UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE
CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

International Co-operative Programme on
Assessment and Monitoring of Air Pollution Effects on Forests

MANUAL

on
methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests

edited by the
Programme Coordinating Centres
Hamburg and Prague 1994

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3rd edition

edited in 1994 by

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CONTENTS

PREFACE

In the early 1980s widespread forest damage was reported from an increasing number of ECE member countries. The rapid dynamics of forest decline at several locations, the absence of obvious classical damaging agents, the results of cause-effect research and an increasing awareness of the impact of air pollutants on the environment lead to various hypotheses involving long-range transboundary air pollution either as a predisiposing, accompanying or even triggering factor.

Against this background, the Executive Body for the Convention on Long-range Transboundary Air Pollution decided, at its third session in July 1985, to launch the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests). The Programme received the mandate 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 depositions), so as to improve evaluation of trends in damage resulting from pollution and to establish a better understanding of cause-effect relationships. The launch of the Programme, including the preparation of a Manual, was financed by the United Nations Environment Programme (UNEP) under UNEP/ECE project FP/6103-83-01.

The Executive Body also decided to establish a Programme Task Force (PTF) with the Federal Republic of Germany as lead country to start with. The PTF followed up the implementation of the Programme (work plan, ECE/EB.AIR/7, Annex IV, 3.3.3).

The structure of ICP Forests is based on National Focal Centres (NFCs) i.e. institutes or laboratories of the participating countries which submit information to two Programme Coordinating Centres (PCCs). These are PCC East at the Forestry and Game Management Research Institute (VULHM) in Prague, Czech Republic, and PCC West at the Federal Research Centre for Forestry and Forest Products (BFH) in Hamburg, Federal Republic of Germany.

The first meeting of the Programme Task Force, held in Freiburg im Breisgau (Federal Republic of Germany) in October 1985, requested the two PCCs to prepare a Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. The first edition of this Manual became available in 1986, and was followed by a second edition in 1989. Since 1989 ICP Forests has, in close cooperation with the European Union (EU), greatly extended its methodical harmonization towards a more intensive monitoring on permanent sample plots. These methods have been incorporated into the present third edition of the Manual.

1. STRUCTURE OF ICP FORESTS

This Chapter provides the background on the programme objectives, its monitoring intensity levels, its monitoring activities and the tasks of its various bodies. Annex 1-1 shows the position of ICP Forests within the structure of the subsidiary bodies under the Convention on Long-range Transboundary Air Pollution. The structure of the bodies of ICP Forests is visualized in Annex 1-2.

1.1 Programme objectives

The main objectives of ICP Forests are

- the continuous large-scale monitoring of air pollution effects on forests
- the contribution to a better understanding of cause-effect relationships.

Consequently ICP Forests on the one hand has to collect information on the spatial and temporal development of forest condition at the European scale, and on the other hand has to extend the knowledge about the causes of recent forest damage with emphasis on critical loads and levels of air pollutants. Both objectives require very different methodical monitoring approaches. These are realized by means of monitoring systems of different representation and different intensity levels which are defined in the following chapter.

1.2 Monitoring intensity levels

1.2.1 Definitions of monitoring intensity levels

The large-scale monitoring of forest condition in Europe must for financial reasons be confined to a low monitoring intensity, i.e. a small number of parameters to be assessed. A contribution to cause-effect studies, however, requires a large number of parameters, which in turn cannot be assessed at a large scale. Therefore, ICP Forests has defined the following three monitoring intensity levels:

Level I: Large-scale survey of forest condition (crown condition, soil condition etc.) aimed at achieving results related to the spatial and temporal development of forest condition. This is accomplished by means of a grid of systematically selected plots covering the forest area of a country (national grids of different densities) and of Europe (16 x 16 km grid) with low monitoring intensity per plot.

Level II: Intensive monitoring of forest condition aimed at the recognition of factors and processes with special regard to the impact of air pollutants on the more common forest ecosystems. This is principally accomplished by means of a number of subjectively selected permanent monitoring plots with higher monitoring intensity per plot.

Level III: Special forest ecosystem analysis aimed at gaining a deeper insight into cause-effect relationships with special regard to the effects of air pollutants. This will be accomplished by means of a number of permanent sample plots suitable for scrutinizing the complex interactions between all compartments of the ecosystem in detail (e.g. including ecosystem balances).

In principle, for each of these Levels a number of sample plots is selected, the selection and the design of which depends on the surveys to be conducted on them. All three levels, their plot selection, their plot design and the assessments conducted on them are described in the following three chapters.

1.2.2 Level I

1.2.2.1 Objectives

The objective of the large-scale representative survey is

- to obtain information on the spatial and temporal variation of forest condition in the individual member states and in Europe and thereby to contribute to the identification of large-scale impacts of long-range transboundary air pollution on the forests of Europe. The results of the Level I monitoring can, especially in connection with those of the Level II monitoring, be a basis for environmental policy decisions.

1.2.2.2 Plot selection and establishment

At Level I the transnational survey and the national surveys have to be distinguished. The plots for these surveys are selected systematically from respective coordinate grids.

The transnational survey is conducted in close cooperation with the EU and aims at the documentation of the development of forest condition on the European level rather than on the national scale. This is achieved by means of a large scale monitoring of tree vitality and a number of site parameters on a uniform 16x16 km transnational grid of sample plots. In several countries the plots of this transnational grid are a subsample of the denser national grid.

The transnational grid was created in Gauss-Krüger projection. The latitude and longitude of the sampling points were then obtained by means of a reprojection of the grid points to geographical coordinates. These coordinates were calculated and provided to the participating countries by the CORINE project of the EU. If a country had already established plots with coordinates deviating from the calculated ones, the existing plots were accepted, provided that the mean point density resembled that of a 16x16 km grid, and that the assessment methods corresponded to those of the ICP Forests Manual and the relevant Commission Regulations. The fact that the grid is currently less dense in parts of the boreal forests can be shown to be of negligibly small influence due to the homogeneity of these forests and their current forest condition.

The national surveys aim at the development of forest condition in the respective country and are therefore conducted on national grids. The densities of these national grids vary between 1x1 km and 32x32 km due to differences in the size of forest area, in the structure of forests and in forest policies.

The following criteria may be used to decide the suitability of a coordinate point within a forest stand:

- the coordinate point must clearly fall into forest land, the forest area surrounding the coordinate point being sufficiently large (i.e. 1 ha) to allow selection, measurement and assessment operations;

- in general the sample point should lie at an appropriate distance from the forest edge, but provisions can also be made that forest edges are statistically adequately represented (mirror imaging).

If a coordinate point is unsuitable because of one or more of the above conditions, the sample point may be shifted over a limited distance. This may be done using a random number grid overlay on the scale of the map used (Annex 1-3), in order to avoid personal bias. Other procedures for shifting are acceptable provided the selection process is unbiased.

In the national surveys each participating country may choose its own design of systematic sampling so long as statistical principles are adhered to and the comparability of data at the international level is not impaired.

1.2.3 Level II

1.2.3.1 Objectives

The monitoring at Level II has the objectives to

- obtain and evaluate information on the impact of air pollutants and other damaging agents on a representative number of forest ecosystems in each of the participating countries

- contribute to the critical loads/levels programme of UN/ECE

- improve the understanding of the cause-effect relationships between tree condition, atmospheric pollution and other causes which could influence forest condition.

1.2.3.2 Plot selection and establishment

Each participating country shall select and install a number of permanent Level II plots. The selection of these permanent plots lies within the responsibility of each participating country. The plots should be selected according to the following criteria:

- The plots should reflect the more important tree species and more widespread growing conditions in each country.

- Within the plot, the situation shall be as homogeneous as possible (regarding e.g. tree species, stand type and site conditions).

- The selected plots should reflect the tree species composition and growing conditions of the surrounding area.

- Whenever possible, plots should be selected which have been monitored during the last years.

- The great advantage of existing data on air quality and meteorological parameters from nearby stations should be taken into consideration whenever establishing Level II plots.

The plot size depends on the stand density, e.g. crown condition assessment and increment inventory need a minimum number of trees on a fixed area, normally 0.25 ha. Each plot is surrounded by a buffer zone with a minimum width of 10 m, if possible.

There should be no differences in the management of the plot, its buffer zone and surrounding forest (e.g. management operations should be comparable and fencing should be limited to a minimum). However, the disturbance of the monitoring activities should be minimized. Trees felled in the plot or in the buffer zone should be registered and whenever possible used for increment analysis.

1.2.4 Level III

The objective of Level III is a deeper insight into cause-effect relationships with special regard to the effects of air pollutants. This objective is planned to be met by means of ecosystem analysis on a number of permanent sample plots, as it is already being carried out by the ICP on Integrated Monitoring. As a consequence, ICP Forests will implement Level III in cooperation with the ICP on Integrated Monitoring.

1.3 Monitoring activities

1.3.1 Level I

The monitoring at Level I comprises the visual assessment of defoliation and discolouration (Chapter 2), partly the sampling and analysis of soil (Chapter 3) as well as the sampling and analysis of needles and leaves (Chapter 4). For each plot of the transnational (16 x 16 km) grid the following plot data should be recorded :

GAUSS-KRÜGER coordinates

- altitude
- aspect
- water availability
- humus type
- soil unit
- mean age of dominant storey

The individual assessments should be carried out with the following frequencies:

Assessment	Frequency
transnational plot data	once (water availability, humus type and mean age have to be updated continuously)
crown condition	every year
soil (solid phase)	once (recommended to be repeated every ten years)
needles / leaves	recommended to be repeated every fifth year

1.3.2 Level II

On the Level II plots, the general plot data shall be assessed, and the assessments specified in Chapters 2 - 6 of the present Manual (assessment of crown condition, soil, foliar analysis, increment and deposition) shall be executed. These assessments are mostly split up in a

mandatory part and an optional part. It is advised to concentrate on the mandatory part of each survey. The individual chapters of the present Manual are regularly updated. Additional chapters on meteorology and vegetation are being planned. The general plot data to be assessed are listed in Annex 1-4.

Assessment	Frequency
general plot data	once (but the description of stand and water availability has to be updated every five years)
crown condition	at least every year
soil	once (recommended to be repeated every ten years)
foliage	at least every two years
deposition	continuously
increment	at least every five years
climate/weather	to be decided at a later stage
vegetation	to be decided at a later stage

1.4 Time schedule, reporting and evaluation

1.4.1 Level I

The results of the defoliation and discolouration assessments have to be submitted along with written reports to PCC West every year for evaluation. As regards the transnational data set, for EU member states the EC remains the official addressee. However, EU member states may also send their transnational data directly to PCC West, in order to insure their arrival at PCC West in time. PCC West will copy the data from EU member states and forward them to EC. For the annual reporting of the results the following deadlines must be observed:

December 15	submission of the transnational data in the proper digital formats,
December 31	submission of written reports and filled forms A1-A3, B1-B3 and C (Chapter 2).

1.4.2 Level II

The general plot data and important information obtained during installation of all Level II plots (Annex 1-4) should be reported to PCC West by December 15, 1994. For those plots established at a later date, however, subsequent reporting will be accepted. Both the raw data assessed and written reports should be submitted to PCC West by December 31, 1996, and from then on every 5 years. Instructions and forms for the submission of data are included in Chapter 7.

1.5 Tasks of the National Focal Centres

The NFCs, as nominated by the participating countries, have the following functions and responsibilities:

- organizing monitoring data collection in accordance with agreed guidelines;
- condensation and synthesis of monitoring data;

- ensuring that the national data have been collected according to the standards and are presented in the formats laid down in the Manual:

- organizing training of field personnel as required;

- participating in intercalibration programmes and other verification procedures organized by the PCCs;

- maintaining contact with the relevant PCC, coordination, cooperation and information wherever and whenever appropriate;

- submitting data in the agreed form and, as soon as possible, to the appropriate PCC.

National Focal Centres are financed by their respective countries.

1.6 Tasks of the Lead Country

The Lead Country convenes and chairs meetings of the Task Force normally once a year. It prepares decisions to be made by the Task Force with the assistance of the ECE Secretariat, the PCCs, the Programme Coordinating Group, the Expert panels and other bodies of ICP Forests. The Lead Country also convenes and chairs meetings of the Programme Coordinating Group. The Lead Country represents ICP Forests in the Working Group on Effects and is in contact with other important monitoring programmes within and outside of the LRTAP-Convention.

1.7 Tasks of the Programme Coordinating Centres

The PCCs East and West, in cooperation with the ECE Secretariat, have the responsibility in particular for:

- collection, checking, processing and storage of data submitted by the NFCs

- coordination and harmonization of methods, observation and measurement procedures in order to assure comparability of data

- clarification of doubtful issues of international importance, in particular of problems affecting compatibility and comparability of forest assessment data

- assistance in planning training courses for the chiefs of national forest damage surveys to facilitate harmonization

- arranging expert meetings to deal with particular technical problems

- organization of intercalibration programmes and implementation of data quality control procedures in the participating countries

- recommendation of methods for sampling and analysis.

PCC West is responsible for the annual evaluation of the data set and for the preparation of the annual Forest Condition Report.

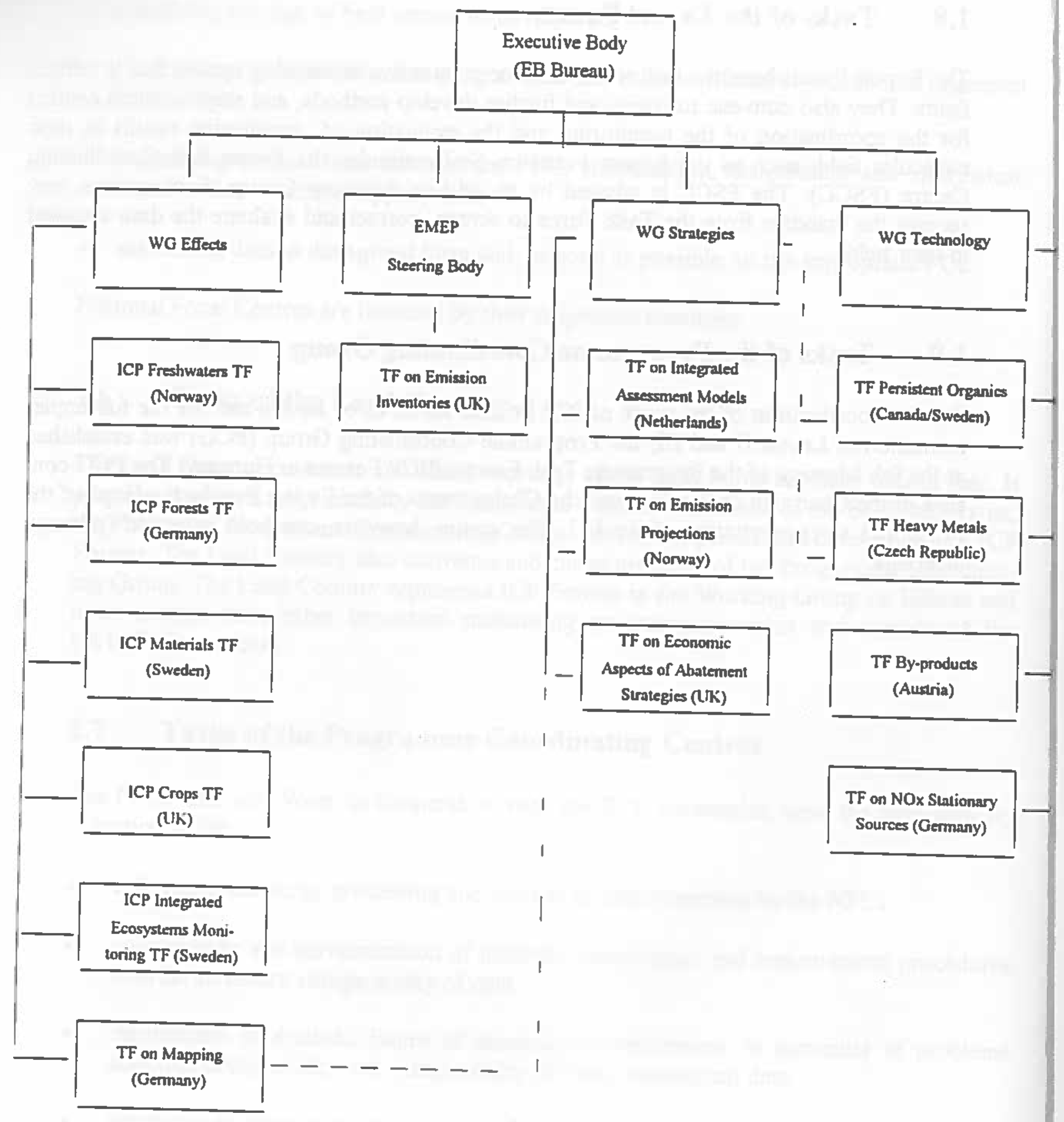
1.8 Tasks of the Expert Panels

The Expert Panels have the task to develop more intensive monitoring approaches in certain fields. They also convene to revise and further develop methods, and may maintain centres for the coordination of the monitoring and the evaluation of monitoring results in their particular field, such as the Expert Panel on Soil maintains the Forest Soil Coordinating Centre (FSCC). The FSCC is advised by an ad-hoc Advisory Group. Such centres may receive the mandate from the Task Force to screen, correct and evaluate the data assessed in their field.

1.9 Tasks of the Programme Coordinating Group

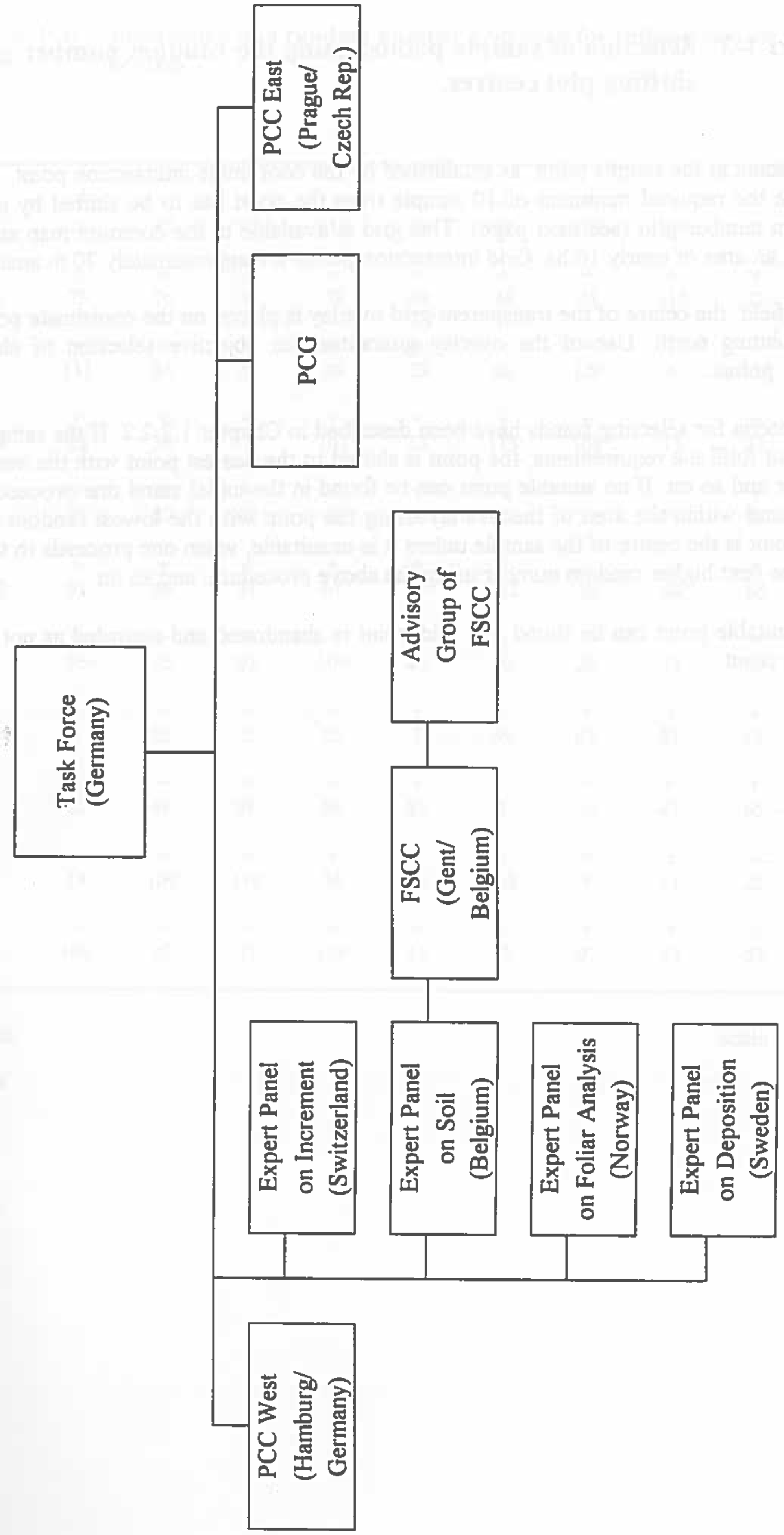
For the coordination of the work of ICP Forests on all three Levels and for the full implementation of Levels II and III, the Programme Coordinating Group (PCG) was established at the 9th Meeting of the Programme Task Force of ICP Forests in Hungary. The PCG consists of the Chairman of ICP Forests, the Chairpersons of the Expert Panels, the Head of the PCCs and a representative of the EU. This group, however, can hold extended (plenary) meetings.

Annex 1-1: Subsidiary bodies of the LRTAP Convention



ICP = International Cooperative Programme
TF = Task Force (with lead country)

Annex 1-2: Bodies of ICP Forests



FSCC = Forest Soil Coordinating Centre
PCC = Programme Coordinating Centre
PCG = Programme Coordinating Group

Annex 1-3: Selection of sample points; using the random number grid for shifting plot centres.

If the stand at the sample point, as established by the coordinate intersection point, does not contain the required minimum of 10 sample trees the point has to be shifted by using the random number grid (see next page). This grid is available in the common map scales and covers an area of nearly 16 ha. Grid intersection points are approximately 70 m apart.

In the field, the centre of the transparent grid overlay is placed on the coordinate points, the top pointing north. Use of the overlay guarantees an objective selection of alternative sample points.

The criteria for selecting stands have been described in Chapter 1.2.2.2. If the sample point does not fulfil the requirements, the point is shifted to the nearest point with the next higher number and so on. If no suitable point can be found in the initial stand one proceeds to the next stand within the area of the overlay using the point with the lowest random number. This point is the centre of the sample unless it is unsuitable, when one proceeds to the point with the next higher random number using the above procedure, and so on.

If no suitable point can be found this grid point is abandoned and recorded as not being a sample point.

Figure 1-3: Illustration of a random number grid used for shifting sample point centres

102	14	57	91	114	89	81	105	119	5	54
58	79	76	34	58	48	38	21	118	22	62
82	111	84	47	40	23	80	120	4	115	50
54	12	39	1	103	53	115	108	15	33	17
44	73	87	92	66	59	98	32	99	72	19
117	51	46	51	67	0	112	50	88	85	37
41	95	35	93	104	45	70	28	74	30	8
113	3	29	75	55	7	59	63	31	12	10
58	20	49	26	96	83	2	24	43	65	9
90	13	100	110	36	75	105	9	11	25	96
94	101	27	71	109	15	77	97	42	52	107

north ↑

scale 1:5000

Annex 1-4: Relevant data to be collected on permanent plots

	Installation	First survey
Descriptive code	Country Observation plot number Actual latitude and longitude	
Site data	Altitude Orientation Total plot size Number of trees in plot Sub-plot (if any)	Availability of water to the principal species Humus type Soil unit (estimate)
Stand data	Mean age of dominant storey Main tree species Yield (estimate)	
Other observation	History of the plot Nearby situated other monitoring station	

2. VISUAL ASSESSMENT OF DEFOLIATION AND DISCOLOURATION

2.1 Sample tree selection

Within both the national and transnational surveys, at each sampling point positioned on forest land, sample trees are systematically selected according to a statistically sound procedure. An example is the 4-point cross cluster, with 4 subplots oriented along the main compass directions at a distance of 25 m from the grid point. On each subplot the 6 trees nearest to the subplot centre are selected as sample trees, resulting into 24 sample trees per plot (Annex 2-1).

Other procedures are possible, however, a minimum of 10 sample trees shall be assessed at each sample point. Also, a significantly larger number of sample trees may be selected in order to describe the health status of the stand more completely.

The tree sample includes all tree species, provided the trees have a minimum height of 60 cm. Only predominant, dominant, and co-dominant trees (canopy classes 1, 2 and 3 according to the system of KRAFT, Annex 2-2) without significant mechanical damage qualify as sample trees.

Trees removed within management operations or blown over by wind must be replaced by newly selected trees. A special evaluation of the replaced trees has shown that, due to the small percentage of removed trees, this replacement does not distort the assessment results. If the stand is clear-cut, the sample point ceases to exist until a new stand has been established.

Selected trees may be marked for re-assessment during subsequent inventories.

In younger, dense stands, where individual crowns are not assessable, sample trees are selected according to a defined process. This process is repeated until sufficient trees with assessable crowns have been found.

2.2 Defoliation and discolouration classes

The most important parameters which have to be recorded at each monitoring intensity level are defoliation and discolouration.

a) Defoliation is assessed in five classes.

- 0 not defoliated
- 1 slightly defoliated
- 2 moderately defoliated
- 3 severely defoliated
- 4 dead

These classes are commonly separated according to needle/leaf loss percentage as follows:

Class	Degree of defoliation	Percentage of needle/leaf loss
0	not defoliated	0 - 10%
1	slightly defoliated	>10 - 25%
2	moderately defoliated	>25 - 60%
3	severely defoliated	>60%
4	dead	

b) Discolouration of foliage, is a valuable diagnostic indicator, and may be assessed, for example, using the following 4 classes:

Class	Discolouration	Percentage of needles/leaves discoloured
0	None	0 - 10%
1	Slight	10 - 25%
2	Moderate	>25 - 60%
3	Severe	>60%

For diagnostic purposes it is necessary to record also which set of needles is discoloured, e.g. only needles of the current year (1), needles older than the current year (2); all needles, regardless of age (3).

c) The combination of defoliation and discolouration classes into a combined damage class is optional; the following system may be used:

Defoliation class	Discolouration class		
	1	2	3
	Resulting damage class		
0	0	1	2
1	1	2	2
2	2	3	3
3	3	3	3

2.3 Guidelines for fieldwork

- Defoliation is generally estimated in 5 or 10 % classes relative to a tree with full foliage. In dense stands this means that approximately the upper half of the tree crown could be assessed and in more open stands the whole tree crown. The reference tree could be either a healthy tree in the vicinity (of the same crown type), a photograph, locally applicable, representing a tree with full foliage, or the sample tree itself with imagined

full foliage. If different classification schemes are used, the class intervals, i.e. the respective defoliation percentages, must be specified.

- Observers must have a satisfactory view of the tree from several observation points. On level ground, the optimal view is given at a distance of one tree length; On slopes, trees should be observed at a distance of about one tree length above the tree or at least on the same level.
- Assessment should be done by two trained observers using binoculars. When the estimates produced by the two observers differ, both should change their observation position (other forms of quality control may be used).
- Assessment should be done in full daylight, but it has to be recognized that the assessment, particularly of crown discolouration, may be affected by the quality of the light and the time of day.
- Observers should be provided with locally applicable, standard photographs of trees of each species and of different crown types with which to compare the trees to be assessed. Examples of various defoliation classes can also be provided if this is considered desirable.

2.4 Training field crews

Field crews should consist of two professionals, at least one a diploma-level/graduate forester as the responsible crew leader. Prior to the beginning of the annual field season, survey crews should undergo a period of concentrated theoretical and practical training in measurement and assessment procedures and in filling out the various forms.

2.5 Check survey

As customary in national forest inventories, a proportion (e.g. 5-10%) of the sample plots measured by each survey crew, must be remeasured by an independent check survey crew. This control inventory covers all measurements and assessments made by the field crews. In case of significant discrepancies, adjustments of instruments of clarification of instructions and their application must be arranged immediately to avoid serious systematic errors.

2.6 Reporting national results to the Programme Coordinating Centres

In order to secure comparability of data, all countries conducting forest damage surveys shall submit their results on the forms supplied by the PCCs (see the following pages).

The methods of assessment and the way the results are compiled must be explained in a supplementary statement.

Forms A1 and B1 are mandatory and refer to the assessment of defoliation in conifers and broadleaves. Forms A2/B2 and A3/B3, which refer to the assessment of discolouration and the combined defoliation/discolouration assessment, are optional.

In addition to national results. NFCs are also requested to submit results for regional units, if available. The same forms should be used.

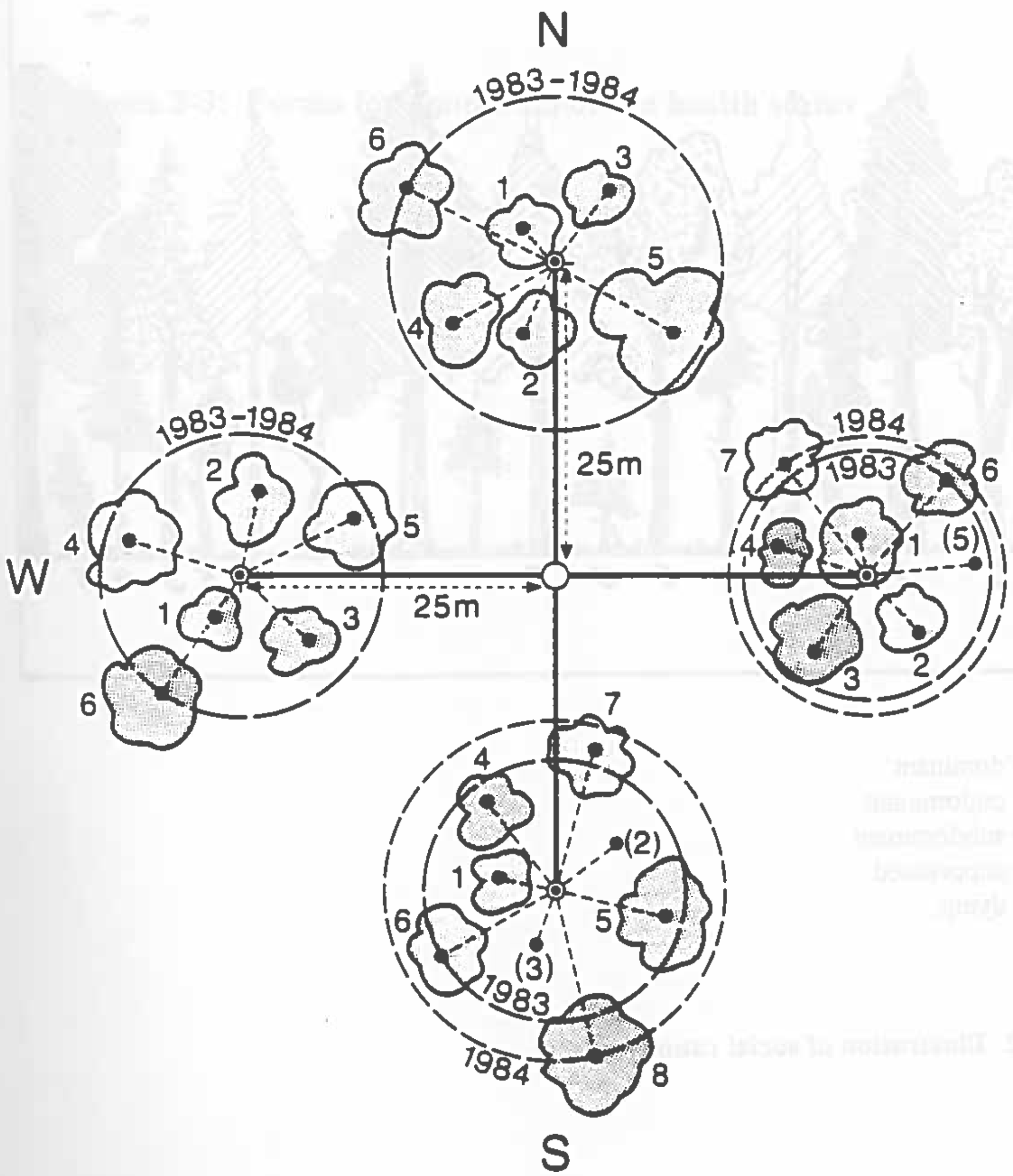
Countries compiling supplements to their basic data should attempt to explain their findings. For example, assertions that a proportion of the damage is attributable to air pollution, should clearly state how this proportion was calculated.

A section of the national report should be devoted to the analysis of important information on the possible causes of the observed damage in particular with reference to atmospheric pollution. Results of any correlations between different types and stages of forest damage (defoliation, discolouration, other signs of damage) and parameters such as site or stand characteristics, climatic data etc. should be included in the annual report.

