection of Forests in Europe.

The review was based on interviews with key persons in and outside the Programme, a limited inquiry which was sent out to the participating countries (National Focal Centres) and the reading and scanning of relevant reports, publication and literature.

The Council Regulation 3528/86 and its amendments forms the legal basis for a systematic network which serves as the basis for a periodic and harmonised assessment of forest damage (Level I) and for a network of intensive permanent plots representing the most important forest ecosystems (Level II), together called the Programme. The networks were established (Level I at the very beginning, Level II more recently), annual reports on forest condition in Europe were produced as well as studies on the relationships between natural and anthropogenic stress and forest ecosystem health. By establishment of the Programme, the annual reports on crown condition in Europe and the studies on the relationships between natural and anthropogenic stress and forest ecosystem health, the objectives of the Council Regulations were fulfilled, as were the objectives of the Commissions Regulations for implementation of the Programme. By establishing a co-operation with ICP Forests the Programme dimensions were enlarged including also 19 non-Member states. Furthermore, the co-ordination of the Programme became a shared initiative between ICP-Forests and the Commission. Following observations were made:

- All the objectives of the Council, the Commission and ICP-Forests have been fulfilled, except for the study on forest ecosystem evolution, which did not get much attention so far.
- The under resolution S1 indicated monitoring Programme in first Ministerial Conference in Strasbourg in 1990 has been fulfilled.
- The Programme has shown the state of the forests and the development over the years covering almost the whole area of Europe making it a unique source of data.
- The Programme has:
 - stimulated co-operation between states in Europe,
 - greatly enhanced the expertise in forest ecosystem monitoring,
 - provided a platform where data on forest health could be exchanged without (political) borders.
- The Programme has had an enormous contribution to the public awareness of forest health in different regions in Europe.
- The experimental projects and the data, especially those, which recently came available from the Level II programme, increasingly contribute to policy related issues.

During the years the monitoring Programme has been operational, much changed in the vision of forest functions and management. Especially the Rio treaty from 1992 initiated the views on sustainable forest management. This was further elaborated at the second Ministerial Conference in Helsinki in 1993 and extended with the multiple functions of forests together with the criteria and indicators for Sustainable Forest Management at the Third Conference in Lisbon. Among the different functions of forests are the preservation of biodiversity, the role of forests in the climate system and the sequestration of carbon, the use for sustainable products and the preservation of our water resources. These functions fit in different treaties, protocols

and policy issues that are highly relevant. For policy development and evaluation and supporting sustainable forest management, criteria and indicators were developed. A monitoring network will be necessary to provide data to further develop and evaluate the criteria and indicators. So far the contribution of the current Programme to the development of criteria and indicators has been limited. The Programme was mainly focussed on the role of air pollution in forest ecosystem health. Only very recently the Programme proposed to broaden the objectives to make it relevant for issues such as biodiversity and carbon sequestration. It would have been better if the Programme had taken (or had been invited to take) a proactive role in the development of the criteria and indicators.

There are areas where the Programme can improve. The main recommendation is to adopt the pan European criteria and indicators of sustainable forest management and to gradually develop the monitoring Programme into that direction. It is needed to provide a formal basis for such a change by a renewal of the Council Regulation. The next phase of the Programme should have a long-term basis of at least 10 years, but should be reviewed regularly. The Programme can implement some (additional) easy to measure parameters first. Pre-studies have to be performed to derive easy to measure quantitative parameters which contribute to the criteria and indicators for sustainable forest management. The monitoring Programme can implement these after a careful evaluation of the need, the methods, the places and time periods these parameters have to be measured. Methods should be better harmonised than has been done so far. Although harmonisation has been actively pursued throughout the Programme there is a too high degree of freedom in the choice of methods that can be used for the assessments. This makes the comparability between data very difficult and sometimes impossible.

The link with ICP Forests is important especially regarding the enlargement of the European coverage. The link with ICP- Forests should not slow the role of the Programme towards broader objectives, because of the link between ICP- Forests and the Convention, which is focussed entirely on air pollution. The costs of the programme are not well balanced: 65% of the Level II plots are assessed for 35% of the costs. The costs could be optimised.

The organisational structure should be renewed in order to improve the quality and the relevance of the Programme. This can be done in two ways: by optimising and simplification of the current structure or by making a new structure operating as a European Forest ecosystems and Information Expert Centre (EFECT). The aim of such a centre would be to develop, provide and evaluate European wide indicators on forest ecosystems and the environment to support Community and national development of SFM policies. The EC has to increase its staff to have a more active role in the Programme management, its strategic development and the evaluations. Furthermore, it is advised to reduce the number of data centres and to concentrate the activities into one competent place.

1. INTRODUCTION

1.1 Background and objective

In 1986 the Pan-European Monitoring Programme was established under the Council Regulation (EEC) No 3528/86 and the amendments to this regulation (526/87, 1613/89, 2157/92 and 307/97). A Community scheme was established starting the first of January 1987 and lasting 15 years to protect forests against atmospheric pollution with the aim to help Member states (and Candidate Member States) to establish a periodic inventory of damage caused to forests and conduct intensive continuous surveillance of forest ecosystems in a network of observation plots. The Ministerial Conferences on the Protection of Forests in Europe held in Strasbourg (1990), Helsinki (1993) and Lisbon (1998) constituted a major initiative in the process of co-operation amongst 38 European countries as well as the European Community to contribute to the protection and sustainable management of European forests. Several resolutions were adopted amongst other:

S1: European network of permanent sample plots for the monitoring of forest ecosystems

It has now been 13 years since the implementation of the monitoring programme. In 2001 a decision has to be made about the future of CR3528/86 and its amendments and with that of the monitoring programme. Recently the Commission completed their view of the Forest Strategy, which was discussed in the Council. In this document under the Community action frame the Community Scheme for the Protection of Forests against Atmospheric Pollution was described. It was stated that the Scheme should further develop, on the basis of a *scientific review*, the framework for a feasible monitoring system which is at the sharp edge of work in this area and which covers the range of potential impacts such as air pollution, climate change, diseases, pests and other stress factors on forest ecosystems. The Commission organised a meeting in May to open new prospects for amending the existing legislation in the year 2001 based on a critical review of the current state of knowledge and experience in this field. The scientific review, as requested by the Council, was discussed at the workshop. The Commission has asked the author of this report to do the review. The objective is *to review the development and outcome of the Programme in view of the objectives of the Council Regulation, the recommendations by the Ministerial Conferences and the future perspectives as described in the Forestry Strategy as well as the regulations*. In this report my findings are described. This forms the final report of contract no. 2000.60.ECN.01.

1.2 Outline of the report

First the history, development and implementation of the programme will be described in Chapter 2. In this chapter also the Council and Commission Regulations as well as the resolutions of the Ministerial Conferences will be described. Chapter 3 lists the objectives of the monitoring programme and the results achieved and highlights the Community added value. Chapter 4 addresses the actual policy questions and future developments, which play an important role in the future of the monitoring programme. In Chapter 5 the programme is evaluated, first in a general sense followed by evaluation of specific subjects and a view on the current status. Chapter 6 lists the recommendations followed from the evaluation. Finally, in Chapter 7 the conclusions of the scientific review are presented, followed by a list of consulted persons and literature.

2. HISTORY, DEVELOPMENT AND IMPLEMENTATION OF THE PROGRAMME

2.1 Historical aspects

There have been worries about forest decline already for many centuries. This had mainly to do with over exploitation because wood was one of the most important resources for energy production, buildings, ships, etc. The environmental influences on the forest health were only of a local nature near to factories such as smelters, etc. (e.g. Smith, 1879). In 1852 a Belgian Commission was established to determine the effect of air pollution from metal smelters on forest damage. They established sort of critical distances based on a relation between forest damage and distance to the smelters. This was the first example of research, developing criteria followed by policy for prevention of forest damage.

Large scale forest decline due to environmental influences were observed much later in the 1970s, especially in central Europe but also in other places in Europe. Since then, forest vitality, together with human health, has become the most important focus of environmental policy development. There was a lot of uncertainty about the scale and trend in forest decline. Therefore, in the early 1980s a programme of preparatory actions was started to encourage Member States to undertake activities to determine the impact and extent of forest damage. In the mid eighties serious forest die back was reported. Different national programmes, e.g. from Norway and Germany, provided evidence for the long-range transport of acidifying components, mainly sulphur, affecting ecosystem compartments as soils and trees. In different countries methods to quantify forest or tree condition were developed.

At its Third session in 1985 the Executive Body for the Convention on Long-range Transboundary Air Pollution (CLRTAP) of the United Nations Economic Commission for Europe (UN/ECE) decided to launch the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests). The programme was mandated to facilitate the collection, on a national level, of comprehensive and comparable data on changes in forests related to actual environmental conditions, in particular air pollution, including acidifying deposition, so as to improve evaluation of trends in damage resulting from pollution and to establish a better understanding of cause-effect relationships. In 1986 the first manual on methods and criteria for harmonised sampling, assessment, monitoring and analysis of the effects of air pollution on forests was published¹. This manual was updated in 1989, 1994 and recently in 1999.

In November 1986 the Council of the European Communities agreed to a Community Scheme on the Protection of Forests against Atmospheric Pollution (Regulation (EEC) No. 3528/86) to provide increased protection for forests in the Community and thereby to contribute in particular to safeguarding the productive potential of agriculture. In order to support the European Commission with the implementation of the European Union Scheme the Standing Forestry Committee's Working Group on Atmospheric Pollution was established in which the Member States are represented. In close co-operation with this Working Group, the methods for the establishment of the periodic inventory were developed and laid down in Commission Regulation (EEC) No. 1696/87. Based upon these rules, the Member States established a systematic grid of observation plots (16x16 km) and started to carry out crown condition assessment by using the common methodology (Level I). Several projects under Article 4 were financed e.g. focussed on harmonising and improving methods. In 1991 several non-EU countries, which already carried out surveys on a national level within the framework of ICP Forests joined the systematic survey on the 16x16 km grid. In 1992 the first common forest condition report was published by both organisations. Since then the systematic grid has steadily increased covering almost 200 million hectares of the European forests. With the increased knowledge that was gained from the surveys on the systematic grid and the results

from experiments carried out in the field, a need for a more intensive monitoring was recognised in order to understand the causal relationships. The Council Regulation was amended to establish an observation network with Intensive monitoring plots, the so-called Level II. In 1994 the implementation of the Pan-European Programme for the Intensive Monitoring of Forest Ecosystems started, based on national selection. Currently almost 900 plots are operational in the Member states and several non-Member states.

2.2 Regulation and its amendments

In this section an overview of the Council and Commission Regulations is given (see also Table 2.1 for a summary), Furthermore, the resolutions and workprogrammes resulting from the three Ministerial Conferences are described.

2.2.1 Council regulation No. 3528/86 and its amendments

Short summary of the regulation and its amendments made by the Council:

CR3528/86:

- Important role of forests maintaining fundamental balances and their contribution to agriculture.
- Concern about harmful effects of atmospheric pollution and the need for forest protection under responsibility of the Commission.
- Establishing of an observation network, a uniform periodic inventory of the damage caused to forests and periodic forest health reports on the extent of damage and the regional progress.
- Research, pilot and demonstration projects for improvements of methods, understanding of causal relations (related to atmospheric pollution) and maintaining and restoration.
- Commission is responsible for co-ordination and monitoring of Community scheme.
- Community should help finance Community Scheme for protection against atmospheric pollution.

CR526/87:

- This amendmend is related to submission of data and reports, application of projects, information, etc.

CR1613/89

- Reinforcement because of persisting forest decline in many parts of the Community. However, there is a broader view of causes: acid deposition and atmospheric pollution leading to direct and indirect (soil) effects and imbalance in nutrients.
- Measures to maintain and restore forests should be aimed at favourable soil conditions.
- The Standing Forestry Commission is established.
- Assessments and evaluations by Member states should be processed centrally.

CR2157/92

- Concern about decline in health and therefore prolongation and supplement of Regulation (10 years).
- Gather detailed information on basic ecological parameters to pinpoint cause – effect relationships by establishing EU network of permanent observation plots for monitoring the forest ecology.

CR307/97

- Conservation of the forest ecosystem for its economic, ecological and social function for people working in rural areas in agriculture.
- Ministerial Conferences: committed to continuing forest damage survey.
- Level I and II for improvement of understanding cause – effect relationships related to atmospheric pollution and meteorological events.
- programme extended to 15 years (1987 – 2002).

The most relevant articles which are currently valid are (article numbers are given):

1. Scheme to provide increased protection for forests in the Community and contribute to safeguarding the productive potential of agriculture.
2. Aims of the Scheme:
 - periodic inventory of damaged caused to forests, in particular atmospheric pollution;
 - establish, co-ordinated, harmonious network of plots;
 - conduct intensive continuous surveillance of forest ecosystems;
 - establish, co-ordinated, harmonious network of plots
3. Periodic forest health report by each Member state.
4. Experiments in the field:
 - to improve understanding of atmospheric pollution and effects;
 - to devise methods of maintaining and restoring damaged forests;
 - pilot and demonstration to improve methods of observation;
 - pilot projects to maintain damaged forests;
 - to provide information on areas, costs, etc.
- 4a. Synoptic processing of information on atmospheric pollution in woodland and its effects.
5. Commission is responsible for co-ordination.
7. Formal procedures and measures.
11. The programme will last 15 years and 40 million ECU is reserved. Annual financial reports should be given
12. EC currently contributes 50% of project costs. In addition the Commission provides funding for meetings, courses, etc.
15. Commission has to apply progress reports to the European Parliament

2.2.2 Detailed rules for implementation of Council regulation No. 3528/86 and its amendments

The European Commission laid down the detailed rules for implementation of CR3528/86 in several Regulations, which are related to the Level I and Level II monitoring programme. The following regulations and amendments were implemented.

Level I:

No. 1696/87: (no longer in force) providing the basis of a monitoring programme on the basis of common methods a periodic inventory of damage caused to forests, in particular atmospheric pollution and establish or extend, in a co-ordinated and harmonious way, the network of observation points to draw up this inventory. It regulates the common methods, application for aid from the Community, the specific inventories for crown condition and reporting.

No. 2995/89: amendment for reporting defoliation in percentage classes and adding the class 'dead trees', following CR1613/89.

Following amendments were the result of CR2157/92:

No. 926/93: Amendment was necessary for the digital data format and for the improvement of the general transparency of the agreed common methodology. Furthermore, measurement and reporting of the soil condition was added.

No. 836/94: Amendment to include the chemical content of leaves and needles (optional).

No. 1398/95: Special regulations for the large homogeneous forests in northern Finland and Sweden, where only sub-samples are needed.

Level II:

No. 1091/94: laying down certain detailed rules for the implementation of CR3528/86 as last amended by No. 2157/92 and for resolution No. 1 of the first Ministerial Conference on the protection of forests in Europe. The purpose of the Community scheme is to help the Member states to:

- conduct intensive, continuous surveillance of forestry ecosystems;

- establish or extend, in a co-ordinated and harmonious way, a network of permanent observation plots required for such intensive, continuous surveillance.

Objectives:

- to conduct an intensive and continuous monitoring of forest ecosystems in relation to the damage caused by atmospheric pollution and other factors influencing forest condition,
- to improve the understanding of the causal relationship between changes in forest ecosystem and the factors influencing it, especially atmospheric pollution, by concentrating at a single location various measurements and monitoring of forest ecosystems and its components,
- to obtain relevant information on the evolution of a number of forest ecosystems in the Community.

Details on the common methods, application and assessments and reporting of crown condition, soil, foliage and increment are given.

No. 690/95: additional descriptions of methods for deposition and meteorology.

No. 1390/97: following the amendment CR307/97, soil solution sampling is added and a method for describing the background information on the monitoring methods in Data Accompanying Reports (DAR). Annual detailed reports from the Member states are required.

No. 1545/99: Common methods are revised, ground vegetation assessment is added and meteorology is updated. Aerial photography and remote sensing is optional.

Table 2.1. *Summary of Regulations and Decisions*²

No.	Type	Content
3528/86	Council Regulation	Establishment of the Scheme
1613/89	Council Regulation	Amending 3528/86
89/367/EEC	Council Decision	Set up of Standing Forestry Committee
2157/92	Council Regulation	Renewal and amending 3528/86
307/97	Council Regulation	Extending 3528/86 to 15 years
526/87	Commission Regulation	Applications (financial aid)
1696/87	Commission Regulation	Methodology (systematic grid)
1697/87	Commission Regulation	Payments (financial aid)
2995/89	Commission Regulation	Amending 1696/87 (improvement of methods)
926/93	Commission Regulation	Adding the soil survey to 1696/87
836/94	Commission Regulation	Adding the foliar survey to 1696/87
1091/94	Commission Regulation	Methodology (intensive monitoring)
690/95	Commission Regulation	Adding the deposition and meteorology survey to 109/94
1398/95	Commission Regulation	Amending 1696/87 (improvement of methods)
1390/97	Commission Regulation	Adding soil solution survey to 307/97
1545/99	Commission Regulation	Adding ground vegetation survey to 307/97
56/1/99	Council Resolution	Forestry strategy

2.3 Ministerial Conferences

Three Ministerial Conferences on forests were held so far: the first in 1990 in Strasbourg, the second in 1993 in Helsinki and the last one in 1998 in Lisbon. Also Ministerial Conferences "Environment for Europe" were organised in Dobruša in 1991, in Lucerne in 1993 and in Sofia in 1995. These will not be discussed here. The results of these conferences in relation to forest ecosystems and the environment and the actions are in line with the Ministerial Conferences on the Protection of Forests in Europe. In this section the resolutions and actions resulting from these Conferences with relevance for the monitoring programme will be discussed.

2.3.1 Ministerial Conference on the protection of forests in Europe, Strasbourg 1990

The Ministerial Conference on the protection of Forests in Europe is an ongoing initiative to co-operate between around 40 European countries to address common threats and opportunities related to forests and forestry. A chain of political level conferences and mechanisms for the

follow-up work constitutes this process. The signatory states and the European Community are responsible for the national and regional implementation of the decisions taken at the conferences. The discussion and work between the conferences is called the Pan European Process, which is characterised by a dynamic joint approach with a strong political commitment.

The First Ministerial Conference took place in 1990 in Strasbourg as a common initiative of France and Finland. Under the impression of dying forests, cross-border protection of the European forests was discussed for the first time at ministerial level. The ministers responsible for forestry and the European Community signed 6 resolutions and committed themselves to technical and scientific co-operation and common measures for the protection of the European forests. The resolutions were:

S1: European network of permanent sample plots for the monitoring of forest ecosystems.

S2: Conservation of forest genetic resources.

S3: Decentralised European data bank on forest fires.

S4: Adapting the management of mountainous forests to new environmental conditions.

S5: Expansion of the EUROSIVA network of research on tree physiology.

S6: European network for research into forest ecosystems.

Resolution S1 was directly related to the EC/ICP-F observation network of permanent sample plots. Resolution S6 was fulfilled by establishing a Concerted action: European Network for Research into Forest Ecosystems (EFERN), which established a Pan-European information mechanism including a database of institutions, scientists, projects and existing ecosystem studies.

2.3.2 Ministerial Conference on the protection of forests in Europe, Helsinki 1993

The Signatory States and the European Community signed the Resolutions and General Declaration. The resolutions were³:

H1: General guidelines for the Sustainable Management of Forests in Europe.

H2: General guidelines for the Conservation of the Biodiversity of European forests.

H3: Forestry Co-operation with countries with Economic Transition.

H4: Strategies for a Process of long-term adaptation of Forests in Europe to Climate Change.

Through the Resolutions and General Declaration the multi-functional role of forest *ecosystems* was recognised. Sustainable management of forests was adapted as the method to *maintain their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystem.*

Formally the role of the monitoring programme following from the first Ministerial Conference was adapted and prolonged and the commitments to the 1979 Convention on Long-Range Transboundary Air Pollution were reaffirmed. Following actions related to the monitoring programme were identified:

Under H2 the following action (10) was listed:

In order to attain aims 9.1, 9.2 and 9.3 the Signatory States and the European Community will implement surveys and research programmes which are specially adapted to their economic, social and environmental conditions and which are, where appropriate, co-ordinated and integrated with similar work resulting from the implementation of the relevant resolutions of the Strasbourg and Helsinki Conferences.

Under H4 the following action (9) was listed:

The Signatory States and the European Community will review, develop and co-ordinate the present monitoring schemes to assess more effectively those large-scale patterns and dynamics of alterations that may be due to climate change in European forest ecosystems. These tasks should be carried out in co-ordination with existing European networks of permanent sample plots.

The conference stressed the general responsibility of signatory states to implement the resolutions and invited international organisations to participate actively in the process. A

number of ad-hoc bodies were created, notably the General Co-ordinating Committee (GCC), its Scientific Advisory Group (SAG) and the Liaison Unit (LU). The Helsinki conference was followed by a large number of meetings mainly directed towards the development, application and identification of criteria and indicators for sustainable forest management. This was done by an inquiry on the pan-European criteria and indicators to the countries and evaluation of the data obtained. It was recognised that measurements for some of the quantitative indicators were not yet available and might need a new programme of systematic data collection or even basic research. The pan-European most suitable quantitative indicators represent the first effort to provide a core set of scientifically based indicators that are technically feasible and cost-effective for assessing SFM. Since the conference most countries have formulated national forest policies under the concept of sustainable development, that deal with the aspects of SFM, environmental protection, conservation of biodiversity in the spirit of Resolutions H1 and H2. So far, few countries have published extensive information on the state of their forests according to national criteria and indicators⁴.

2.3.3 Ministerial Conference on the protection of forests in Europe, Lisbon 1998

The Signatory States and the European Community adopted two resolutions⁵:

L1: People, forests and forestry: Enhancement of the socio-economic aspects of sustainable forest management.

L2: Pan-European criteria, indicators and operational level guidelines for sustainable forest management.

The Third Ministerial Conference put more emphasis on the socio-economical aspects of forests and the need for sustainable forest management, operationalised by adopting six criteria. The definition of SFM defined by the second Ministerial Conference was reconfirmed, just as the resolutions. Forests have a contribution to the sustainable development of society, the development of rural areas, provision of renewable sources and protection of global and local environments. The value of functions of forests in socio-economic, environmental, ecological and cultural sense and the role for society to maintain and improve these functions were recognised. No specific role of the Pan European monitoring programme was listed, except for criteria 2 (in Annex 2), under 2.1:

Health and vitality of forests should be periodically monitored, especially key biotic and abiotic factors that potentially affect health and vitality of forest ecosystems, such as pests, diseases, overgrazing and overstocking, fire and damage caused by climatic factors, air pollutants or by forest management operations.

Indirectly, several areas could be identified with a potential contribution of the programme. These are similar to those from the second Conference and are related to increasing public awareness, education of forest managers or owners, research and advise, related to SFM, maintaining and improving biodiversity and the role of forests in the carbon cycle. Furthermore, now specific criteria are formulated a potential role for implementation and monitoring can be seen.

Recently, the Work Programme on the Follow-up of the third Ministerial Conference was adopted⁶. In this work programme the list of criteria and indicators, which were adopted at the Conferences, the actions needed, the actors, time frame and status were published. Apart from the resolutions adopted in Strasbourg and Helsinki and the on-going activities carried-out in the follow-up of these resolutions, no direct actions for the monitoring programme were listed, except for the participation in a few actions related to the Improvement of Pan-European Indicators for SFM.

3. OBJECTIVES, RESULTS ACHIEVED AND COMMUNITY ADDED VALUE

3.1 Objectives of the programme

Regulation 3528/86 established the Community Scheme on the Protection of Forests against Atmospheric Pollution, in order to provide increased protection for forests in the Community and thereby contribute in particular to safeguarding the productive potential of agriculture. This was adopted particularly in view of the essential role that forests play in maintaining fundamental balances, as regards soil, water, climate, fauna and flora.