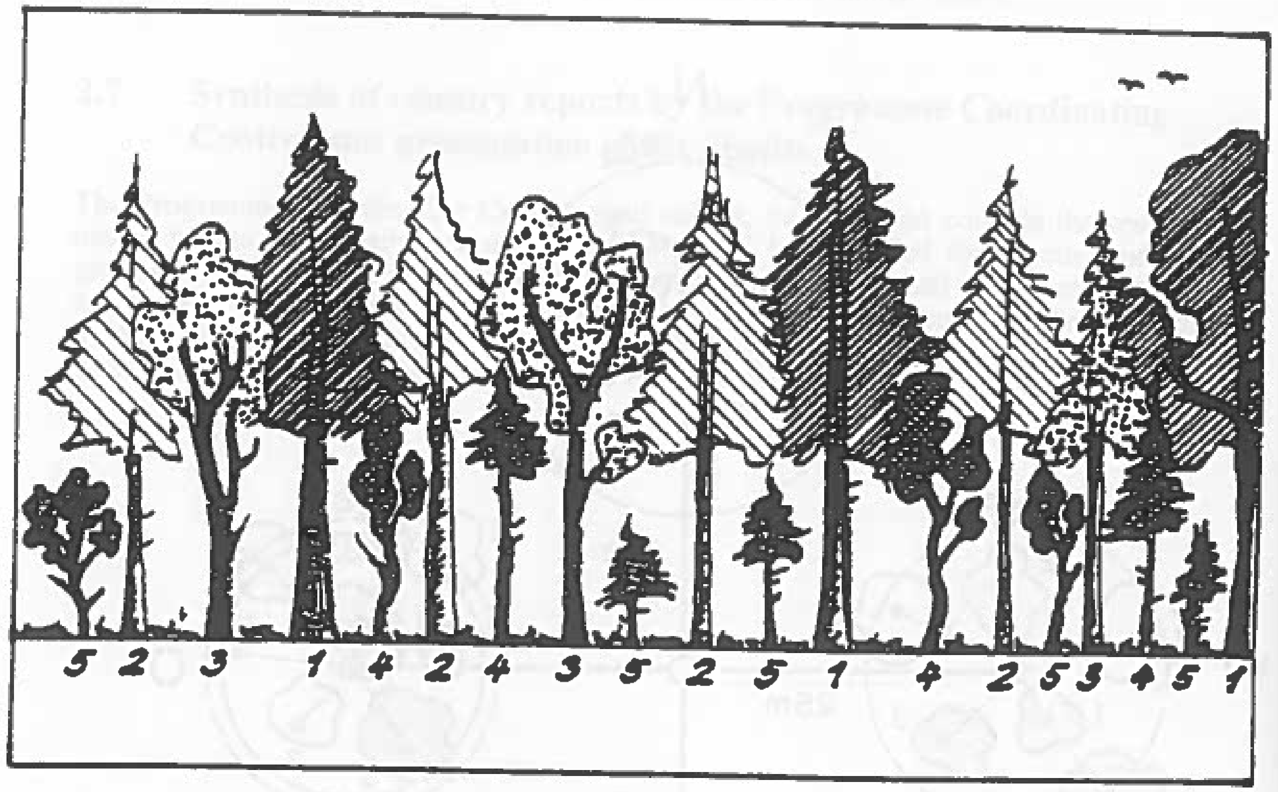
2.7 Synthesis of country reports by the Programme Coordinating Centres and presentation of the results

The Programme Coordinating Centres shall collect, evaluate and compile the results submitted by the participating countries. Results shall be compiled for species and species groups, age classes, growth regions or regional units. Results shall be presented in tabular and graphic form and shall be complemented by a text pointing out the salient features of the forest health conditions by countries and for the respective ECE-region as a whole. This general statement shall be submitted to the ECE-Secretariat.

Annex 2-1: Illustration of 4-point cluster with 6-tree sample and sample tree replacement



Annex 2-2: Illustration of social status classes (crown canopy classes) after Kraft



1= dominant
2= codominant
3= subdominant
4= suppressed
5= dying

Figure 2-2: Illustration of social canopy classes

Annex 2-3: Forms for annual report on health status

Convention on Long-Range Transboundary Air Pollution

International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests

Annual report on health status of main tree species on the basis of defoliation:

country: region: growth area:

institution (national local centre):

survey period: day/month - day/month/year

(from - to) - 19

CONIFERS

form A1

Classification		Percentage of trees defoliated														
		trees up to 59 years old							trees 60 years and older							
1	2	3	4	5	6	7	8	9(3-8)	10	11	12	13	14	15	16(10-15)	17(9+16)
	species:						others	total						others	total	grand total
	area of species:															
	no. of sample trees:															100
defoliation class	percentage of needle loss	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0 not defoliated																
1 slightly defoliated																
2 moderately defoliated																
3 severely defoliated																
4 dead																
total		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Return to Programme Co-Ordinating Centre West Bundesforschungsanstalt für Forst- und Holzwirtschaft, Leuschnerstraße 91, D-2050 Hamburg 80, Federal Republic of Germany

Convention on Long-Range Transboundary Air Pollution

International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests

Annual report on health status of main tree species on the basis of discoloration:

country: region: growth area:

institution (national local centre):

survey period: day/month day/month/year

(from - to) 19

CONIFERS

form A2

Classification		Percentage of trees discolored (yellowed)														
		trees up to 59 years old							trees 60 years and older							
1	2	3	4	5	6	7	8	9(3-8)	10	11	12	13	14	15	16(10-15)	17(9+16)
	species:						others	total						others	total	grand total
	area of species:															
	no. of sample trees:															100
discoloration class	percentage of needles discol.	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0 not discolored																
1 slightly discolored																
2 moderately discolored																
3 severely discolored																
total		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

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Convention on Long-Range Transboundary Air Pollution

International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests

Annual report on health status of main tree species on the basis of the combined assessments:

country: ______ region: ______ growth area: ______

institution (national focal centre): ______

survey period: day/month - day/month/year

(from - to) ______ - ______ 19 ______

CONIFERS

form A3

Classification		Percentage of trees damaged (defoliation and yellowing combined)														
		trees up to 59 years old							trees 60 years and older							
1	2	3	4	5	6	7	8	9(3-8)	10	11	12	13	14	15	16(10-15)	17(9+16)
	species:						others	total						others	total	grand total
	area of species:															
no. of sample trees:																
combined damage class																100
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0 not damaged																
1 slightly damaged																
2 moderately damaged																
3 severely damaged																
4 dead																
total		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Return to Programme Co-Ordinating Centre West, Bundesforschungsanstalt fur Forst- und Holzwirtschaft, Leuschnerstraße 91, D-2050 Hamburg 80, Federal Republic of Germany

Convention on Long-Range Transboundary Air Pollution

International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests

Annual report on health status of main tree species on the basis of defoliation:

country: ______ region: ______ growth area: ______

institution (national focal centre): ______

survey period: day/month - day/month/year

(from - to) ______ - ______ 19 ______

BROADLEAVES

form B1

Classification		Percentage of trees defoliated														
		trees up to 59 years old							trees 60 years and older							
1	2	3	4	5	6	7	8	9(3-8)	10	11	12	13	14	15	16(10-15)	17(9+16)
	species:						others	total						others	total	grand total
	area of species:															
	no. of sample trees:															100
defoliation class	percentage of leaf loss	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0 not defoliated	0 - 10%															
1 slightly defoliated	11 - 25%															
2 moderately defoliated	26 - 60%															
3 severely defoliated	> 60%															
4 dead																
total		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

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Convention on Long-Range Transboundary Air Pollution

International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests

Annual report on health status of main tree species on the basis of discoloration:

country: ______ region: ______ growth area: ______

institution (national focal centre): ______

survey period: day/month day/month/year

(from - to) ______ 19 ______

BROADLEAVES

form B2

Classification		Percentage of trees discolored (yellowed)														
		trees up to 59 years old							trees 60 years and older							
1	2	3	4	5	6	7	8	9(3-8)	10	11	12	13	14	15	16(10-15)	17(9+16)
	species:						others	total						others	total	grand total
	area of species:															
	no. of sample trees:															100
discoloration class	percentage of leaves discol.	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0 not discolored																
1 slightly discolored																
2 moderately discolored																
3 severely discolored																
total		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

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Convention on Long-Range Transboundary Air Pollution

International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests

Annual report on health status of main tree species on the basis of the combined assessments:

country: ______ region: ______ growth area: ______

institution (national focal centre): ______

survey period: day/month - day/month/year

(from - to) ______ - 19 ______

BROADLEAVES

form B3

Classification		Percentage of trees damaged (defoliation and yellowing combined)														
		trees up to 59 years old							trees 60 years and older							
1	2	3	4	5	6	7	8	9(3-8)	10	11	12	13	14	15	16(10-15)	17(9+16)
	species:						others	total						others	total	grand total
	area of species:															
	no. of sample trees:															100
combined damage class		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0 not damaged																
1 slightly damaged																
2 moderately damaged																
3 severely damaged																
4 dead																
total		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Return to Programme Co-Ordinating Centre West, Bundesforschungsanstalt für Forst- und Holzwirtschaft, Leuschnerstraße 91, D-2050 Hamburg 80, Federal Republic of Germany

Convention on Long-Range Transboundary Air Pollution

International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests

Country:

SURVEY

All species / 10%-distribution - form C

All species

no. of sample plots	no. of sample trees	% trees defoliated						
		class 0 none	class 1 slight	class 2 moderate	class 3 severe	class 4 dead	class 2 to 4 moderate to severe	class 1 to 4 slight to severe

Distribution by 10%-defoliation classes (optional) - enter number of trees/class or % of total

	n	number (%) of trees per 10% - class									
		0 10	11 20	21 30	31 40	41 50	51 60	61 70	71 80	81 90	91 100
all species											
conifers											
broadleaves											

Annex 2-4: Example of defoliation in Norway spruce and Scots pine

Norway spruce

The effect of defoliation varies according to the growth habits of individual trees. Three types of branching occur:

- comb, brush and plate (figure 2-4.1)

  Also, defoliation patterns vary on individual trees. The following defoliation types can be recognized on spruce, especially when defoliation is moderate to severe (class 2-3):

- Larch type (figure 2-4.2)

  A more or less even defoliation of the whole crown results in a larch-like appearance. The lower crown is most seriously affected, whereas the top appears normal. Spruces with comb-like branching are particularly conspicuous when damaged because of the absence of needles from the limply hanging second and higher order branches. Spruces with comb-like as well as those with brush-like branching drop branches of second and higher order when defoliation is severe.

- Sub-top dying type (figure 2-4.3)

  "Window-like" defoliation appears just below the fully foliated top, regardless of the branching type. In the lower parts of the crown the foliage remains denser but in severely damaged trees defoliation extends over the entire crown, blurring the distinction between this and the "larch-type" defoliation.

- Top dying type (figure 2-4.4)

  Defoliation in that part of the crown exposed to the light is more severe than in shaded parts of the crown. In the advanced state, the top dies and a lower branch may take over as the leader. Top dying should not be confused with mechanical damage to the leader.

- Peripheral defoliation type (figure 2-4.5)

  In this type, defoliation occurs evenly throughout the crown from the outside towards the interior.

Scots pine

Damage symptoms are essentially similar to those in Norway spruce, but the types of defoliation vary. Branching habit does not vary between individuals as in Norway spruce.

- Regular defoliation (figure 2-4.6)

  This is the most common form of defoliation and consists of needle loss and shoot dieback in the lower crown. The number of annual needle sets present in summer profoundly influences the estimates of defoliation (POLLANSCHÜTZ, 1985); in springtime before flushing the number of needle sets is at its lowest.

- Top dying (not illustrated)

  Needle loss or shoot death in the upper crowns characterizes this type; it is commoner in Scots pine than in Norway spruce.

Figure 2-4.1: Branching types of Norway spruce

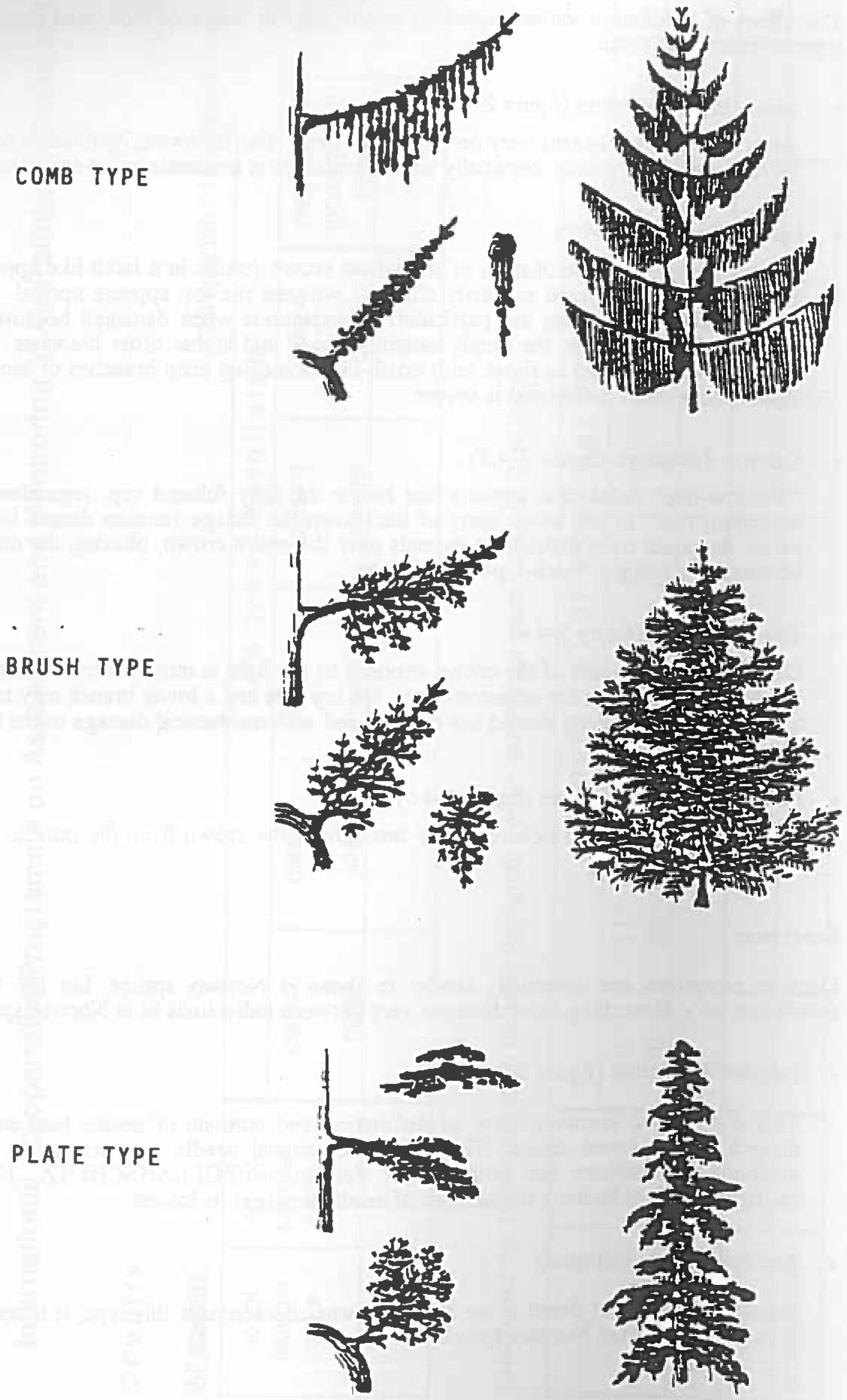


Figure 2-4.2: "Larch" type defoliation

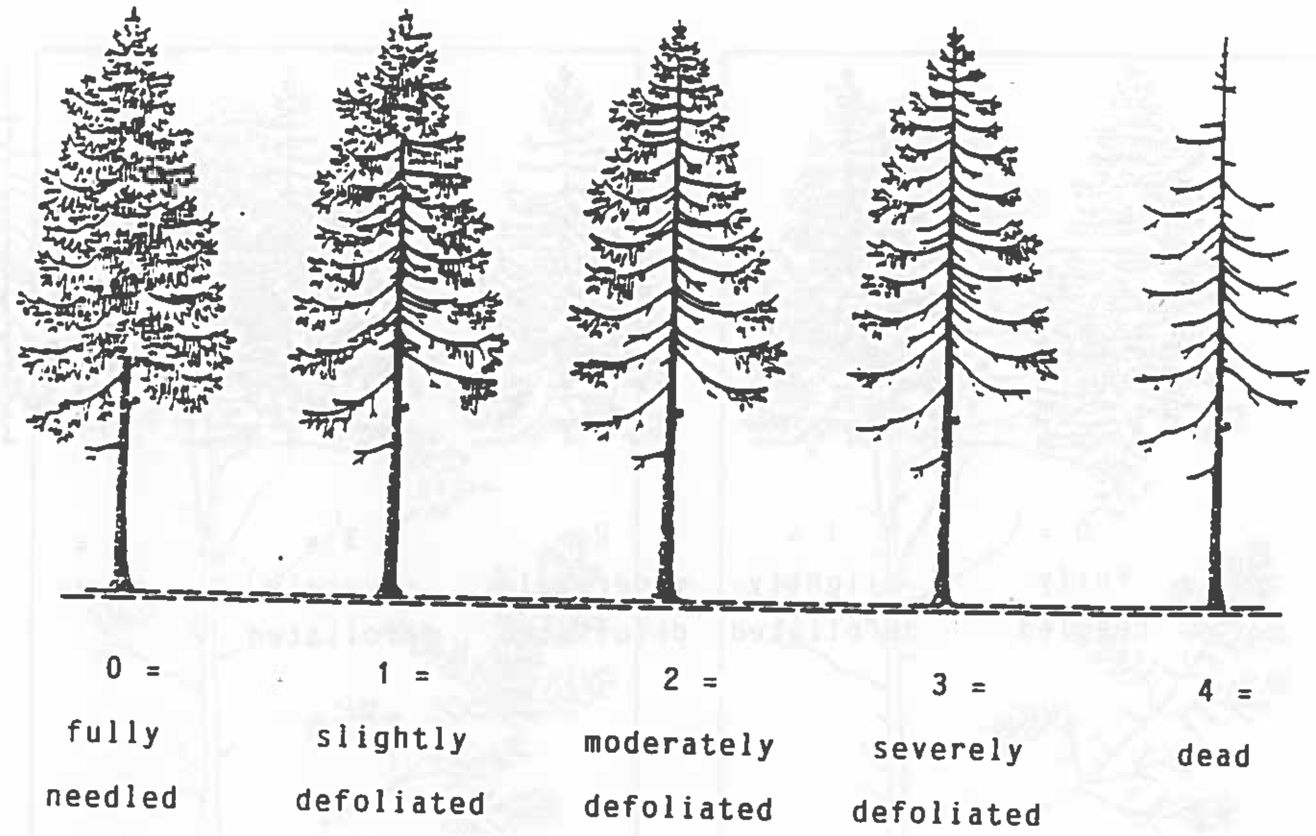


Figure 2-4.5: Peripheral defoliation

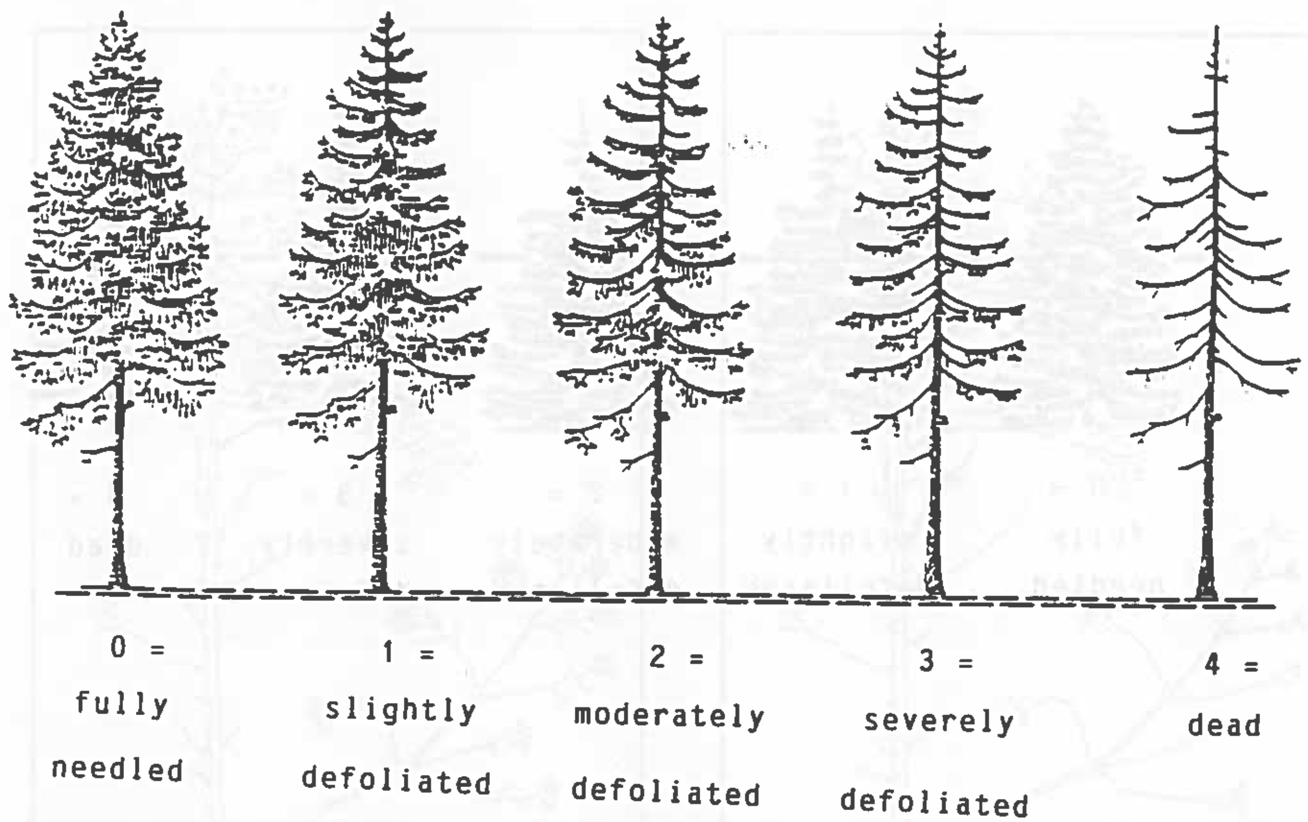


Figure 2-4.3: "Sub-top dying" type defoliation

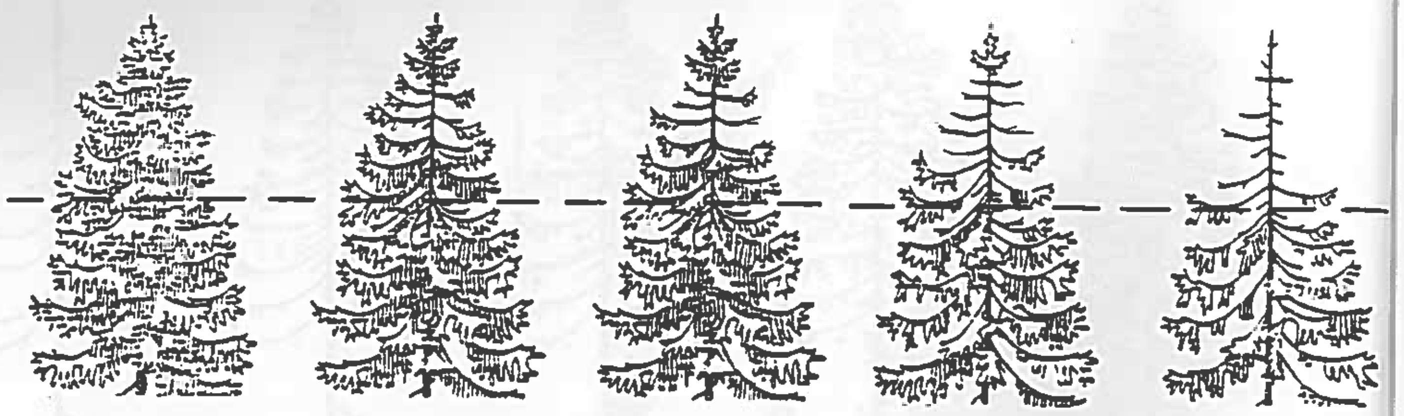


Figure 2-4.4: "Top-dying" defoliation

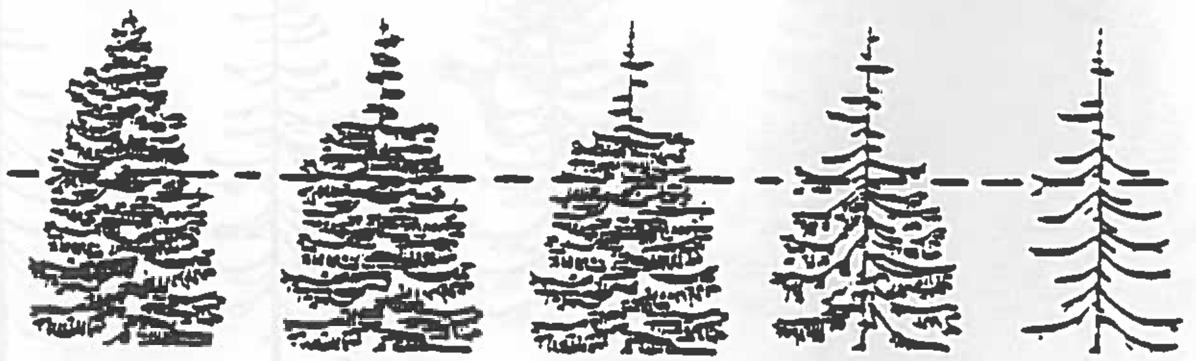
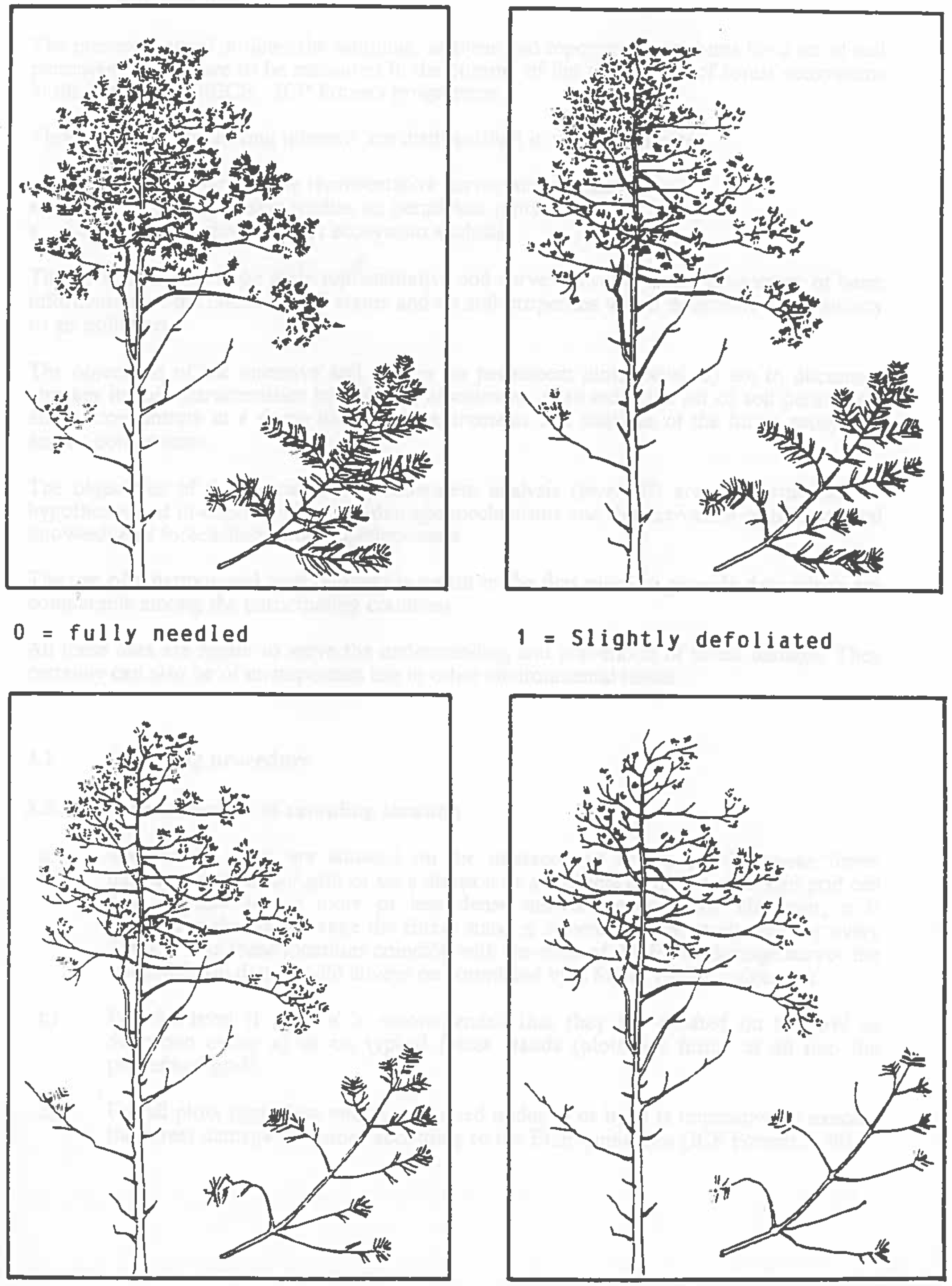


Figure 2-4.6: Regular defoliation of Scots Pine



3. SAMPLING AND ANALYSIS OF SOIL

3.1 Introduction

The present manual outlines the sampling, analysis and reporting procedures for a set of soil parameters which are to be measured in the context of the monitoring of forest ecosystems in the UNEP - UN/ECE - ICP Forests programme.

Three levels of monitoring intensity are distinguished in this programme:

- Level I : large scale representative survey and assessment
- Level II : intensive studies on permanent plots
- Level III: special forest ecosystem analysis

The purpose of the large scale representative soil survey (level I) is the assessment of basic information on the chemical soil status and on soil properties which determine its sensitivity to air pollution.

The objectives of the intensive soil studies on permanent plots (level II) are to document changes in soil characteristics by periodic assessment of an extended set of soil parameters and to concentrate at a single location measurements and analyses of the forest ecosystem and its components.

The objectives of the special forest ecosystem analysis (level III) are the verification of hypotheses and in-depth analyses of damage mechanisms and the derivation of fundamental knowledge of forecasting future developments.

The use of a harmonized methodology is meant in the first place to provide data which are comparable among the participating countries.

All these data are meant to serve the understanding and prevention of forest damage. They certainly can also be of an important use in other environmental issues.

3.2 Sampling procedure

3.2.1 Determination of sampling location

a) The level I plots are situated on the intersections of the pan-European forest damage 16 x 16 km² grid or on a division or a multiple of the 16 x 16 km² grid cell size. In this way a more or less dense network may result. However, it is imperative that on average the forest stand is covered by one study plot for every 256 km². As these locations coincide with the ones of the forest damage survey the collected soil data should always be completed by a forest vitality judgement.

b) For the level II plots it is recommended that they are situated on the grid as described under a) or on typical forest stands (plots not fitting at all into the predefined grid).

c) For all plots regardless whether selected under a) or b), it is imperative to execute the forest damage inventory according to the ECE-guidelines (ICP Forests, 1986).

3.2.2 Characterization of the sampling plots

3.2.2.1 Pedological characterization of the sampling plots

The pedological characterization is mandatory for the level II study plots and is optional for the level I study plots. This characterization includes at least one detailed profile description and is to be carried out only once before starting any other measurements. The aim of this pedological characterization is to provide part of the static background information on the concerned soil in order to improve the interpretation of other data which are to be collected (Chapter 3.3.2).

The profile descriptions according to the FAO-guidelines for profile description (FAO, 1990) will be made in the buffer-zone. Care should be taken that the profile description(s) is/are made on a location which is representative for the actual sampling area (Chapter 3.2.3).

3.2.2.2 Physical characterization of horizons

The determination of the soil granulometry is mandatory for level II study plots and is optional for level I study plots.

The particle size fractions are : < 2 µm, 2 - 63 µm, 63 - 2000 µm (FAO). If 50 µm is used to separate silt and sand fractions, conversion to the 63 µm limit has to be done.

It is advised to determine the dry bulk density on undisturbed volumetric samples. If the dry bulk density is not determined, a reasonable estimation of this parameter should be made.

3.2.3 Methodology for soil sampling

The actual sampling area should be selected within a homogeneous part of the study-plot, for which the profile description is representative.

After removal of the litter, the soil is sampled by genetic horizon or by fixed layer.

The organic top layer (O-horizon) is sampled separately.

If sampling is done by fixed depth, results will be reported for the following layers:

Level I		Level II	
Mandatory	**Advised**	**Mandatory**	**Advised**
0-10 cm	0-5 cm	0-10 cm	0-5 cm
10-20 cm	5-10 cm	10-20 cm	5-10 cm
	10-20 cm	20-40 cm	10-20 cm
		40-80 cm	20-40 cm
			40-80 cm

For organic horizons (i.e. superficial and buried O- and H-horizons) a different analysis strategy has to be applied.

If samples are taken according to the horizons, depth and thickness of the horizons as identified in the profile description will be extrapolated over the sampling area.

For every sampled layer or horizon, one representative composite sample will be collected or several separate samples; the number of subsamples collected for the composite sample and the sampling date should be reported.

It is recommended to collect an amount of soil large enough so that a part of it can be stored for eventual reanalysis in the future.

3.2.4 Conservation and preparation of samples

The described method applies to samples of H- and O-horizons and mineral horizons.

Macroscopic roots and stony material (> 2 mm) must be manually removed. All samples must be dried at a temperature not higher than 40°C. They are ground immediately before the analysis, and only for those analyses for which ground material is necessary.

3.3 Soil parameters and analytical reference methods

3.3.1 H- and O-horizons

Definition of H- and O-horizon: according to FAO-guidelines (FAO, 1990).