The objectives of the programme were defined as follows:

- to establish, on the basis of an appropriate observation network, a uniform periodic inventory of the damage caused to forests. This inventory provides information on the extent and development of forest condition in the different regions of the European Union;
- Member states are encouraged to carry out field experiments and pilot and demonstration projects to:
 - Improve the methods of observing and measuring damage to forests;
 - To increase the understanding of atmospheric pollution in forests and the effects of such pollution on forests;
 - Devise methods of maintaining and restoring damaged forests.

These objectives are leading for this review. However, because of the co-operation with ICP Forests the objectives of ICP Forests, which were also adopted by the Commission, are also described here. The objectives of ICP Forests and the EU responsible for directing the programme and operationalisation of the above mentioned Directive objects were formulated as follows⁷:

- To gain further knowledge of the spatial and temporal variation in forest condition and of its relationships to stress factors, in particular air pollution. This is realised by means of an international large-scale systematic network. This is referred to as the Level I monitoring intensity.
- To investigate the relationships between air pollutants and other stress factors on forest ecosystems, and to study the development of important forest ecosystems in Europe. This is achieved through intensive monitoring at selected observation plots, which is referred to as the Level II monitoring intensity.
- To provide a deeper insight into the interactions between the various components of forest ecosystems by means of information available from in-depth studies on the influence of air pollution and other stress factors.

Recently, the objectives were discussed, based on the internal review, and widened. These have been listed in the Draft Strategy as a common proposal of ICP Forest and the EC⁸. The Draft Strategy has not yet been approved. The proposed objectives are:

- (a) to provide further information on the spatial and temporal variation in forest condition in relation to anthropogenic (in particular air pollution) as well as natural stress factors on an European and national large-scale systematic network (Level I),
- (b) to contribute to a better understanding of the relationships between the condition of forest ecosystems and anthropogenic (in particular air pollution) as well as natural stress factors through intensive monitoring on a number of selected observation plots spread over Europe (Level II) and to study the development of important forest ecosystems in Europe,
- (c) to provide a deeper insight into the interactions between the various components of forest ecosystems by means of available information from in-depth studies,
- (d) to contribute in close co-operation with the ICP Mapping to the calculation of critical levels/loads and their exceedances in forests and to improve collaboration with other environmental monitoring programmes inside and outside the CLRTAP,

- (e) to contribute by means of the monitoring results to other aspects of relevance for forest policy at national, pan-European and global level, such as effects of climatic changes on forests or biodiversity in forests,
- (f) to provide policy-makers and the general public with relevant information.

Especially objective (e) would mean an opening of the monitoring programme towards other areas apart from air pollution. This summer the Executive Body has to decide on the new objectives.

3.2 Products and results

An enormous amount of reports have been produced related to the factors influencing forest health. These reports and publications were partly the result of the EU financed and co-ordinated programme and of national funding. It is impossible to make a comprehensive overview of this material. During the years that the programme exists, several overview reports and/or papers have been produced. Also conferences and workshops were organised in order to bring together specific knowledge on various topics or addressed the overall question of forest health and the factors determining it. The general conclusions of all these studies, conferences, etc. can be summarised as follows:

- there is not one specific factor determining forest health
- forests are exposed to multi stress from natural and anthropogenic origin
- in extreme situations one cause can be identified

More specific products and results and the community added value will be given in the next sections.

3.2.1 Products

The main product is the Level I and Level II monitoring network, its infrastructure, the data produced and the knowledge gained from it. The annual Technical reports and Executive Reports are also important products⁹. The Soil report shows for the first time the Europe wide soil status and extend of acidification of forest soils¹⁰. Two years ago a study was done on the 10 years of monitoring, the so-called ten years overview report¹¹. In this report the results of 10 years of Level I monitoring were linked to external databases and model results to test hypothesis on forest damage in relation to natural and anthropogenic stress. The EU wide database on forest characteristics and health and the Pan-European platform for data exchange on the environmental aspects of Forests are important products. Finally, a very important product is the co-operation between the European countries and the commitment of all the countries to the programme. This good co-operation has led to the implementation of a comparative monitoring programme.

3.2.2 Results

The programme has served as an early warning system. Despite criticisms about the quality and the interpretations, it is an early warning system: if large-scale factors affect our forest ecosystem, it will be detected!

It has provided trends in forest condition over Europe of different species, but also on a regional level. For several years the overall trend has shown for most species a small increase in defoliation, except for Maritime pine, which show a steady increase in defoliation, and Holm Oak, which showed a strong increase until 1995, but a slight recovery afterwards. Regionally trends are different and causes might be different also. These are results from the Level I programme.

During recent years data from the Level II have become available. These are used to test hypothesis on the relation between forest ecosystem health and natural and anthropogenic stress. The Technical Reports on the Intensive Monitoring provide results on the assessments and its quality. Furthermore, through statistical tests relationships were derived amongst the different parameters. From these analyses some important conclusions could already be drawn. Results e.g showed that:

- Both bulk and total deposition of N are higher than S deposition at nearly all the 400 plots monitored up to now, illustrating the more important role of nitrogen.
- Meteorological data allow the calculation of temperature stress and drought stress, being relevant for evaluations of the relative contribution of air pollution to impacts on forest ecosystem condition.
- Part of the variation in crown condition can be explained by differences in precipitation, temperature, N and S deposition, when accounting for differences in e.g tree species and stand age.
- The foliar N and S concentrations of the coniferous species, especially pine, were significantly related to the N and S deposition.
- Concentrations of NO₃ and ratios of Al to Ca+Mg+K above levels that are indicative for adverse effects, do occur at a substantial number of plots and the variation in concentrations of those ions in the soil solution can to a large extent be explained by differences in atmospheric deposition and to a lesser extent by variations in precipitation and soil chemistry.

The Strategy document for the Intensive Monitoring Programme¹² provides a good plan of the possible evaluations and studies which can/will be done in the coming years.

3.2.3 Community added value

Forests are very valuable to people, especially emotionally. The monitoring of the state of our forests provides some confidence in our future and provides a quantitative measure of our activities. The Level I system is already implemented since 1987. This has led to

- Policy and public awareness: Information on trends in regional forest damage has led to a realistic view on the state of forest, which took away worries about the large-scale forest die-back;
- Early warning system: inventories of plagues and diseases or environmental factors influencing forest health;
- Pan-European co-operation between Member states and non-Member states and a EU-wide coverage of research with comparable methods, showing problem areas, supporting policy development;
- Building of knowledge about forest health in relation to environmental factors;
- Providing quick inventories e.g. about damage due to storms, see recent severe storms in France, Denmark, Germany and Switzerland.

The level II system has only been implemented since 1994/1995. The system is still expanding as far as the number of data and plots is concerned. In the actual structure the data is published after 3 years because the countries are responsible for the data and have a year for quality checks and after that the EU have to check the data and a report can be made. This implies that the community added value is likely to be larger in the future than up to now, when more data become available. Examples of added value are:

- Contribution to the monitoring of Indicators for sustainable forest management
- Contribution to the evaluation of air pollution protocols (multi-pollutant, multi-effect and heavy metals) based on information on relationships (already available) trends and critical loads (planned within 1-2 years).
- Contribution to the Climate change Convention based on data with respect to carbon sequestration in forests

4. ACTUAL POLICY QUESTIONS AND FUTURE DEVELOPMENTS

Concerns about many environmental problems in Europe are being addressed through the development of both national and international policies, which aim to minimise trace gas emissions and their impacts. The key themes are listed below, noting in brackets the relevant agreements, with the instruments of prime importance noted by *:

1. *Climatic change*: a) emissions or sequestration of the greenhouse gases CO₂, N₂O, CH₄, CFC's, HFC's, SF₆, O₃ etc., which cause global warming and b) aerosols (primary emitted and secondary formed), which have a cooling effect (1*, 2*, 3*, 4, 5, 6, 7).
2. *Effects of elevated CO₂*: direct effects of enhanced CO₂ include altered plant productivity (with the effects modified by atmospheric nitrogen deposition) and, potentially, species competition change in semi-natural ecosystems (1*, 2*, 3*, 4, 5, 6, 7).
3. *Acidification*: long-range transport of primary gases SO₂, NO_x, NH₃ and derivatives (aerosols, acid gases) leading to acidification of soils and freshwaters (4, 5, 6, 7, 8*, 9*, 10*, 11*, 12*, 13*).
4. *Eutrophication*: long-range transport of reduced nitrogen (NH_x) and reactive oxidised nitrogen (NO_y) compounds (including NH₃, NH₄⁺, NO_x, HNO₃, NO₃⁻, HNO₂ etc.), leading to soil and plant community changes particularly in semi-natural ecosystems (5, 6, 7, 8*, 9*, 10*, 11*, 12*, 13*).
5. *Regional ozone and particle formation*: through emissions of primary gases (SO₂, NO_x, NH₃, VOC). Peak concentrations of 'episodes' affecting human health, ecosystems, crops and forest trees (5, 7, 9*, 10*, 12*, 13*).
6. *Tropospheric chemistry changes*: through emissions of primary gases (NO_x, VOC, SO₂, NH₃) and formation of O₃, other photochemical products and aerosols, affecting 'background' levels to which the episodes add (5, 7, 9*, 10*, 12*, 13*).
7. *Toxic substances*: including the volatile toxic substances: Persistent Organic Pollutants, (POPs) and Polycyclic Aromatic Hydrocarbons (PAH), plus heavy metals such as Cd, Zn, Hg, Pb, Ni, Cu, which may affect ecosystems (5, 7, 8*, 10*, 13*).
8. *Feedback mechanisms*: including the influence of Forest ecosystems on the hydrological and nutrient cycle (1*, 2*, 4, 5, 6, 7, 9*, 13*).

¹ UN Framework Convention on Climate Change - Kyoto Protocol

² UN Montreal Protocol

³ EU Methane Strategy

⁴ Helsinki Agreement on Forest Protection

⁵ UN Biodiversity Convention

⁶ EU Agenda 2000

⁷ EU Habitats Directive (Natura 2000).

⁸ EU Directive on Integrated Pollution Prevention and Control (IPPC).

⁹ EU Acidification Strategy

¹⁰ UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP)

¹¹ CLRTAP: 2nd Sulphur Protocol,

¹² CLRTAP: multi-pollutant, multi-effect 'Nitrogen Protocol' being developed.

¹³ EU Air Quality Directive

Directive 96/62/EC on ambient air quality assessment and management provides a framework for the measurement, reporting and improvement of air quality in the EU. Local and regional action plans to comply with the limit values are required. There are plans for a regular assessment of air quality, including air in forests, as an important instrument for local authorities. Forests are expressly mentioned in Annex II to the Directive as a factor to be taken into account when limit values and alert thresholds are set. Assessment of data of the impact on forests of air pollution, particularly ozone, is therefore important and needs to be co-ordinated with existing activities, e.g. within the monitoring programme. It is also worthwhile to mention

the ozone Daughter Directive (92/72/EEC) in which targets for ozone are listed and the need for monitoring of concentrations in rural areas.

Another important Directive is the National Emission Ceiling, which, based on the same methods used in the Gothenburg Protocol, sets national emissions ceilings for SO₂, NO_x, NH₃ and VOC based on critical loads in Europe. These ceilings will be even lower than those listed in the Protocol. This will bring about progress on protection of forests.

Within the Kyoto Protocol emission reductions for greenhouse gases are agreed upon. In the protocol there is room for renewable energy (biomass) and the use of carbon sinks as reduction potential. In the follow-up of the protocol these options are negotiated. Current negotiations are aimed at fixing the rules of implementation of the Kyoto Protocol, especially regarding carbon sinks in forests (6th conference of the Parties, November 2000). Forests have a high carbon sequestration potential and criteria and indicators will be developed which will result in quantification of this potential. These indicators will represent a certain value, expressed as CO₂ equivalent reduction.

Leading for the coming years in forest research and monitoring will be the Forestry Strategy for the European Union (1999/C 56/01) and the workprogramme resulting from the three Ministerial Conferences. The Forestry Strategy acknowledge the multi-functional role of forests and the stimulation of Sustainable Forest Management. Forests are regarded as multi-purpose which several functions to society. Important subjects are Sustainable Forest indicators; climate change; biodiversity and habitats; afforestation; wood quality; influence of forest on the environment; game resource; protection of agricultural land; recreation, erosion, etc. List of the multiple functions of forests:

- Biodiversity and genetic resources
- Recreation and tourism
- Carbon sequestration
- Wood products
- Protection of agricultural areas
- Game production and conservation
- Improvement of the environment (air and water resources; silence)
- Landscapes and ecological corridors
- Climate regulation (hydrological cycles)
- Erosion protection
- Energy production
- Increasing value of life/living

Each of these functions require a level of quality and protection of forests. For wood products, e.g. up to a certain level fertilisation with CO₂ or nitrogen might benefit the productivity and even the quality, whereas for biodiversity in the forest ecosystem these factors should be as low as possible or virtually absent! For recreational aspects, the level of protection of forest is much lower than e.g. for biodiversity or game resources. There is a need on the one hand to establish different criteria for the different uses, but on the other hand information to develop these criteria and to monitor the feasibility, effect of management and measures, etc. A monitoring programme could have an important function in this direction.

The second and third Ministerial Conferences on the Protection of Forests in Europe were directed to the long-term sustainable management of Forests in Europe. This is translated in the development of 'criteria and indicators for sustainable forest management'. Examples are the maintenance of (i) forests as a net carbon sink to reduce the build up of atmospheric greenhouse gasses, (ii) forest ecosystem health and vitality, (iii) forest production, (iv) biological diversity of forest understorey and (v) protective functions of soil and water resources. The Pan-European criteria and indicators for sustainable forest management established at the follow-up of the programmes can be listed as follows:

- 1. Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles.**
 - Area of forest and other wooded land and changes in area
 - Changes in total and mean volume of growing stock and age structure or appropriate diameter distribution classes
 - Total carbon storage and changes in the storage in forest stands
- 2. Maintenance of forest ecosystem health and vitality**
 - Total amount of, and changes over the past 5 years in depositions of air pollutants (assessed in permanent plots)
 - Changes in serious defoliation of forests over the past 5 years
 - Serious damage caused by biotic or abiotic agents: by insects and diseases; by fire; by storm; and by game or other animals
 - Changes in nutrient balance and acidity over the past 10 years (EU or national network)
- 3. Maintenance and encouragements of productive functions of forests**
 - Balance between growth and removals of wood over the past 10 years
 - Percentage of forest area managed according to management plan or guidelines
 - Total amount of and changes in the value and/or quantity of non-wood forest products
- 4. Maintenance, conservation and appropriate enhancement of biological diversity**
 - Changes in the area of natural and ancient semi-natural forest types; strictly protected forest reserves and forests protected by special management regime
 - Changes in number and percentage of threatened species in relation to total number of forest species using reference lists
 - Changes in the proportions of stands managed for the conservation and utilisation of forest genetic resources
 - Changes in the proportion of mixed stands of 2-3 species
 - In relation to total area regenerated, proportions of annual area of natural regeneration
- 5. Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)**
 - Proportion of forest area managed primarily for soil protection
 - Proportion of forest area managed primarily for water protection
- 6. Maintenance of other socio-economic functions and conditions**
 - Share of the forest sector from the gross national product
 - Provision of recreation: area of forest with access per inhabitant, % of total forest area
 - Changes in the rate of employment in forestry, notably in rural areas

All the different policies related to forest ecosystems, its management and its role in the environment are represented by these criteria and indicators. They have been adopted by the Ministerial Conferences on the Environment and in the different workprogrammes following the Ministerial Conferences, Agreement on Biodiversity, Protocol on climate change, etc. Furthermore, they can serve to fulfil the needs from the Environment Directives with regard to environment and forest issues. The criteria and indicators should be further developed in such a way that quantification in the field provides tools to develop and evaluate policy on forest ecosystems. Furthermore, a good monitoring system is necessary which can provide these data. Part of it fits in the current monitoring programme and in National Forest Inventories, but for some important indicators nothing is available at this moment.

5. EVALUATION: THE ADEQUACY OF THE INTENSIVE MONITORING PROGRAMME IN VIEW OF ITS OBJECTIVES AND ACTUAL DEMANDS

5.1 Introduction

The most important part of this review is the evaluation of the adequacy of the Intensive Monitoring Programme in view of its objectives and actual demands. This is done according to several questions, which are related to the questions raised by the Council and the European Parliament, and the actions undertaken by the European Commission. In a second step the recommendations from the Ministerial Conferences are evaluated. Following questions are relevant for this evaluation:

- What were the questions of the Council and European Parliament?
- What was the European Commission (EC) instructed to do?
- What has the EC done? and
- Did it answer the questions raised and the instructions given by the Council and European Parliament?
- Where are we now?
- What were the recommendations of the Ministerial Conferences?
- In how far did the Monitoring programme fulfil the needs stated in the Ministerial Conferences?
- What can be expected here in the near future? How should the Programme change/improve?

Chapter 3 describes the questions of the Council and European Parliament, the instructions of the EC and the actions undertaken by the EC in detail. Furthermore, in Chapter 3 the recommendations from the Ministerial Conferences are described. In this chapter it will be evaluated if the programme has provided the answers of the Council and European parliament (section 6.2) and if it fulfilled the recommendations from the Ministerial recommendations (section 6.3). Section 6.4 addresses the current state of affairs. In section 6.5 specific topics will be evaluated.

5.2 What were the questions of the Council and European Parliament, what was the EC instructed to do and what was the result?

In 1986 the European Parliament agreed on a Community Scheme on the Protection of Forests against Atmospheric Pollution, Council Resolution 3528/86. Several amendments followed as the result of the concern about the increasing damage and the difficulties of establishing causal relations (see chapter 3). The instructions were to:

- establish a monitoring network with harmonised methods (Level I),
- establish Intensive monitoring with harmonised methods (Level II),
- study causal relationships,
- co-ordinate the monitoring and evaluations,
- arrange the financial support of the programme, and

Observation network of permanent plots (Level I)

The Council Regulations and amendments have led to Commission Regulations (and amendments) to establish observation network **Level I** in 1987 and the intensive monitoring programme Level II in 1994 (see Chapter 3). Level I monitoring plots were implemented on a 16x16 km grid over Europe by the Member States using harmonised methods and, since the co-operation with ICP-F on Forests, also at non EU countries in Europe. At these plots defoliation and needle loss is annually assessed with harmonised methods and the results are reported by the National Focal Centres to the Commission and to the Council. In 1994 the long-term Level

II monitoring programme was implemented where the influence of atmospheric pollution and meteorology on forest condition is assessed. With the implementation of the monitoring programme, the annual reporting and gained knowledge the Commission fulfilled their obligations from the Council Regulation. Furthermore, the Commission Regulations have been implemented and executed by the Member States. The programme had a great influence on the public awareness of the extent of forest damage in Europe and the difference in different regions. Nationally there were differences in the way the programme results were put forward to the public. Especially in Germany, but also in France, the annual assessment results reached the front pages of the newspapers. By the connection with ICP Forest the European coverage of the programme is extended including also non-Member States. This has been of great value to the programme. Furthermore, a direct relation to policy development (Protocols established within the Convention) and policy evaluation on a European scale became possible.

Trends in forest conditions have been established and reported annual. The observation network functioned as proposed in the different regulations. There has been some serious criticism on the forest condition assessments, its comparability and the use as indicators for forest health. Tom Brydges explicitly expressed this in a review in 1998 assigned by the Working group on Effects resorting under the LTRAP Convention. Furthermore, the results of the 10 years Overview report showed the same shortcomings. Partly this problem was tackled by the implementation of the Level II programme.

Furthermore, inter calibrations, courses, etc. were held regularly and the option of using digital photography is currently investigated and, if conclusive, could be implemented. There is still the question of the comparability of the crown condition data for spatial evaluation of the forest damage and the use for policy evaluation and development. However, as stated above, any major deterioration of forest condition in parts of European would be detected.

In the almost 15 years the Level I programme existed we have experienced the most extreme weather condition of the 20th century. Furthermore, due to the protocols signed by the European countries under the Convention and the national acidification policies, in this period deposition of sulphur decreased 60 to 80% and nitrogen deposition decreased about 30%. It is remarkable that this has not (yet) been addressed by the Level I programme and that no evaluation is made if such events and trends can be detected in the effects on forests. The Level II programme exists too short to contribute to such an evaluation, although in the Technical reports, using historical (external) data such an attempt has been made. This subject is highly policy relevant, but also very important for the existence of the programme itself.

Intensive monitoring (Level II)

At the end of the eighties it became clear that there is a complex interaction between multiple stress and tree and forest ecosystem health. In order to study the causal relations the Intensive monitoring programme (**Level II**) was implemented in 1994. Within the Commission Regulations the objectives of the intensive monitoring programme were defined as follows:

- to conduct an intensive and continuous monitoring of forest ecosystems in relation to the damage caused by atmospheric pollution and other factors influencing forest condition,
- to improve the understanding of the casual relationship between changes in forest ecosystem and the factors influencing it, especially atmospheric pollution, by concentrating at a single location various measurements and monitoring of forest ecosystems and its components,
- to obtain relevant information on the evolution of a number of forest ecosystems in the Community.

The first two objectives have been addressed quite accurately in the Level II programme. At this moment almost 900 plots are established in Europe. The results of this programme are reported annual in Technical reports from FIMCI. Furthermore, data evaluation strategies have been proposed and executed. These are mainly directed towards statistical analysis of the relation between effect parameters and natural and anthropogenic stress parameters and to test the hypotheses on cause effect relationships. The programme has not addressed the last objective so far because Level II activities started only recently. The focus has been more on the chemical state of the forest ecosystem and on the derivation of statistical relation ships.

A weak point is the lack of a relationship between effects and emissions. In principal this should be established through the links with ICP-F by connections with e.g. EMEP modelling. There have been some attempts to do so (see 10 years overview report), but has not been done for Level II. The other connection is the estimates of critical loads for forests, which are used in protocol development. Emission reductions are based on a/o. the exceedance of critical loads for forests. The interpretation of the data obtained at Level II is focussed on chemical cycling and on the establishment of statistical evaluations. So far, integration has not been given much attention, except in a statistical way. Process based models have not been tested and further developed. Model application would be a good means to integrate the results of the different surveys and the different Levels. Because of the relative short term existence of the programme it cannot be expected that all these aspects would have been addressed. The Strategy Plan on the Intensive Monitoring clearly lists these activities and proposals are made to include them in the evaluations of coming years.

The commitment of and co-operation between countries within the programme is very large as can be seen from the immediate implementation of (new) measurements after a new Regulation or amendment, from the participation in ring-tests and training courses, the participation in intercomparison studies and the response to inquiries!

Conclusion

In general I conclude that what has been done fulfils the Regulations of the Council and the EC. With the connection to ICP Forests and the Convention, the co-ordination and dimensions have even increased to what originally was intended. The only objective that so far has not been fulfilled is the production of relevant information on ecosystem evolution. Coming years the Intensive monitoring programme will produce important data, which according to the Strategy plan will be used for policy relevant evaluations and contributions to policy development.

5.3 What were the recommendations from the Ministerial Conferences and has the programme fulfilled them?

What was recommended?

The Resolutions from the three Ministerial Conferences are listed in Chapter 3. The three Conferences resulted in several resolutions signed by the European Community and Signatory States that have a direct or indirect relation to the monitoring programme. In Strasbourg the first Resolution was a direct support of the programme:

S1: '*European Network of Permanent Plots for Monitoring of Forest Ecosystems*'.

Resolution S6 stated '*European Network for Research into Forest Ecosystems*'. This resolution was followed by the concerted action EFERN (European Forest Ecosystem Research Network), which established a communication network, international co-operation and a database on ecosystem research on a pan-European scale. The concerted action ended in March 1999¹³. There is no relation with the programme.