3.3.1.1 Soil parameters in Level I plots

3.3.1.1.1 *Mandatory set of parameters*

Parameter	Reference Analytical Method	Units (1)	Reference literature
1. pH($CaCl_2$)	Extractant: 0.01 M $CaCl_2$ Measurement: pH-electrode		LABEX 8703-01-1-1 ISO-TC190/SC3/GT8
2. C.org	dry combustion	g/kg	
3. Total N	dry combustion	g/kg	
4. P	digestion: aqua regia (2)	mg/kg	
5. K	digestion: aqua regia (2)	mg/kg	
6. Ca	digestion: aqua regia (2)	mg/kg	
7. Mg	digestion: aqua regia (2)	mg/kg	
8. Amount of organic layer	Volume (cylindric)-dry weight	kg/m²	

3.3.1.1.2 *Optional set of parameters*

Parameter
1. $CaCO_3$ if pH($CaCl_2$)>6
2. Na
3. Al
4. Fe
5. Cr
6. Ni
7. Mn
8. Zn
9. Cu
10. Pb
11. Cd

3.3.1.2 Soil parameters in Level II plots

3.3.1.2.1 *Mandatory set of parameters*

Parameter	Reference Analytical Method	Units (1)	Reference literature
1. pH($CaCl_2$)	Extractant: 0.01 M $CaCl_2$ Measurement: pH-electrode		LABEX 8703-01-1-1 ISO-TC190/SC3/GT8
2. C.org	dry combustion	g/kg	
3. Total N	dry combustion	g/kg	
4. P	digestion: aqua regia (2)	mg/kg	
5. K	digestion: aqua regia (2)	mg/kg	
6. Ca	digestion: aqua regia (2)	mg/kg	
7. Mg	digestion: aqua regia (2)	mg/kg	
8. Amount of organic layer	Volume (cylindric)-dry weight	kg/m²	

3.3.1.2.2 *Optional set of parameters*

Parameter
1. $CaCO_3$ if pH($CaCl_2$)>6
2. Na
3. Al
4. Fe
5. Mn
6. Zn
7. Cu
8. Pb
9. Cd
10. Cr
11. Ni
12. Hg
13. S
14. pH(H2O)
15. EC
16. Exchangeable acidity
17. Exchangeable cations Base cations: K, Ca, Mg, (Na) Acid cations: Al, (Fe), (Mn), (H) ()=optional
18. CEC
19. Base saturation

3.3.2 Mineral horizons

3.3.2.1 Soil parameters in Level I plots

3.3.2.1.1 *Mandatory set of parameters*

Parameter	Reference Analytical Method	Units (1)	Reference literature
1. pH($CaCl_2$)	Extractant: 0.01 M $CaCl_2$ Measurement: pH-electrode		LABEX 8703-01-1-1 ISO-TC190/SC3/GT8
2. C.org	dry combustion	g/kg	
3. Total N	dry combustion	g/kg	
4. $CaCO_3$ if pH($CaCl_2$)>6	Calcimeter	g/kg	AFNOR C 31 - 105

3.3.2.1.2 *Optional set of parameters*

Parameter

1. Exchangeable acidity
2. Exchangeable cations
   Base cations:
   K, Ca, Mg, (Na)
   Acid cations:
   Al, (Fe), (Mn), (H)
   ()=optional
3. CEC
4. Base saturation

3.3.2.2 Soil parameters in Level II plots

3.3.2.2.1 *Mandatory set of parameters*

Parameter	Reference Analytical Method	Units (1)	Reference literature
1. pH($CaCl_2$)	Extractant: 0.01 M $CaCl_2$ Measurement: pH-electrode		LABEX 8703-01-1-1 ISO-TC190/SC3/GT8
2. C.org	dry combustion	g/kg	
3. Total N	dry combustion	g/kg	
4. $CaCO_3$ if pH($CaCl_2$)>6	Calcimeter	g/kg	AFNOR X 31- 105
5. Exchangeable acidity (3) (4)	titration of the $BaCl_2$ extraction to pH 7.8 or sum of acid cations $Al^{3+}+Fe^{2+}+Mn^{2+}+(H^{+})$	cmol+/kg	
6. Exchangeable cations (4) Base cations: K, Ca, Mg, (Na) Acid cations: Al, (Fe), (Mn), (H) ()=optional	Extractant: 0.1 M $BaCl_2$ (5)	cmol+/kg	
7. CEC (4)	Alternative 1: sum base cations + Titratable Ex-changeable Acidity	cmol+/kg	
	Alternative 2: sum base cations + sum acid cations	cmol+/kg	
8. Base saturation (4)	to be calculated: (sum base cations/CEC)x100	%	

3.3.2.2.2 *Optional set of parameters*

Parameter

1. EC
2. pH(H_2O)
3. S
4. Total Ca, Mg, Na, K, Al, Fe, Mn
5. Aqua regia P (2)
6. Zn, Cu, Pb, Cd

Remarks

1): Results have to be expressed on an oven-dry basis (105°C)

2): Ratio: 2 g soil/15 ml HCl concentrated + 5 ml HNO_3 concen-trated

3): H can be derived by a) "German" method (difference in pH before and after extraction and model)
b) by titration:
H=(H+Al)titration - (Al)titration.

If b), use of 1M KCl extraction is recommended, rather than 0.1 M $BaCl_2$

Al can be derived by c) Using AAS or ICP-AES Al value
d) by titration - see b)

4): These parameters have not to be determined in case $CaCO_3$ is present

5): Ratio: should be reported.

3.4 Procedure for data reporting

Following rules apply:

Data will be reported separately for the H- and O-horizons and for the mineral soil.

For the mineral soil reporting is done according to the defined mandatory depth layers regardless of whether the soil was sampled and analyzed by horizon or by layer. As such recomputing may be required. If data are collected for horizons or for more detailed layers than the mandatory ones, the corresponding figures should also be transferred.

Data shall be submitted to PCC West after thorough control as specified in Chapter 1.4.

3.5 References

FAO, 1990. Guidelines for soil profile description (third edition revised). Food and Agriculture Organization of the United Nations. Soil Resources, Management and Conservation Service. Land and Water Development Division. Rome, Italy. 70 pp.

ICP (ed.), 1986. Manual on methodologies for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. Programme Coordinating Centres east and west of the international cooperative programme on assessment and monitoring of air pollution effects on forests. 92 pp.

Starr, M.R. (ed), 1990. Draft Report Soil Expert Panel Meeting held in Helsinki, Finland, January 9-10, 1990. 66 pp.

Ministerie van de Vlaamse Gemeenschap (ed.), 1990. Draft Report Soil Expert Panel Meeting held in Leuven, Belgium, November 11-14, 1990. 8 pp. + annexes.

Annex 3-1

METHOD SHEET
UNEP - UN/ECE METHOD 9100SA

Moisture Content

Reference METHODS : ISRIC 1987

METHOD SUITABLE FOR : H- AND O-HORIZONS
MINERAL HORIZONS

I. PRINCIPLE

Calculation of the results of soil analysis is done on basis of "oven-dry" soil[1]. The moisture content of air-dry soil is determined prior to soil analysis.

II. APPARATUS

Moisture tins or flasks with closely fitting lid.
Drying oven.

III. REAGENTS

IV. PROCEDURE

Transfer ca. 5 g fine earth to a tared moisture tin and weigh with 0.001 g accuracy (A gram).
Dry overnight at 105°C (lid removed).
Remove tin from oven, close with lid, cool in desiccator and weigh (B gram).

Calculation:

The moisture content in wt% is obtained by :

$$\textbf{Moist \%} = \frac{A-B}{B-\text{tare tin}} \times 100$$

The corresponding correction factor for analytical results or for amount of sample to be weighed in for analysis is:

$$\textbf{moisture correction factor} = \frac{100 + \%\ \text{moist}}{100}$$

V. REPORT

Report moisture content in % with 1 decomal place.

---

[1] From the viewpoint of soil-plant relationship it may be argued that for a number of soil parameters it is relevant to express values on a soil volume basis (w/v) rather than on the usual soil weight basis (w/w). Soil weight can easily be converted to volume by using the bulk density.

Annex 3-2

METHOD SHEET
UNEP - UN/ECE METHHOD 9101SA

Particle size analysis

Reference METHODS : ISRIC 1987

METHOD SUITABLE FOR : MINERAL HORIZONS

I. PRINCIPLE

Separation of the mineral part of the soil into various size fractions and determination of the proportion of these fractions. The analysis includes all soil material, i.e. including gravel and coarser material, but the procedure below is applied to the fine earth (< 2 mm) only. Of paramount importance in this analysis is the pretreatment of the sample aimed at complete dispersion of the primary particles. Therefore, generally, cementing materials (usually of secondary origin) such as organic matter and calcium carbonate are removed. Removal of organic matter by H_2O_2 and carbonates by a mildly acid buffer pH 5 is normally carried out. After shaking with a dispersing agent, sand is separated from clay and silt with a 63 µm) sieve. The sand is fractionated by dry sieving, the clay (< 2 µm) and silt (2-63 µm) fractions are determined by the pipette method.

II. APPARATUS

Water bath
Hot plate
Reciprocating shaking machine
Sieving machine (Fritsch Analysette, by vibration)
Set of sieves, including bottom (diameter ca. 20 cm)
Heavy brass funnel (diameter ca. 23 cm) on stand
Small 63 µm sieve (diameter ca. 8 cm)
Glass sedimentation cylinders, marked at 1 litre
Drying oven
Moisture tins
Stopwatch

III. REAGENTS

Hydrogen peroxide, 30%
Acetate buffer solution, ca. 1 M.
Dissolve 680 g Na-acetate. $3H_20$ in ca. 4 l water
Adjust to pH 5.0 with ca. 250 ml glacial acetic acid (use pH meter).
Make to 5 l.
Dispersing agent: sodium hexametaphosphate 4% and soda 1% solution.
Dissolve 40.0 g $(NAP0_3)_6$ and 10.0 g Na_2C0_3 in water in a 1 l volumetric flask and make to volume. Both chemicals should be dried overnight at 105 C prior to use.
Sodium chloride, saturated solution.
Dissolve 350 g NaCl in 1 l warm water. Cool.

IV. PROCEDURE

A distinction is made on basis of the presence or absence of calcium carbonate:
(1) Calcareous soils: pH-H_2O > 6.8
(2) Non-calcareous soils: pH-H_2O ≤ 6.8

In case carbonate is present (case 1) this is removed by a mildly acid buffer treatment prior to oxidation of organic matter. If carbonate is absent (case 2) start with oxidation of organic matter.

1. Removal of carbonate

(1) Weigh out ca. 20 g fine earth into a 1 l beaker (at carbonate contents exceeding 10%, weigh out proportionally mor soil).
(2) Add ca. 100 ml buffer solution and heat on water bath (100 °C). Cover beaker with watch-glass. After effervescence has stopped, add increments of ca. 25 ml buffer until effervescence does not recur after addition of new buffer. In case of very high carbonate contents, 5 ml increments of glacial acetic acid can be used instead of buffer. In this case, the pH should be monitored with calibrated indicator paper.
(3) Centrifuge and decant or, alternatively, let stand overnight and siphon off supernatant solution.
(4) Depending on chosen procedure, add ca. 250 or 500 ml water respectively and repeat (3). In case of partial peptization, add a few ml saturated NaCl solution.
Note: this washing procedure is to remove calcium acetate from the suspension as this may be transformed into the insoluble calcium oxalate during the ensuing oxidation procedure. Proceed with 2. (2).

2. Oxidation of organic matter

(1) Weigh out ca. 20 g fine earth into a 1 l beaker.
(2) Add 15 ml water and 15 ml H_2O_2 30% (in case of buffer pretreatment less or no water need to be added). Cover beaker with watch-glass. In case of strong frothing place beaker in basin with cold water. In addition, frothing can be tempered by "ant-foam" or a few of alcohol.
(3) Let stand overnight.
(4) The next day, place beaker on water bath (ca. 80 °C) and regularly add 5-10 ml increments of H_2O_2 30% until decomposition of organic matter is completed (usually supernatant is clear then).
(5) Add H_2O to a volume of ca. 300 ml.
(6) Place on hot plate and carefully boil for 1 hr. to remove any remaining H_2O_2.
(7) Remove beaker from hot plate and allow to cool.
(8) Centrifuge and decant or, alternatively, allow material to settle in the beaker and siphon off.
(9) Add ca. 300 ml water and redisperse sediment. Repeat (8) and (9) until peptization is achieved. Should this take too many washings (more than 4) then add a few ml saturated NaCl solution to promote peptization.

Note: With gypsiferous soils many washings are sometimes needed to dissolve all gypsum.

3. Dispersion

(1) Transfer suspension quantitatively to a 1 l polythene bottle (if no pretreatment is given, weigh out ca. 20 g into this bottle).
(2) Add 20.00 ml dispersing agent, make the volume to ca. 400 ml water and cap the bottle.
(3) Shake overnight (16 hrs.) on a reciprocating shaker at ca. 125 strokes/min. (adjust speed so that a good dashing of the suspension is obtained).

4. Separation of fractions

(1) Pass the suspension trough a 63 µm sieve which is placed in a funnel positoned above a sedimentation cylinder. Use a wide (3 cm) rubber policeman.
(2) Make to 1 litre mark with water. Proceed with this according to 6.
Note: Include a blank (cylinder with water from same source) for temperature measurement of clay determination.
(3) Wash the sand fraction remaining on the sieve quantitatively into a porcelain dish, evaporate on waterbath and dry at 105 °C for about an hour.

5. Determination of sand fractions

(1) Transfer the dried of 4.(3) to the top sieve of a stacked set of sieves of the following mesh sizes: 1250 µm (A), 630 µm (B); 200 µm (C); 125 µm (D); 63 µm (E); bottom.
(2) Sieve for 10 mins. on the sieving machine at the settings: amplitude 7.0 and interval 4 (at this setting the sieves vibrate at a frequency of 3000 x per minute and an amplitude of ca. 2 mm for 4-second periods interrupted for 1/2 second).
(3) Empty each sieve into a tared weighing dish by tapping it upside down on the brass funnel placed above the dish. Weigh with 0.01 g accuracy (net wt. A trough E, individual sand fractions).
(4) If any material is collected in sieve bottom (< 63 µm) transfer this to suspension in sedimentation cylinder mentioned in 4. (2).

6. Determination of silt and clay

Fraction < 63 µm

(1) After adding material < 63 µm possibly collected during sieving (see 5.(4)) close the sedimentation cylinder with a rubber stopper and shake well.
(2) Place the cylinder on the table, remove stopper and immediately pipette 20 ml from the centre of the cylinder.
(3) Transfer the aliquot to a tared moisture tin, evaporate on water bath and dry overnight at 105°C.
(4) Remove tin from drying oven, close with lid and cool in desiccator. Weigh with 0.001 g accuracy (net wt. F for fraction < 63 µm).

Fraction < 20 µm

(5) After measuring the temperature of the suspension, again stopper the cylinder and shake well.
(6) Place the cylinder on a vibration-free table under the pipette-assembly.
(7) After exactly 5 min. pipette 20 ml at a depth indicated in Table 1.
(8) Transfer aliquot to tared moisture tin, evaporate on water bath and dry overnight at 105°C.
(9) Remove tin from drying oven, close with lid and cool in desiccator. Weigh with 0.001 g accuracy (net wt. G for fraction < 20 µm).

Fraction < 2 µm

(10) After 5 1/2 hrs. measure temperature in blank cylinder and pipette 20 ml at a depth indicated in Table 1.
Note: If temperature differs from initial temperature, use mean temperature.
(11) Transfer aliquot to tared moisture tin, evaporate on water bath and dry overnight at 105°C.
(12) Remove tin from drying oven, close with lid and cool in desiccator. Weigh with 0.001 g accuracy (net wt. H for fraction < 2 µm).

Table 1 - Depth (in cm) at which fraction < 20 µm and < 2 µm are pipetted as a function of the temperature and after indicated settling time

Temp. °C	**5 mins. < 20 µm**	**5 1/2 hrs. < 2 µm**	**Temp. °C**	**5 mins. < 20 µm**	**5 1/2 hrs. < 2 µm**
19	10.5	6.9	28	13.0	8.6
20	10.8	7.1	29	13.3	8.8
21	11.0	7.2	30	13.6	9.0
22	11.3	7.4	31	13.9	9.1
23	11.6	7.6	32	14.2	9.3
24	11.9	7.8	33	14.4	9.5
25	12.1	8.0	34	14.8	9.7
26	12.4	8.2	35	15.1	9.9
27	12.7	8.4	36	15.4	10.1

7. Calculation

The calculation base is the oven-dry sample weight after all treatments. It is obtained by summation of all individual fractions:

Clay	(< 2 µm)	= (H x 50) - 1.00 g[1]	(wt.K)
Silt	(2-20 µm)	= (G x 50) - 1.00 g - K	(wt.L)
Silt	(20-63 µm)	= (F x 50) - 1.00 g - K - L	(wt.M)
Sand	(< 63 µm)	= A + B + C + D + E	(wt.N)

Sample weight = K + L + M + N (all weights in grams)

The proportional amounts (in %) of the fractions are now calculated by:

% clay (< 2 µm) $= \frac{K}{\text{sample wt.}} \times 100$

% silt (2-20 µm) $= \frac{L}{\text{sample wt.}} \times 100$

% silt (20-63 µm) $= \frac{M}{\text{sample wt.}} \times 100$

% sand (63-125 µm) $= \frac{E}{\text{sample wt.}} \times 100$

% sand (125-200 µm) $= \frac{D}{\text{sample wt.}} \times 100$

% sand (200-630 µm) $= \frac{C}{\text{sample wt.}} \times 100$

% sand (630-1250 µm) $= \frac{B}{\text{sample wt.}} \times 100$

% sand (1250-2000 µm) $= \frac{A}{\text{sample wt.}} \times 100$

[1] correction for dispersing agent

V. REPORT

It is an agreed convention that the percentage of each particle size grade is reported on the basis of oven-dry soil free of organic matter (max. 1 decimal place).
Note: With this calculation, the clay, silt and sand fractions are obtained in percentage of the fine earth (minus carbonate and organic matter which have been removed). The coarse fraction < 2 mm, if present, is reported in percentage of the total soil. If all fractions need to be reported on total soil basis convert above obtained figures for clay, silt and sand as follows:

% clay, silt, sand of total soil =

$$\frac{100 - \%\ (\text{fraction} > 2\text{mm} + \text{carbonate} + \text{org. matter})}{100} \times \%\ \text{clay, silt, sand of fine earth}$$

Annex 3-3

METHOD SHEET
UNEP - UN/ECE METHOD 9102SA

$CaCO_3$

Reference METHODS : AFNOR X 31 - 105

METHOD SUITABLE FOR : H- AND O-HORIZONS
MINERAL HORIZONS
IF $pH(CaCl_2)>6$

I. PRINCIPLE

The soil sample is treated with a strong acid. The loss of CO_2 gas is measured volumetrically.

II. APPARATUS

Calcimeter

III. REAGENTS

concentrated hydrochloric acid 37% diluted 1/1 (V/V) with di-water free of CO_2.

Calcium Carbonate ($CaCO_3$) pure.

IV. PROCEDURE

1. Sample preparation

All the material is milled to passe a sieve of 0.2 mm.

2. Sample amount

Take a sample amount according to table I.

$CaCO_3$-content in % predicted	0.5 - 3.9	4 - 9.9	10 - 19.9	20 - 39.9	40 - 79.9	+ 80
Sample amount m1 in grammes	10	5	2.5	1	0.5	0.25

Table I

3. Reaction

Bring the sample in the reaction vessel, place the tube with 10 ml of hydrochloric acid (1/1) in the vessel and close the system. Before closing the 3 way valve, make sure that the zero reading is corrected.
Mix the hydrochloric acid with the sample by shaking the reaction vessel.
Follow and equilibrate permanently the height of the water column with the ampoul. (E)
Read the volume (V_1) when no further change occurs in the liquid level.

4. Calibration

Under the same conditions of temperature and pression, proceed like under nr. 3, with 0.050 g, 0.100 g, 0.150 g and 0.200 g of calciumcarbonate.
Determine the calibration curve and with this curve and V_1 the amount m_2 of $CaC0_3$ in the sample.

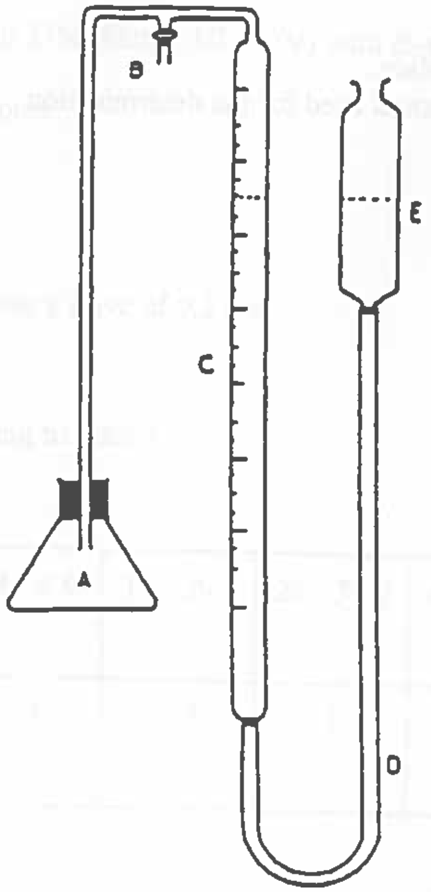
5. Calculation

$$\% \, CaCO_3 = 100 \cdot \frac{m_2}{m_1}$$

m_1 = sample amount in grammes
m_2 = amount of $CaC0_3$ in grammes in the sample.

V. REPORT

% $CaC0_3$ with 1 decimal place.
Report also the sample amount used for the determination.



A : Reaction vessel
B : 3- way valve
C : Graduated tube 100 ml
D : Rubber tube
E : Ampoul to equilibrate

Figure 3-3.1: Calcimeter

Annex 3-4

METHOD SHEET
UNEP - UN/ECE

METHOD 9103SA

<u>pH $(CaCl_2)$</u>

Reference METHODS : LABEX 8703-01-1-1
ISO/TC190/SC3/GT8

METHOD SUITABLE FOR : H-AND O-HORIZONS
MINERAL HORIZONS

I. PRINCIPLE FOR MINERAL HORIZONS [1]

The pH of the soil ist potentiometrically measured in the supernatant suspension of a 1:5 soil : liquid ($CaCl_2$ 0.01 M) mixture

II. APPARATUS

pH meter with appropriate electrode (s)
End-over-end shaking machine
Shaking bottles (plastic) 200 ml.

III. REAGENTS

Di-water
pH-buffersolutions
$CaCl_2$ solution 0.01 M; make a solution of 1.4702 g $CaCl_2$. $H_2$0/liter

IV. PROCEDURE

Take 20 g. sample into 200 ml bottle.
Add 100 g. $CaCl_2$ solution with a dispenser or pipette and cap the bottle.
Shake for 2 hours.
Calibrate the pH meter with buffer solutions (pH 7 and aH 4)
Before opening the bottles for measurement, shake by hand.
Immerse eletrode(s) in upper part of suspension.
Read pH when reading has stabilized.

V. REPORT

pH ($CaCl_2$) 1 decimal place.

[1] PRINCIPLE FOR H- AND O-HORIZONS
same as for mineral horizons but soil: liquid = 1/20

Annex 3-5

METHOD SHEET
UNEP - UN/ECE METHOD 9104SA

C-organic: Dry Combustion

Reference METHODS :

METHOD SUITABLE FOR :	H- AND O-HORIZONS MINERAL HORIZONS

According to the operating instructions.

Annex 3-6

METHOD SHEET
UNEP - UN/ECE METHOD 9105SA

Total Nitrogen: Dry Combustion

Reference METHODS :

METHOD SUITABLE FOR :	H- AND O-HORIZONS MINERAL HORIZONS

According to the operating instructions.

Annex 3-7

METHOD SHEET
UNEP - UN/ECE

METHOD 9106SA

Exchangeable acidity and exchangeable CEE and Base saturation

Reference METHODS :

METHOD SUITABLE FOR : MINERAL HORIZONS
NOT TO BE DETERMINED IN CASE $CaCO_3$ IS PRESENT

A. Exchangeable acidity

There are two alternatives:

1. Titration of the $CaCl_2$ extraction to pH 7.8
2. sum of acid cations $Al^{3+} + Fe^{2+} + Mn^{2+} + (H^+)$

I. PRINCIPLE

The sample is extracted by unbuffered 0.1 M $BaCl_2$.
The exchangeable acidity is determined

a) by titration of this solution to pH 7.8 or
b) by measuring Al^{3+}, Fe^{2+}, Mn^{2+} and (H^+)

II. APPARATUS

Burette
Atomic Absorption Spectrophotometer or ICP
pH meter
Shaking machine
Centrifuge

III. REAGENTS

0.1 M $BaCl_2$
1 M KCl

IV. PROCEDURE

Place 2 g of soil passed over a 2 mm sieve plus 20 ml of 0.1 M bariumchloride in a 30 ml plastic centrifuge tube and shake for 2 h.
Centrifuge and retain the supernatant solution for analysis.

a. Titration of the $BaCl_2$ extraction to pH 7.8

b. Measuring the acid cations (exchangeable cations)

Al by AAS or ICP
Fe by AAS or ICP
Mn by AAS or ICP
(H) :

Alternative 1: by the "German" method (difference in pH before and after extraction and model).

Alternative 2: by titration H = (H + Al) titration - Al(AAS or ICP). This titration is recommended to do on a 1 M KCl extraction rather than 0.1 M Ba Cl_2.

The exchangeable acidity is the sum of the amounts of the acid cations Al^{3+}, Fe^{2+}, Mn^{2+} and (H^+).

V. REPORT

Results in cmol+/kg with w significant digits.

B. Exchangeable cations

I. PRINCIPLE

The sample is extracted by unbuffered 0.1 M BaCl2 and in this solution the exchangeable cations are measured.

II. APPARATUS

Burette
Atomic Absorption Spectrophotometer or ICP
pH meter
Shaking machine
Centrifuge

III. REAGENTS

0.1 M $BaCl_2$
1 M KCl

IV. PROCEDURE

Place 2 g of soil passed over a 2 mm sieve plus 20 ml of 0.1 M bariumchloride in a 30 ml plastic centrifuge tube and shake for 2 h.

Centrifuge and retain the supernatant solution for analysis.

Measuring the exchangeable cations

Base cations:
K by AAS, FER or ICP
Ca by AAS, FER or ICP
Mg by AAS, FER or ICP
Na by AAS, FER or ICP

Acid cations:
Al by AAS or ICP
Fe by AAS or ICP
Mn by AAS or ICP
(H) :

Alternative 1: by the "German" method (difference in pH before and after extraction and model).

Alternative 2: by titration H = (H + Al) titration - Al(AAS or ICP). This titration is recommended to do on a 1 M KCl extraction rather than 0.1 M Ba Cl_2.

V. REPORT

Results in cmol+/kg with 2 significant digits.

C. CEC

I. PRINCIPLE

The CEC is calculated by making the sum of all exchangeable cations.

II. CALCULATION

Depending on the applied analytical method, there are two alternatives to calculate the CEC:

1. Sum base cations + titratable exchangeable acidity
2. Sum base cations + sum acid cations.

III. REPORT

Results in cmol+/kg with 2 significant digits.

D. Base Saturation

I. PRINCIPLE

The base saturation has to be calculated as

$$\frac{\text{Sum base cations}}{\text{CEC}} * 100$$

II. REPORT

In % with at least 1 decimal place.

Annex 3-8

METHOD SHEET
UNEP - UN/ECE METHOD 9107SA

Aqua Regia extractant determinations P, K, Ca, Mg

Reference METHODS :

METHOD SUITABLE FOR : H- AND O-HORIZONS

I. PRINCIPLE

The soil is treated with a mixture of strong acids. (Wet destruction).
The different elements are measured by AAS, FAAS, ICP and spectrophotometry.

II. REAGENTS

Hydrochloric acid (p = 1.19 g/ml).
Nitric acid (p = 1.4 g/ml).
Hydrogenperoxide 30% v/v (analytical grade).

III. EXTRACTION PROCEDURE

Weigh 2 g dry material into a 100 ml round bottom flask. Add a small amount of water (2-3 ml) to obtain a slurry. Then add 15 ml of concentrated HCl and 5 ml of concentrated HNO_3 and add also carefully 10 ml H_2O_2.
Boil gently under reflux for 2 hours.
Rinse the condensor with max. 30 ml water and boil again for 15 minutes.
Allow to cool slowly to about room temperature. Remove the condensor.
Filter the solution from the flask through an acid resistant paper filter and collect in a 100 ml volumetric flask.
Rinse the filter and residu 5 times with a few ml of warm 1 M nitric acid.
Allow to cool and dilute with 1 M nitric acid to the mark.

IV. ANALYTICAL DETERMINATIONS

All the elements can be measured by ICP or DCP.
K, Ca also by flame spectrophotometry.
Mg by atomic absorption spectrophotometry.
P by colorimetry.

V. REPORT

Results in mg/kg with w significant digits.

4. SAMPLING AND ANALYSIS OF NEEDLES AND LEAVES

4.1 Introduction: Interest of foliar analysis for assessment of forest health

The aims of forest condition assessment are not only to know the conditions at a given date and to detect its changes (positive or negative) over time but also to gain insight into the causes of a potential deterioration or improvement.

Limited mineral nutrition may be a direct cause of tree condition deterioration or a factor which increases adverse air pollution effects. High concentrations of certain elements in the leaf or needle tissues may be sign of intoxication and of excessive immission of these elements into forest ecosystems.

Thus, besides soil sampling and analysis, the sampling and analysis of needles or leaves analysis is essential. The analyses have to be performed at regular time intervals in order to establish potential relationships between the evolution of the stand condition and the evolution of the mineral nutrition. At least in the studies of intermediate or high intensity (see below), foliage sampling must be frequent enough to allow the detection of an evolution of the mineral nutrition level in spite of the inter-annual fluctuations in element concentrations.

In conformity to the draft manual three levels of study can be defined:

- a minimum level of intensity, in large scale survey and assessment plots (level I plots);
- an intermediary level of intensity to be performed in intensive study plots (level II plots);
- a higher intensity level, to be performed totally or partially, in the plots corresponding to special forest ecosystem analysis (level III plots).

The sampling and analysis procedures to be applied in any level of intensity are subject to the agreement of the expert group on foliage analysis.

4.2 Sampling

Preliminary remark

For each sample plot, relevant information with regard to fertilisation, liming, etc. shall be indicated. Details shall be recorded on the type of fertilizer used, the quantity and the year of application.

4.2.1 Frequency

Level I: foliar analysis is optional in these plots; if a country decides to make such analysis, it is recommended that sampling and analyses are made at least every five years.

Level II: foliar analysis is mandatory. Sampling and analysis must be done at least every two years.

Level III: foliar analysis is mandatory every year.

4.2.2 Date

Deciduous species (including larch): sampling must be done when the new leaves are fully developed, and before the very beginning of the autumnal yellowing and senescence.

Evergreen species: sampling must be done during the dormancy period.

States are requested to define for each region, and inside each region for plains and mountains, the most convenient period for the sampling and analysis of the various species, and to keep to this period.

4.2.3 Number of trees to be sampled and analysed

Level I: if foliar analysis (optional) is performed, it is recommended to sample at least 3 trees of each main species. A composite sample shall be made by mixing equal quantities of each sample after drying.

Level II: every two years, at least 5 trees of each main species present in the plot are sampled; the five samples are individually preserved in bags; for analysis, a composite sample is made by mixing equal quantities of each of the five samples (in case the five trees are analysed individually, the mean value is calculated for each element).

Level III: every year at least 8 trees of each main species are sampled and individually preserved in bags. A composite sample is made for analyses by mixing equal quantities of each individual sample; every five years the eight trees are individually analysed in order to determine the variability of the total element concentrations in the plot.

4.2.4 Selection of the sample trees

The number of trees needed for the sampling (3, 5 or 8) are selected in such a way that:

- the trees are spread over the total plot area, or around the plot if the stand is homogeneous over a larger area (see below);
- the trees belong to the predominant and dominant classes (forest with closed canopy) or to the trees with average height ± 20% (forest with open canopy);
- the trees are in the vicinity of the locations where soil samples were taken for analysis; however care must be taken that the main roots of the sample trees have not been damaged by soil sampling;
- the trees are different from those used for the crown assessment, in order to avoid that successive samplings induce loss of foliage; stand and site conditions are homogeneous on an area larger than the plot where the crown conditions have been assessed, it is advisable to choose the sample trees outside the plot;
- the trees are representative of the mean defoliation level of the plot (± 5% of the mean foliage loss);
- the trees are representative of the sanitary status of the plot.

The same sample trees shall be sampled over the years; the trees must be numbered. For species with small crowns and too few needles (or leaves) per year, it is allowed (but not recommended) to alternate between two sets of 5 (level II) or 8 (level III) trees, when necessary to avoid damage to the sample trees. Each set must respond to the above conditions.

4.2.5 Selection of leaves and needles to be sampled

The trees in the plot cannot be felled, which may influence the sampling method of leaves or needles.

It is important that sampled leaves or needles have developed in full light. Generally speaking the current year needles or leaves of evergreen species are most convenient for judging the nutrition level but, for a number of elements, comparing element concentration in older needles with that in current year needles may be interesting.

The sampled leaves or needles must be taken from the upper third of crown, but not from the very first whorls in the conifers; in stands where the different whorls can be clearly identified, it is advisable to sample between the 7th and the 15th whorl.

For deciduous species, sampling is done on current year leaves or needles.

For evergreen species, sampling of both the current year needles or leaves and the second year needles or leaves (current + 1) is:

- optional in level I plots;
- recommended in level II plots;
- mandatory in level III plots.

For all species it is necessary to take care that leaves or needles which are sampled are mature ones, especially for species which have several flushes per year (e.g. *Pinus halepensis*, *Pseudotsuga menziesii*, *Eucalyptus* spp., *Quercus* spp.).

For *Larix* spp. and *Cedrus* spp. samples are taken of the short twigs of the previous year.

4.2.6 Orientation

In general sampling must be carried out in such a way that all the orientations are represented in the set of sample trees. If necessary it is allowed to sample different orientations on each tree of the sample set. In special sites with evident influence of one orientation (e.g. steep slopes or strong dominant wind) only one orientation is sampled, which always has to be the same. In such cases, it is necessary to document the orientation.

4.2.7 Quantity of material to be sampled

The recommended quantities are:

- grams of fresh needles or leaves for each sampled age class, if only major elements and Fe, Mn, Zn, Cu are analysed;
- grams of fresh needles or leaves if also other elements such as F, Cl, Cd, Pb, Al and B are analysed.

Each country may decide to sample a larger quantity of leaf material, according to the need of its own analytical methods, or in order to conserve samples for the future.

4.2.8 Means of sampling

As trees cannot be felled, any convenient way of sampling, taking into consideration kind and size of stands etc., is acceptable, provided that it does not lead to contamination of the sample, to heavy tree damage, or to risks for the sampling team.

4.2.9 Pretreatment before sending the samples to the laboratories for analysis

For broadleaves, it may be advisable to detach the leaves from the twigs (and even, in certain species, the small leaves from the axis) but this is not necessary for the conifer needles. The shoots of the current year and those of the second year are separated and preserved in separate bags. The use of perforated high density polyethylene bags is recommended. If possible, samples are dried in a clean room and stored in a cool place in perforated polyethylene bags.