The second conference in Helsinki resulted in the definition of Sustainable Forest Management and the need for criteria and indicators. The resolutions that are linked to the monitoring programme are: H2: *General guidelines for the Conservation of the Biodiversity of European forests* H4: *Strategies for a Process of long-term adaptation of Forests in Europe to Climate Change*. Under the listed actions resulting from these resolutions reference is made to the monitoring programme.

Finally, in Lisbon, the multiple functions of forest ecosystems were recognised and the criteria and indicators for Sustainable Forest Management were adopted. The current monitoring programme is related to the second criteria: *Maintenance of forest ecosystem health and vitality*. There are some specific recommendations to the monitoring programme, the most direct one being resolution S1. Indirectly, the recommendations were to recognise SFM as a guiding principle and have a pro-active role in the development of criteria and indicators for SFM and gradually adjust the programme to provide quantitative data that are needed for the criteria and indicators. In practice this has not been done. The Pan European/ICP-F forest monitoring programme has not yet made a significant contribution to the development of criteria and

indicators. After the second Conference a proactive role would have been good to help identify indicators and means to implement and monitor them. This could have speed up the process of adoption and implementation (within the programme). Furthermore, it would have been a good opportunity to advertise the usefulness and the role of the programme. Now the programme is confronted with the need of monitoring indicators where it is not adopted to this need. Some of the criteria and indicators could be implemented in the Level I programme, whereas the research needs can partly be covered by extension of the Level II programme.

The actions that have been taken at Level II were:

- implementation of ground vegetation to assess the effects of air pollution, but also to provide data on biodiversity;
- implementation of meteorology (partly because of climate change);
- Climate change: to determine the carbon sequestration by forests;
- Start of discussions of adaptation within the programme; change of objectives in 2000!

Conclusions

Already some years ago, e.g. in 1992 (Rio), or in 1993 (Helsinki) reference was made to the forest being a multiple purpose system having different functions for society, such as wood products, environmental and ecological function and recreational function. The need for a sustainable forest management policy and related research and monitoring was stressed. Furthermore, the need to investigate the carbon fixation option and the role of forests in preserving and increasing biodiversity was said to be the major new issues in forestry. Although the regulative framework was not suited to start activities in these fields, discussions should have been started earlier on the role of the monitoring programme in relation to these issues. Only in 1999 small changes in that direction were agreed upon and it will take some time before changes in the programme can be made to fulfil the needs in this direction. Furthermore, I think that SFM is so important for forestry that the programme has to define its objectives in terms how to contribute to SFM, in the sense of research, monitoring of indicators, education and public relations. This should be done from the expertise and tasks of the programme, which should be broadened, to the relation between forests and environment. Under SFM and the criteria and indicators I list all aspects of forest ecosystems and its threats, including air pollution, climate change, biodiversity, ground water pollution, rural development, etc.

It is difficult to determine the relation between the resolutions of the Conferences with e.g. the European Forestry strategy. It is to the Member states to participate in the Conferences and to sign the resolutions and implement the agreements. This is on a much more voluntary basis than EU legislation. As long as the Ministerial Conferences and the European Forestry strategy go in the same directions, which is the case up till now, no problems are expected. What worries me is that the preparations and guidance of the two bodies is not done entirely from the same perceptions and this might result in discrepancies. This emphasises the important role of the individual Member states.

5.4 Where are we now?

The Council Regulation will expire at the end of the year 2001. Several developments have taken place the last years related to the multiple use of forests and Sustainable Forest Management (SFM). Recently the Commission completed their view of the Forest Strategy, which was discussed in the Council. In this document under the Community action frame the Community Scheme for the Protection of Forests against Atmospheric Pollution was described. It was stated that the Scheme should further develop, on the basis of a scientific review, the framework for a feasible monitoring system which is at the sharp edge of work in this area and which covers the range of potential impacts such as air pollution, climate change, diseases, pests and other stress factors on forest ecosystems. It should also provide a sound database for decision makers and for research to improve the protection of forest ecosystems. The Commission organised a meeting to open new prospects for amending the Council Regulation no. 3528/86. This will be done through a critical review of the current state of knowledge and experience in this field.

It is clear from the Forestry Strategy, the Ministerial Conferences, the Convention(s) and the different EU Directives (Air quality, NEC, Habitat, etc.) that there is a need for a monitoring system. Furthermore, the results of the Level I, but certainly the Level II programme shows that the work that has been done is valuable and not ended. Changes are, however, needed to adopt the programme towards the criteria and indicators for SFM, which will be the guiding instrument for the coming years. Forest ecosystems, with all its functions will become even more important in our society than up till now, in social and economical sense. New economical value will be found in the sustainable products, sustainable energy and carbon sequestration. The social value will come from employment, recreation and spiritual values. Several threats will be there for forests, not only resulting from air pollution, but also from urbanisation, the need for space for industrialisation, etc., but also the multiple function of forests is a threat. This clearly shows the need for a new commitment of the Council to a long-term monitoring programme to make sure our resources are conserved, with enough quality and diversity to provide the multiple functions.

5.5 Evaluation of specific topics

5.5.1 Organisation

The Member States are responsible for the implementation, execution, quality, data and reporting of the national programmes. This is arranged through the NFC's and is co-ordinated by ICP Forests under the task force and Standing Forestry Commission. The organisational structure is given in Figure 5.1.

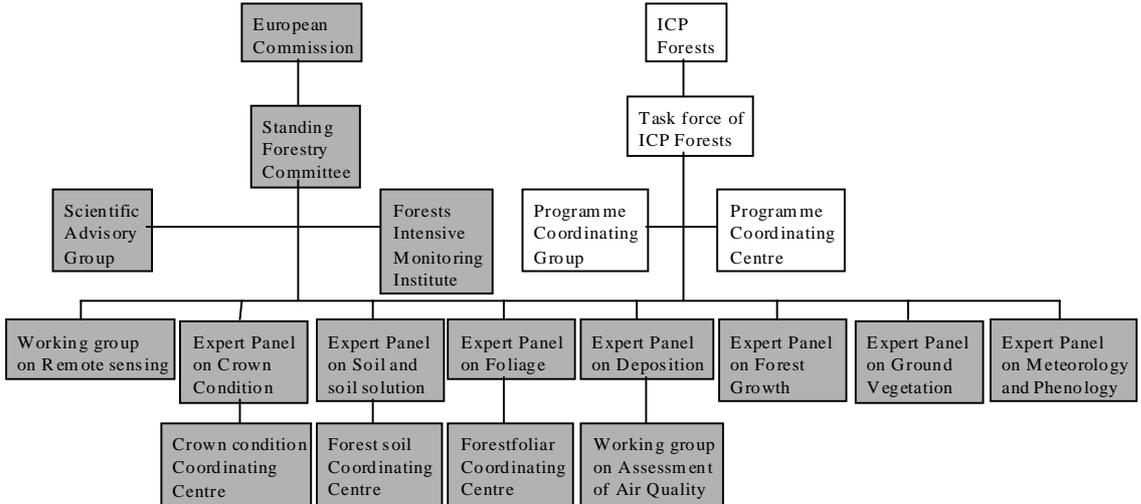


Figure 5.1. Organisation of the programme. EC and common groups are in grey; ICP Forests groups in white

The EU contributes up to 50% of the costs of the programme. One of the main problems is that the Member States have a large degree of freedom to execute the programme. This is of great concern for a monitoring programme which should provide comparable data in terms of accuracy, quality and comparability (see also section 5.5.5). The EU should claim a stronger role in co-ordinating the programme. Time available for that is currently too limited. Adequate staff should be provided and therefore need expansion.

There is no Community Forest Policy¹⁴. Without a Community Forest Policy it is difficult to implement a co-ordinated Community forest monitoring programme, because the Member states decide on their activities. Because of the connection with ICP Forest, a common co-ordinated monitoring programme was established. The difficulties emerging from the lack of a Community forest policy are, however, still also present in the monitoring programme and the individual countries have a large impact on the coherence within the programme. Not all

countries commit themselves to a centrally co-ordinated programme and are not willing to adopt the methods adopted. Air pollution, climate change and natural stresses, such as extreme meteorological events and pest and diseases do not note national borders and actions related to sustainable forest management taking these cross border stress into account should be co-ordinated/executed on an international scale. It is strongly suggested to seek the common national and EU interests in order to create a more focussed cost-effective monitoring programme.

The connection with ICP Forests has had some important advantages: it increased the programme to European dimension, it broadened the audience and the end-users of data and provided the opportunity to co-ordinate the monitoring programme and sharing the co-ordination costs. It, however, has had some disadvantages too. It has made the organisational structure, the responsibility and the transparency less clear. It has also led to more bureaucracy leading to less flexibility. I get the impression that there is a competition between the EU (who pays and co-ordinates) and ICP-F (who co-ordinates). All in all this is not a healthy situation for a co-ordinated programme (see Commission Regulation which states: ... *and establish or extend, in a co-ordinated and harmonious way, the network of observation points...*). Because of the link of ICP-F to the Convention on Transboundary Air Pollution, it has been difficult to open the programme for themes such as climate change, sustainable forest management and biodiversity, which were adopted at the Ministerial Conferences as important for future forest policies but are much less important to the Convention. Recently the objectives of ICP-F and EC were changed to open the programme to biodiversity and climate change directed requests. However, this is done by a 'data-push' instead of making an inventory on what the data needs are and how the programme could be adjusted to fulfil these needs.

Germany has played an important role in the organisation of the programme, because it is lead country in ICP Forest and it provided the representatives in the Commission. Furthermore, its role in bridging eastern and western countries and making sure that a platform was created for co-operation on equal basis was important.

There are too many meetings and not all of them are effective and efficient! This is partly the result of the complex structure, the formal character of the programme and the fact that all the Member states and participating non-Member states have to be represented. These experts are not per definition the experts needed for the EU programme. Participants are nominated by their Ministry and are not necessarily the ideal persons for the different tasks!

Most of the additional tasks are voluntary, such as e.g. chairman of the Expert Panels. These unpaid jobs take a lot of time and people who depend on external financing usually are not able to do these kinds of tasks. The result is that EP's take too little initiative to perform or co-ordinate evaluations.

The programme and its organisation is not very flexible and that is good for the monitoring results, but it is negative in a rapidly changing world with changing requirements and ideas about forest ecosystems!

5.5.2 Finances

Mandatory parameters should be measured and reports should be delivered, before payment can be received. However, in practice the data flow is independent of the financing. 65% of the Level II plots are assessed for 35% of the total costs! Thus only 35% of the plots use 65% of the total costs. This means that the costs of the programme can be optimised if the same costs are counted for similar activities. The question is how to do that by still providing the required products and without serious loss of quality. Most of the costs should have been made because the set-up of the infrastructure is most expensive. However, the annual requested budgets are still rising each year, which means that either the number of plots are increasing or the running costs are getting more expensive.

The EU has reserved 40 million Euro for the whole programme between 1998 and 2002. This budget can not be exceeded, even though the requests for support is rapidly increasing during the last years. For several countries it means that less than 50% of the requested funds is contributed by the EC or less is done. Furthermore, due to the budget limitations less article 4

projects were financed during recent years, which has had an influence on the evaluations and scientific support of the programme.

So far it has been impossible to get a detailed overview of the different costs, per assessment, the contribution to meetings, co-ordination, data management, etc. It has therefore not been possible to extensively review the financial part of the programme.

5.5.3 Scientific quality of the programme

It is difficult to determine the scientific quality and value of the programme, because there are no criteria for doing so. Furthermore, it is a monitoring programme and not a research programme. The scientific quality might be determined by counting the number of papers in international reviewed journals, the number of thesis's that have been produced, the number of patents, the number of key-notes at Conferences and important meetings and the number of scientific reports. An overview of these products is not available and it is almost impossible to get it on the short term. It was not possible to get an overview of the national reports. It is my impression that there is no overview of the (scientific) outcome of national studies. It is therefore also not possible to determine the exact contribution of these studies to science and the quality of the programme. The material that was provided was of good quality.