Great care must be taken to clearly mark each sample (forest, number of plot, species, age of needles, etc.) before sending it to the laboratory for analysis. These identifications must be given outside the bag (directly on the bag by indelible ink, or by clasping a label on the bag). It is recommended to repeat these identifications inside the bag on a paper label written with indelible ink. The label should be folded in order to avoid leaves or needle contamination by contact with ink.

Only trees of the main 50 species are to be sampled (see respective code list in Chapter 7.3).

4.3 Chemical analyses

Only the total element concentration is determined.

4.3.1 Treatment before analysis

The determination of the mass of 100 leaves or 1,000 needles, as well as the shoot mass, are recommended for level II and level III and the current year shoot.

It is not necessary to cut the petioles of the leaves but in case of compound leaves it may be advisable to detach the small leaves from the axis if this has not been done in the forest. Avoid contamination, no powder and plastic gloves.

It is not necessary to systematically wash the samples, but it may be advisable in regions with a high level of air pollution or near the sea. The samples shall be washed with water without any additions.

Oven drying must be done at no more than 80°C for at least for 24 hours. The needles shall be removed from the twigs with the same precautions as for detaching the small leaves from their axis.

Dry samples shall be ground in order to obtain a fine powder, as homogeneous as possible. There will always remain some fibres, depending on the tree species; this is not a major inconvenience if they are small and if the powder is mixed carefully before taking samples for analysis. For Mn, Fe, Cu, Cd, Al and Pb determination, it has to be assured that the grinder does not contaminate the samples. The grinder may be tested by grinding dried fibrous cellulose and analysing it for these elements before and after the grinding.

4.3.2 Elements to be determined

Levels I and II plots: mandatory: N, S, P, Ca, Mg and K; optional: Na, Zn, Mn, Fe and Cu;

Levels III plots: mandatory: N, S, P, Mg, Ca, K, Na, Zn, Mn, Fe and Cu; optional: F, Cl, Cd, Pb, Al and B.

4.3.3 Digestion (or ashing) and analysis

4.3.3.1 General considerations and quality assurance

Each country is allowed to use its national methods. But it is necessary to compare the total element concentrations obtained by national methods with those certified on the reference standard samples.

Annex 4-1: Choice of needles and leaves

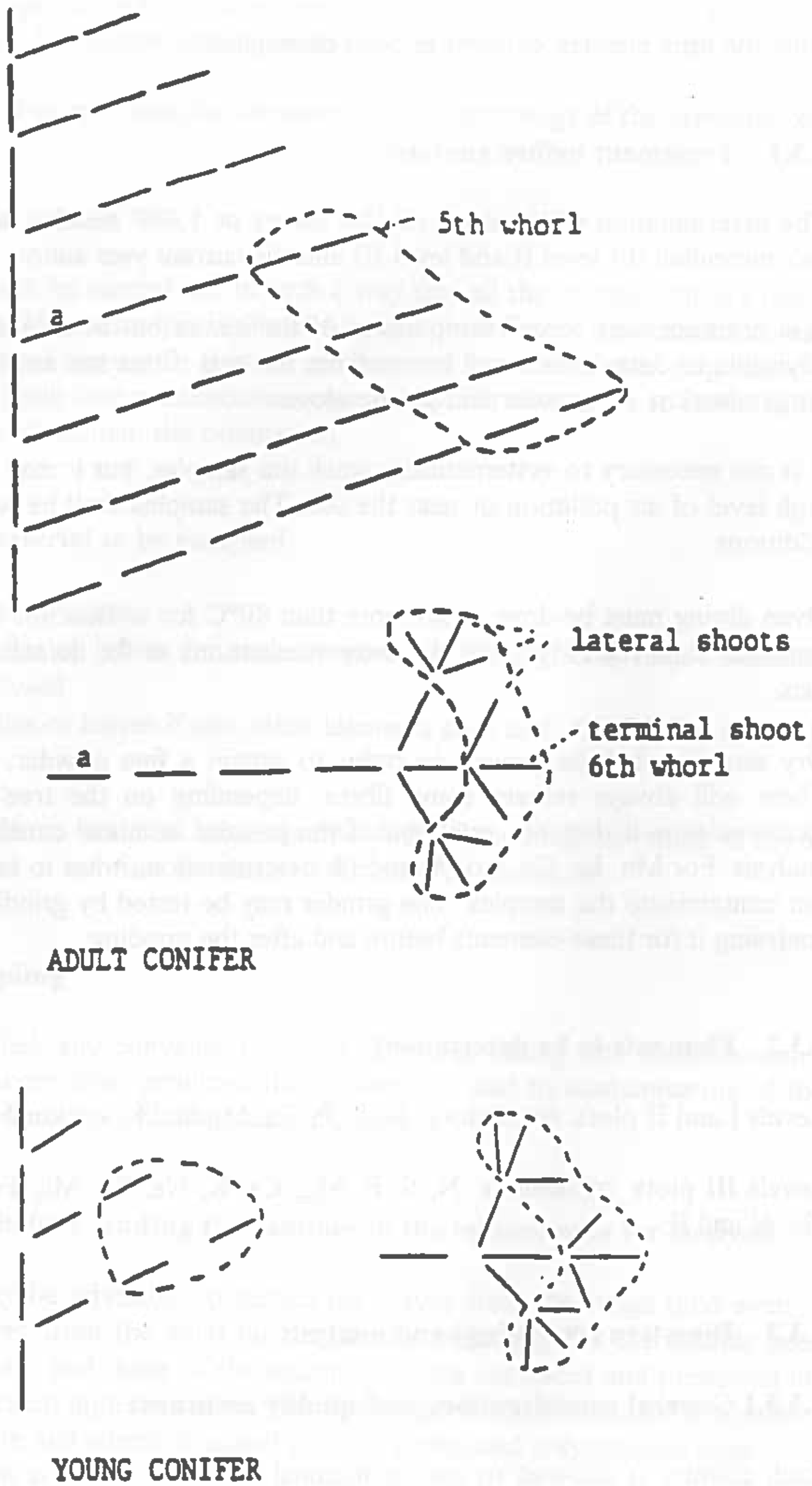


Figure 1

Figure 2

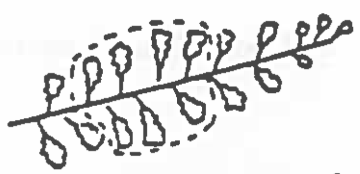


Figure 3

Annex 4-2: Methods of digestion (indicative)

As a guide, the most common methods of wet digestion or dry ashing are given hereinafter. Four main groups of methods are used.

A. Wet digestion in acid and/or oxiding conditions

For instance:

<u>A1. Kjeldahl method for N</u>
Organic N is digested in concentrated H_2SO_4, in the presence of catalysts and converted into NH_4^+. N eventually present in NO_3^- or NO_2^- form is not transformed into NH_4^+ and therefore not determined by methods specific for NH_4^+.

<u>A2. Digestion by oxidants and hot acids at room pressure</u>
- $H_2SO_4 + H_2O_2$ (for N and P analysis);
- $H_2SO_4 + HNO_3$;
- HNO_3;
- $H_2O_2 + HNO_3$;
- HNO_3 or H_2O_2 followed by $HClO_4$. Perchloric acid is very efficient but dangerous (risk of explosion by contact with organic material, or drying and heating perchlorates). The storage and manipulation must be done very cautiously. $HClO_4$ digestion must be preceded by cold attack of the sample powder by H_2O_2 110 V or concentrated HNO_3 during 24 hours in order to digest most of the organic tissues before adding $HClO_4$.
- HNO_3 + HF, teflon vessels; after digestion one has to fume away the HF with HNO_3.

These methods may be used for N ($H_2SO_4 + H_2O_2$), P, S, Ca, Mg, K, Na, Mn, Zn and Cu.

<u>A3. Digestion with $H_2O_2 + HNO_3$ in a microwave oven</u>

<u>A4. Pressurized digestion with HNO_3, or $HNO_3 + H_2O_2$ in teflon bombs at 180°</u>
- 200 mg vegetal powder + 3 ml concentrated HNO_3
  This method may be used for the same elements as for A2 methods except N: S, P, Ca, Mg, K, Na, Mn, Zn, Cu and for Al, Cd, Pb, Cl and B.

<u>A5. Digestion in HNO_3 under a backward column</u>
This method is used for Ca and Pb determination, but may be used for other elements except N.

B. Dry ashing

The sample powder is heated at 450-600° for 4 hours and ashes are dissolved in water or dilute acids (HCl, HNO_3, $HClO_4$).

B1. Dry ashing at room pressure in a furnace at 450-600°, according to the element, in platinum, porcelain, quartz or Ni curcibles. Ash dissolution may be made with acids, HCl, $HClO_4$.

This method is convenient for P, K, Na, Ca, Mg, Fe, Mn, Zn. For P it may be recommended to wait at least 24 hours before analysis in order to obtain a complete oxidation of P into PO_4^{--}.

There may be Si and Al precipitates which are insoluble in HCl and which may absorb a small quantity of elements; but the corresponding error is generally negligible. It may be avoided by filtration of the ash HCl solution, calcination of the filter in a platinum curcible, dissolution of the filter ashes in HF, dry evaporation, dissolution of the residue in HCl, and addition of this solution to the first filtrate.

The latter procedure is necessary for Al analysis, the solubilization of which is not complete without using HF, and for elements present in very small quantities in the plant tissue (Cu). Platinum crucible is necessary for use of HF; also teflon and carbon are possible.

For several elements (Cl, S, Pb, Cd) dry ashing at room pressure causes loss by volatilization. In order to prevent it, additions of stabilizing products are necessary: $Mg(NO_3)_2$ (for S), NH_4NO_3 (for Cd and Pb), Na_2CO_3 (for Cl), CaO (for B, F), NaOH (for F).

B2. Low temperature (50-60°) ashing in O_2 atmosphere excited by a radiofrequency magnetic field, during 8 hr; this method is used for F analysis.

B3. Combustion in a Schöniger flask, a closed flask in which plant powder is burnt in O_2 atmosphere and directly dissolved in acidic or alcalic solution. This method is used for many elements, including S, P, Cl, but is very time consuming because only one sample can be ashed and digested at the same time.

C. Integrated oxydation and detection

More and more frequently special apparatus are used, performing automatically, in a closed circuit, oxidation, detection and quantification of gases coming from oxidation. Several firms sell such apparatus which are globally called CHN or NS apparatus.

Analysis of N and S by these methods will be probably more and more used in the future. Unlike the Kjeldahl, these methods give total N concentration, including NO_2^- and NO_3^- forms. Therefore it is necessary for N to indicate the results in connection with the method used.

D. X-ray fluorescence

All metals and no metals up to B can be determined with X-ray fluorescence, without digestion or ashing, in compacted vegetal powder.

Annex 4-3: Determination

Many ways for the determination of the various elements are possible.

A. Titration

- NH_4^+ after digestion by the Kjeldahl method and distillation of NH_3 in HBO_3;
- Cl: by $Ag(NO_3)_2$ in presence of CrO_4^{--} (end of the precipitation of $AgCl_2$ is detected by the red colour of $AgCrO_4$
- Cl: by micro-titration with AgNo3 in acetonic solution and potentiometric indication
- SO_4 by titration with $BaCl_2$ and thorine as indicator

B. Colorimetry

- NH_4: indophenol blue; or FIA method (diffusion of NH_3 through a teflon membrane, and colorimetry in a solution of phenol + ethanol + NaCl + NaOH);
- P: phosphovanadomolybdate (yellow) or molybdene blue;
- Cl: colorimetry of $Fe(SCN)_3$ after reaction of $Hg(SCN)_2$;
- S: metorine (8); DMSA III and other colour indications
- B: 1-1' dianthrimide

C. Turbidimetry

S: turbidimetry of a suspension of insoluble $BaSO_4$ with a tensioactive agent (Tween 80).

D. Ionic chromatography: for P, S, Cl, F

E. Specific ion electrodes: for F, Cl

F. Capillary electrophoresis: for Cl, S

G. Flame emission spectrophotometry: for K, Na

H. Flame atomic absorption spectrophotometry

H1: without electrothermic system (graphite oven): Na, K, Ca, Mg, Fe, Mn, Zn, Al and Cu
H2: with graphite oven: Pb, Cd and Cu.

I. ICP (inductively coupled plasma)
I1: without ultrasonic nebulisation: Na, K, Ca, Mg, Fe, Mn, Zn, Al, Cu, P, S, Cl and B.
I2: with ultrasonic nebulisation: Pb, Cd and Cu.

J. Processes C (ashing with direct determination, in CHN or NS apparatus) and D (direct determination by X-ray fluorescence) are mentioned.

Annex 4-4: Most commonly used methods for analysing various elements

N

a) N organic + NH_4:
- Digestion

- Kjeldahl method: concentrated H_2SO_4 with K_2SO_4 and Se as catalysts;
- methods derived from the Kjeldahl method: other catalysts than Se, which is toxic in the environment, such as Ti, Cu; $H_2SO_4 + H_2O_2$ without catalyst.

- Determination

- NH_4^+ colorimetry (indophenol blue or FIA method);
- NH_3 distillation and titration

b) total N: CHNS apparatus

S

a) Digestion or ashing

- wet acidic and oxidizing digestion: HNO_3, $H_2O_2 + HNO_3$; $H_2O_2 + HClO_4$; $HNO_3 + HClO_4$;
- HNO_3 in teflon bombs;
- dry ashing with addition of $Mg(NO_3)_2$ and MgO; ash dissolution in HCl or water;
- Schöniger flask.

b) Determination

- Turbidimetry by $BaSO_4$ (with dissolution by HCl and filtration before $BaSO_4$ precipitation is recommended);
- ICP;
- Ionic chromatography (after ash dissolution in water);
- Colorimetry.

c) Direct determination by CHN of NS apparatus.

d) Direct determination by X-ray fluorescence.

P

a) Digestion or ashing

- wet acidic and oxidizing digestion: $H_2SO_4 + H_2O_2$, $H_2SO_4 + HNO_3$, HNO_3, $HNO_3 + H_2O_2$, $H_2O_2 + HClO_4$; $HNO_3 + HClO_4$;
- HNO_3, or $HNO_3 + H_2O_2$, in teflon bombs;

- dry ashing at 450-500° at room pressure (wait 24 h after ash dissolution in HCl or $HClO_4$ before determining PO_4^{---});
- Schöniger flask.

b) Determination
- Colorimetry: phosphovanadomolybdate or molybdene blue;
- ICP;
- ionic chromatography;
- X-ray fluorescence (direct determination).

Ca, Mg, Fe, Mn, Zn

a) Digestion or ashing
- wet acid and oxidizing digestion at room pressure (HNO_3, H_2SO_4 + HNO_3, HNO_3 + H_2O_2, H_2O_2 + $HClO_4$, HNO_3 + $HClO_4$);
- NHO_3, or HNO_3 + H_2O_2, in teflon bombs;
- dry ashing at room pressure, ash dissolution in HCl or $HClO_4$;
- Schöniger flask

b) Determination
- atomic absorption spectrophotometry;
- ICP;
- X-ray fluorescence (direct determination).

K, Na

a) Digestion or ashing: see 3.3.4.4

b) Determination
- flame emission spectrophotometry;
- atomic absorption spectrophotometry;
- ICP;
- X-ray fluorescence (direct determination).

Cl

a) Digestion or ashing
- HNO_3, or HNO_3 + H_2O_2, in teflon bomb;
- dry ashing at 450-550° after addition of Na_2CO_3 and ash dissolution in hot water;
- Schöniger flask.

b) Determination
- titrimetry with $AG(NO_3)_2$;
- colorimetry of $Fe(SCN)_3$ after reaction with $Hg(SCN)_2$;
- ionic chromatography;
- capillary electrophoresis;
- specific electrode;
- ICP;
- X-ray fluorescence (direct determination).

B

a) Digestion or ashing
- HNO_3, or HNO_3 + H_2O_2, in teflon bomb;
- dry ashing at 450-500° after addition of CaO, and ash dissolution in 25% acetic acid;
- Schöniger flask.

b) Determination
- colorimetry by 1-1'dianthrimide;
- direct determination by X-ray fluorescence;
- ICP.

F

a) Dry ashing
- at 600° for 16 hours (after progressive temperature increase) with addition of CaO (1 g sample + 0,2 g CaO); ash dissolution in 4N $HClO_4$;
- at 450° for 16 hours in Ni crucible, with addition of NaOH; ash dissolution by pH 5,7 buffered acid (buffer HCl) acetic or HCl/citric acid); The muffle must be covered with Ni.
- low temperature ashing in O_2 atmosphere;
- Schöniger flask.

b) Determination
- specific electrode (eventually after micro-diffusion procedure of trimethylfluorosilane (TMFS) in 0,1 M NaOH, after ash dissolution in $HClO_4$);
- ionic chromatography.

Al

a) Digestion or dry ashing
- dry ashing at 450-500° in platinum crucible, ash dissolution by HCl, filtration, collection, of the filtrate, calcination of the filter, digestion of ash by HF, dry evaporation, dissolution of the residue in HCl and addition to the first filtrate;
- dry ashing at 450-500° in platinum or Ni crucible, followed by alkaline fusion of the ashes in lithium borate $LiBO_2$, and uptake in diluted HNO_3;
- HNO_3, or HNO_3 + H_2O_2, in teflon bomb.

b. Determination
- Flame atomic absorption spectrometry;
- ICP;
- X-ray fluorescence (direct determination).

Cu

a) Digestion or ashing
- wet acid digestion (HNO_3, $HNO_3 + H_2O_2$, $HNO_3 + HClO_4$, $H_2O_2 + HClO_4$);
- HNO_3, or $HNO_3 + H_2O_2$, in teflon bomb;
- dry ashing and ash dissolution in HCl or $HClO_4$;
- dry ashing, dissolution in HCl, filtration, calcination of the filter, HF, Dry evaporation, dissolution in HCl (as for Al determination).

b) Determination
- Flame atomic absorption spectrometry;
- I.C.P.;
- I.C.P. with ultrasonic nebulisation.

Pb and Cd (5 g sample)

a) Digestion or ashing
- HNO_3, or $HNO_3 + H_2O_2$, in teflon bomb;
- acid extraction by HNO_3 in a flask with a backward column;
- dry ashing at 450-550°C after addition of NH_4NO_3, ash dissolution in HCl (for determination by ICP) or HNO_3 (for determination by atomic absorption).

b) Determination
- Electrothermic atomic absorption spectrometry (after ash dissolution in HNO_3);
- ICP with ultrasonic nebulisation (after ash dissolution in HCl);
- Flame atomic absorption spectrometry.

Recapitulation of digestion or ashing methods (see Annex 4-6).

Annex 4-5: Data expression-Units

The total concentration of elements in needles or leaves must be given by reference at 105° dried material. The residual water content after drying at 60-80° must be determined by drying at 105° and weighing, and the results given by the analysis performed on 65-80° dried powder must be corrected. On the same way it is recommended to dry again samples at 65-80° immediately before weighing them for analysis.

Major elements (N, P, S, K, Mg, Ca) must be expressed in $mg.g^{-1}$ dry powder.

Trace elements (Fe, Mn, Zn, Cu, Pb, Na, Cl, Al, B) must be expressed in $\mu g.g^{-1}$ dry powder.

Annex 4-6: Validation of the analytical results

As shortly indicated in 4.3.3.1, the total element concentrations obtained by the national methods have to be checked in order to be sure of the accuracy of these methods. Two steps of quality assurance are to be foreseen:

Comparison of the results of the national methods with the concentrations of reference standard samples. These reference standard samples, with certified total element concentrations, supplied e.g. by CBR of the EEC (Central Bureau or References) or by ISO (International Standard Organization), or by the US group of foliar analysis, will be sent to the national local experts (or laboratories) for analysis, with the request to send the analysis results (with 3 repetitions) to the chairman of the working group, within a delay of 6 months after receipt of the reference standard samples. The certified concentrations of the latter will be supplied subsequently when the results of all (of most of the) laboratories involved have been received.

In order to permanently check the analysis accuracy, it is also recommended that each laboratory disposes of several own reference samples of different compositions (e.g. at least one poor and one rich) to be included in each analysis series and element concentrations of which have been determined before by methods which give results in good agreement with the element concentrations of the reference standard samples.

Annex 4-7: Digestion, ashing and determination methods

Table 4-7.1: Summary of the digestion or ashing procedures

	N	P	K, Na, Ca, Mg, Fe, Zn, Mn	Al	Cu	Cd	Pb	Cl	B	F
A - **Wet acidic oxydizing conditions**										
A1 - Kjeldahl	X									
A2 - Oxidant and hot acids at room pressure										
H_2SO_4+H_2O_2	X	X								
H_2SO_4+HNO_3		X	X							
HNO_3		X	X		X					
H_2O_2+HNO_3		X	X		X					
$HClO_4$		X	X		X					
A3 - H_2O_2+HNO_3 in microwave oven		X	X		X					
A4 - HNO_3, or HNO_3 + H_2O_2 in teflon bombs at 180°	X	X	X	X	X	X	X	X	X	
A5 - HNO_3 digestion under backward colomn						X	X			
B - **Dry ashing**										
B1 at room pressure 450-500°										
- without HF treatment		X	X							
- with HF treatment		X	X	X	X					
- with addition of stabilizing products						X(2)	X(1)	X(3)	X(4)	X(4,5)
B2 - Low temperatures in O_2										X
B3 - Schöniger flask		X	X		X			X		
C - **Integrated oxidation and detection** (CHN, NS devices)	X									

(1) : $Mg(NO_3)2$ (2) : NH_4NO_3 (3) : Na_2CO_3 (4) : CaO (5) : NaOH

Table 4-7.2: Determination methods

	N	S	P	K	Na	Ca	Mg	Fe	Mn	Zn	Al	Cu	Cd	Pb	Cl	B	F
Tritration	X(1)														X(2)		
Colorimetry	X(3)	X(4)	X(5)												X(6)	X(7)	
Turbidimetry		X															
Ionic chromatography		X	X												X		X
Specific electrods																	X
Capillary electrophoresis		X													X		
Flame emission spectroph.				X	X												
Flame atomic ads. spectroph																	
- without graphite oven				X	X	X	X	X	X	X	X	X					
- with graphite oven												X	X	X			
- ICP without nebulisation		X	X	X	X	X	X	X	X	X	X	X			X	X	
- ICP with nebulisation												X	X	X			
Integrated oxidation and detection	X	X															
X-ray fluorescence		X	X	X	X	X	X	X	X	X	X				X	X	

(1): NH3 distillation
(2): $AgNO_3$ in presence of CrO_4--
(3): Indophenol blue or FIA method (phenol + ethanol + NaCl + NaOH)
(4): Metorine
(5): Phosphovanadomolybdate or molybdene blue
(6): $Fe(SCN)_3$
(7): 1-1' dianthrimide

Annex 4-8: List of recommended species for level I and II

1	Acer campestre
5	Acer pseudoplatanus
6	Alnus cordata
7	Alnus glutinosa
10	Betula pendula
11	Betula pubescens
13	Carpinus betulus
15	Castanea sativa
17	Eucalyptus sp.
18	Fagus moesiaca
19	Fagus orientalis
20	Fagus silvatica
21	Fraxinus excelsior
23	Fraxinus ornus
28	Olea europaea
29	Ostrya carpinifolia
31	Populus alba
32	Populus canescens
33	Populus hybrides
34	Populus nigra
35	Populus tremula
36	Prunus avium
41	Quercus cerris
42	Quercus coccifera
43	Quercus faginea
44	Quercus frainetto
46	Quercus ilex
48	Quercus petraea
49	Quercus pubescens
50	Quercus pyrenaica
51	Quercus robur (Q. pedunculata)
52	Quercus rotundifolia
53	Quercus rubra
54	Quercus suber
56	Robinia pseudoacacia
58	Tilia cordata
100	Abies alba
101	Abies borisii-regis
102	Abies cephalonica
105	Abies pinsapo
107	Cedrus atlantica
115	Juniperus thurifera
116	Larix decidua
117	Larix kaempferi (L. leptolepis)

118	Picea abies
120	Picea sitchensis
121	Pinus brutia
123	Pinus cembra
124	Pinus contorta
125	Pinus halepensis
127	Pinus leucodermis
129	Pinus nigra
130	Pinus pinaster
131	Pinus pinea
132	Pinus radiata
134	Pinus sylvestris
135	Pinus uncinata
136	Pseudotsuga menziesii

Annex 4-9: Practical ways of sampling

a) Long pruning device

Sampling of needles and leaves with a pruning device

Since 1985 The Finish Forest Research Institute has used a pruning device to collect needle- and leafsamples.

The device is constitued of six easily attached handlers, a cutter and a cord (Fig. 1-2). The length overall is 18 m and the material is coal fibre. The cutter is made of 1,5 mm thick steel sheet and it weights about 150 g. The attaching is made with two different kind of joints (Fig. 3). The detailed guidelines of the using the pruning device is presented in the appendix 1.

According to long experience of the Finnish Forest Research Institute, the sampling of 10 trees takes about two hours. At the time the other person cuts the sample branches and the other puts them into the plastic bag for transport and storage.

The best way to lift up the pruning device, is to it steadily and smoothly. The lift will success at most by the length of 12 m, if there aren't any trees or other obstacles. Other parts will be attached while the handle is lifted, using the top as a support.

Each sample of a branch will be selected by the directions. Within the directions, you should take a branch that's a good sample and it won't stuck inside the canopy, but will come down. The diamter of the branch is 1,5 cm, which will be cut fairly. For example hardness of the branch anhd cold will effect on the cutter. It's good to roll the drawstring around the handle, so it won't stuck on branches and it will support the stem while cutting and it will keep up better during transportation.

It's important that you don't screw on the aluminium joint by force, because it may get stuck. There might be pieces of aluminium or other materials in the thread. In that case, spirits or other washable liquid will help.

Coal fibre is very durable by it's bending strength, but it won't stand sharp blows, because they may cause invisible damage and the tube can easily break when loaded. If the joints must be glued again (with dual constituent glue), a small piece of the tube is cut to get a new junction.

WARNING!
Coal fibre is very conductive, so be careful while working near electric wires. Especially from high voltage, such as 110 Kw wire, can be generated an electric arc in some distance (no knowledge of the accurate distance).

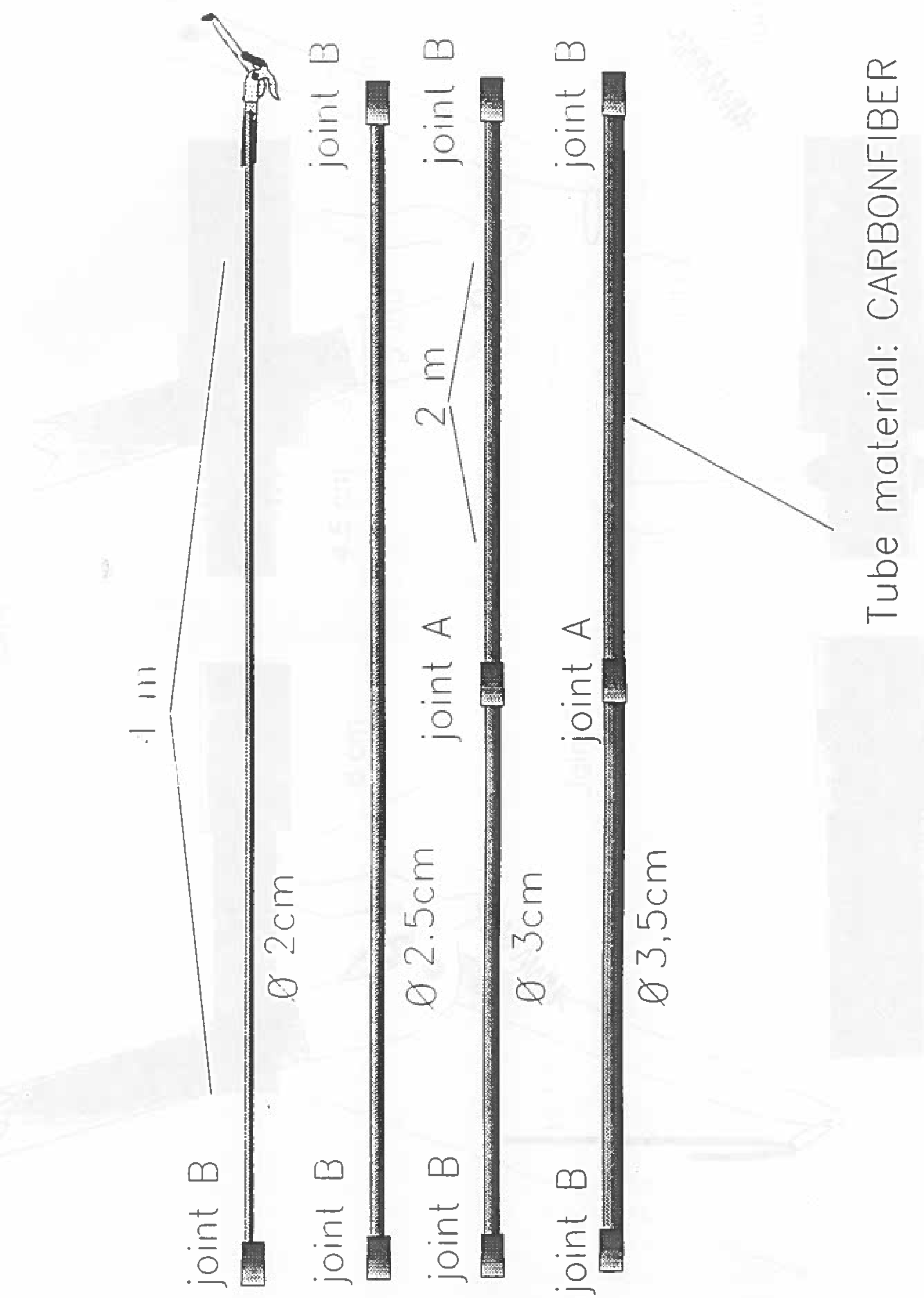


Figure 1

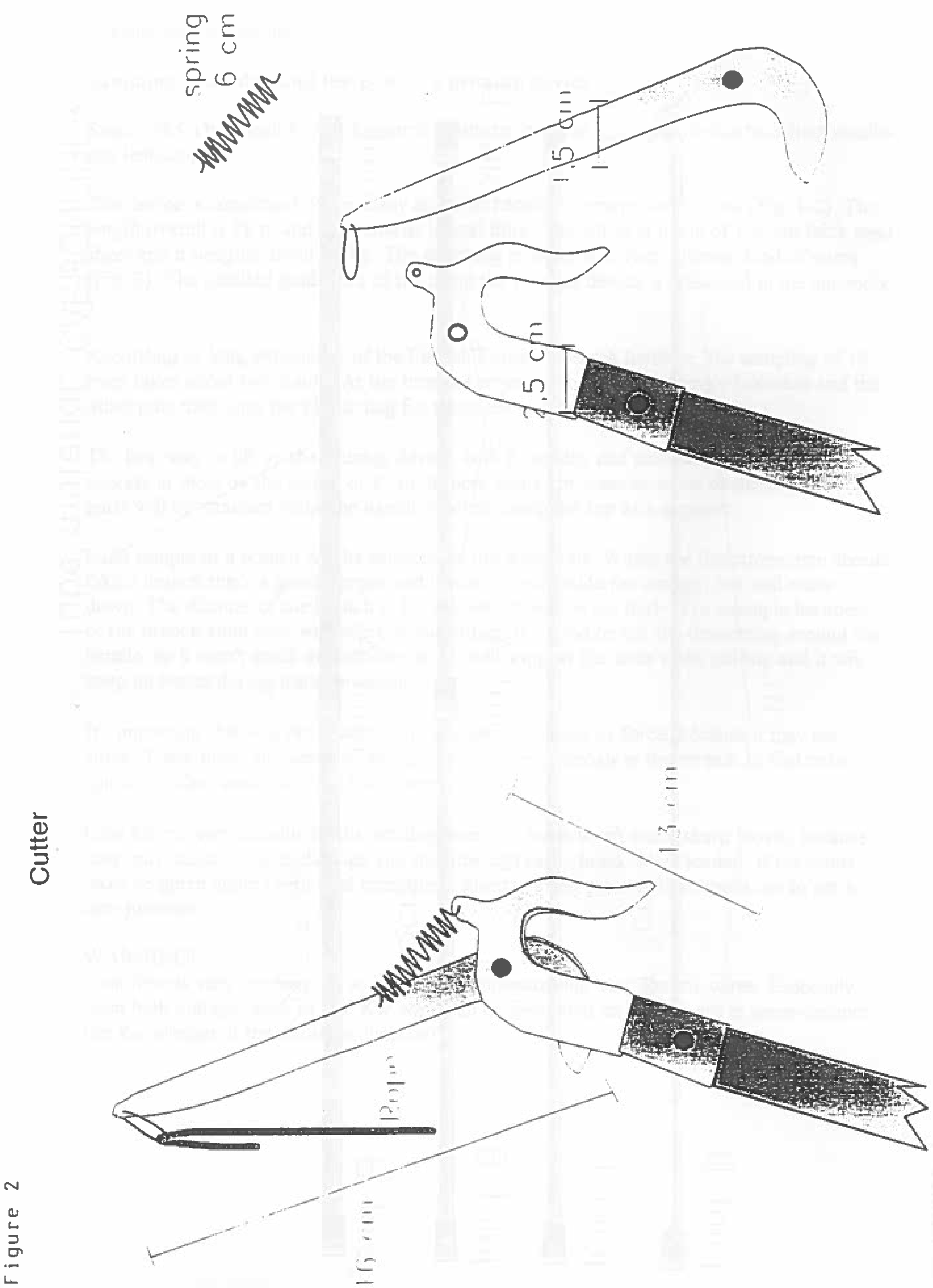


Figure 2

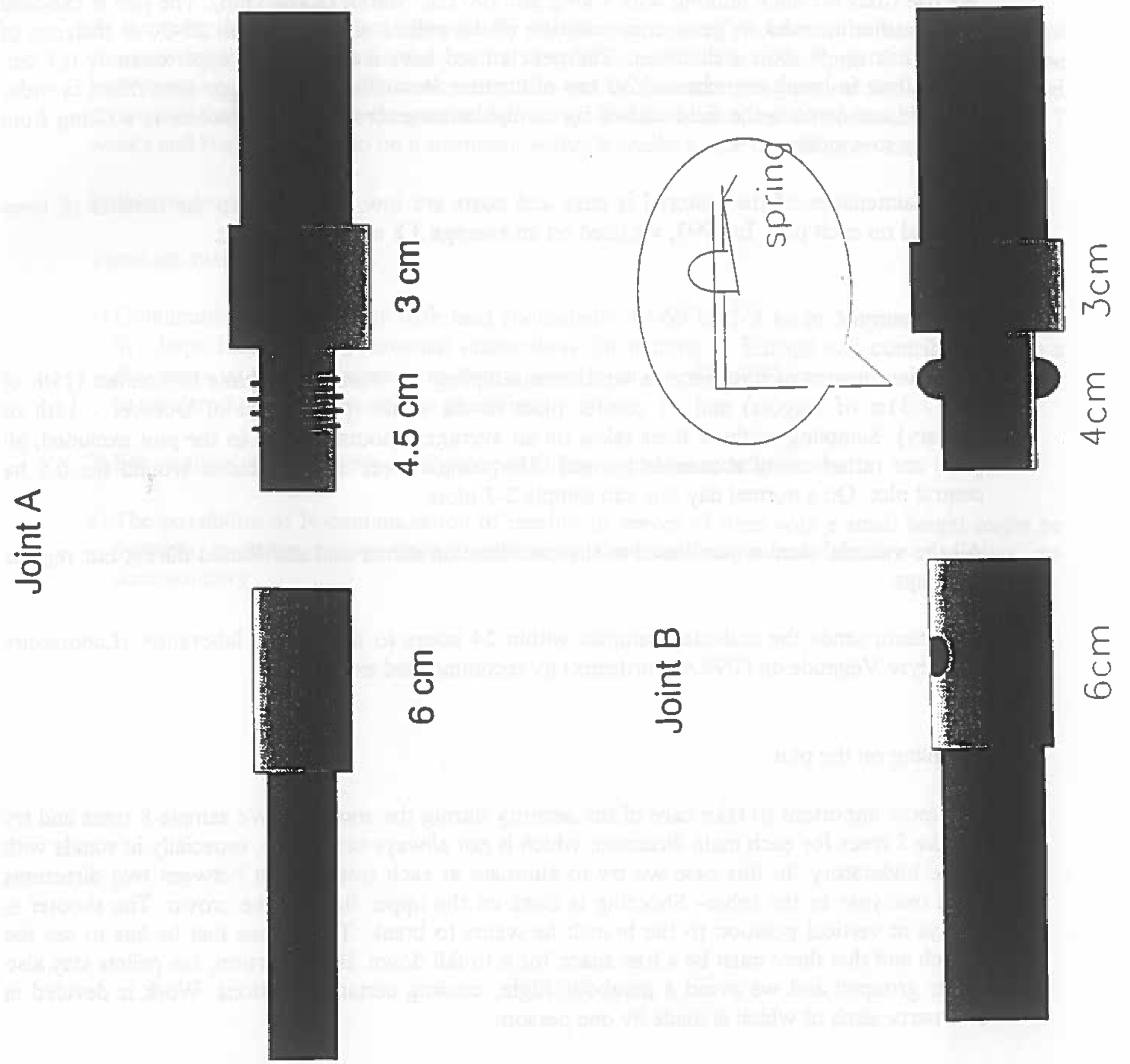


Figure 3

b) Shooting

Foliar sampling in the French permanent plot network for the long-terme monitoring of forest ecosystems (Renecofor[1])

Material

We use rifles for duck hunting with a long gun (90 cm, Marlin Goose Gun). The gun is chocked at the outlet in order to get a concentration of the pellets of buck-shot at 25-30 m distance of approximately 50-60 cm diameter. The pellets used have a diameter of approximately 0,5 cm. They allow to break branches of 2-3 cm of diamter. Actually we use single-shot rifles, in order to avoid accidents in the field caused by manipulation errors when the shooter is walking from one tree to another.