It has been a tremendous task of the reviewer to find out what exactly the history of the programme was, who decided what, where the main responsibilities lie, etc. This shows, to my opinion, that the public relations need much more attention. The reports that have been produced where those required by the Commission and the Council. Only recently there became more attention for public relations and the connection to the world outside the programme. This has resulted in an EU leaflet, an ICP Forest internet site and visits to meetings from other programmes. On a national Level some of the countries put a lot of effort in their public relations.

The quality of the Executive reports has improved through recent years and is now good. There are, however, doubts about some interpretations putting a too strong emphasis on the damaging aspect of air pollution, which is not directly obvious from the data. References are not always chosen objectively. The Technical reports on Crown condition provide a lot of statistical information and the national reports. The assessment or evaluation of the state of forests in Europe is not balanced and interpretations are in some cases subjective. The Technical reports of the Intensive monitoring are of good scientific quality and provide a good contribution to science. I wonder whether it is necessary and feasible to publish them every year (the same probably holds for the Technical reports on crown conditions).

5.5.4 Monitoring set-up

- Level II plots are selected to be representative for the National forest ecosystems, according to the Commission Regulations: "*plots should be located in such a way that the more important forest species and more wide spread growing conditions in the respective country are represented*". However, it is explicitly stated that Level II is not representative of Europe in a statistical way, which can only be so if the selection is not representative for the country, or not all countries participate, or the criteria used by the countries for the selection of plots were different!? The question is whether this is tested and if true, then the results of the individual plots should be used for testing and development of models for generalisation. The question then is if 900 plots are necessary. It might therefore be better to investigate for what part of Europe (forests/soils/etc.) the plots are representative.
- The way the plots are operated is not the same everywhere: some have a fence which can be trespassed by animals whereas others are completely closed. Some plots special paths are used, etc. Furthermore, the documentation of plots is poor in terms of usability for evaluation studies. Remote Sensing is a technique with a large potential for deriving these kind of data. Unfortunately remote sensing is still a very green and unexplored area and a lot of research is necessary before it can be used as a solid monitoring tool for different purposes (including crown condition assessment). The remote sensing activities are increasing and the working group does some good work. However, a better link should be

- made between the monitoring programme (ground truthing), remote sensing observations and their interpretation! The same is true for aerial photography.
- Level III is not implemented so far, although it was already mentioned in the ICP Forest manual in 1989. There has been some contacts between ICP Forest and ICP Integrated Monitoring. The plot research in ICP IM can be considered as natural unmanaged ecosystems on a catchment scale Level III monitoring. Furthermore, there is discussion about subdividing Level II into plots where all the assessments are done (core plots) to distinguish from the rest (Level II).
 - Several data are lacking, which are necessary for evaluation of the data quality and of causal relationships and integrated studies, such as management of the forest, several forest characteristics (height, distance to forest edge, etc.), Na and Cl in soil solution, DOC in throughfall, water fluxes, etc.
 - I am not in a position to judge if all the surveys done at the Level II plots are necessary with the frequency and intensity that they are performed. An independent evaluation should be performed, which results e.g. from the internal review executed within ICP Forests¹⁵. I can only say that I have serious doubts about some parameters and the plots where they are measured. Meteorological measurements, e.g., are included because these parameters are very important for forest ecosystem health. Meteorology is measured at a large scale by the individual countries and large detailed databases are available to determine grid-wise meteorological parameters, e.g. at JRC and at the European Centre for Meteorology and Weather Forecast (ECMWF). I wonder if meteorological measurements at the plots are really necessary and what additional measurements at the plots can add to existing networks and the generalisations obtained from them. The only parameter that is difficult to interpolate and thus difficult to obtain from measurements other than those at the plots is precipitation. Precipitation is measured on a bi-weekly or monthly basis by bulk-samplers in the open field and by throughfall samplers below the canopy. Furthermore, it might be necessary to perform additional measurements in mountainous regions. A pre-study on the necessity, frequency and location of such measurements would have been fruitful.
 - The upscaling from Level I to Level II has been discussed in the programme. This is difficult because the programme is not set-up for upscaling. It is necessary to use the Level II data to test models, which can be used for upscaling. Such proposals are made in the Intensive monitoring strategy document.

5.5.5 Data management and quality

Data management:

The data centre(s) collect the data from the national level into Pan European databases. Presently, the Level I data collection is divided over three institutes whereas the Level II data collection is concentrated in one institute. On Level I, the data for the crown condition are collected by the BFH, Hamburg (which combines this task with its PCC tasks); the soil data are collected by the FSCC (Gent) and the foliar chemistry data by the FFCC (Vienna). On Level II all data are collected by FIMCI (Heerenveen/Wageningen). Evaluations are mostly carried out with the main scope(s) of the data centre as the central subject. Since the Level I data for the three disciplines is collected in three different centres, special provisions should be made for the validation between the various surveys, especially with respect to the consistency of the plot data and crucial location and site characteristics. This task has been allocated with the BFH, since the overall co-ordination of the monitoring is also carried out by this institute.

Level I: Crown condition at Level I is collected annually by the BFH/PCC. The validation of the data included in the data base includes a general test on the correctness of the reported data, but does only include a limited check on the completeness and on the consistency with previously loaded plot characteristics, which has led to the inclusion of conflicting site, stand and location characteristics and/or incomplete general characteristics. The chemical forest soil condition at Level I has been investigated once. The validation of the data included a ring test, an evaluation of the applied method and a limited set of plausible ranges for the obtained results. The chemical foliar condition at Level I has been investigated once in less than half of the countries and distributed over several years. The validation of the data included ring tests, an

evaluation of the applied method and comparison with a set of plausible ranges for the obtained results. A special task is the validation of plot (location, site and stand) data between the three Level I surveys, since the data collection at Level I is carried out by three different institutes. A good link between the three databases is indispensable for any internal or external evaluation. However, hardly any validation of this kind was carried out, which appeared to be a major thread and/or an avoidable source of loss of available data and noise in all internal or external evaluations. Part of the work done by external institutes, including necessary validation, could/should have been done much earlier by the Level I data institutes.

Level II: The various surveys at Level II are reported in annual technical reports by the FIMCI. The validation of the data included in the database includes checks on the consistency of the plots data, both between consecutive assessments and different between surveys, a comparison of applied methods and the large set plausibility checks, which can already be carried out by the countries before submitting their data.

The main conclusions, with regards to the data management in the present situation, are:

- The fragmentation of the data collection at Level I is a main cause for inefficient working and extra need for communication and validation.
- Inadequate validation procedures have led to a Level I database, which still requires a lot of validation. This applies particularly for conflicting plot, site and stand characteristics between the three databases and between successive crown condition assessments. There are too many errors in the system: how to overcome these? It has been shown that there is a role of the data centres to check the data and confront NFC's with inconsistencies. However, this takes a lot of manpower. NFC's have the responsibility and they should be more active!!
- The level of staffing of the Level I data centres and the imbedding in regular research programmes is insufficient to assure the continuity and the scientific quality of the output.
- The Level II data centre has a strong emphasis on soil and chemical related disciplines. This is counterweighted by the imbedding in institutes that can provide additional expertise and by a pool of external experts.
- Long-term commitment is necessary for laboratories, data centres, etc.
- The question is if the use of 4 data centres is an effective approach or that it could better be concentrated in one centre.

Several parameters are assessed, but not reported because they are not mandatory nor optional. The database and data management should be so flexible that these data are also included. A system should be developed where in every step the documentation is added to the data, without blowing-up the database too much. Certification teams should be introduced to follow the international ISO standards. They should assess the procedures followed and check if NFC's fulfil their laboratory work as they should do, do all the checks, etc. Before the assessments are done procedures have to be developed first. ISO9001 can be used as an example!

Data quality

A quality aspect is the comparability and the accuracy of the data. An important aspect is the fact that the Member States are responsible for the implementation and execution of the monitoring programme, which they base on the manuals provided (and revised) by the Expert Panels. These manuals are not based on scientific aspects alone. There is a strong subjective element in the manuals through preferences of different countries, costs, methods which have been chosen already, etc. Generally different analytical methods are used in different countries and it is difficult to reach a consensus on methods. Also the principle of "recommended" methods need, in case using other methods, to prove that they are reliable. This directly leads to the organisation of a very large QA/QC programme to establish the quality, accuracy, precision and comparability of the different methods. A clear example for this is the methods used to measure open field precipitation. This is one of the oldest environmental chemical measurement and methods were optimised and tested during the years. In 1999 a comparison experiment started for throughfall sampling in Speulder forest and for precipitation sampling in Schagerbrug. The methods used by the different countries were installed at the two locations.

Most of the methods do not meet the criteria developed for good precipitation measurements and are far from the accurate methods developed in the eighties!

A lot is done about the quality of the assessment of different parameters: comparisons are made for crown condition assessments, ring tests are done every two years for the foliar analysis, and deposition methods are compared in a joint field experiment in Schagerbrug and Speulder forest, ring tests of throughfall and precipitation samples are performed regularly. Meteorological observations are done according to met-office standards. For soil solution ring tests and intercomparisons have been organised and lab training was organised. More attention is, however, needed mainly because of the above mentioned difficulties.

The programme was set-up/initiated as a monitoring programme to make *a uniform periodic inventory of the damage caused to forests*. At the time it was assumed that effects of natural and anthropogenic stress affecting forest (tree) health could easily be monitored by discoloration and defoliation as these were the effects observed in severely damaged forests due to acidification. These parameters were therefore chosen as “effect parameters” to be monitored. In the meantime it has become clear that the forest condition is affected by various stresses, acting sequentially or concomitantly, which are expressed in a large range of effect parameters, few of them being specific. The effect parameters discoloration and defoliation are also not specific and without additional information difficult to interpret. This has been a discussion topic for many years and was also criticised in the review of Tom Brydges. The underlying problem is that there is no uniform specific parameter, which represents forest vitality (health) and can be monitored in a cost-effective way. The result was that the monitoring programme was extended with additional parameters in order to determine the (chemical) state of the forests (effects). Furthermore, the Intensive programme was established to support the monitoring programme and to find relationships between stress and effects. Currently the use of digital camera's is investigated. Pictures can be used as independent assessment of crown condition and provides the possibility to reassess crown conditions at other times by other persons. It is clear that the initial set-up of a monitoring programme shifted to a more research oriented programme by monitoring different parameters. The influence of biotic factors and ozone should be given more attention.

5.5.6 Policy relevance and Community value

Especially in the eighties and early nineties the programme was highly policy relevant and had an important added value to the community. It provided scientific judgement about the forest dieback situation and the annual changes therein, which was needed because of the great concern from the public. During the almost 15 years of monitoring public awareness and priority has changed. The large-scale forest dieback was not as serious as supposed and it became clear that the predictions of large-scale forest dieback at the turn of the century would not become true. Was the state of the environment the second most important societal topic at the end of the eighties, after economics, at the end of the nineties, however, it dropped on the list. It is clear that the programme had a (in)direct contribution to policy development and public awareness at the end of the eighties, which is supported by the resolutions of the first Ministerial Conference. However, as public awareness changed, the scientific knowledge about the complex interactions increased, the scientific community failed to provide the evidence for the predictions of large-scale forest dieback and the level of pollution decreased, the value of the programme has decreased. Most of the knowledge on the complex interactions was gained from national acidification research programmes and research supported by DG-RES. The focus of Forests has changed rapidly in the nineties as the result of changes in society. Forests were increasingly considered as ecosystems and atmospheric pollution was considered as one parameter in Sustainable Forest Management, next to parameters related to climate change, biodiversity, spatial development, etc.. This has become clear from the second Ministerial Conference in 1993 and has been further elaborated and operationalised by the third Conference. The programme has so far not actively picked this up and did not change the set-up and focus accordingly.

The programme was very much inside oriented (see also 6.5.6) and the formalities related to obtain data and information limit its use. There is an enormous fear that if others use

the data that they do the wrong things with it because they cannot judge the data as good as the scientists of the programme can. This is an attitude that does not fit in modern society. It is a fear that the outside world identifies the weaknesses and that others will use the data for those assessments you want to do yourself but failed to do so far, or that the outcome is not in line with the opinion of the programme.