The maintenance of the material is easy and costs are low, compared to the number of trees sampled on each plot. In 1993, we used on an average 3,8 catridge per tree.

Organisation

We have 8 teams of two persons which are sampling 51 broadleaved plots in summer (15th of July - 31st of August) and 51 conifer plots in the winter period (1st of October - 15th of January). Sampling of the 8 trees takes on an average 2 hours (access to the plot excluded; all plots are rather easily accessible by car). The sample trees are distributed around the 0.5 ha central plot. On a normal day one can sample 2-3 plots.

All the material used is purchased at the coordination center and distributed during our regular meetings.

Each team sends the collected samples within 24 hours to our central laboratory (Laboratoire d'Analyse Végétale de l'INRA-Bordeaux) by recommended express mail.

Sampling on the plot

It is most important to take care of the security during the shooting. We sample 8 trees and try to take 2 trees for each main direction, which is not allways easy to do, especially in stands with dense understory. In this case we try to alternate at each tree at least between two directions from one year to the other- Shooting is done on the upper third of the crown. The shooter is always in vertical position to the branch he wants to break. This means that he has to see the branch and that there must be a free space for it to fall down. Being vertical, the pellets stay also better grouped and we avoid a parabolic flight, causing certain deviations. Work is devided in two parts, each of which is made by one person:

- shooting: this means also that the shooters hands will be contaminated;

- collecting: it is done with polyethylene gloves. Broadleaves are detached and counted. We take individual samples of each tree in seperate polyethylene bags with micro-perforation. For broadleaves we count at least 100 leaves per tree in order to be able to produce a sufficient

[1] Réseau National de survi à long terme des Ecosystémes Forestiers

quantity of a mixed sample based on the 40°C dry weight. For conifers we take the whole annual shoots.

On most of the plots we will try to sample always the same group of 8 trees. In those cases where this is not possible (e.g. small crowns), we will alternate every year with a second group of 8 trees. These cases are rather rare (< 10% estimated).

At the laboratory

At the reception, samples are immediately checked. In case of problems, the laboratory informs the coordination center, in order to find a solution within the time limits for sampling. The laboratory confirms within 4 weeks after the end of each sampling period that all samples did arrive and that they are on the way to be analyzed. All the samples are to be analyzed within 7 weeks and the results are to be transmitted within 8 weeks to the coordination center.

Problems encountered

There are mainly 3 problems:

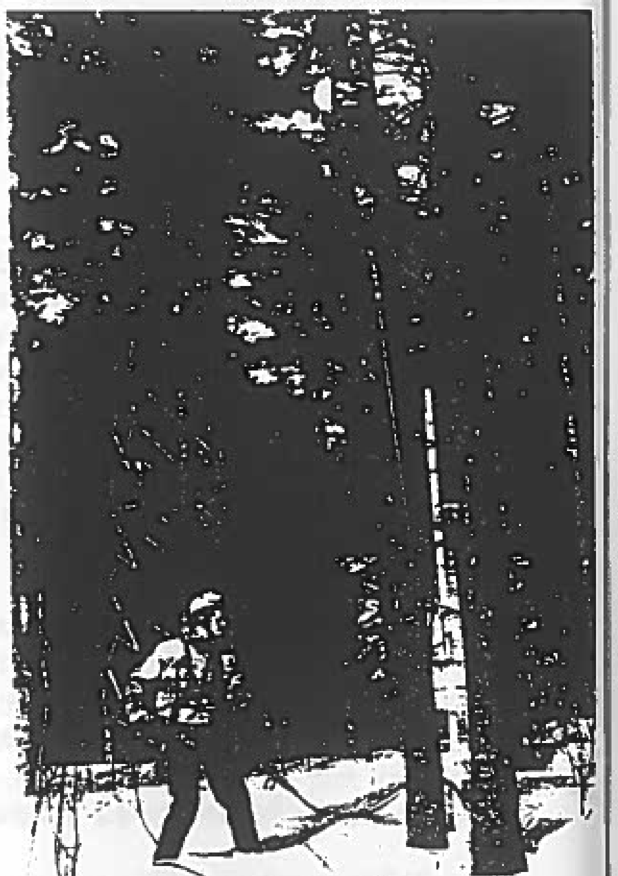
1) Contamination of the sites with lead (potentially 40-60 kg/2-3 ha in 30 years are possible). We hope that the environmental instructions for hunting in Europe will contribute within a few years to the development of cartridge with pellets of a different metal, which is not able to be introduced into the soil by alteration.

2) For conifers, we have only rarely the possibility to choose a definite whorl.

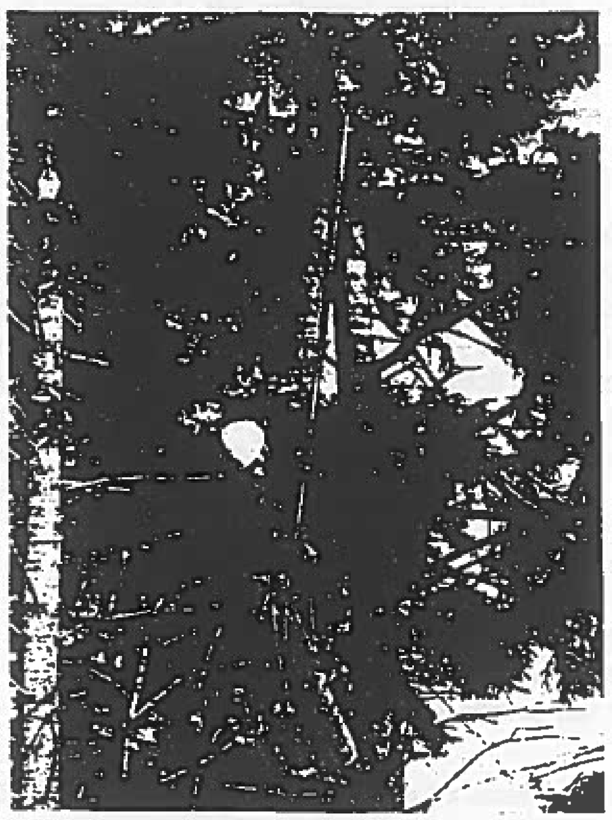
3) The possibility of N contamination of needles or leaves of trees with a small height might be possible, eventhough experiments, comparing shot and hand-sampled leaves or needles, are contradictory.

c) Climbing

We need a ladder (2 x 3), pole-pruner (5 m), special rope (50 m) and ordinary climbing equipment for 2 persons. Total weight: 10-15 kg.



We use the ladder to reach the first whirls. The climber is secured by the man on the grou



It is possible to cut off any branch in the crown..

.... and we also reach neighbour trees up till 5-6 m away.

5. ESTIMATION OF GROWTH AND YIELD

5.1 Introduction

5.1.1 Definition

Increment is defined here as the periodic growth of trees and stands, including basal area (as a minimum requirement), height and volume.

5.1.2 Objectives

The primary objective of the monitoring of increment in Level II plots is to provide an additional assessment of tree and stand condition. These assessments, together with others undertaken at Level II, will form the basis for comparisons of particular forest types throughout the ECE-region.

5.1.3 Use of the data

Increment studies by periodic measurements are mandatory on Level II. Tree ring analyses on either cores or disks are optional on Level II. At least 15 years of data will be required from the plots before reliable estimates of increment change can be obtained.

The increment data collected on the Level II plots will not be suitable for extrapolating to larger areas. In this respect, the plots should be seen as permanent monitoring plots and not as inventory plots.

5.1.4 Basic methodology

The monitoring of increment is divided into two parts:

- The monitoring of future increment is done by means of periodic measurements of all the trees in the plots or subplots.

- To establish past growth patterns, a single sampling for tree ring analysis should be done on several trees in the surroundings of the plots. This can be done by sampling increment cores or disks.

5.2 Methodology

5.2.1 Sample plots

The minimum Level II plot size is 0.25 ha, expressed on a horizontal plane, as currently specified in the ECE-Manual. This size is sufficient for any assessment of increment that might be undertaken on the plot. For the measurement of increment, the plot may be sub-divided into sub-plots and a proportion of the sub-plots assessed. The size of these sub-plots should be in accord with the mensurational procedures of the country concerned and must be large enough to give reliable estmates of stand increment over the entire measurement period. The exact size of any sub-plots shluld be determined and reported. When establishing plots, due regard should be given to the time required to undertake growth studies; plots should be viable for at least 15 years. Increment measurements should preferably not be started on a plot within 5 years of any previous thinning, but should be continued through subsequent thinning cycles.

Existing mensuration sample plots that will be viable for at least 15 years can be used as the increment sub-plot if they are in a homogeneous stand suitable for Level II plot establishment.

In maquis, coppice and similar vegation types where the methods described in this chapter are inappropriate, further methods will be developed.

Each plot should have a buffer zone. For increment, this buffer zhone should be equivalent in width to the mean height of the dominant trees in and around the plot.

Periodic measurements must be undertaken at least every fifth year.

Measurements should be reported every five years, when possible, the first measurement period extending the winter of 1994-1995 to the winter of 1999-2000, and subsequent periods in 1999-2000 to 2004-2005 and 2004-2005 to 2009-2010.

5.2.2 Periodic measurements

Measurements of dbh on all trees in the plot (min 0.25 ha) are mandatory. Measurements of other indices (see Annex) on the plot or sub-plots are optional, although it is emphasised here that height measurements will significantly enhance the value of the data.

All trees should be individually identifiable by numbering. The height for dbh measurements should also be indicated, preferably on the tree side facing the plot centre. The spatial coordinates of all trees on the sub-plot should be recorded (optional) for both relocation and for the adequate assessment of some of the factors known to significantly influence the tree increment.

It is recommended to have an assessment of the plot prior to any thinning operations. Maximum use should be made of any removed tree (e.g. stem analysis, biomass assessment, etc.).

5.2.3 Tree ring analysis

Increment cores or tree disks must not be sampled from the trees on the plot, as this will influence some of the monitoring results. Trees cut for thinning purposes should be used for stem analyses where possible.

Trees to be felled for stem analysis should be selected sufficiently far from the plots in order to avoid changes to the trees in the plots (e.g. extra light, more available root space etc.) but close enough to represent similar site conditions.

Trees selected for coring and stem analysis should be representative of the trees in th stands with respect to the research objectives. All normal measurements made in the plots should also be made on the sampled trees.

5.2.4 Stand records

The past history of growth in the stand is essential for interpreting future increment (e.g. thinnings, fertilization and other relevant changes to the forest stand must be available). All details of managment operations undertaken in the plot are essential from the time of plot establishment, including:

- type of thinning
- time of thinning
- basal area removed
- volume removed
- number of trees removed
- fertilization
- litter raking
- grazing
- pruning or brashing

Any other uses should also be documented. The fates of all individual trees from the start of the monitoring should be recorded.

5.3 Analysis of the data

Individual countries will be responsible for collating and analysing the data from their Level II plots. A central database will be established and maintained to facilitate international studies.

5.4 Data submission

The following raw data should be submitted: (* Mandatory)

Site identification *
Tree number *
Tree species *
Date of assessment *
DBH (measurement tape) or DBH (min and max) if callipers used *
Bark thickness
Tree height
Crown length
Crown width

Annex 5-1 Detailed suggestions for measurements

5-1.1 Crown and tree measurements

Individual countries should use their national systems. The following guidelines should be used in cases of doubt.

5-1.1.1 Diameter at breast height

The diameter at breast height (1.3 m) of all trees with a diameter of 5.0 cm overbark or greater in the plots/sub-plots should be measured at least every five years. Diameters should be measured perpendicular to the longitudinal axis of the stem (i.e. at an angle on leaning trees). Forked trees, with the fork below 1.3 m, should be treated as two separate trees. Similarly, coppice shoots originating from a single stool should be treated as separate trees. If there is an irregularity at 1.3 m, diameter measurements should be taken at points above and below the irregularity and the values averaged. Trees with root buttresses above ground level should have their diameters measured 1.3 m above the ground on the upper side of the tree. Lichens and loose debris should be removed prior to the measurement. Measurement should be made using a diameter tape or an instrument of similar accuracy, and should be recorded to the nearest 0.1 cm. The point(s) of measurement should be clearly marked on the tree, with the ideal marking consisting of a point at which the maximum diameter is measured and a point at right-angles to this (the second point being necessary when using callipers for the measurements).

5-1.1.2 Tree height

Tree height should be measured on a sub-sample of trees, as the measurements will enable the preparation of height growth curves. Crown length and mean crown width also provide useful information, but these should be measured on all trees within a subplot rather than on single trees scattered throughout the plot. As width DBH, measurements should be made at least every five years.

5-1.1.3 Bark thickness

Bark thickness is defined as the average thickness of the bark, measured from the surface of the bark to the wood. It is measured using a handheld guage. Measurements of bark thickness, to the nearest 1 mm, should only be undertaken on fallen or felled trees because of potential damage to the vascular cambium.

5-1.1.4 Tree height

Tree height in the sense of the assessment is defined as the vertical distance between the highest point of the crown and the ground. It is different from tree length,. which is the bole length from ground level to the tip of the tree. The proportion of trees assessed will depend on the nature of the stand, but should be sufficient to draw up statistically reliable diameter-height curves for at least the main species present on the sub-plot. Measurements should be made to the nearest 0.1 m, although this level of accuracy may not be achieved in larger trees.

5-1.1.5 Crown length

Crown length is defined as the distance from the top of the crown to the base of the obvious crown. When this is variable, average should be taken. At the base, branches should only be included if they have a basal diameter of 3 cm or more and are within 2 m of the main part(s) of the crown. Measurements should be made to the nearest 0.5 m.

5-1.1.6 Crown width

Crown width is defined here as the mean of two or more measurements of crown projection taken perpendicular to each other , excluding epicormic branches. At least four radii should be measured (Figure 5-1.1.6-1), with eight or more radii being required for accurate of mapping of tree crowns in stands. The radii should be oriented North, South, East and West when 4 radii are measured. Each radius should be measured from the stem, with an addition being made to allow for the radius of the stem. Measurements should be made to the nearest 0.5 m and reported as a mean for the tree.

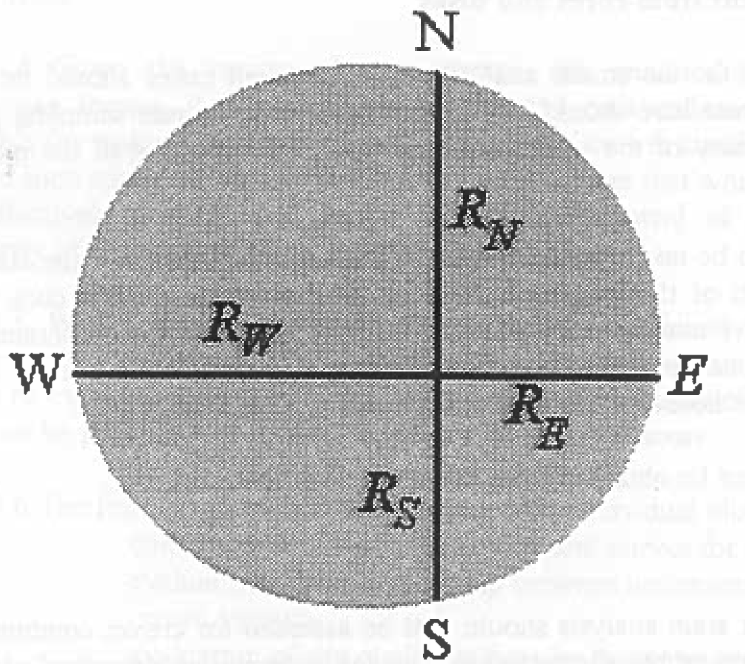


Figure 5-1.1.6-1: Measurements of crown diameter (4 radii)

DBH and other physical parameters should be measured outside the growing season. Height estimates of broad-leaved trees are usually only practical when there is no foliage present.

5-1.2 Regeneration

Regeneration should be assessed in sub-plots within the main monitoring plots. Seedlings (less than 2 cm diameter at breast height but more than 10 cm in height) should be distinguished from saplings (dbh between 2 cm and 5 cm). Counts of both should be made in ten sub-plots systematically distributed through the main monitoring plot. Sub-plots should be circular, with a radius of 1.87 m, giving a total sampling area of 100 m^2 per plot (10 x 10 m^2). Only live stems should be included. In detailed monitoring studies, the vigour of seedlings and saplings should be assessed using a three-point scale:

Class 1: Plants with more than 33% of the tree height in foliage, with no dieback in the upper 50% of the crown and with more than 80% of the foliage in normal condition.

Class 2: Plants that do not fit classes 1 or 3.

Class 3: Plants with more than 80% of the crown affected by dieback and/or abnormal foliage.

5-1.3 Radial increment from cores and disks

From each tree selected for increment analysis, two increment cores should be taken at breast height (1.3 m). Great care should be taken to ensure the correct sampling points on the stem so that any ovality of the stem's cross section or eccentricity of the pith can be accounted for.

Increment borings should be taken perpendicular to the longitudinal axis of the stem and in such a way that the pith of the tree is reached or almost reached. Each core is stored immediately in a protective container for transport to the laboratory. Each container should be marked with the plot number, the tree number and the direction of the core. After the boring has been taken, the hole in the tree should be sealed with suitable wax.

Increment cores should not be obtained from living trees within the plot

5-1.4 Stem analysis

5-1.4.1 Any tree used for stem analysis should first be assessed for crown condition, social class etc. After completion of the diameter/height measurements (as described above) and before the felling, a mark is made at breast height (1.3 m) at the northern aspect of the stem. The tree should be felled in a direction away from the plots to avoid possible damage to trees in the plot.

5-1.4.2 After felling, a disk of 5 cm ithick is cut at breast height and the northern direction mark is now indicated on the cross section. A second disk is taken just below the lowest green branch. For trees with a relatively long crown, a third disk is taken at the point where the top shoot reaches a diameter of 7 cm. This presents a minimum requirement, and the data will be considerably enhanced if more sections are taken. The distance from the base of the tree should be recorded for each stem section.

5-1.4.3 Trees should not be felled in the plots specifically for stem analysis. Instead, advantage should be taken of normal thinning operations. Where no such activity occurs, trees from outside the plot area (e.g. in the buffer zone) should be used. Trees from further away are unlikely to be representative of growth within the plots.

5-1.5 Data analysis

5-1.5.1 The following is given only as a guideline. Individual countries remain free to analyse the data from their Level II plots in whichever way they feel is most appropriate.

5-1.5.2 All measurements should be expressed in terms of basal area (m^2). Where height data have been collected, it may be possible to establish volume increment (m^3). However, the error surrounding estimates of volume increment may be considerable, particularly in older trees. Before determining height growth, the reliability of the estimates must be established by estimating and subsequently measuring the height of a sample of trees.

5-1.5.3 Ingrowth presents a problem as measurements only begin at diamter of 5 cm overbark. For basal area increment of trees recorded in year t but not in t-1, the initial diameter should be taken as 5 cm. Standing dead trees should be included in the assessment of basal area, but it is important to report the proportion of the basal area that consists of dead trees.

5-1.5.4 Given the variety of tree species, site qualities and management regimes in European forests, it is highly unlikely that the data collected on Level II plots will be suitable for making more than superficial comparisons in stand growth rates across Europe. While such comparisons are possible, the sample sizes that would be required are so large as to effectively prohibit any degree of statistical control of the data. Consequently, the majority of analyses are likely to be site-specific.

5-1.5.5 Within a plot, the sample sizes may be sufficient to undertaken a number of analyses. In particular, it will be possible to develop relationships between the growth (basal area) of trees and indices of their vitality. However, because of the initial sampling design, it will not be possible to extrapolate the results to larger areas.

5-1.5.6 The following analyses are suggested for individual plots:
- construction of diameter - increment curves for each species
- evaluation of the relationship between increment and other measures of crown vigour)
- evaluation of site quality indices by comparing increment with measures of site quality
- evaluation of climatic responses of trees.

6. MEASUREMENT OF DEPOSITION

6.1 Measurement of deposition

In addition to the monitoring of forest parameters, deposition measurements are to be included in the programme on the ICP Forests Level II plots.

6.1.1 Objectives

The objective of deposition monitoring on the Level II plots is to produce deposition data relevant to the specific sites, on which intensive monitoring is performed.

The objective of this sub manual on deposition is to provide a procedure for deposition measurements and analysis in order to harmonise the deposition measurements within ICP Forests and to create comparability to other deposition measurements within ECE programmes. Comparability is important. In the long run, the deposition measurements on the Level II plots will improve the input for the UN - ECE mapping of critical loads, and further improve the abatement strategies over Europe.

6.1.2 Choice of method

Several methods are possible to use to measure or estimate deposition to forests. However, only one of them, the throughfall method, fills the requirements as being relatively simple and economically feasible for most countries. Throughfall can also be used in complex terrain, such as forested areas on exposed heights and slopes. Another advantage is that contributions from fog and cloud water deposition is included in the throughfall deposition. In addition to throughfall, wet deposition (deposition via precipitation) in the open field should be measured and, for some types of forest stands, also stemflow.

The main drawback of the throughfall method is the interaction between the canopy and the throughfall water for nitrogen, potassium, calcium and magnesium. However, the result from throughfall monitoring can still be used as a valuable indicator for the nitrogen and base cation deposition to the forest. Throughfall deposition can give information on the lower limit of the true deposition of nitrogen and the upper limit of true deposition of base cations other than sodium.

To estimate the nitrogen deposition, models have to be applied, using air concentrations of nitrogen compounds and meteorology as input data. For more detailed information on deposition of base cations, canopy budget models have to be applied to differentiate the contributions from leaching and dry deposition in the net throughfall (throughfall plus stemflow minus wet deposition).

6.1.3 Deposition monitoring on Level II

In most countries, sites for the forest monitoring activities within ICP Forests Level II are already selected. Deposition monitoring must be site specific and it is recommended that measurements should be made on all sites. If deposition is only measured on a selection of plots, it is recommended to chose them in such a way that they are spatially well distributed over the country.

Throughfall deposition measurements should preferably be measured on the plot itself or very close to it. Wet (bulk or wet-only) deposition should be measured in the open field close to the plot. The measurements may in no way interfere with other measurements in soil and vegetation. Caution must be taken not to cause any damages to the forest plot. Air pollution measurements should also be site specific, but could for practical reasons, or for reasons of co-ordination with other projects, be made at some distance. There must, however, be no influence from local emission sources. The measurement site must not be influenced by climatic conditions other than what is found at the forest plot.

The plots where deposition is measured should be described in detail. Some of the information is already included in the descriptions of the forest monitoring plots (longitude, latitude, altitude, exposition, tree species, etc.). Other information need to be documented with special consideration to the deposition situation (exposition to local emission sources and local land use, location in relation to forest edges etc.). For interpretation and understanding of the deposition processes to the forest stands, information on factors such as canopy roughness, leaf area index, etc. is valuable.

6.2 Sampling techniques for throughfall and stemflow monitoring

6.2.1 Principle

The measurements of throughfall and stemflow should be made in such a way that the results are representative for the plot area. This means that a sufficiently large number of samplers should be used and the samplers should be placed in such a way that the variation in throughfall and stemflow is covered. Stemflow measurements are considered mandatory in beech stands and optional in all other stands. Stemflow may however give important contributions for other deciduous stands and for young spruce stands. In case it is not clear whether stemflow should be measured or not, it is recommended to verify its importance to the total deposition at each plot. Throughfall deposition measurements must always be combined with precipitation sampling in the open field.

6.2.2 Sampling equipment

Selection of collectors

Countries are free in the selection of collectors. For the throughfall sampling, either funnels or gutters can be used. Stemflow collectors, attached directly to the tree stems, can be selected in forms of spirals or collars. However, it is recommended to use the equipment used within the Integrated Monitoring project or within the EMEP-net. To ensure comparability within a country, the national standard equipment should be used on all plots. Comparability on an international scale is an additional advantage, allowing deposition data to be of multiple use. The same type of collector can be used for throughfall and for open field sampling.

For snow sampling special collectors are recommended. Examples of rain, snow and stemflow collectors are shown in the manuals for Integrated Monitoring and for EMEP.

Material

The material of which the collector and its containers, tubes, glue etc. is made should in no way interact with the sample solution. Polyethylene is a suitable material recommended for the studies of macro-ions. For sampling heavy metals a separate polyethylene equipment, which is acid washed at the laboratory before use, must be used.

Size of collectors

The area of the funnel shall be wide enough to collect sufficiently large samples for analysis of all ions of interest. In most cases a diameter of 20 cm is suitable. The collection bottle shall be large enough to contain the largest amount of precipitation expected during the sampling period at the sampling location. In many cases 2 litre bottles are used. In areas where the precipitation is generally low and sampling frequency is high, a larger funnel diameter is recommended.

6.2.3 Siting criteria

Number of samplers

A throughfall collector samples only the small area where it is placed. In order to take into account the large local variations in throughfall deposition to a forest stand, a sufficiently large number of collectors must be used. As an example, 10 collectors or more are needed for a 30 times 30 m sampling plot (Figure 6.1-1). Less than 10 samplers are usually not sufficient to cover the variability. For a Level II plot (50 times 50 m), 10 - 15 samplers are necessary. If gutters are used, the number and length of gutters must be sufficient to cover the variability of the stand deposition. Advice on how many and how large samplers are needed, can be obtained in a pre-study. It is recommended to carry out such a pre-study of the variation within the plot before the final sampling strategy is selected. This can be done by using a large number of collectors and analysing only one parameter, e. g. conductivity or potassium.

Variations in stemflow are also large, depending on the variation in tree species and tree size at the plot. To cover this variability, a minimum of five to ten stemflow collectors is usually considered sufficient. The recommended pre-study can preferably include also the need of stemflow measurements in the final sampling programme and if so, how many and which types of trees shall be sampled.

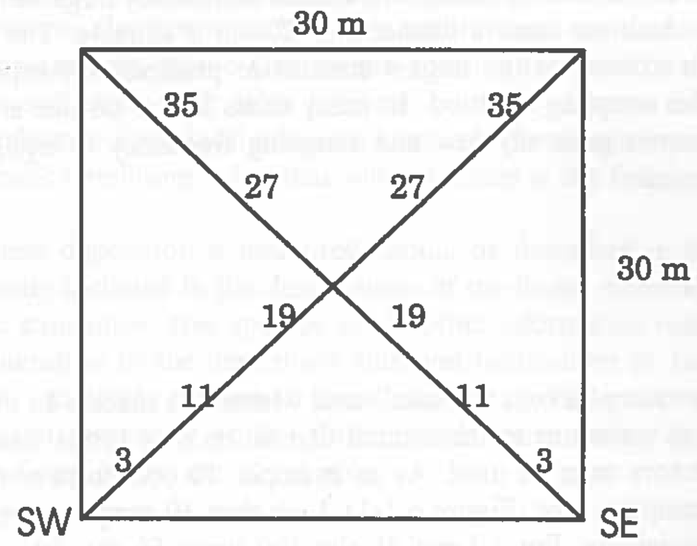
Siting of throughfall collectors

The throughfall collectors should be placed, with the opening area horizontal at a height of approximately 1 m over the ground level to avoid contamination by soil. It is important to shield the sample containers from sunlight and warming. It is therefore recommended to store the sample containers in a cool and dark place e. g. in a pithole.

As it is important that sampling is made in such a way that representative samples are collected, without interfering with other activities at the plot, the throughfall measurements could also be made near but not on the plot, e. g. in the buffer zone. Or, sampling could be made on the plot and the sample containers could if possible be stored in a pithole in the buffer zone. When sampling devices are placed in plots located at slopes, it is recommended to make the pitholes for storage of sample solution on the side of the plot or down-slope.

The collectors should be placed in such a way that they provide a representative measure of the total forest stand deposition. The collectors can be sited around some trees (tree wise) or randomly or systematically in the plot (plot wise). Plot wise sampling is recommended, see Figure 6.1-1. The exact location, place and height above the ground, of the samplers within or near to the plot is to be recorded along with other data concerning the plot.

Figure 6.1-1: An example of systematic siting of collectors in a plot. The samplers are located along the diagonals of a square forest plot area. In this case the sample plot is 30 x 30 m and the samplers are placed at certain distances (m) from the SW and SE corners in all plots.



Siting of stemflow collectors

Collectors shall be attached to trees growing on or adjacent to the plot. If the sizes of the trees are very different, stemflow shall be sampled on trees of different diameter and canopy size classes. The stemflow collectors shall be placed around the stem of the trees between 0.5 and 1.5 m above ground level. Sample containers should be stored cool and dark. As for throughfall sampling, care should be taken not to interfere with other monitoring activities on the plot and not to damage the trees.

6.2.4 Sampling period

Sampling will be made monthly, weekly or at time interval between the two, e. g. every two or three weeks, depending mainly on climate and method used (evaporation and growth of algae in the sample containers should be avoided). But also the risk of data loss due to contamination should be considered. It is worse loosing one of a relatively few long-time samples than loosing one of many short-time samples. The frequency of emptying the funnels should be the same for all deposition measurements (throughfall, stemflow and wet deposition).

6.2.5 Sampling, sample handling and cleaning

General procedure

Sampling, sample handling and cleaning should be carried out in the same manner for throughfall and stemflow monitoring. During the handling of the sample all possible con-

tamination of samples and equipment must be avoided. It is a general precaution never to touch with hands the surface of the equipment that come in direct contact with the sample solution. All incidents, special procedures and observations during sampling and sample handling should be recorded in the sampling log-book and in the forms that follow the samples to the laboratory.

Before sampling

A clean collection gauge is used to collect the sample solution. Rinse the equipment with deionised water before the sampling. An alternative method is to place a new strong polyethylene plastic bag in the sample container for each sampling period.

Storage conditions during sampling

As mentioned above, it is important that bottles are kept away from light and kept cool during and after sampling. If the sample cannot be stored in a pithole, it should be covered, for example by using aluminium foil.

Prevention of algae growth

The cool and dark storage will to a considerable extent prevent growth of algae. In many cases and especially during the darker and colder season, keeping the bottle dark is sufficient. As an additional precaution during the sunny and warm season, a preservative can be added to the sample container before sampling. A variety of chemicals are used for this purpose. The main criteria is to use an effective, non-volatile preservative, which does not interfere with the analysis of any ion of interest. It may be necessary to use two parallel samplers, one with preservative and one without. Preservation could be made by adding a surplus of solid iodine crystals, approximately 1 g per 5 litre sample bottle. Persistent chemicals such as mercury should be avoided for environmental reasons. Any use of preservatives shall be recorded in the log-book.

To determine the potential nitrogen transformation, the following test can be made periodically. The standard sampler, unpreserved and kept dark, is run in parallel with two extra samplers located close to the standard sampler. One of the extra samplers is run with preservative, the other is unpreserved and exposed to light. All samples are analysed for nitrogen compounds, nitrate, ammonium and organic nitrogen. The difference in nitrogen concentration will indicate the degree of nitrogen transformation.

Snow samples

Rain collectors are changed to snow collectors when, according to meteorological statistics, there is great risk for snow. The time period for this differs of course between regions.

Collecting the samples for analysis

After each sampling period, the volume of each individual throughfall and stemflow sample must be determined. The sample is decanted by means of a clean funnel into a clean measuring cylinder. Each sample can then be analysed separately or be pooled together to a collective sample. A suitable aliquot of each sample, or of the collective sample, is transferred to a laboratory bottle. The funnel, measuring cylinder and laboratory bottle used should be made of polyethylene or borosilicate glass. Precautions shall be taken to avoid contamination.

After snow sampling, the snow collection gauge is closed with a tight cover and taken indoors to melt the snow. Then the same procedure and the same precautions as above, are applied.

Pooling of samples from the same sampling period
The pooling of samples can be made either in the field or in the laboratory. If only part of the collective sample is transported to the laboratory, it must be well mixed in the field before taking an aliquot. If samples are pooled to collective samples, at least two separate samples shall be collected in order to avoid loss of data during the sampling period due to contamination e. g. by bird droppings. If stemflow samples are pooled together, they can only be pooled for trees of the same species and of similar size and dominance. Throughfall and stemflow samples should not be pooled together. All details on the pooling procedure shall be recorded in the log-book. If samples from certain collectors are not used, details shall be given on which collectors (number) are not included and the reason for it.

Pooling of samples from subsequent sampling periods
Weekly samples can be analysed as they are or, in order to save money, mixed to monthly samples before analysis. If samples are mixed, they must be mixed in proportion to the total sample volume. However, special care must be taken in the mixing procedure. Every additional step in the sample preparation involves additional risks of contamination and errors.

Transportation to the laboratory
All laboratory bottles shall be clearly marked with plot number, collector number, sample type (throughfall, stemflow) and sampling period. Laboratory bottles should be transported to the laboratory as soon as possible, under warm weather conditions preferably in cold boxes.

Storage of samples
The sample bottles shall be kept in a cold (4°C) and dark store until analysed. The transportation and storage period should be kept as short as possible.

6.3 Sampling techniques for wet deposition monitoring

6.3.1 Principle

Throughfall and stemflow measurements should always be combined with measurements of precipitation in order to study the wet deposition. Rain and snow, is collected in the open field close to the forest stand. The sampler may be open all the time (bulk collector) or open only during periods when precipitation is falling (wet-only collector). The bulk collector will sample not only the wet deposition but to some extent also dry deposition. In some areas this dry deposition contribution is small. The precipitation amount is determined by measuring the sample volume. In addition, it is recommended to measure also the precipitation amount at the sampling site using a standard meteorological device.

6.3.2 Equipment, bulk deposition samplers or wet-only samplers

Selection of collectors
Countries are free in the selection of collectors. As for throughfall, it is recommended to use collectors of standard design. The same type of collector should be used on all plots. The comparability of results is an important factor, between the ICP sites, but also on a national and an international scale in comparison to other projects, e. g. Integrated Monitoring and EMEP results, due to multiple use purposes.

The aerodynamic design of the sampler and its influence on the collection efficiency for rain drops and snow flakes, is even more important when sampling in the open field compared to sampling within the forest. WMO has set up certain requirements, which a wet deposition collector should comply with (WMO, 1971). Comparison between measured precipitation volume of the collector used to that measured by the meteorological standard device is part of the quality assessment.

A so called bird ring is recommended in order to prevent droppings from birds sitting on the top of the collector to enter the sample.

Wet-only or bulk collectors
Either wet-only or bulk deposition collectors are to be used. The wet-only collectors will only be open during periods of precipitation. The bulk collectors will be open during the whole sampling period, and will thus receive a certain amount of dry deposition from large particles and gaseous compounds in the atmosphere. Every country should decide for each plot, at the beginning of the measurements, if bulk or wet-only collectors are to be used. Information on the contribution of dry deposition and on the differences observed between wet-only and bulk collectors can in many cases be obtained by the EMEP monitoring experiences in each country. Alternatively, in a pre-study, the two types of samplers could be run in parallel for some time at the same site.

Snow collector
For collection of snow, a different collector should be used during the winter period in areas where snow is expected. The snow collection in the open field is even more difficult compared to rain collection and more difficult in the open field compared to within the forest. The selection of an efficient snow sampler is essential.

Size of collector
The open area of the collector should be large enough to sample a quantity of rain sufficient for analysis during most sampling periods. A diameter of 20 cm is suitable in most cases. In areas where the precipitation amount is generally low and the sampling frequency is high, a larger funnel diameter is recommended.

Material
See 6.2.2 above.

6.3.3 Siting criteria

Number of samplers
The installation of two parallel identical samplers for precipitation is recommended, in order to decrease the risk of losing one sample due to contamination, and in order to obtain a larger quantity of solution for analysis in drier periods.

Siting
Sampling is carried out in the open field at a place where results representative for the forest plot precipitation will be obtained, as regards chemical composition as well as annual amount. It is recommended to select a wind shielded location near the forest measurement site, e.g. in an open glade. At a windy site, the collection efficiency will decrease. It is important to avoid water dripping from near-by bushes and trees into the collector. Regular cutting of bushes, trees and high grass must be carried out within at least a radius of 10 m.

Surrounding objects, e. g. trees, buildings, should not be closer to the collector than a distance equal to approximately two times their height.

Collectors should be located with the opening of the collector horizontal, at approximately 1.5 m above the ground.

6.3.4 Sampling period

The same sampling frequency should be selected for the wet deposition measurements as for the throughfall measurements, see 6.2.4.

6.3.5 Sampling, sample handling and cleaning

Sampling, sample handling and cleaning will be carried out in the same manner as for throughfall and stemflow measurements, see 6.2.5 above.

6.4 Fog sampling

In regions with a high fog frequency, it is also recommended that fog is sampled. Fog water is often very concentrated and fog sampling can at least give information on the concentration of ions in the fog solution. However, there is a problem of data interpretation associated with the fog measurements, since there is no routine procedure for relating the fog amount collected to a horizontal area.

Fog samplers can be active (actively sucking air) or passive (passively collecting impacting fog droplets). There are no standard instruments or standard procedures for fog monitoring, since there are few routine measurements carried out in Europe today. The chemical composition of the collected fog solution is determined with routine analyses in the same manner as throughfall and precipitation solutions.

6.5 Air pollution measurements

6.5.1 Principle

Air pollution measurements are suggested to be optional in the ICP Forests deposition measurement programme. When considering the need for air pollution data represent-ative for the forest plots, it must be clear whether local sources of air pollution or special climatic conditions influence the plot. If so, the large scale measurement results will not be possible to use and local measurements must be carried out. On the highest level of ambition, air pollution data shall be measured close to the forest plot.

6.5.2 Use of air concentration data

Air pollution data at the forest plot are valuable for several reasons:

- Comparison of air pollution concentrations with critical levels for pollutants, such as ozone, sulphur dioxide and nitrogen dioxide, can be made in order to assess the risk of direct effects of these gases on the forest trees and vegetation. Data from the site are specially important in cases where representative data are not available from national and international monitoring or cannot be used due to the local situation.

- Air pollution data can be used to calculate dry deposition according to standard procedures. Total deposition can for some components, which are not subject to up-take or leaching by the canopy, e. g. sulphur, be estimated in two ways, by throughfall measurements and by calculated dry deposition added to the measured wet deposition. Wet deposition should in this case be measured as wet-only deposition. In some low-polluted areas and for some components such as sulphur, the difference between wet-only and bulk collectors is small, and bulk deposition results can be used as wet deposition. For other pollutants such as nitrogen, for which throughfall monitoring will not give the total deposition, calculation of the atmospheric deposition is the only possible way to estimate the dry deposition to forest. Air pollution measurements of nitrogen compounds are therefore necessary in addition to the throughfall monitoring. For airborne particulate compounds, such as base cations, the chemical composition should be determined within the different particle size ranges.

6.5.3 Air pollution data available

Measurements representative for the large scale pollution pattern over Europe are continuously carried out within the EMEP programme. In addition, calculations of air concentrations are made with the EMEP model. On a lower level of ambition, EMEP air pollution data can be used at the ICP Forests sites. Some consideration must, however, be paid to the representativity of EMEP data in relation to the location of the ICP sites, especially as regards local sources and climatic conditions.

6.5.4 Parameters, sampling frequency and sampling procedures

Air pollution measurements, should be made daily in accordance with EMEP routines, see the EMEP manual, or as long-term measurements, weekly or monthly means, using diffusion samplers for the gaseous compounds. Parameters included in the optional programme are compiled in table 6.5.4-1.

Table 6.5.4-1: Optional air pollution monitoring on the level two plots

Compounds	Parameters	Comment
Gaseous compounds	O_3, SO_2, NO_2, NO, HNO_3, HNO_2, NH_3. VOC	With regard to direct effect on vegetation, ozone is in most areas in Europe the most important pollutant.
Particulate compounds	SO_4^{2-}, NO_3^-, NH_4^+, base cations	For calculating the dry deposition of particulate compounds, such as base cations, measurements should preferably be made with consideration to particle size distribution.

Of the parameters mentioned above, ozone may be pointed out as very important due to the fact that the European ozone levels are frequently exceeding what is considered to be the critical level. Ozone concentrations at forest plots are also difficult to estimate from large scale measurements and calculations since ozone is greatly influenced by local pollution and local climate.

6.6 Analytical procedures

Parameters to be analysed in the collected samples are presented in table 6.6.1. The parameters are divided into mandatory and optional parameters. The mandatory parameters are parameters which are considered necessary to measure on a European scale. On a regional scale, it may be considered necessary to measure some of the optional parameters to obtain complete information. Alkalinity should be determined as a mandatory parameter if the annual median pH at the site is >5. For other sites, alkalinity is optional, but is recommended to measure in all samples with a pH>5.

Table 6.6.1: Mandatory and optional parameters for analysis of throughfall, stemflow, precipitation, fog water and air concentrations.

Sample solution	Mandatory	Optional	Comments
Throughfall, stemflow	pH, conductivity		
	Base cations; Na^+ K^+ Mg^{2+} Ca^{2+}	Al^{3+}, Mn^{2+}, Fe^{3+}	
	Other cations; NH_4^+	Heavy metals such as Cu, Zn, Hg, Pb, Cd, Co, Mo	
	Anions; Cl^-, NO_3^- SO_4^{2-}	Total - P, PO_4^{3-}	Phosphate will indicate contamination due to bird droppings. However total-P is a more stable parameter to measure
	Alkalinity	Alkalinity	Mandatory if annual median pH>5. recommended to measure in all samples with pH>5.
	N_{total}	S_{total} $C_{tot\ org}$ (TOC) $C_{dissolved\ org}$ (DOC)	
Wet deposition*	pH, conductivity		
	Base cations; Na^+ K^+ Mg^{2+} Ca^{2+}	Al^{3+}, Mn^{2+}, Fe^{3+}	
	Other cations; NH_4^+	Heavy metals such as Cu, Zn, Hg, Pb, Cd, Co, Mo	
	Anions; Cl^-, NO_3^- SO_4^{2-}	Total - P, PO_4^{3-}	Phosphate will indicate contamination due to bird droppings. However total-P is a more stable parameter to measure
	Alkalinity	Alkalinity	Mandatory if annual median pH>5. Recommended to measure in all samples with pH>5.
		S_{total}, N_{total}	
Fog, frozen fog (rime)		pH, conductivity	
		Base cations; Na^+ K^+ Mg^{2+} Ca^{2+}	
		Other cations; NH_4^+	
		Anions; Cl^-, NO_3^- SO_4^{2-}, Total - P	
		Alkalinity	See alkalinity above.
		Al^{3+}, Mn^{2+}, Fe^{3+} and heavy metals	
Air concentrations		See table 6.5.4-1	Analytical procedure is most cases directly linked to the sampling procedure.

* measured as wet-only or bulk deposition

Countries are free in the choice of analytical methods as long as good quality is assured. It is however recommended that standardised methods are used, preferably those applied in the EMEP and Integrated Monitoring programmes, see e. g. the EMEP manual and ISO methods. Methods for analysis of precipitation, throughfall, stemflow and fog water are compiled in table 6.6.2. The list of possible methods is not complete, but the methods most frequently used are mentioned. The table also give some information on pretreatments necessary when using the different methods. More details is found in the EMEP manual.

Table 6.6.2: List of procedures for analysis of precipitation, throughfall, stemflow and fog water solutions. Most of the instrumental methods below require filtration of sample before analysis to remove dispersed particles.

Parameter	Method/ Instrument	Pretreatment needed	Comments
pH	• Potentiometry		To be analysed in the laboratory
Alkalinity	• Titrimetric determination		To be measured as a mandatory parameter at stations where the annual median pH>5.
Sulphate	• Ion chromatography • Spectrophotometry, e. g. the Thorin method • Isotope dilution • Potentiometric determination	Filtration of sample is necessary before IC-analysis (filter 0.8µm).	Ion chromatography is the recommended method
Nitrate	• Ion chromatography • Spectrophotometry e. g. the Griess method • Ion selective electrode	Filtration of sample is necessary before IC-analysis	Ion chromatography is the recommended method
Chloride	• Ion chromatography • Spectrophotometric Hg tiocyanate - iron method • Titration with $AgNO_3$	Filtration of sample is necessary before IC-analysis.	Ion chromatography is the recommended method
Total phosphorus Phosphate	• Ion chromatography • Spectrophotometry	The sample is preserved before analysis. For determination of total P the sample is treated with an oxidising agent at high temperature and pressure to convert all P to phosphate.	Ion chromatography is the recommended method
Ammonium	• Spectrophotometry e. g. the indophenol method and Flow injection analysis (FIA) • Ion selective electrode	Filtration of sample is necessary for FIA analysis	
Base cations; Na, K, Mg, Ca	• Atomic absorption spectr. • ICP emission spectrometry	Filtration of sample is necessary (filter 0.45µm)	

Table 6.6.2 continued

Aluminium and heavy metals (except Hg)	• Atomic absorption spectroscopy • ICP MS spectrometry	The sample is preserved with nitric acid. Preconcentration of samples and control of blanks is often necessary due to low concentrations.	Instrument with a low detection limit is necessary due to low concentrations.
Hg	• Cold vapour fluorescence • Cold vapour atomic absorption spectrophotometry	The sample collectors are pre acidified	
Total nitrogen	• Elementary analysis • Kjeldahl analysis and determination of nitrate and nitrite		Total N is analysed as nitrogen, N_2 Total nitrogen is calculated as the sum of Kjeldahl N, nitrate N and in some cases nitrite N
Organic nitrogen	• Kjeldahl analysis and ammonium analysis		Org N is the difference between Kjeldahl N and ammonium N
Total organic carbon (TOC)	• IR spectroscopy after oxidation to CO_2 (ISO 8245) • Flame ionization after reduction to CH_4 (ISO 8245)		Total organic C will give information on the presence of compounds such as carbohydrates. These compounds may be an indication of nutrient leakage /forest damage.
Dissolved organic carbon (DOC)	The same analytical procedures as for organic carbon.	Filtration of the sample before analysis (filter 0.45µm)	DOC is determined as organic carbon in the filtered sample.

6.7 Quality assurance programme

6.7.1 Principle

Deposition monitoring is a semi-continuous procedure on a weekly to monthly basis, including many steps. All the steps in the procedure shall be defined in a quality assurance programme: beginning with the sampling and maintenance in the field, the transportation of the samples to the laboratory, the handling of the samples within the laboratory, analysis and finally data processing, data storage and data submission to national focal centres and central data bank. The aim is to avoid contamination and errors as far as possible. A quality assurance programme should be defined for the measurements at each national institute. One important step in the programme is to document all actions and incidents during sampling, sample handling and analysis.

Statistical analysis of the measurements can be made for each plot in order to assure that the sampling is representative. If monitoring sites or procedures are altered it is recommended to follow the consistency of the time series by running parallel stations or parallel equipment for some time. These data may later be used.

Training sessions for deposition monitoring and data handling could be arranged for example by the PCCs or in co-operation with EMEP and Integrated Monitoring.

6.7.2 Quality assurance in the field

It is recommended to prepare a national reference manual, in which each step in the monitoring procedure is strictly defined and which is handled over to the operators in connection with instructions on the spot. Every step of the work, including special precautions in order to avoid contamination and cleaning procedures, should be well documented.

Spare parts should be kept in store so that broken, stolen or vandalised parts of the sampling equipment can be rapidly (within a week) replaced.

Communication between the operator and the central project manager should be regular. All operations and special incidents or findings at the plot should be noted in the sampling logbook. The sampling stations should be visited and the sampling procedures checked at least once a year.

6.7.3 Quality assurance for sample transportation

Each expedition of samples should be accompanied by a special control form, informing the lab of the type and origin of the samples, special observations that may be of interest for the analysis, such as suspected contamination etc. Measured total volumes of the samples should also be noted in these forms.

Transportation of the samples should be made in special boxes to protect the samples from light and heat and to avoid breakage of containers.

6.7.4 Quality assurance in the laboratory

It is recommended that all samples (or at least all samples with the same parameter) are analysed at one laboratory in each country. The laboratory should use well defined sample handling and analytical procedures, according to national or European standards for good laboratory practices. The use of reference samples, for example from the Community Bureau of References, n° CRM 398, or samples prepared after the EPA guidelines, is recommended for regular analytical quality control. The use of control charts for daily analytical quality control is also recommended.

In the laboratory quality assurance procedures routines should be included for calculating ion balance and for calculating conductivity to be compared to the measured conductivity of the samples.

6.7.5 Comparability of results

Countries are free in the selection of sampling equipment and monitoring procedures. However, comparability of results is essential for the data quality of the deposition measurements in the ICP project. Much more information will be gained on deposition to forest and its spatial and temporal variation, if the monitoring results are comparable to data produced within other monitoring nets on a national and international scale. Regular intercomparisons between the different national samplers are necessary to find out if there are significant differences in collection efficiency and sampling procedure. Laboratory intercomparison are useful tools for studying discrepancies in the analytical procedure. Preferably and if possible,

these intercomparisons should be co-ordinated with inter comparisons arranged by EMEP, Integrated Monitoring, HELCOM and PARCOM.

6.8 Data handling and reports

Simple guidelines for calculations can be found below. All concentrations means should be volume weighed. To calculate the deposition at the site, use the precipitation amount obtained by the sampling collector. Compare with the results from the meteorological standard gauge. Simple guidelines for calculations are given in Annex 6-1.

6.8.1 Interpretation of the throughfall data

Some details on data evaluation of throughfall and precipitation results are given below.

Sulphur: Throughfall (plus stemflow) are in most areas of Europe representative for the total deposition to the forest. Some questions remain about throughfall data in very low-polluted areas. Dry deposition (including contributions from fog/cloud water deposition, can be calculated as the difference between throughfall and wet deposition. This difference is also called net throughfall. For this purpose, wet deposition should ideally be measured using wet-only collectors. However in areas where very low dry deposition contributions are obtained to the bulk collector, also bulk deposition data are possible to use. In areas with a high fog frequency, fog and cloud water deposition can be measured optionally and be separated from the dry deposition part of the net throughfall.

Nitrogen: Oxidised, reduced and organic nitrogen is analysed separately in throughfall and stemflow. The sum of these compounds is the total nitrogen in the throughfall plus stemflow deposition. Total nitrogen is also possible to measure with a specific analytical procedure.

Total nitrogen in throughfall and stemflow can be compared to the total nitrogen (mainly nitrate and ammonium) in wet deposition. In areas with a low nitrogen load, the throughfall plus stemflow nitrogen flux is often lower than the wet deposition due to canopy up-take. In areas with high throughfall deposition, signs of high nitrogen load to the soil is also indicated by e. g. leaching of nitrate to soil water.

The total nitrogen deposition from the atmosphere to the forest includes also the amount of gaseous nitrogen compounds taken up by vegetation via stomata and the amount of nitrogen deposited to the tree surface, and taken up by the tree or by lichens, algae and other organisms. Today there are no routine procedures to estimate the amount taken up by the tree.

Dry deposition of nitrogen from the atmosphere can be estimated from data on air concentrations of the most important gaseous (nitrogen dioxide, nitric acid, ammonia) and particulate (nitrate and ammonium) nitrogen compounds in combination with data on meteorology and surface characteristics using traditional deposition model calculations.

Optionally total nitrogen deposition with fog and cloud water can be determined by separate measurements.

Base cations: Sodium is in most areas considered to be totally obtained from atmospheric deposition mainly by sea salt. The sodium in throughfall is considered to be a good measure of the total sodium deposition.

Magnesium, calcium and potassium can be derived from both leaching and atmospheric deposition. There are several approaches used today to separate between the two processes. However they all include considerable uncertainties. Work is presently going on in order to elaborate a useful procedure.

6.8.2 Data validation

Data validation and quality assurance should be applied in accordance to what is suggested by Integrated Monitoring. For the validation, data are scrutinised as regards ion balances, conductivity, presence of extreme values, any discrepancies in the covariation between parameters and between stations. All discrepancies noted and corrected must be documented and must accompany the results to the data storage.

6.8.3 Guidelines for the treatment of missing values and data below the detection limit

In the validated data set, gaps due to missing values have to be filled in order to estimate the yearly mean concentration and deposition. To calculate a sufficiently reliable yearly mean concentration, not more than 4 weekly or one monthly value per year should be missing.

If data are missing (≤4 weekly values and one monthly value), calculate the yearly mean concentration in the sample solution based on the available data. The yearly deposition is estimated by multiplying the yearly mean concentration with the annual sample volume. A separate measurement of precipitation amount is valuable when wet deposition, throughfall or stemflow samples are missing. Some conclusions may be drawn as regards the missing volume for one period in relation to the total annual volume. If there are large seasonal variations in pollution concentrations, a more "true" annual mean may be obtained if the weekly or monthly value missing is extrapolated with consideration to season. In this extrapolation, the seasonal variation of results from a near-by plot and its normal covariation with the plot of interest is used.

For statistical calculations, if values are below the detection limit, use a value which is 0.5 times the detection limit.

All details on how data are treated and how the calculations are made shall be documented and accompany the result to the data storage.

6.8.4 Data storage

All validated data should be sent yearly to each national focal centre and to a central data storage. The routines for data submission and data storage will be worked out in more detail later. A mandatory data format is necessary. Formats are presently being prepared by the EC, but are not yet in a final form (Annex 6-2). These may be used also for the ICP Forest deposition data. A code list must be linked to this format. It is an advantage to use the same codes as in other parallel projects, e. g. the Integrated Monitoring (Annex 6-3).

6.8.5 Data report

The preparation of an annual report on data collected during the year is recommended. The document shall contain the results obtained and the interpretation of results. All important irregularities in sampling and analytical procedure, missing data and encountered errors in the validation should be documented. A comparison with other national results as regards deposition to forests is recommended as a further step in the validation of the results.

A separate document, which could be an annex to the first annual report shall be prepared to document sampling and analytical procedures.

6.9 References

Environment Data Centre, (1993), Manual for Integrated Monitoring, Programme Phase 1993-1996. National Board of Waters and the Environment, Helsinki , Finland.

EMEP (1977), Co-operative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe, Manual for Sampling and Chemical Analysis. EMEP/CHEM 3/77. Norwegian Institute for Air Research Lillestrøm, Norway.

WMO (1971), Guide to meteorological instrument and observing practices, WMO-No. 8. TP. 3 Geneva

Annex 6-1: Simple guidelines for calculations

Conversion from ions to elements

Calculate the results to be reported in S, N and P using the formula

concentration of element = factor x concentration of ion

where:

$$\text{factor} = \frac{\text{atomic weight of element}}{\text{formula weight of ion}}$$

e.g.

conc SO_2S	=	0.5005 (conc SO_2)
conc SO_4S	=	0.3338 (conc SO_4)
conc NO_2N	=	0.3045 (conc NO_2)
conc NO_3N	=	0.2259 (conc NO_3)
conc NH_4N	=	0.7765 (conc NH_4)
conc PO_4P	=	0.3261 (conc PO_4)

Calculation of mean pH

The original pH values must be converted to conc H^+ before calculation - the mean conc H^+ is then reconverted to a pH-value:

$$\overline{H^+} = 1/n\sum_{i=1}^{n} 10^{-pH_i}$$

where:

$\overline{H^+}$ = mean proton activity

pH_i = pH-values of samples

n = number of samples

$$\overline{pH} = \log_{10}(\overline{H^+})$$

Calculation of volume weighed means

Weighed means for precipitation (precipitation, throughfall and stemflow) chemistry are calculated using the formula:

$$\overline{X} = \frac{\sum_i c_i m_i}{\sum_i m_i}$$

where:

c = measured concentration during a period

m = precipitation during the period

Guidelines to calculate quantities in mm from stemflow volumes

The volumes of the stemflow are measured in litres per tree per period. In order to calculate the total deposition per hectare it is necessary to recalculate these volumes into volumes per period. The volumes are to be reported in mm per period.

As only a limited number of trees (e.g. 5) are measured for stemflow, an estimate has to be calculated for the total stemflow for all trees in the plot.

It is recommended to use the following method to calculate the total stemflow per hectare per year. It is based on the total basal area of the trees used for the stemflow measurements and the total basal area of all the trees in the plot (of 0.25 ha).

The formula used is:

$$\textit{Total volume in the plot} = (\textit{Total stemflow of n trees}) * \frac{\textit{Total basal area of all trees in the plot}}{\textit{Total basal area of the n trees}}$$

where:

- *n* is the number of trees used for the stemflow measurements (e.g. 5)
- the *Total stemflow of n trees* is stated in litres
- the *Total basal area of all trees in the plot* is stated in m²
- the *Total basal area of the n trees* is stated in m²

The result (in litres) is then divided by the plot area (in hectares) to calculate the total volume per hectare. Division with 10 000 results in the quantity in mm.

This should be reported per measuring period.

7. SUBMISSION OF DATA

The following Chapters 7.1 and 7.2 contain the forms for the submission of Level I and Level II data, respectively, to PCC West. These forms were designed by EC and correspond to those used under the respective Commission Regulations.

EC also provided the respective sample files for the submission of data in digital format on a diskette. This diskette was circulated among the focal centres of ICP Forests by PCC West, from which also additional copies may be ordered.

Chapter 7.3 contains the code list of the ICP on Integrated Monitoring, which was included on request of the Expert Panel on Deposition for harmonization purposes.

7.1 Forms for Level I plots

7.1.1 Forms for visual assessment of defoliation and discolouration

7.1.1.1
File: XX1993.PLO
Contents of file with the information on plot level to be used in combination with the tree vitality inventory

Sequence	Country	Observation Point	Date (DD MM YY)	Latitude coordinate (+ DD MM SS)	Longitude coordinate (± DD MM SS)	Water	Humus	Altitude	Orien-tation	Mean age	Soil unit	Observations
1 — 4	6 — 7	9 — 12	14 — 19	21 — 27	29 — 35	37	39	41 — 42	44	46 47	49 — 51	53 — 63
1												
2												
3												
4												
5												
6												
7												
8												
9												
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11												
12												
13												
14												
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16												
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18												
19												
20												
21												
22												
23												
24												

Column

1 to 4		Sequence number of plots (1 to 9 999)
6 to 7	(1)	Country code (France = 01, Belgium = 02, etc.)
9 to 12	(2)	Plot number (maximum 9 999)
14 to 19	(3)	Date of observation in DD MM YY (e.g. 22 06 90)
21 to 27	(4)	Latitude in + DD MM SS (e.g. + 505852)
29 to 35	(4)	Longitude in (+ or −) DD MM SS (e.g. + 035531)
37	(5)	Water availability (insufficient = 1, sufficient = 2, excessive = 3)
39	(6)	Humus type (Mull = 1, Moder = 2, etc.)
41 to 42	(7)	Altitude (in 50-metre classes from 1 to 31)
44	(8)	Orientation (N = 1, NE = 2, etc.)
46 to 47	(9)	Mean age of dominant storey (in 20-year classes from 1 to 8)
49 to 51	(10)	Soil unit (101 to 253)

In the last column a remark on the plot can be included:

53 to 63 (11) Other observations (word)

7.1.1.2
File: XX1993.TRE
Contents of file with the information on tree level

Sequence	Observation point	Tree	Species	Defoliation	Dis-col.	Easily identifiable causes of damage T1	T2	T3	T4	T5	T6	T7	T8	Identification of damage type	Other observations
1 — 5	7 — 10	12 — 13	15 — 17	19 — 21	23	25	27	29	31	33	35	37	39	41 — 50	52 — 61
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
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22															
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															

Column

1 to 5		Sequence number of trees (1 to 99 999)
7 to 10	(12)	Plot number (maximum 9 999)
12 to 13	(13)	Tree number (according to sequence 1 to 30, replacements 31 +)
15 to 17	(14)	Species (001 to 199)
19 to 21	(15)	Defoliation (0, 5, 10, 20, 15, ..., 95, 100%)
23	(16)	Discolouration (0, 1, 2, 3 or 4)
25	(17)	Damage caused by: game and grazing (1 = yes)
27 (*)	(17)	Damage caused by: insects (1 = yes)
29 (*)	(17)	Damage caused by: fungi (1 = yes)
31 (*)	(17)	Damage caused by: abiotic agents (1 = yes)
33 (*)	(17)	Damage caused by: direct action of man (1 = yes)
35 (*)	(17)	Damage caused by: fire (1 = yes)
37 (*)	(17)	Damage caused by: known local/regional pollutant (1 = yes)
39 (*)	(17)	Other damage (1 = yes)
41 to 50 (*)	(18)	Identification of damage type (name)
52 to 61 (*)	(19)	Other observations (word)

(*) Leave blank if no damage has been observed.

7.1.1.3
Code list and explanatory codes for the files XX1993.PLO and XX1993.TRE

Information on plot level

(1) *Country*

1= FRANCE
2= BELGIE-BELGIQUE
3= NEDERLAND
4= DEUTSCHLAND
5= ITALIA
6= UNITED KINGDOM
7= IRELAND
8= DANMARK
9= ELLAS
10= PORTUGAL
11= ESPAÑA
12= LUXEMBOURG
13= HELVETIA
14= ÖSTERREICH
15= MAGYAR
16= ROMANIA
17= POLSKA
18= SLOVENSKO
19= NORGE
20= SVERIGE
21= SUOMI
22= LIETUVA
23= HRVATSKA REP.
24= CESKA REP.
25= EESTI
26= SLOVENIJA
27= MOLDOVA

(2) *Observation point number*

The observation point number corresponds to the number indicated for the intersection of the grid at this point on the list of latitude and longitude coordinates provided by the Commission (Forests and Forestry Division). Deviations from the numbers of this list shall be described clearly.

(3) *Date of observation*

The date of observation is to be completed in the following order:
e.g.