5.5.7 Relation to other programmes and activities

Through ICP Forests there is a formal relation with other work under the LRTAP Convention. However, there is very little co-operation with the other ICP's, the Working Group on Effects and other bodies (such as EMEP). The manuals of ICP Forest and ICP Integrated Monitoring have been compared and tuned to some extent, but the outcome of the different programmes have never been compared. Also the results of EMEP monitoring and modelling have never been directly linked with the deposition work within the programme. The results have not yet been used by ICP Mapping. Furthermore, links with formal bodies are very limited or only started very recently (EUROSTAT, EEA, DG's, etc.).

It is rather disappointing if you surf through the internet to see how many forest research links can be found and how little reference is made to the programme! There are a lot of activities presented at the internet which are aimed at forest research and co-ordination in a broad sense: FAO, IUFRO, COST Actions and Concerted Actions, IFF, UNED, IFP, EFI etc. A stronger interaction with these activities, if relevant, should be sought.

6. RECOMMENDATIONS

In view of the future an opinion will be formulated on:

- the capacity to fulfil (or contribute) to the specified needs in the Forestry strategy
- the improvements needed.
- the direct steps needed for improvement to the actual monitoring system (Level I and II) in view of all the above mentioned aspects.

In 1999 the Forestry Strategy was adopted by the Council. Sustainable Forest Management is the guiding principal in the Forestry Strategy. The instrument to develop and evaluate SFM is the Pan European Criteria and indicators as formulated and adopted at the Lisbon Ministerial Conference in 1998 (see Chapter 5). For these criteria and indicators parameters of the forest ecosystem should be quantified related to issues like air pollution, climate change, biodiversity, water pollution, etc. Some of these indicators can directly be obtained from the current monitoring programme, for some slight changes or extensions are needed and a last group can be identified where large changes are needed or where no quantitative indicators are formulated and need further development. The program set-up and infrastructure is a very good basis for providing quantitative indicators related to forest ecosystems and the environment.

Last December the multi-pollutant-multi-effect protocol was signed by 29 states in Gothenborg and will result in a further decrease of emissions, critical load and critical level exceedance and effects in Europe. This protocol abates four components. There is a great need for monitoring and evaluation of the protocols, which are mainly based on models of the chemical cycles in nature. This will be the main emphasis for ICP Forest under the LTRAP Convention for coming years. In close connection and based on the same principals the EC NEC Directive will be implemented soon, with even somewhat lower emission ceilings on national level. This requires monitoring of the effects on ecosystem (forest) pollution/input levels, effects and changes on restoration Also the Daughter Directive of ozone under the Air Quality Directive will require evaluation of the progress. The current monitoring program fully supports these needs and can, after some optimisation, provide cost-effective data for policy (protocol) evaluation.

Based on the outlook presented above I strongly recommend to provide a formal structure to extend the Pan European monitoring programme on Forest Ecosystems. The connection with ICP-F should be established in some form to keep the link to the Convention and to include the non-Member states. The programme provides a Pan European platform where data is exchanged between different nations in Europe, without (political) borders. This makes the programme of great value. The EC needs a new Regulation in order to prolong the monitoring programme and make the necessary budgets available. The current Council Regulation can be renewed still with the focus on air pollution, but by widening its objectives towards SFM and the Criteria and Indicators. Given the long-term nature of different indicators, the policy and protocol targets, etc., the programme should have a long-term basis and support. A review at least every 5 years is necessary in order to determine the progress in view of its objectives and its relevance for actual policy and policy development or evaluation. I strongly recommend to open the programme, to increase the accessibility of data, to establish links to other databases and to use the data more for policy oriented products. In the following sections I will list some specific recommendations, which might be useful to consider when the programme will be extended.

6.1 Organisation

The programme has to be directed to the Resolutions of the second and third Ministerial Conferences and the resulting EU work programme. This means that it should play an important role as expert centre on the relation between forest ecosystems and the environment (see also below). This role should be based on the monitoring programme (at different levels), the

knowledge gained from the results and the expert knowledge. This means that the programme should be more directed towards different environmental factors affecting forest ecosystems and ecosystems affecting the environment. In this way it can increase its contribution to the development, implementation and monitoring of indicators and criteria which are used for Sustainable Forest Management. It has to be extended towards biodiversity, climatic change, carbon and nitrogen cycling, water quality, air pollution, hydrological cycles, etc. For the current situation it means that it has to be evaluated how the programme can be optimised to fulfil its obligations from CR3528/86 with reasonable accuracy and quality and can be extended to fulfil the SFM needs.

The co-operation between ICP-F and the EU is a good basis for improving the value and co-ordination of the programme, especially for the co-operation with non-Member states within the programme. ICP-F is currently forced by the Working Group on Effects and the Executive Bureau to put too much emphasis on the Convention related to air pollution and to the national interests. The programme has to be extended addressing the criteria and indicators for SFM, which is much broader than air pollution alone. Therefore, the organisational structure needs changes. If the Executive Body does not allow ICP-F to widen its objectives, ICP-F might better be the partner for the sub-part of the programme focussing on atmospheric pollution instead of the whole programme directed to SFM. This would have consequences for the organisational structure. Meetings should be reduced and more efficient! Furthermore, given my comments on the current organisational structure in section 6.5.1, I see a need to simplify and optimise it. There are two ways this can be done: i) by taking the programme and the end-users as such as a starting point and suggest a new structure or ii) by taking the current situation as a starting point and suggest changes. Both options will be discussed in the next sections.

6.1.1 New structure

Forest policies get a much more international perspective. Furthermore, the sustainable, multi-functional use of forests is recognised. Therefore it is necessary to co-operate on a global scale when working on SFM and the interaction between environment and forests in the broad sense (climate change, biodiversity, natural and anthropogenic threats, such as urbanisation, splitting-up of forest areas, air pollution, etc.). The programme should establish a much broader and stronger role in advising from the knowledge that is gained from monitoring, research and evaluation, to policy makers as well as the public (through education, etc.) and research community. I see an opportunity for the creation of a European Forest ecosystems and Information Expert Centre (EFFECT). The aim of such a centre would be to develop, provide and evaluate European wide indicators on forest ecosystems and the environment to support Community and national development of SFM policies. This is done by monitoring, evaluation, research co-ordination, database management, knowledge basis, education, public awareness, advise and policy support. The current programme could be directed towards such an expert centre, which can act as a Programme Management Group.

ICP-F could be represented in the Programme Management Group, specially responsible for forest ecosystems and the effects of air pollution and the relation with the Convention. By widening the objectives of ICP-F and opening the data for SFM and related topics, this might secure the participation of non-Member states in the programme.

The tasks of such a Programme Management Group could be:

- monitoring programme
- database
- research co-ordination
- knowledge basis
- developing, application and interpretation of remote sensing methods
- evaluation of research in the area
- education
- public awareness
- advise, e.g. developing criteria for sustainable development; sustainable forest management in relation to the effect of forests on the environment and vice versa,

- policy support: evaluation of policy through evaluation of monitoring and research results, e.g. by focussing on questions such as: what species can be conserved/increased with certain forest management practices within different environments; which combinations of ecosystems, climate and environmental factors are most sensible and which can tolerate highest stress; what are critical limits for forest ecosystems under different conditions and with different management?; etc.

In this way, EFECT will have the responsibility to co-ordinate the programme, secure data quality and provide the end users with products. The Group should consist of respected scientists or programme managers, who will be paid for their work in the group. EFECT can support EFICS by directly delivering the data and information, covering a large part of EFICS, especially for the information related to forest ecosystems and the environment.

6.1.2 Optimisation of current structure

Given the current organisational structure, I strongly advise to simplify and to strengthen the programme co-ordination. The Taskforce and the Standing Forestry Commission will have their own responsibilities and mandates. It would be good if a stronger relation between the two could be established to prevent overlap and to increase synergy. Below these two bodies I would suggest to create a new Programme Management Group (PMG), which could replace the SAG and PCG. The PMG is responsible for the programme, the data quality, data management, evaluations, connections to other programmes and databases and the production of end-products. Members of the PMG are paid for their work. One institute is responsible for data management, this can be done by forming a consortium with expertise in different fields. Expert panels or project groups are only established when needed for specific topics and will not be permanent. Chairman of the Expert Panels and the work done should be paid, e.g. as Article 4 projects. One of the first Expert panel projects that should be started is about integration. Furthermore, a project on indicator development and short and long-term implementation should be started.

The programme should periodically be reviewed externally in order to see if the objectives are fulfilled, etc.

For a lot of the listed recommendations I see the problem that 50% is paid by the EU and the other 50% by the Member states and that there is no Community Forestry Strategy. It is therefore very difficult to co-ordinate the programme on a European level and to prescribe who has to do what, where and how! It has to be clear to the states that by co-ordination their own value is increased without diminishing the national interests!!

6.2 Finances

More budget should be available for pre-studies to determine what critical parameters should be monitored to address a certain issue and for evaluations, also for specific evaluations for specific questions.

The costs of the programme should be optimised in order to make room for these changes. The question is how to do that by still providing the required products and without serious loss of quality. The Council has to make a decision about extension of the programme in 2001. By providing a good programme plan that is aimed at the needs resulting from the Council, the Ministerial Conferences and the societal demands for helping implement SFM would certainly convince the Council of its value and help to find new financial support.

6.3 Scientific quality of the programme

The programme should be opened to other users to increase its use, e.g. within research communities, through the internet, etc. Currently no webpage is available showing results of the programme and from different forests institutes no single link to the programme was found! Establishing an internet site with results, data and knowledge about forests, etc. is strongly advised. By putting a fraction of the data and results from integration on the web, which can be used, e.g. for model evaluation, data become more known to the research community and to the

public. This is advertising for the programme, but also feedback is obtained from scientists who use the data and evaluate their models or compare with other data. Also, in this way links to other data will be established. Those scientists who need more data than placed on the web will apply for them and for those arrangements can be made about exchange of results, etc. The access to the data should be simplified. The internet, but also other channels should be used to publish results obtained by the programme, both in simple wording as well as in scientific journals. In this way the programme becomes more known and scientists will be invited to use the data for further evaluations, also in other areas than covered by the programme itself.

It is good to have an annual Executive Report of the year's activities and results. The reports should be distributed widely amongst the public, policy makers in different areas, NGO's, etc. This is currently already the case. I don't see a need for annual Technical reports of both Level I and II in the future. It might be better to publish in one year a technical report for Level I and the next only for Level II.

It is necessary to produce a summary/evaluation of the results obtained from the different (article 4) projects and national studies that have been executed. These should be summarised and the lessons learned should be implemented.

6.4 Monitoring set-up

If there was one easy to assess, clear effect parameter than the programme would be simple! As there is none, it is not known what to monitor and different levels must be identified. However, more effect parameters and biotic factors should be measured. This should also be directed towards ecosystem health, biodiversity and global change. An area that so far has been neglected is ecosystem development and succession. This might be important to detect long-term effects, which so far have not been detected because of the focus on the chemical status of the ecosystem and related effects.

As indicated in chapter 5 the main emphasis in forest management and research will be on criteria and indicators for sustainable development. The programme can make a valuable contribution to these indicators without directly increasing the workload to a large extent. New indicators for which no clear measurable quantities are available and which are not measured within other programmes should first be studied at a research level, or it should be discussed in workshops by the research community which parameters should be measured to provide information on such indicators. Then a proposition should be made how and where these parameters should be measured, for what period and when evaluations of the progress should be done and what the costs are. Then a proposal is made to the co-ordination (EU). If concurrent or alternative measurements are proposed, both parameters should for a certain time be measured simultaneously in order to determine the value and trends of past measurements. One should be very careful though to change methods in a monitoring network, this always leads to breaks in trends! In this way the programme can be optimised and extended focussing on the political questions.