Day		Month		Year	
0	8	0	9	9	2

(4) *Latitude-/lor.gitude coordinates*

Fill in the six-figure latitude and longitude coordinates of the observation point. These coordinates will differ from the coordinates of the corresponding point of the network provided by the Commission when the observation point in question has been replaced as instructed in paragraph II.1 of this Annex,
e.g.:

	±	Degrees		Minutes		Seconds	
— latitude	+	5	0	1	0	2	7
— longitude	–	0	1	1	.5	3	2

the first box is used to indicate a + or – coordinate

(5) *Availability of water to principal species*

1: Insufficient
2: Sufficient
3: Excessive

(6) *Humus type*

1: Mull
2: Moder
3: Mor
4: Anmor
5: Peat
6: Other
7: Raw (Roh)

(7) *Altitude*

1: ≤ 50 m	12: 551 to 600 m	23: 1 101 to 1 150 m
2: 51 to 100 m	13: 601 to 650 m	24: 1 151 to 1 200 m
3: 101 to 150 m	14: 651 to 700 m	25: 1 201 to 1 250 m
4: 151 to 200 m	15: 701 to 750 m	26: 1 251 to 1 300 m
5: 201 to 250 m	16: 751 to 800 m	27: 1 301 to 1 350 m
6: 251 to 300 m	17: 801 to 850 m	28: 1 351 to 1 400 m
7: 301 to 350 m	18: 851 to 900 m	29: 1 401 to 1 450 m
8: 351 to 400 m	19: 901 to 950 m	30: 1 451 to 1 500 m
9: 401 to 450 m	20: 951 to 1 000 m	31: > 1 500 m
10: 451 to 500 m	21: 1 001 to 1 050 m	
11: 501 to 550 m	22: 1 051 to 1 100 m	

(8) *Orientation*

1: N	4: SE	7: W
2: NE	5: S	8: NW
3: E	6: SW	9: flat

(9) *Mean age of dominant storey (years)*

1: ≤ 20	5: 81 to 100
2: 21 to 40	6: 101 to 120
3: 41 to 60	7: > 120
4: 61 to 80	8: Irregular stands

(10) *Soil unit*

Fluvisols
101 Eutric Fluvisols
102 Calcaric Fluvisols
103 Dystric Fluvisols
104 Mollic Fluvisols
105 Umbric Fluvisols
106 Thionic Fluvisols
107 Salic Fluvisols

Gleysols
108 Eutric Gleysols
109 Calcic Gleysols
110 Dystric Gleysols
111 Andic Gleysols
112 Mollic Gleysols
113 Umbric Gleysols
114 Thionic Gleysols
115 Gelic Gleysols

Regosols
116 Eutric Regosols
117 Calcaric Regosols
118 Gypsic Regosols
119 Dystric Regosols
120 Umbric Regosols
121 Gelic Regosols

Leptosols
122 Eutric Leptosols
123 Dystric Leptosols
124 Rendzic Leptosols
125 Mollic Leptosols
126 Umbric Leptosols
127 Lithic Leptosols
128 Gelic Leptosols

Arenosols
129 Haplic Arenosols
130 Cambic Arenosols
131 Luvic Arenosols
132 Ferralic Arenosols
133 Albic Arenosols
134 Calcaric Arenosols
135 Gleyic Arenosols

Andosols
136 Haplic Andosols
137 Mollic Andosols
138 Umbric Andosols
139 Vitric Andosols
140 Gleyic Andosols
141 Gelic Andosols

Vertisols
142 Eutric Vertisols
143 Dystric Vertisols
144 Calcic Vertisols
145 Gypsic Vertisols

Cambisols
146 Eutric Cambisols
147 Dystric Cambisols
148 Humic Cambisols
149 Calcaric Cambisols
150 Chromic Cambisols
151 Vertic Cambisols
152 Ferralic Cambisols
153 Gleyic Cambisols
154 Gelic Cambisols

Calcisols
155 Haplic Calcisols
156 Luvic Calcisols
157 Petric Calcisols

Gypsisols
158 Haplic Gypsisols
159 Calcic Gypsisols
160 Luvic Gypsisols
161 Petric Gypsisols

Solonetz
162 Haplic Solonetz
163 Mollic Solonetz
164 Calcic Solonetz
165 Gypsic Solonetz
166 Stagnic Solonetz
167 Gleyic Solonetz

Solonchaks
168 Haplic Solonchaks
169 Mollic Solonchaks
170 Calcic Solonchaks
171 Gypsic Solonchaks
172 Sodic Solonchaks
173 Gleyic Solonchaks
174 Gelic Solonchaks

Kastanozems
175 Haplic Kastanozems
176 Luvic Kastanozems
177 Calcic Kastanozems
178 Gypsic Kastanozems

Chernozems
179 Haplic Chernozems
180 Calcic Chernozems
181 Luvic Chernozems
182 Glossic Chernozems
183 Gleyic Chernozems

Phaeozems
184 Haplic Phaeozems
185 Calcaric Phaeozems
186 Luvic Phaeozems
187 Stagnic Phaeozems
188 Gleyic Phaeozems

Greyzems
189 Haplic Greyzems
190 Gleyic Greyzems

Luvisols
191 Haplic Luvisols
192 Ferric Luvisols
193 Chromic Luvisols
194 Calcic Luvisols
195 Vertic Luvisols
196 Albic Luvisols
197 Stagnic Luvisols
198 Gleyic Luvisols

Lixisols
199 Haplic Lixisols
200 Ferric Lixisols
201 Plinthic Lixisols
202 Albic Lixisols
203 Stagnic Lixisols
204 Gleyic Lixisols

Planosols
205 Eutric Planosols
206 Dystric Planosols
207 Mollic Planosols
208 Umbric Planosols
209 Gelic Planosols

Podzoluvisols
210 Eutric Podzoluvisols
211 Dystric Podzoluvisols
212 Stagnic Podzoluvisols
213 Gleyic Podzoluvisols
214 Gelic Podzoluvisols

Podzols
215 Haplic Podzols
216 Cambic Podzols
217 Ferric Podzols
218 Carbic Podzols
219 Gleyic Podzols
220 Gelic Podzols

Acrisols
221 Haplic Acrisols
222 Ferric Acrisols
223 Humic Acrisols
224 Plinthic Acrisols
225 Gleyic Acrisols

Alisols
226 Haplic Alisols
227 Ferric Alisols
228 Humic Alisols
229 Plinthic Alisols
230 Stagnic Alisols
231 Gleyic Alisols

Nitisols
232 Haplic Nitisols
233 Rhodic Nitisols
234 Humic Nitisols

Ferralsols
235 Haplic Ferralsols
236 Xanthic Ferralsols
237 Rhodic Ferralsols
238 Humic Ferralsols
239 Geric Ferralsols
240 Plinthic Ferralsols

Plinthosols
241 Eutric Plinthosols
242 Dystric Plinthosols
243 Humic Plinthosols
244 Albic Plinthosols

Histosols
245 Folic Histosols
246 Terric Histosols
247 Fibric Histosols
248 Thionic Histosols
249 Gelic Histosols

Anthrosols
250 Aric Anthrosols
251 Fimic Anthrosols
252 Cumulic Anthrosols
253 Urbic Anthrosols

(11) *Other observations*

Relevant information concerning the plot shall be stated here.

(12) *Observation point number*

See explanation item 2

(13) *Sample tree number*

The tree sample at each observation point for the evaluation of forest damage must consist of a minimum of 20 sample trees. However, the number of sample trees may not exceed 30. Care should be taken to ensure that the same number is used for the same tree in the consequent years.

(14) *Species (Reference Flora Europaea)*

Broadleaves

001: *Acer campestre*
002: *Acer monspessulanum*
003: *Acer opalus*
004: *Acer platanoides*
005: *Acer pseudoplatanus*
006: *Alnus cordata*
007: *Alnus glutinosa*
008: *Alnus incana*
009: *Alnus viridis*
010: *Betula pendula*
011: *Betula pubescens*
012: *Buxus sempervirens*
013: *Carpinus betulus*
014: *Carpinus orientalis*
015: *Castanea sativa (C. vesca)*
016: *Corylus avellana*
017: *Eucalyptus sp.*
018: *Fagus moesiaca*
019: *Fagus orientalis*
020: *Fagus sylvatica*
021: *Fraxinus angustifolia spp. oxycarpa (F. oxyphylla)*
022: *Fraxinus excelsior*
023: *Fraxinus ornus*
024: *Ilex aquifolium*
025: *Juglans nigra*
026: *Juglans regia*
027: *Malus domestica*
028: *Olea europaea*
029: *Ostrya carpinifolia*
030: *Platanus orientalis*
031: *Populus alba*
032: *Populus canescens*
033: *Populus hybrides*
034: *Populus nigra*
035: *Populus tremula*
036: *Prunus avium*
037: *Prunus dulcis (Amygdalus communis)*
038: *Prunus padus*
039: *Prunus serotina*
040: *Pyrus communis*
041: *Quercus cerris*
042: *Quercus coccifera (Q. calliprinos)*
043: *Quercus faginea*
044: *Quercus frainetto (Q. conferta)*
045: *Quercus fruticosa (Q. lusitanica)*
046: *Quercus ilex*
047: *Quercus macrolepis (Q. aegilops)*
048: *Quercus petraea*
049: *Quercus pubescens*
050: *Quercus pyrenaica (Q. toza)*
051: *Quercus robur (Q. penduculata)*
052: *Quercus rotundifolia*
053: *Quercus rubra*
054: *Quercus suber*
055: *Quercus trojana*
056: *Robinia pseudoacacia*
057: *Salix alba*
058: *Salix caprea*
059: *Salix cinerea*
060: *Salix eleagnos*
061: *Salix fragilis*
062: *Salix sp.*
063: *Sorbus aria*
064: *Sorbus aucuparia*
065: *Sorbus domestica*
066: *Sorbus torminalis*
067: *Tamarix africana*
068: *Tilia cordata*
069: *Tilia platyphyllos*
070: *Ulmus glabra (U. scabra, U. montana)*
071: *Ulmus laevis (U. effusa)*
072: *Ulmus minor (U. campestris, U. carpinifolia)*
073: *Arbutus unedo*
074: *Arbutus andrachne*
075: *Ceratonia siliqua*
076: *Cercis siliquastrum*
077: *Erica arborea*
078: *Erica scoparia*
079: *Erica manipuliflora*
080: *Laurus nobilis*
081: *Myrtus communis*
082: *Phillyrea latifolia*
083: *Phillyrea angustifolia*
084: *Pistacia lentiscus*
085: *Pistacia terebinthus*
086: *Rhamnus oleoides*
087: *Rhamnus alaternus*
099: Other broadleaves

Conifers

100: *Abies alba*
101: *Abies borisii-regis*
102: *Abies cephalonica*

103: *Abies grandis*
104: *Abies nordmanniana*
105: *Abies pinsapo*
106: *Abies procera*
107: *Cedrus atlantica*
108: *Cedrus deodara*
109: *Cupressus lusitanica*
110: *Cupressus sempervirens*
111: *Juniperus communis*
112: *Juniperus oxycedrus*
113: *Juniperus phoenicea*
114: *Juniperus sabina*
115: *Juniperus thurifera*
116: *Larix decidua*
117: *Larix kaempferi (L. leptolepis)*
118: *Picea abies (P. excelsa)*
119: *Picea omorika*
120: *Picea sitchensis*
121: *Pinus brutia*
122: *Pinus canariensis*
123: *Pinus cembra*
124: *Pinus contorta*
125: *Pinus halepensis*
126: *Pinus heldreichii*
127: *Pinus leucodermis*
128: *Pinus mugo (P. montana)*
129: *Pinus nigra*
130: *Pinus pinaster*
131: *Pinus pinea*
132: *Pinus radiata (P. insignis)*
133: *Pinus strobus*
134: *Pinus sylvestris*
135: *Pinus uncinata*
136: *Pseudotsuga menziesii*
137: *Taxus baccata*
138: *Thuya sp.*
139: *Tsuga sp.*
199: Other conifers

(15) *Defoliation*

Defoliation figure for each sample tree expressed as a percentage (in steps of 5 %) compared with a tree with complete foliage. The actual percentage is used.

0 = 0 %
5 = 1 to 5 %
10 = 6 to 10 %
15 = 11 to 15 %.

(16) *Discolouration codes*

0: no discolouration (0 to 10 %)
1: slight discolouration (11 to 25 %)
2: moderate discolouration (26 to 60 %)
3: severe discolouration (> 60 %)
4: dead

(17) *Easily identifiable causes of damage*

Add a mark (1) in the corresponding column(s).

T1 = game ad grazing
T2 = presence or traces of an excessive number of insects
T3 = fungi
T4 = abiotic agents (wind, snow, frost, drought)
T5 = direct action of man
T6 = fire
T7 = known local/regional pollutant
T8 = other

(18) *Identification of damage type*

Where possible, further identification of the damage type should be added e.g. for insects: the species or group (e.g. 'bark beetles').

(19) *Other observations on tree level*

Any additional observations which may be of interest shall be clearly noted on the form.

(e.g. possible influencing factors (recent drought, temperature extremes); other damage/stress symptoms).

(20) *Replacing of sample trees*

In the case where trees of the original sample have been removed (extraction, windthrow, etc.) and replaced in the sample, these replaced trees receive a new number (above 30) and shall be mentioned under observations.

7.1.2 Forms for sampling and analysis of soil

7.1.2.1
File: XX1995.PLS
Contents of reduced plot file to be used in combination with the forest soil condition inventory

Sequence (1 — 4)	Country (6 — 7)	Observation point ± (9 — 12)	Date (D D M M Y Y) (14 — 19)	Latitude coordinate (+ D D M M S S) (21 — 27)	Longitude coordinate (± D D M M S S) (29 — 35)	Altitude (37 — 38)	Soil unit (40 — 42)	Observations (44 — 54)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								

Column

1 to 4		Sequence number of plots (1 to 9 999)
6 to 7	(1)	Country code (France = 01, Belgium = 02, etc.)
9 to 12	(2)	Plot number (maximum 9 999)
14 to 19	(3)	Date of observation in DDMMYY (e.g. 22 06 90)
21 to 27	(4)	Latitude in + DDMMSS (e.g. + 505852)
29 to 35	(4)	Longitude in (+ or −) DDMMSS (e.g. + 035531)
37 to 38	(5)	Altitude (in 50-metre classes from 1 to 31)
40 to 42	(6)	Soil unit (101 to 253)

In the last column a remark on the plot can be included:

44 to 54 (7) Other observations (word)

7.1.2.2
File: XX1995.SOM
Contents of file with soil sampling information (mandatory)

Sequence Number	Plot	Horizon	Samp Cod (0,1,2)	Date (ddmmyy)	pH (CaCl₂)	C_Org (g/kg)	N (g/kg)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	OrgLay (kg/m²)	CaCO₃ (g/kg)	Observation	
1—5	7—10	12—14	16	18—23	25—27	29—31	33—36	38—40	42—45	47—50	52—55	57—59	61—63	65—75	
0	0	SAM													
1		H	0		.		.								
2		O	0		.		.								
3		M05	1		.		.								
4		M51	1		.		.								
5		M01	9		.		.								
6		M12	0		.		.								
99999	9999	M48	2	311295	9.9	999	99.9	999	9999	9999	9999	999	999		maximum value (**)

The first line (line = 0) is used to indicate what sampling analysis method (SAM) has been used.

Indicate for each paramter what analysis method has been used:

0 = No deviation from approved method.
1 = Analysed according to alternative method (*).
9 = Recomputed data (*).

1 — 5	Sequence number	Sequence number of samples (1 to 99 999)
7 — 10	Observation point number	Corresponding plotnumber (maximum 9999)
12 — 14	Level	Code for depth level (H, O, M05, M51, M01, M12)
16	Samp cod	Code for sampling method (0 = approved method, 1 = as advised (*), 9 = recalculated (*))
18 — 23	Date	Date of analysis (ddmmyy)

Parameters		(Mandatory file) Units (***)	H/O	Min	Approved method	Remarks
25 — 27	pH (CaCl₂)		M	M	pH-electrode	
29 — 31	C-org	(g/kg)	M	M	dry combustion	
33 — 36	N	(g/kg)	M	M	dry combustion	
38 — 40	P	(mg/kg)	M		extr: aqua regia	
42 — 45	K	(mg/kg)	M		extr: aqua regia	
47 — 50	Ca	(mg/kg)	M		extr: aqua regia	
52 — 55	Mg	(mg/kg)	M		extr: aqua regia	
57 — 59	OrgLayer	(kg/m²)	M		volume dry—weight	
61 — 63	$CaCO_3$	(g/kg)		M	calcimeter	(if pH ($CaCl_2$) > 6)
65 — 75	Observation	Words				

M = mandatory, blank = not required

(*) Methods and recomputations that have been used shall be described in detail in an annex to the soil condition report.
(**) Maximum values are used when the actually registered value is equal to or higher than the maximum value. When the actual registered value is below the minimum value that could be entered, the minimum value shall be used. If no quantity could be measured (i.e. below detection limits) a special code — 1 (minus 1) will be used. When no analysis has been carried out for this parameter a zero or blank shall be used.
(***) Based on oven—dry weight.

7.1.2.3
File: XX1995.SOO
Contents of file with soil sampling information (optional)

Sequence Number	Plot	Hori-zon	Samp Cod (0,1,2)	Date (ddmmyy)	Na (mg/kg)	Al (mg/kg)	Fe (mg/kg)	Cr (mg/kg)	Ni (mg/kg)	Mn (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Cd (mg/kg)	Ac_Exc (cmol+/kg)	BCE (cmol+/kg)	ACE (cmol+/kg)	CEC (cmol+/kg)	Base Sat %	Observation
1—5	7—10	12—14	16	18—23	25—28	30—34	36—40	42—44	46—48	50—53	55—57	59—61	63—65	67—69	71—73	75—78	80—83	85—88	90—91	93—103
0	0	SAM																		
1		H	0											.		.	.	.		
2		O	0											.		.	.	.		
3		M05	1											.		.	.	.		
4		M51	1											.		.	.	.		
5		M01	9											.		.	.	.		
6		M12	0											.		.	.	.		
99999	9999	M48	2	311295	9999	99999	99999	999	999	9999	999	999	999	9.9	999	99.9	99.9	99.9	99	(**)

The first line (line # 0) is used to indicate what sampling analysis method (SAM) has been used.
0 = no deviation from approved method.
1 = analysed according to alternative method (*)
9 = recomputed data (*)

1 — 5	Sequence Number	Sequence number of samples (1 to 99 999)
7 — 10	Observation Point number	Corresponding plotnumber (maximum 9 999)
12 — 14	Level	Code for depth level (H, O, M05, M51, M01, M12)
16	Samp cod	Code for sampling method (0 = approved method, 1 = as advised (*), 9 = recalculated (*))
18 — 23	Date	Date of analysis (ddmmyy)

Parameters	Units (***)	H/O	Min	Approved method (Optional file)	Remarks
25 — 28 Na	(mg/kg)	O		extr: aqua regia	
30 — 34 Al	(mg/kg)	O		extr: aqua regia	
36 — 40 Fe	(mg/kg)	O		extr: aqua regia	
42 — 44 Cr	(mg/kg)	O		extr: aqua regia	
46 — 48 Ni	(mg/kg)	O		extr: aqua regia	
50 — 53 Mn	(mg/kg)	O		extr: aqua regia	
55 — 57 Zn	(mg/kg)	O		extr: aqua regia	
59 — 61 Cu	(mg/kg)	O		extr: aqua regia	
63 — 65 Pb	(mg/kg)	O		extr: aqua regia	
67 — 69 Cd	(mg/kg)	O		extr: aqua regia	

Parameters	Units (***)	H/O	Min	Approved method (Optional file)	Remarks
71 — 73 Ac-Exc	(cmol+/kg)		O	titration	Exchangeable acidity
75 — 78 BCE	(cmol+/kg)		O	extr: $BaCl_2$	Base cations exchangeable
80 — 83 ACE	(cmol+/kg)		O	$BaCl_2$	Acid cations exchangeable
85 — 88 CEC	(cmol+/kg)		O		Cation exchange capacity
90 — 91 BaseSat	%		O		
93 — 103 Observation	Words				

O = optional, blank = not required

(*) Methods and recomputations that have been used shall be described in detail in an annex to the soil condition report.
(**) Maximum values are used when the actually registered value is equal or higher than the maximum value. When the actual registered value is below the minimum value that could be entered, the minimum value shall be used. If no quantity could be measured (i.e. below detection limits) a special code — 1 (minus 1) will be used. When no analysis has been carried out for this parameter a zero or blank shall be used.
(***) Based on oven—dry weight.

7.1.2.4
Code list and explanatory codes for the files XX1995.PLS, XX1995.SOM and XX1995.SOO
Explanatory notes to FILE XX1995.PLS

(1) *Country*

1= FRANCE
2= BELGIE-BELGIQUE
3= NEDERLAND
4= DEUTSCHLAND
5= ITALIA
6= UNITED KINGDOM
7= IRELAND
8= DANMARK
9= ELLAS
10= PORTUGAL
11= ESPAÑA
12= LUXEMBOURG
13= HELVETIA
14= ÖSTERREICH
15= MAGYAR
16= ROMANIA
17= POLSKA
18= SLOVENSKO
19= NORGE
20= SVERIGE
21= SUOMI
22= LIETUVA
23= HRVATSKA REP.
24= CESKA REP.
25= EESTI
26= SLOVENIJA
27= MOLDOVA

(2) *Observation point number*

The observation point number corresponds to the number indicated for the intersection of the grid at this point on the basis of latitude and longitude coordinates provided by the Commission (Forests and Forestry Division) and/or replacements. The observation points numbers shall correspond to the plot numbers of the tree vitality inventory in the corresponding year.

(3) *Date of sampling*

The date of sampling is to be completed in the following order:

e.g.

Day		Month		Year	
0	8	0	9	9	2

(4) *Latitude-/longitude coordinates*

Fill in the full six-figure latitude and longitude coordinates of the observation point. These coordinates will differ from the coordinates of the corresponding point of the network provided by the Commission when the observation point in question has been replaced as instructed in paragraph II.1 of Annex I.

e.g.

	±	Degrees		Minutes		Seconds	
— latitude	+	5	0	1	0	2	7
— longitude	−	0	1	1	5	3	2

The first box is used to indicate a + or − coordinate.

(5) *Altitude*

1:	≤ 50 m	12:	551— 600 m	23:	1 101—1 150 m
2:	51—100 m	13:	601— 650 m	24:	1 151—1 200 m
3:	101—150 m	14:	651— 700 m	25:	1 201—1 250 m
4:	151—200 m	15:	701— 750 m	26:	1 251—1 300 m
5:	201—250 m	16:	751— 800 m	27:	1 301—1 350 m
6:	251—300 m	17:	801— 850 m	28:	1 351—1 400 m
7:	301—350 m	18:	851— 900 m	29:	1 401—1 450 m
8:	351—400 m	19:	901— 950 m	30:	1 451—1 500 m
9:	401—450 m	20:	951—1 000 m	31:	>1 500 m
10:	451—500 m	21:	1 001—1 050 m		
11:	501—550 m	22:	1 051—1 100 m		

(6) *Soil unit*

Fluvisols

101 Eutric Fluvisols
102 Calcaric Fluvisols
103 Dystric Fluvisols
104 Mollic Fluvisols
105 Umbric Fluvisols
106 Thionic Fluvisols
107 Salic Fluvisols

Gleysols

108 Eutric Gleysols
109 Calcic Gleysols
110 Dystric Gleysols
111 Andic Gleysols
112 Mollic Gleysols
113 Umbric Gleysols
114 Thionic Gleysols
115 Gelic Gleysols

Regosols

116 Eutric Regosols
117 Calcaric Regosols
118 Gypsic Regosols
119 Dystric Regosols
120 Umbric Regosols
121 Gelic Regosols

Leptosols

122 Eutric Leptosols
123 Dystric Leptosols
124 Rendzic Leptosols
125 Mollic Leptosols
126 Umbric Leptosols
127 Lithic Leptosols
128 Gelic Leptosols

Arenosols

129 Haplic Arenosols
130 Cambic Arenosols
131 Luvic Arenosols
132 Ferralic Arenosols
133 Albic Arenosols
134 Calcaric Arenosols
135 Gleyic Arenosols

Andosols

136 Haplic Andosols
137 Mollic Andosols
138 Umbric Andosols
139 Vitric Andosols
140 Gleyic Andosols
141 Gelic Andosols

Vertisols

142 Eutric Vertisols
143 Dystric Vertisols
144 Calcic Vertisols
145 Gypsic Vertisols

Cambisols

146 Eutric Cambisols
147 Dystric Cambisols
148 Humic Cambisols
149 Calcaric Cambisols
150 Chromic Cambisols
151 Vertic Cambisols
152 Ferralic Cambisols
153 Gleyic Cambisols
154 Gelic Cambisols

Calcisols

155 Haplic Calcisols
156 Luvic Calcisols
157 Petric Calcisols

Gypsisols

158 Haplic Gypsisols
159 Calcic Gypsisols
160 Luvic Gypsisols
161 Petric Gypsisols

Solonetz

162 Haplic Solonetz
163 Mollic Solonetz
164 Calcic Solonetz
165 Gypsic Solonetz
166 Stagnic Solonetz
167 Gleyic Solonetz

Solonchaks

168 Haplic Solonchaks
169 Mollic Solonchaks
170 Calcic Solonchaks
171 Gypsic Solonchaks
172 Sodic Solonchaks
173 Gleyic Solonchaks
174 Gelic Solonchaks

Kastanozems

175 Haplic Kastanozems
176 Luvic Kastanozems
177 Calcic Kastanozems
178 Gypsic Kastanozems

Chernozems

179 Haplic Chernozems
180 Calcic Chernozems
181 Luvic Chernozems
182 Glossic Chernozems
183 Gleyic Chernozems

Phaeozems

184 Haplic Phaeozems
185 Calcaric Phaeozems
186 Luvic Phaeozems
187 Stagnic Phaeozems
188 Gleyic Phaeozems

Greyzems

189 Haplic Greyzems
190 Gleyic Greyzems

Luvisols

191 Haplic Luvisols
192 Ferric Luvisols
193 Chromic Luvisols
194 Calcic Luvisols
195 Vertic Luvisols
196 Albic Luvisols
197 Stagnic Luvisols
198 Gleyic Luvisols

Lixisols

199 Haplic Lixisols
200 Ferric Lixisols
201 Plinthic Lixisols
202 Albic Lixisols
203 Stagnic Lixisols
204 Gleyic Lixisols

Planosols

205 Eutric Planosols
206 Dystric Planosols
207 Mollic Planosols
208 Umbric Planosols
209 Gelic Planosols

Podzoluvisols

210 Eutric Podzoluvisols
211 Dystric Podzoluvisols
212 Stagnic Podzoluvisols
213 Gleyic Podzoluvisols
214 Gelic Podzoluvisols

Podzols

215 Haplic Podzols
216 Cambic Podzols
217 Ferric Podzols
218 Carbic Podzols
219 Gleyic Podzols
220 Gelic Podzols

Acrisols

221 Haplic Acrisols
222 Ferric Acrisols
223 Humic Acrisols
224 Plinthic Acrisols
225 Gleyic Acrisols

Alisols

226 Haplic Alisols
227 Ferric Alisols
228 Humic Alisols
229 Plinthic Alisols
230 Stagnic Alisols
231 Gleyic Alisols

Nitisols

232 Haplic Nitisols
233 Rhodic Nitisols
234 Humic Nitisols

Ferralsols

235 Haplic Ferralsols
236 Xanthic Ferralsols
237 Rhodic Ferralsols
238 Humic Ferralsols
239 Geric Ferralsols
240 Plinthic Ferralsols

Plinthosols

241 Eutric Plinthosols
242 Dystric Plinthosols
243 Humic Plinthosols
244 Albic Plinthosols

Histosols

245 Folic Histosols
246 Terric Histosols
247 Fibric Histosols
248 Thionic Histosols
249 Gelic Histosols

Anthrosols

250 Aric Anthrosols
251 Fimic Anthrosols
252 Cumulic Anthrosols
253 Urbic Anthrosols

(7) *Other observations*

Relevant information concerning the plot shall be stated here.

Explanatory notes to FILE XX1995.SOM

(8) *Sampling layer*

O: Organic layer
H: Organic layer
M01: Mineral layer (0—10 cm)
M05: Mineral layer (0—5 cm) (advised)
M51: Mineral layer (5—10 cm) (advised)
M12: Mineral layer (10—20 cm)

(9) *Sampling method code*

It is mandatory to submit the data by layer. The sampling could (if well documented) be carried out differently. The following codes shall be used to indicate the sampling method:

0 = no deviation from approved sampling method.

1 = sampled as advised.

9 = sampled in a different way, analysis results have been recomputed. A full explanation of the used method, including the recomputation shall be included in the forest soil condition report.

(10) *Date of analysis*

The date of the start of the analysis shall be completed in the same way as the date of sampling (item 3).

(11) *Soil analysis*

The following parameters are mandatory (Man) in the soil sample analysis of the organic layers (H/O) and mineral layers (M):

	Organic H/O	Mineral M01, M12 (M05, M51)	Approved methods
pH ($CaCl_2$)	Man	Man	Labex 8703-01-1-1 and ISO/TC190/SC3/GT8
C-org	Man	Man	Dry combustion
N	Man	Man	Dry combustion
P	Man		Extr: Aqua regia
K	Man		Extr: Aqua regia
Ca	Man		Extr: Aqua regia
Mg	Man		Extr: Aqua regia
OrgLay	Man		Volume (cylindric)-dry-weight
$CaCO_3$		Man	AFNOR X 31-105 (if pH ($CaCl_2$) > 6)

(12) *Sampling analysis method (SAM)*

In the first line (sequence number 0) the sampling analysis method is indicated for each parameter.

0 = sample is analysed according the method as indicated in the approved method.

1 = sample is analysed according to an alternative method (to be indicated by the Soil Expert Panel).

9 = sample is analysed by a different method and/or results have been recomputed.

In the latter two cases (SAM = 1 or 9) a full description of the used analysis methods and/or recomputations shall be given in an annex to the soil condition report.

Explanatory notes to FILE XX1995.SOO

(8) *Sampling layer*

- O Organic layer
- H Organic layer
- M01 Mineral layer (0—10 cm)
- M05 Mineral layer (0—5 cm) (advised)
- M51 Mineral layer (5—10 cm) (advised)
- M12 Mineral layer (10—20 cm)

(9) *Sampling method code*

It is mandatory to submit the data by layer. The sampling could (if well documented) be carried out differently. The following codes shall be used to indicate the sampling method:

0 = no deviation from approved sampling method.

1 = sampled as advised.

9 = sampled in a different way, analysis results have been recomputed. A full explanation of the used method, including the recomputation shall be included in the forest soil condition report.

(10) *Date of analysis*

The date of the start of the analysis shall be completed in the same way as the date of sampling (item 3).

(11) *Soil analysis*

The following parameters are optional (Opt) in the soil sample analysis of the organic layers (H/O) and mineral layers (M):

	Organic H/O	Mineral M01, M12 (M05, M51)	Approved methods
$CaCO_3$	Opt		AFNOR X 31—105 (if pH ($CaCl_2$) > 6)
Na	Opt		Extr: Aqua regia
Al	Opt		Extr: Aqua regia
Fe	Opt		Extr: Aqua regia
Cr	Opt		Extr: Aqua regia
Ni	Opt		Extr: Aqua regia
Mn	Opt		Extr: Aqua regia
Zn	Opt		Extr: Aqua regia
Cu	Opt		Extr: Aqua regia
Pb	Opt		Extr: Aqua regia
Cd	Opt		Extr: Aqua regia
Ac-Exc		Opt	LABEX L8703-26-1-1
BCE		Opt	Bascomb
ACE		Opt	Bascomb
CEC		Opt	Bascomb
BaseSat		Opt	LABEX L8703-26-1-1

(12) *Sampling analysis method* (SAM)

In the first line (sequence number 0) the sampling analysis method is indicated for each parameter.

0 = sample is analysed according to the method as indicated in the approved method.

1 = sample is analysed according to an alternative method (to be indicated by the Soil Expert Panel).

9 = sample is analysed by a different method and/or results have been recomputed.

In the latter two cases (SAM = 1 or 9) a full description of the used analysis methods and/or recomputations shall be given in an annex to the soil condition report.

7.1.3 Forms for sampling and analysis of needles and leaves

7.1.3.1
File: XX1995.PLF
Contents of reduced plot file to be used in combination with the survey on the chemical content of needles and leaves

1 - - 4 6 - 7 9 - - 12 14 - - - 18 20 - - - 25 27 - - - - - 33 35 - - - - - 41 43 - 44 46 - - - - - - 56

Sequence	Country	Plot number	Sample number	Sampling date (D D M M Y Y)	Latitude coordinate (+ D D M M S S)	Longitude coordinate (± D D M M S S)	Altitude	Observations
1			.					
2			.					
3			.					
4			.					
5			.					
6			.					
7			.					
8			.					
9			.					
10			.					
11			.					
12			.					
13			.					
14			.					
15			.					
16			.					
17			.					
18			.					
19			.					
20			.					
21			.					
22			.					
23			.					
24			.					

Column	
1 — 4	Sequence number of plots (1 to 9999)
6 — 7	Country code (France = 01, Belgium = 02, etc.)
9 — 12	Plot number (maximum 9999)
14 — 18	Sample number (tree species code - leaves type). Tree species (from 001 to 199) and leaves type for current leaves (= 0) and current + 1 (= 1)
20 — 25	Date of sampling in DD MM YY (e.g. 220690)
27 — 33	Latitude in + DD MM SS (e.g. + 505852)
35 — 41	Longitude in (+ or −) DD MM SS (e.g. + 035531)
43 — 44	Altitude (in 50 meter classes from 1 to 31)

In the last column a remark on the plot can be included:

46 — 56 Other observations (in words).

7.1.3.2

File: XX1995.FOO

Contents of file with foliar analysis (optional parameters)

Sequence number	Plot number	Sample number	Date of analysis (DD MM YY)	Optional parameters: Na (µg/g)	Zn (µg/g)	Mn (µg/g)	Fe (µg/g)	Cu (µg/g)	Pb (µg/g)	Al (µg/g)	B (µg/g)	Observation
1 – 5	7 – 10	12 – 16	18 – 23	25 – 30	32 – 36	38 – 43	45 – 49	51 – 55	57 – 60	62 – 66	68 – 72	74 – 84
1		.						.	.			
2		.						.	.			
3		.						.	.			
4		.						.	.			
5		.						.	.			
6		.						.	.			
7		.						.	.			
8		.						.	.			
		.						.	.			
99999	9999	199-1	311311	999999	99999	999999	99999	99-99	99-9	99999	9999	

maximum value (*)

1 — 5	Sequence number	Sequence number of samples (1 to 99 999)
7 — 10	Plot number	(maximum 9999)
12 — 16	Sample number	Tree species (from 1 to 199) and leaves type ; current (= 0) or current + 1 (= 1)
18 — 23	Date	Date of analysis (DD MM YY)

Optional parameters		Units (**)
25 — 30	Na	µg/g
32 — 36	Zn	µg/g
38 — 43	Mn	µg/g
45 — 49	Fe	µg/g
51 — 55	Cu	µg/g
57 — 60	Pb	µg/g
62 — 66	Al	µg/g
68 — 72	B	µg/g
74 — 84	Observation	in words

For *Larix* sp. and *Cedrus* sp., samples are taken of the short twigs of the previous year

(*) Maximum values are used when the actually registered value is equal or higher than the maximum value. When the actual registered value is below the minimum value that could be entered, the minimum value shall be used. If no quantity could be measures (i.e. below detection limits) a special code − 1 (minus 1) will be used. When no analysis has been carried out for this parameter a zero or blank shall be used.

(**) By reference at 105 ° dried material.