Processes of change take time. Level II is implemented only 6 years ago and still not fully operational. Evaluations are now becoming relevant and necessary. The change towards more actual policy questions is necessary and the programme should be opened to that. This, however, time will be needed for pre-studies and to get commitment and implementation. In the following the different levels of monitoring will be discussed.

Level I: continue trends of crown condition, especially defoliation. (including if possible more reliable health indicator, photography, forest characteristics,...). Use the infrastructure to extend the assessments towards SFM criteria and indicators, e.g. pest, diseases and plagues; red list species; epiphytic lichens; increment, growth and forest characteristics, including management. More integration by starting at the biological processes to understand reaction on natural/anthropogenic stress: branch architecture, fruiting, insects, diseases, etc. Repeat the nutrient status every 5 years, soil every 10 years. Develop models for estimation of meteorology and deposition, etc.

Level II: Contrary to the Level I assessment, the Level II network is not designed for statistical evaluation rather than testing of hypotheses of cause – effect relationships. It is not designed to cover Europe so that the data are representative of Europe, but it must represent the European species and environmental and climatic areas. The purpose must be to monitor key parameters necessary to evaluate the chemical, biological, ecological and physical changes in the ecosystem and to evaluate models describing the ecosystem (changes) and which are used for generalisation. The intensity of the measurements and the measurement programme at the Level II plots can differ because of the specific climatic and environmental factors, which dominate in different areas. This is expressed in the following table:

Table 6.1. Overview of aims, key parameters and possible relations with other activities or databases which could be used as an input for selection of Level II plots, both the general ones (only a limited number of parameters) as the core sites (all parameters)

Compartment	Aim/effect	Key effect parameters	current availability of effect factor	stress	Key stress parameters	Current availability of key factor	Possible relation with other databases/ activities	Possibility to include	Relevant area
water resources	Ground water quality	pH, element concentrations	+	nitrogen	N deposition	+			N-E-C-EU
				acidification	acid deposition	+			N-E-C-EU
climate (two ways)	Carbon storage	carbon storage/ sequestration	-	toxicity/pollution	HM deposition	-	-	+	C-EU
			+	climate	C/N,	+			EU
			-		CO ₂ flux	-	+ (Carbo-Europe)		EU
					concentrations		-		
soil resources	soil quality/ functioning	pH, leaching,		meteorology	CO ₂ , N ₂ O, CH ₄	-			EU
			+	Nitrogen	P, T, ET	+			N-E-C-EU
			+	acidification	N deposition	+			N-E-C-EU
Fauna	Biodiversity	number of species and composition/ fauna change		toxicity/pollution	HM deposition	-	-	+	C-EU
			-	acidification	concentrations		-	+	C-EU
					- HM	+			N-E-C-EU
Flora	Biodiversity	Number of species and composition/ vegetation change	+/-	meteo (drought)	- pH, Al, Ca	+			N-E-C-EU
			-		- NH ₄ , NO ₃	+			N-E-C-EU
					P, T, ET	+			EU
					concentrations/deposition	+ MARS			
Trees	wood production	growth wood quality		nitrogen	- NH ₄ , NO ₃	+			S-EU
				acidification	- acidity, Ca	+			N-EU
	crown condition	defoliation/ discolouration		ozone	- ozone	+			EU
				toxicity/pollution	- HM	+/-	+ (EMEP, etc.)		C-E-EU
Social	Recreation	land use, visual aspects		drought/ frost	P, T, ET	+/-	+ (satellite)	+	EU
				spatial planning	land use	+			EU
				spatial planning	land use	-			EU
				'visual condition'	land use	+			EU
		biodiversity		crown condition (see biodiversity)				EU	

The EU sees the requested costs growing and the question is if this expansion is necessary. Cost is strongly related to quality and usefulness of the product. After 6 years it is necessary to evaluate which plots provide useful information for the EU scale, showing gradients in deposition of different compounds, specific air quality situation (ozone), combinations, specific meteorology, mountains, etc. The quality of the data of these plots should also be assessed. If useful and correct, then a plot can be financed (50%) from the EU perspective. In those areas where plots are needed the EU might develop a special subsidiary programme to establish a plot (100%) and run it for a necessary number of years until the costs are reduced and the countries provide 50% of the budget. The message is here: concentrate on high quality plots where a high quality data standard can be reached and on the most relevant and useful parameters! This could mean less plots, but also intensification in some areas. More and better prescription of methods which can and which cannot be used is necessary.

Research sites: detailed study of processes to determine the key parameters which should be measured on Level II and Level I. Research strategy should be based on hypothesis, which should be adopted or rejected!

A link between Level I and Level II (and research sites) should be established through development, evaluation and validation of models. Countries have the task to do evaluations and integration, but usually they do not have the capacity. It is therefore advised to centralise this tasks. This is a good option for combining EU and national interests.

Remote sensing has a high potential, especially for monitoring spatial parameters. It is my conviction that remote sensing could have a key role in monitoring of forest condition and forest parameters. The technique is however green and preliminary. In several countries some promising results are obtained. The development should, however, be more directed towards the parameters needed for monitoring and should be more focussed on the objectives.

6.5 Data management and quality

There are complaints about the quality of the data; databases and evaluation studies. These should be improved. I would advise to make one institute responsible for data management and evaluations, through co-operation with some additional institutes.

Certification is a good tool to improve methods and to keep quality high. A team of experts that visit the research institutes every year for an assessment could do certification. This would stimulate the different laboratories or assessment teams to improve their quality, based on professional advice and recommendations. The ultimate consequence must be that, if after several consultations the quality is still too poor that the team or laboratory is apparently not fit to do the job and another must be sought.

The methods used for the different assessments should be much more harmonised. There is too much freedom in the choice of different methods. Therefore, additional extensive intercomparison studies are needed to show that different methods produce the same results. By using the same methods the comparability of data will strongly improve.

6.6 Policy relevance and Community value

The data that result from the programme should be used to develop policies to reduce the stress forests are exposed to, to support the Air Quality Directive and to support Sustainable Forest Management. This could e.g. be done by deriving critical limits for different stress factors, such as critical loads (soil) and critical levels (exposure to gases), but also critical meteorology parameters or nutrient cycles, etc. Furthermore, the data should be used to evaluate the effect of different policies, such as the Protocols signed under the Convention or the Directives by the European Commission. The most recent protocol, the multi-effect-multi-pollutant protocol signed in Copenhagen in December 1999 is based on effects of pollutants on ecosystems, amongst others forests. The agreed reductions in emissions will lead to a decrease in stress and improved forest ecosystem vitality. The programme should use its data to assess these positive effects.

The data, evaluations and assessments should be made public much more frequent and much more open. An internet site should be made where such information can be found. Here

also limited data should be made available to the research community and the public to be used for further analysis. This should invite people to use the data and therewith increase its value. Furthermore, a contribution to education could be made by translating the knowledge about forest health and the influence of human activities on forest health into 'digestible' information.

6.7 Relation to other programmes and activities

More integration and co-operation with other programmes, such as EMEP, ICP-IM, IUFRO, FAO, EFICS, etc. is necessary. Furthermore, interaction and co-operation with other networks should be sought in order to contribute to broad assessments by using the data of other networks, but also by promoting the use of the program data by others. Relevant networks are:

- EMEP
- ICP Mapping, Integrated monitoring, Crops, etc.
- National air quality and meteorological networks
- Inventories on Pest and diseases
- Biodiversity monitoring networks
- Carbo-Europe
- WMO
- FAO
- EUROSTAT
- Soil inventory
- MARS
- ECMWF
- Remote sensing
- Etc.

7. CONCLUSIONS

Schematic overview of review conclusions

	Positive points	Negative points
1.	Council Regulations and Commission Regulations have been fulfilled	The research on the evolution of ecosystems, one of the objectives of the Council regulation has not been addressed until now.
2.	Ministerial Conferences Strasbourg (S1) has been fulfilled	Ministerial Conferences in Helsinki and Lisbon (on biodiversity and Sustainable Forest Management) were not picked up
3.	The programme has contributed to the public awareness and to the state of knowledge on forest health trends	Extreme weather situations have not adequately been picked up. Although sulphur (S) was reduced considerably in the last 10 years, it is hardly mentioned
4.	Connection with the ICP Forests increased the programme to European dimensions	The connection to the ICP Forests increased also the organisational structure and made it less flexible. It has been difficult to open the programme for the above mentioned points 2 and 3, as ICP Forest is directly linked to the Convention (CLRTAP)
5.	There is a good co-operation with different nations and between west and eastern Europe	Due to the formal character of the programme, too many meetings have to be organised. Some of the meetings are not very effective and efficient.
6.	Member and non-member states have contributed to a large extent to realise the monitoring programme with European dimensions	Costs of the programme are not well balanced. 75% of the level II plots are assessed for 35% of the costs. Optimisation will provide financial leeway.
7.	Harmonisation of methods including QC/QA programmes	Quality aspects need to be continued, some methods need to be improved, especially in the condition of Crown and ecosystem by including extra effect parameters.
8.	The Intensive Monitoring has successfully been implemented and has led to a thorough evaluation plan of which the first outcomes are already available	Remote Sensing is still very green and unexplored area with a high potential.
9.	Programme provides a platform where data are exchanged without (political) borders.	Programme is oriented inside and data accessibility should be improved.

RECOMMENDATIONS

1.	In Gothenborg (and probably also in the EU) ceilings have been (will be) set for emissions	This requires monitoring of effects. The programme could play an important role here.
2.	The programme does not contribute to a large extend to the Resolutions form Helsinki and Lisbon	The programme should be directed towards different environmental factors affecting forest ecosystems and ecosystems affecting the environment. Especially issues such as biodiversity, sustainability, climate change, carbon and nitrogen cycling should be picked up.
3.	Although the co-operation of EU and ICP Forest is a good thing, the ICP F currently puts too much emphasis on the Convention and national interests.	As the programme has to be extended (see point 2 above) the organisational structure needs to change.
4.	Effect parameters are limited	More effect parameters and biotic factors need to be defined and monitored.
5.	Budgets are now used for the assessments	Costs should be optimised. If this is done, some budget should then be made available for pre-studies on critical parameters to be monitored.
6.	Quality of data, databases and evaluation studies has to be improved	Advise to make one institute responsible for all data management and evaluations, through co-operation with some additional institutes: merge the current datacenters for level I.
7.	Quality of data has to be improved or kept high	Introduce certification as a tool to improve harmonisation of methods and high quality of data.
8.	The programme is financed 50-50 by EU and the Member States. As there is no clear Community Forest Strategy in this aspect conflicts arise.	A clear strategy has to be developed.
9.	The addressing of the various aspects is now done incomplete and by different groups	Create an Expert Centre for the European Forest Ecosystems and Environment or at least a strong programme management group. Add more EU staff to support the programme.

8. LIST OF ABBREVIATIONS

CE	Council of Europe
CEC	Commission of the European Community
COST	Cooperation in the field of Scientific and Technical Research
DG	General Directorates of the European Commission
EC	European Commission
ECMWF	European Centre for Meteorology and Weather Forecast
EEA	European Environmental Agency
EFFECT	European Forest ecosystem and information Expert Centre
EFICS	European Forest Information and Communication Centre
EFI	European Forest Institute
EMEP	European Monitoring and Evaluation Programme
FAO	Food and Agriculture Organisation of the United Nations
FIMCI	Forest Intensive Monitoring Coordinating Institute
ICP	International Co-operative Programme on Assessment and Monitoring of Air Pollution on Forests
IFF	International Forum on Forests
IPF	Intergovernmental Panel on Forests
IUFRO	International Union of Forestry Research Organisation
LTRAP	Long-range Transport of Air Pollution
MARS	Meteorological Archive and Retrieval System
NEC	National Emission Ceilings
NFC	National Focal Centre
PCG	Programme Coordinating Group
PMG	Programme Management Group
SFM	Sustainable Forest Management
UN/ECE	United Nations/European Community of Economic development
UNE	United Nations Environment Programme
WMO	World Meteorological Organisation

9. LIST OF SCANNED LITERATURE AND CONSULTED PERSONS

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