7.1.3.3

File: XX1995.FOM

Contents of file with foliar analysis information (mandatory parameters)

Sequence number	Plot number	Sample number	Date of analysis (DD MM YY)	Tree numbers in composite sample			Mandatory parameters: N (mg/g)	S (mg/g)	P (mg/g)	Ca (mg/g)	Mg (mg/g)	K (mg/g)	Observation
1 – 5	7 – 10	12 – 16	18 – 23	25 – 27	29 – 31	33 – 35	37 – 41	43 – 47	49 – 52	54 – 58	60 – 64	66 – 70	72 – 82
1		.					.	.	.	.	.	.	
2		.					.	.	.	.	.	.	
3		.					.	.	.	.	.	.	
4		.					.	.	.	.	.	.	
5		.					.	.	.	.	.	.	
6		.					.	.	.	.	.	.	
7		.					.	.	.	.	.	.	
8		.					.	.	.	.	.	.	
		.					.	.	.	.	.	.	
99999	9999	199.1	311295	999	999	999	99.99	99.99	9.99	99.99	99.99	99.99	

Maximum value (*)

1 — 5	Sequence number	Sequence number of samples (1 to 99 999)
7 — 10	Plot number	(maximum 9999)
12 — 16	Sample number	Tree species, leaves type ; tree species (from 001 to 199) and leaves type for current (= 0) and current + 1 (= 1)
18 — 23	Date	Date of analysis (DD MM YY)
25 — 27	Tree number of first tree from which foliage has been taken	
29 — 31	Tree number of second tree from which foliage has been taken	
33 — 35	Tree number of third tree from which foliage has been taken	

Mandatory parameters		Units (**)
37 — 41	N	mg/g
43 — 47	S	mg/g
49 — 52	P	mg/g
54 — 58	Ca	mg/g
60 — 64	Mg	mg/g
66 — 70	K	mg/g
72 — 82	Observation	in words

For *Larix* sp. and *Cedrus* sp., samples are taken of the short twigs of the previous year

(*) Maximum values are used when the actually registered value is equal or higher than the maximum value. When the actual registered value is below the minimum value that could be entered, the minimum value shall be used. If no quantity could be measures (i.e. below detection limits) a special code − 1 (minus 1) will be used. When no analysis has been carried out for this parameter a zero or blank shall be used.

(**) By reference at 105 ° dried material.

7.1.3.4
Code list and explanatory codes for the files XX1995.PLF, XX1995.FOO and XX1995.FOM

(1) *Country*

1= FRANCE
2= BELGIE-BELGIQUE
3= NEDERLAND
4= DEUTSCHLAND
5= ITALIA
6= UNITED KINGDOM
7= IRELAND
8= DANMARK
9= ELLAS
10= PORTUGAL
11= ESPAÑA
12= LUXEMBOURG
13= HELVETIA
14= ÖSTERREICH
15= MAGYAR
16= ROMANIA
17= POLSKA
18= SLOVENSKO
19= NORGE
20= SVERIGE
21= SUOMI
22= LIETUVA
23= HRVATSKA REP.
24= CESKA REP.
25= EESTI
26= SLOVENIJA
27= MOLDOVA

2. *Observation plot number*

The observation plot number corresponds to the number indicated for the intersection of the grid at this point on the list of latitude and logitude coordinates provided by the Commission (Forests and Forestry Division) and/or replacements. The observation plots numbers shall correspond to the plot numbers of the tree vitality inventory (Annex I) in the corresponding year.

3. *Sample number*

The sample number consists of the tree species code and the type of the leaves or needles in the sample. The tree species codes are listed in paragraph II.3. The code for the leaves type is 0 for the current leaves and 1 for the leaves of last year (= current + 1) e.g. 118.1 for the needles of last year for the *Picea abies*.

4. *Date of sampling*

The date of sampling is to be completed in the following order:

e.g.

Day	Month	Year
08	09	94

5. *Latitude/longitude coordinates*

Fill in the full six figure latitude and longitude coordinates of the observation plot. These coordinates will differ from the coordinates of the corresponding plot of the network provided by the Commission when the observation plot in question has been replaced as instructed in paragraph II.1 of Annex I.

e.g.

	+/−	Degrees		Minutes		Seconds	
— latitude	+	5	0	1	0	2	7
— longitude	−	0	1	1	5	3	2

the first box is used to indicate a + or − coordinate.

6. *Altitude*

1 : ≤ 50 m
2 : 51 — 100 m
3 : 101 — 150 m
4 : 151 — 200 m
5 : 201 — 250 m
6 : 251 — 300 m
7 : 301 — 350 m
8 : 351 — 400 m
9 : 401 — 450 m
10 : 451 — 500 m
11 : 501 — 550 m
12 : 551 — 600 m
13 : 601 — 650 m
14 : 651 — 700 m
15 : 701 — 750 m
16 : 751 — 800 m
17 : 801 — 850 m
18 : 851 — 900 m
19 : 901 — 950 m
20 : 951 — 1 000 m
21 : 1 001 — 1 050 m
22 : 1 051 — 1 100 m
23 : 1 101 — 1 150 m
24 : 1 151 — 1 200 m
25 : 1 201 — 1 250 m
26 : 1 251 — 1 300 m
27 : 1 301 — 1 350 m
28 : 1 351 — 1 400 m
29 : 1 401 — 1 450 m
30 : 1 451 — 1 500 m
31 : > 1 500 m

7. *Other oberservations*

Relevant information concerning the plot shall be stated here.

Observation plot number

See explanation item 2

Sample number

See explanation item 3

8. *Date of analysis*

The date of the start of the analysis shall be completed in the same way as the date of sampling (Form 5a, item 4).

9. *Tree numbers*

The same trees are sampled over the years. These trees are numbered.

10. *Foliar analysis*

The following parameters are mandatory:

N, S, P, Ca, Mg and K.

Methods for analysis are descripted in the Manual of the Foliar Expert Panel, approved in the Task Force meeting of May 1993.

For deciduous species, sampling is done on current year leaves or needles. For evergreen species, sampling of both the current year needles or leaves and the second year needles or leaves (current + 1) is recommended.

11. *Other observations*

Any additional observation which may be of interest shall be clearly noted on the form,

e.g. orientation, fertilization/liming ...

Observation plot number

See explanation item 2

Sample number

See explanation item 3

12. *Date of analysis*

The date of the start of the analysis shall be completed in the same way as the date of sampling (Form 5a, item 4).

13. *Foliar analysis*

The following parameters are optional:

Na, Zn, Mn, Fe, Cu, Pb, Al and B.

Methods for analysis are descripted in the Manual of the Foliar Expert Panel, approved in the Task Force meeting of May 1993.

14. *Other observations*

Any additional observation which may be of interest shall be clearly noted on the form,

e.g. orientation, fertilization/liming ...'

7.2 Forms for Level II plots

7.2.1 Forms for general plot data

7.2.1.1
File: XXGENER.PLT
Contents of file with the information on plot level to be completed during installation

Sequence 1–4	Country 6–7	Observation plot number 9–12	Latitude coordinate (+DD MM SS) 14–20	Longitude coordinate (+DD MM SS) 22–28	Altitude 30–31	Orientation 33	Installation date (DD MM YY) 35–40	Total plot size (ha) 42–47	Number of trees in plot 49–52	Size of sub-plot (ha) 54–59	Mean age 61–62	Main tree species 64–66	Yield absolute / relative 68–70	Observations 72–82
1								.		.				
2								.		.				
3								.		.				
4								.		.				
5								.		.				
6								.		.				
7								.		.				
8								.		.				
9								.		.				
10								.		.				
								.		.				

Column		See explanatory notes
1– 4	Sequence number of plots (1 to 9 999)	
6– 7	Country code (France = 01, Belgium = 02, etc.)	(1)
9–12	Observation plot number (maximum 9 999)	(2)
14–20	Latitude in + DDMMSS (e.g. + 50 58 52)	(4)
22–28	Longitude in (+ or –) DDMMSS (e.g. + 03 55 31)	(4)
30–31	Altitude (in 50 metre classes from 1 to 51)	(7)
33	Orientation (N = 1, NE = 2, etc.)	(8)
35–40	Installation date in DDMMYY	(3)
42–47	Total plot size (in 0,0001 ha)	(11)
49–52	Number of trees in total plot	(12)
54–59	Size of sub-plot (in 0,0001 ha)	(11)
61–62	Mean age of dominant storey (in 20 year classes from 1 to 8)	(9)
64–66	Main tree species	(15)
68	Yield estimate — absolute	(13)
70	Yield estimate — relative	(13)

In the last column a remark on the plot can be included:

72–82	Other observations (word)	(99)

7.2.1.1

File: Submission in written form

Other observations on the plots of the intensive monitoring of the forest ecosystems

Country:	(*)	Latitude: (D D M M S S)	(*)	Date of instalation: (D D M M Y Y)	
Plot number:		Longitude:	(*)		
Main species:	(*)	Altitude:	(*)		

Nearby meteorologic station and/or other monitoring or observation plots (history or active)

Name/number	Latitude (*)	Longitude (*)	Information type
....			....
....			....
....			....

Information obtained during installation

Description of forest during installation: (mixtures, storeys, game, regeneration, etc.)

....

....

....

....

....

History of forest management before installation of plot (establishment, thinning, fertilization, etc.)

	year
....	....
....	....
....	....
....	....

Information obtained during years of monitoring

History of forest management after installation of plot (thinnings, fertilization, litter raking, etc.)

Year	Activity	Details (quantities, %)
....	....	....
....	....	....
....	....	....
....	....	....

(*) See explanatory notes in Chapter 7.2.7

7.2.2 Forms for visual assessment of defoliation and discolouration

7.2.2.1

File: XX1993.PLT

Contents of file with the information on plot level to be used with the crown assessment

Sequence 1–4	Country 6–7	Observation plot number 9–12	Assessment date (D D M M Y Y) 14–19	Latitude coordinate (+ D D M M S S) 21–27	Longitude coordinate (+ D D M M S S) 29–35	Altitude 37–38	Mean age 40–41	Observations 43–53
1								
2								
3								
4								
5								
6								
7								
8								
9								
1 0								

Column		See explanatory notes
1– 4	Sequence number of plots (1 to 9999)	
6– 7	Country code (France = 01, Belgium = 02, etc.)	(1)
9–12	Plot number (maximum 9999)	(2)
14–19	Date of assessment	(3)
21–27	Latitude in + DDMMSS (e. g. +50 58 52)	(4)
29–35	Longitude in (+ or –) DDMMSS (e. g. +03 55 31)	(4)
37–38	Altitude (in 50 metre classes form 1 to 51)	(7)
40–41	Mean age of dominant storey (in 20 year classes from 1 to 8)	(9)

In the last column a remark on the plot can be included:

43–53	Other observations (word)	(99)

7.2.2.2

File: XX1993.TRE

Contents of file with the information on tree level to be used with the crown assessment

Sequence 1–5	Observation plot number 7–10	Assessment date (D D M M Y Y) 12–17	Tree # 19–22	Species 24–26	Defoliation 28–30	Dis-co-lour-ation 32	Easily identifiable causes of damage T1 T2 T3 T4 T5 T6 T7 T8 34–48	Identification of damage type 50–55	Other observations 57–67
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Column		See explanatory notes
1– 5	Sequence number of trees (1 to 99 999)	
7–10	Plot number (maximum 9999)	(2)
12–17	Date of survey in DD MM YY (e.g. 220690)	(3)
19–22	Tree number (as marked during installation)	(14)
24–26	Species (001 to 199)	(15)
28–30	Defoliation (0, 5, 10, 15, 20, ..., 95, 100 %)	(16)
32	Discolouration (0, 1, 2, 3 or 4)	(17)
34 (*)	Damaged caused by: game and grazing (1 = Yes)	(18)
36 (*)	Damaged caused by: insects (1 = Yes)	(18)
38 (*)	Damaged caused by: fungi (1 = Yes)	(18)
40 (*)	Damaged caused by: abiotic agents (1 = Yes)	(18)
42 (*)	Damaged caused by: direct action of man (1 = Yes)	(18)
44 (*)	Damaged caused by: fire (1 = Yes)	(18)
46 (*)	Damaged caused by: known local/regional pollutant (1 = Yes)	(18)
48 (*)	Other damage (1 = Yes)	(18)
50–55 (*)	Identification of damage type (name)	(19)
57–67	Other observations (word)	(20)

(*) Leave blank if no damage has been observed.

7.2.3 Forms for sampling and analysis of soil

7.2.3.1

File: XX1995.PLS

Contents of reduced plot file to be used in combination with the forest soil inventory

Sequence 1–4	Country 6–7	Observation plot number 9–12	Date (D D M M Y Y) 14–19	Latitude coordinate (+ D D M M S S) 21–27	Longitude coordinate (+ D D M M S S) 29–35	Altitude 37–38	Soil unit 40–42	Water 44	Hu-mus 46	Observations 48–58
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										

Column		See explanatory notes
1– 4	Sequence number of plots (1 to 9 999)	(1)
6– 7	Country code (France = 01, Belgium = 02, etc.)	(2)
9–12	Plot number (maximum 9 999)	(3)
14–19	Date of sampling in DD MM YY (e. g. 22 06 90)	(4)
21–27	Latitude in + DD MM SS (e.g. + 50 58 52)	(4)
29–35	Longitude in (+ or –) DD MM SS (e.g. + 03 55 31	(7)
37–38	Altitude (in 50 metre classes from 1 to 51)	(10)
40–42	Soil unit (101 to 253)	(5)
44	Water availability (insufficient = 1, sufficient = 2, excessive = 3)	(6)
46	Humus type (mull = 1, moder = 2, etc.)	

In the last column a remark on the plot can be included:

48–58	Other observations (word)	(99)

7.2.3.2
File: XX1995.SOM
Contents of file with soil analysis information (mandatory)

Sequence number 1–5	Observation plot number 7–10	Horizon 12–14	Sample code (0,1,2) 16	Date of analysis (dd mm yy) 18–23	pH ($CaCl_2$) 25–27	C_Org (g/kg) 29–31	N (g/kg) 33–36	P (mg/kg) 38–40	K (mg/kg) 42–45	Ca (mg/kg) 47–50	Mg (mg/kg) 52–55	OrgLay (kg/m²) 57–59	$CaCO_3$ (g/kg) 61–63	Ac-Exc (cmol⁺/kg) 65–67	BCE (cmol⁺/kg) 69–72	ACE (cmol⁺/kg) 74–77	CEC (cmol⁺/kg) 79–82	BaseSat % 84–85	Observations 87–97	
0	0	SAM																		
1		H	0		.		.								.	.	.			
2		O	0		.		.								.	.	.			
3		M05	1		.		.								.	.	.			
4		M51	1		.		.								.	.	.			
5		M01	9		.		.								.	.	.			
6		M12	0		.		.								.	.	.			
7		M24			.		.								.	.	.			
8		M48			.		.								.	.	.			
99999	9999	M48	2		9.9	999	99.9	999	9999	9999	9999	999	999	999	99.9	99.9	99.9	99		Maximum value (**)

The first line (line #0) is used to indicate what sampling analysis method (SAM) has been used.
Indicate for each parameter what analysis method has been used:

0 = No deviation from approved method
1 = Analysed according to alternative method (*)
9 = Recomputed data (*)

1–5	Sequence number (1 to 99 999)		
7–10	Observation plot number (maximum: 9 999)		(2)
12–14	Level	Code for depth level (H, O, M05, M51, M01, M12, M24, M48)	(21)
16	Sample code	Code for sampling analysis method (0 = approved method, 1 = as advised, 2–8 = any subsequent sub-samples, 9 = recalculated) (*)	(22)
18–23	Date	Date of analysis (ddmmyy)	(3)

Mandatory file

	Parameters	Units (***)	H/O	Min	Approved method	Remarks
25–27	pH($CaCl_2$)		Mandatory	Mandatory	pH-electrode	
29–31	C_org	(g/kg)	Mandatory	Mandatory	Dry combustion	
33–36	N	(g/kg)	Mandatory	Mandatory	Dry combustion	
38–40	P	(mg/kg)	Mandatory		Extractant: aqua regia	
42–45	K	(mg/kg)	Mandatory		Extractant: aqua regia	
47–50	Ca	(mg/kg)	Mandatory		Extractant: aqua regia	
52–55	Mg	(mg/kg)	Mandatory		Extractant: aqua regia	
57–59	OrgLayer	(kg/m²)	Mandatory		Volume dry-weight	
61–63	$CaCO_3$	(g/kg)		Mandatory	Calcimeter	(if pH $CaCl_2$ > 6)
65–67	Ac-Exc	(cmol⁺/kg)		Mandatory	Titration	Exchangeable acidity
69–72	BCE	(cmol⁺/kg)		Mandatory	Extractant: $BaCl_2$	Base cations exchangeable
74–77	ACE	(cmol⁺/kg)		Mandatory	Extractant: $BaCl_2$	Acid cations exchangeable
79–82	CEC	(cmol⁺/kg)		Mandatory	Bascomb	Cation exchange capacity
84–85	BaseSat	%		Mandatory	LabexL8703-26-1-1	
87–97	Observation	Words				

Blank = not required.

(*) Methods and recomputations that have been used shall be described in detail in an annex to the soil condition report.
(**) Maximum values are used when the actually registered value is equal or higher than the maximum value. When the actual registered value is below the minimum value that could be entered, the minimum value shall be used. If no quantity could be measured (i.e. below detection limits) a special code −1 (minus 1) will be used. When no analysis has been carried out for this parameter a zero or blank shall be used.
(***) Based on oven-dry weight.

7.2.3.3
File: XX1995.SOO
Contents of file with soil analysis information (optional)

Sequence number 1-5	Plot number 7-10	Horizon 12-14	Sample code (0,1,2) 16	Date of analysis (dd mm yy) 18-23	$CaCO_3$ (g/kg) 25-27	Na (mg/kg) 29-32	Al (mg/kg) 34-38	Fe (mg/kg) 40-44	Cr (mg/kg) 46-48	Ni (mg/kg) 50-52	Mn (mg/kg) 54-57	Zn (mg/kg) 59-61	Cu (mg/kg) 63-65	Pb (mg/kg) 67-69	Cd (mg/kg) 71-73	Hg (mg/kg) 75-78	S (mg/kg) 80-83	pH(H_2O) 85-87	EC (mS/m) 89-90	Ac_Exc (cmol⁺/kg) 92-94	BCE (cmol⁺/kg) 96-99	ACE (cmol⁺/kg) 101-104	CEC (cmol⁺/kg) 106-109	BaseSat % 111-112	P (mg/kg) 114-116	Ca (mg/kg) 118-121	Mg (mg/kg) 123-126	K (mg/kg) 128-131	Observations 133-143	
0	0	SAM																												
1		H	0												.	.		.			.	.	.							
2		O	0												.	.		.			.	.	.							
3		M05	1												.	.		.			.	.	.							
4		M51	1												.	.		.			.	.	.							
5		M01	9												.	.		.			.	.	.							
6		M12	0												.	.		.			.	.	.							
7		M24													.	.		.			.	.	.							
8		M48													.	.		.			.	.	.							
99999	9999	M48	2		999	9999	99999	99999	999	999	9999	999	999	999	9.9	9.99	9999	9.9	99	999	99.9	99.9	99.9	99	999	9999	9999	9999		Maximum value (**)

The first line (line # 0) is used to indicate what sampling analysis method (SAM) has been used.
Indicate for each parameter what analysis method has been used:

0 = No deviation from approved method
1 = Analysed according to alternative method (*)
9 = Recomputed data (*)

1–5	Sequence number (1 to 99 999)		
7–10	Observation plot number (maximum: 9 999)		(2)
12–14	Level	Code for depth level (H, O, M05, M51, M01, M12, M24, M48)	(21)
16	Sample code	Code for sampling analysis method (0 = approved method, 1 = as advised (*), 9 = recalculated) (*)	(22)
18–23	Date	Date of analysis (dd mm yy)	(3)

7.2.4 Forms for sampling and analysis of needles and leaves

7.2.4.1
File: XX1995.PLF
Contents of reduced plot file to be used in combination with the survey of chemical content of needles and leaves

Sequence 1–4	Country 6–7	Observation plot number 9–12	Date (D D M M Y Y) 14–19	Latitude coordinate (+ D D M M S S) 21–27	Longitude coordinate (+ D D M M S S) 29–35	Altitude 37–38	Observations 40–50
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							

Column		See explanatory notes
1– 4	Sequence number of plots (1 to 9 999)	(1)
6– 7	Country code (France = 01, Belgium = 02, etc.)	(2)
9–12	Plot number (maximum 9 999)	(3)
14–19	Date of sampling in DD MM YY (e. g. 220690)	(4)
21–27	Latitude in + DD MM SS (e. g. +505852)	(4)
29–35	Longitude in (+ or –) DD MM SS (e. g. +035531)	(4)
37–38	Altitude (in 50 metre classes from 1 to 51)	(7)

In the last column a remark on the plot can be included:

40–50	Other observations (word)	(99)

7.2.4.2
File: XX1995.FOM
Contents of file with foliar analysis information (mandatory)

Sequence number 1–5	Observation plot number 7–10	Sample number 12–16	Date of analysis (dd mm yy) 17–22	Number of sampled trees # 1 24–27	# 2 29–32	# 3 34–37	# 4 39–42	# 5 44–47	Mass of 100 leaves (g) 49–52	Mass of 1000 needles (g) 54–57	Shoot mass (g) 59–62	N (mg/g) 64–68	S (mg/g) 70–74	P (mg/g) 76–79	Ca (mg/g) 81–85	Mg (mg/g) 87–91	K (mg/g) 93–97	Observations 99–109	
1		.										.	.	.	.	.	.		
2		.										.	.	.	.	.	.		
3		.										.	.	.	.	.	.		
4		.										.	.	.	.	.	.		
5		.										.	.	.	.	.	.		
6		.										.	.	.	.	.	.		
7		.										.	.	.	.	.	.		
8		.										.	.	.	.	.	.		
99999	9999	199.1	311295	9999	9999	9999	9999	9999	9999	9999	9999	99.99	99.99	9.99	99.99	99.99	99.99		Maximum value (*)

			See explanatory notes
1– 5	Sequence number (1 to 99 999)		
7–10	Observation plot number (maximum 9 999)		
12–16	Sample number	Tree species (Code from 1 to 199) and leaves type (0 = current, 1 = current + 1)	(2)
17–22	Date of analysis	Date of analysis (DDMMYY)	(23)
24–27	Tree number #1	Number of first tree in sample	(3)
29–32	Tree number #2	Number of second tree in sample	(24)
34–37	Tree number #3	Number of third tree in sample	(24)
39–42	Tree number #4	Number of fourth tree in sample	(24)
44–47	Tree number #5	Number of fifth tree in sample	(24)
49–52	Mass of 100 leaves	Mass of 100 current year leaves	(24)
54–57	Mass of 1 000 needles	Mass of 1 000 current year or 1 000 current + 1 year needles	(25)
59–62	Shootmass	Mass of shootmass	(25)
			(26)

Mandatory file

Parameters		Units (**)
64–68	N	mg/g
70–74	S	mg/g
76–79	P	mg/g
81–85	Ca	mg/g
87–91	Mg	mg/g
93–97	K	mg/g
99–109	Observation	Words

Those parameters have to be filled in once for the current needles and leaves and once for the current + 1 needles.
For *Larix sp.* and *Cedrus sp.* samples are taken of the short twigs of the previous year.

(*) Maximum values are used when the actually registered value is equal or higher than the maximum value. When the actual registered value is below the minimum value that could be entered, the minimum value shall be used. If no quantity could be measured (i.e. below detection limits) a special code –1 (minus 1) will be used. When no analysis has been carried out for this parameter a zero or blank shall be used.
(**) By reference at 105 °C dried material.

7.2.4.3
File: XX1995.FOO
Contents of file with foliar analysis information (optional)

Sequence number	Observation plot number	Sample number	Date of analysis (dd mm yy)	Na (µg/g)	Zn (µg/g)	Mn (µg/g)	Fe (µg/g)	Cu (µg/g)	Pb (µg/g)	Al (µg/g)	B (µg/g)	Observations	
1–5	7–10	12–16	18–23	25–30	32–36	38–43	45–49	51–55	57–60	62–66	68–72	74–84	
1		.						.	.				
2		.						.	.				
3		.						.	.				
4		.						.	.				
5		.						.	.				
6		.						.	.				
7		.						.	.				
8		.						.	.				
		.						.	.				
99999	9999	199.1	311295	999999	99999	999999	999 9	99.99	99.9	99999	99999		Maximum value (*)

See explanatory notes

1–5 Sequence number (1 to 99 999)
7–10 Observation plot number (maximum 9 999) (2)
12–16 Sample number Tree species (code from 1 to 199) and leaves type (0 = current, 1 = current + 1) (23)
18–23 Date Date of analysis (DDMMYY) (3)

(Optional file)

	Parameters	Units (**)
25–30	Na	µg/g
32–36	Zn	µg/g
38–43	Mn	µg/g
45–49	Fe	µg/g
51–55	Cu	µg/g
57–60	Pb	µg/g
62–66	Al	µg/g
68–72	B	µg/g
74–84	Observation	Words

For *Larix* sp. and *Cedrus* sp. samples are taken of the twigs of the previous year.

(*) Maximum values are used when the actually registered value is equal or higher than the maximum value. When the actual registered value is below the minimum va[lue] that could be entered, the minimum value shall be used. If no quantity could be measured (i. e. below detection limits) a special code – 1 (minus 1) will be used. Wh[en] no analysis has been carried out for this parameter a zero or blank shall be used.
(**) By reference at 105 °C dried material.

7.2.5 Forms for estimation of growth and yield

7.2.5.1
File: XX1996.PLI
Contents of reduced plot file to be used for increment

Sequence	Country	Observation plot number	Assessment date (DD MM YY)	Latitude coordinate (+ DD MM SS)	Longitude coordinate (± DD MM SS)	Total plot size (ha)	Number of trees in total plot	Sample plot size (ha)	Observations
1–4	6–7	9–12	14–19	21–27	29–35	37–42	44–48	50–55	57–67
1						.		.	
2						.		.	
3						.		.	
4						.		.	
5						.		.	
6						.		.	
7						.		.	
8						.		.	
9						.		.	
10						.		.	
						.		.	

Column

See explanatory notes

1– 4 Sequence number of plots (1 to 9 999)
6– 7 Country code (France = 01, Belgium = 02, etc.) (1)
9–12 Plot number (maximum 9 999) (2)
14–19 Date of observation in DD MM YY (e.g. 22 06 94) (3)
21–27 Latitude in + DD MM SS (e.g. + 50 10 27) (4)
29–35 Longitude in + or – DD MM SS (e.g. – 01 15 32) (4)
37–42 Total plot size in hectares (maximum 9,9999 hectares) (11)
44–48 Number of trees in total plot (12)
50–55 Sample plot size in hectares (maximum 9,9999 hectares) (11)
57–67 Other observations (word) (99)

7.2.5.2
File: XX1996.IPM
Contents of file with increment information - periodic measurements

	Mandatory					Optional					
Sequence	Plot number	Tree number	Species	Diameter (cm)	Diameter 2 (cm)	Bark (cm)	Height (m)	Tree volume (m^3)	Crown length (m)	Crown width (m)	Observations
1–4	6–9	11–14	16–18	20–24	26–30	32–34	36–39	41–46	48–51	53–56	58–68
1				.	.	.	.	.	.	.	
2				.	.	.	.	.	.	.	
3				.	.	.	.	.	.	.	
4				.	.	.	.	.	.	.	
5				.	.	.	.	.	.	.	
6				.	.	.	.	.	.	.	
7				.	.	.	.	.	.	.	
8				.	.	.	.	.	.	.	
9				.	.	.	.	.	.	.	
10				.	.	.	.	.	.	.	
				.	.	.	.	.	.	.	

Column		See explanatory notes	Mandatory	Optional	Remarks
1– 4	Sequence number records (1 to 99 999)				
6– 9	Plot number (maximum 9 999)	(2)	Mandatory		
11– 4	Tree number	(14)	Mandatory		
16–18	Species (001 to 199)	(15)	Mandatory		
20–24	Diameter (maximum 999,9 cm)	(27)	Mandatory		
26–30	Diameter (maximum 999,9 cm)*	(27)	Mandatory (*)		
32–34	Bark (maximum 9,9 cm)	(28)		Optional	
36–39	Height rounded off to nearest 0,5 metres (maximum 99,5 m)	(29)		Optional	
41–46	Tree volume (maximum 99 999 m^3)	(30)		Optional	
48–51	Crown length rounded off to neares 0,5 metres (maximum 99.5 m)	(31)		Optional	
53–56	Crown width rounded off to nearest 0,5 metres (maximum 99,5 m)	(32)		Optional	
58–68	Other observations (word)			Optional	

(*) Mandatory when calipers are used

7.2.5.3
File: XX1996.IRA
Contents of file of increment information - ring analysis and stem disc analysis (optional)

Sequence	Plot number	Tree (R/D ###)	Species	DBH_t (o.b.) (cm)	Diameter*$_t$ (cm)	Diameter*$_{t-5}$ (cm)	Diameter*$_{t-10}$	Diameter*$_{t-15}$	Diameter*$_{t-20}$	Diameter*$_{t-25}$	Diameter*$_{t-30}$	Diameter*$_{t-35}$	Diameter*$_{t-40}$	Diameter*$_{t-45}$	Diameter*$_{t-50}$	Observations
1–4	6–9	11–14	16–18	20–24	26–30	32–36	38–42	44–48	50–54	56–60	62–66	68–72	74–78	80–84	86–90	92–102
1					.	.	.	.	.	.	.	.	.	.	.	
2					.	.	.	.	.	.	.	.	.	.	.	
3					.	.	.	.	.	.	.	.	.	.	.	
4					.	.	.	.	.	.	.	.	.	.	.	
5					.	.	.	.	.	.	.	.	.	.	.	
6					.	.	.	.	.	.	.	.	.	.	.	
7					.	.	.	.	.	.	.	.	.	.	.	
8					.	.	.	.	.	.	.	.	.	.	.	
9					.	.	.	.	.	.	.	.	.	.	.	
10					.	.	.	.	.	.	.	.	.	.	.	
					.	.	.	.	.	.	.	.	.	.	.	

DBH_t (o.b.) Diameter breast height over bark in year of assessment (=t)
Diameter*$_t$ Diameter breast height under bark in year of assessment (=t)

Column		See explanatory notes
1 to 4	Sequence number (1 to 99 999)	
6 to 9	Plot number (maximum 9 999)	(2)
11 to 14	Tree number with initial R for ring analysis and D for disk sampling	(24)
16 to 18	Species (001 to 199)	(15)
20 to 24	Actual DBH over bark (maximum 999,9 cm)	(27)
26 to 30	Actual diameter under bark (maximum 999,9 cm)	(33)
32 to 36	Diameter under bark five years ago (maximum 999,9 cm)	(33)
38 to 42	Diameter under bark 10 years ago (maximum 999,9 cm)	(33)
44 to 48	Diameter under bark 15 years ago (maximum 999,9 cm)	(33)
50 to 54	Diameter under bark 20 years ago (maximum 999,9 cm)	(33)
56 to 60	Diameter under bark 25 years ago (maximum 999,9 cm)	(33)
62 to 66	Diameter under bark 30 years ago (maximum 999,9 cm)	(33)
68 to 72	Diameter under bark 35 years ago (maximum 999,9 cm)	(33)
74 to 78	Diameter under bark 40 years ago (maximum 999,9 cm)	(33)
80 to 84	Diameter under bark 45 years ago (maximum 999,9 cm)	(33)
86 to 90	Diameter under bark 50 years ago (maximum 999,9 cm)	(33)
92 to 102	Other observations (word)	

7.2.5.4
File: XX1996.IEV
Contents of evaluated data on increment (optional)

Sequence	Plot number	Periodic measurements: Trees/plot	Periodic measurements: Basal area/plot	Periodic measurements: Volume/plot	Ring analysis and stem disc analysis: Basal area/plot	Volume/plot$_t$	Thinning	Basal area/plot$_{t-5}$	Volume/plot$_{t-5}$	Thinning	Basal area/plot$_{t-10}$	Volume/plot$_{t-10}$	Thinning	Basal area/plot$_{t-15}$	Volume/plot$_{t-15}$	Thinning	Basal area/plot$_{t-20}$	Volume/plot$_{t-20}$	Thinning	Basal area/plot$_{t-25}$	Volume/plot$_{t-25}$	Observations
			(m²/plot)	(m³/plot)	(m²/plot)	(m³/plot)	(Y/N)	(m²/plot)	(m³/plot)	(Y/N)	(m²/plot)	(m³/plot)	(Y/N)	(m²/plot)	(m³/plot)	(Y/N)	(m²/plot)	(m³/plot)	(Y/N)	(m²/plot)	(m³/plot)	
1–4	6–9	11–14	16–20	22–26	28–32	34–38	40	42–46	48–52	54	56–60	62–66	68	70–74	76–80	82	84–88	90–94	96	98–102	104–108	110–120
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

Column		See explanatory notes	Evalution of periodic measurements	Evaluation of ring and stem disc samples
1 to 4	Sequence number			
6 to 9	Plot number (maximum 9 999)	(2)	Optional	Optional
11 to 4	Number of trees per plot (maximum 9 999 trees/per plot)	(12)	Optional	
16 to 20	Basal area per plot (maximum 999,9 m²/plot)	(34)	Optional	
22 to 26	Volume per plot (maximum 999,9 m³/plot)	(35)	Optional	
28 to 32	Basal area per plot (maximum 999,9 m²/plot)	(34)		Optional
34 to 38	Volume per plot (999,9 m³/plot)	(35)		Optional
40	Thinning between now and five years ago (Yes = 1, no = 0)	(36)		Optional
42 to 46	Basal area per plot five years ago (maximum 999,9 m²/plot)	(34)		Optional
48 to 52	Volume per plot five years ago (maximum 999,9 m³/plot)	(35)		Optional
54	Thinning between five and 10 years ago (Yes = 1, no = 0)	(36)		Optional
56 to 60	Basal area per plot 10 years ago (maximum 999,9 m²/plot)	(34)		Optional
62 to 66	Volume per plot 10 years ago (maximum 999,9 m³/plot)	(35)		Optional
68	Thinning between 10 and 15 years ago (Yes = 1, no = 0)	(36)		Optional
70 to 74	Basal area per plot 15 years ago (maximum 999,9 m²/plot)	(34)		Optional
76 to 80	Volume per plot 15 years ago (maximum 999,9 m³/plot)	(35)		Optional
82	Thinning between 15 and 20 years ago (Yes = 1, no = 0)	(36)		Optional
84 to 88	Basal area per plot 20 years ago (maximum 999,9 m²/plot)	(34)		Optional
90 to 94	Volume per plot 20 years ago (maximum 999,9 m³/plot)	(35)		Optional
96	Thinning between 20 and 25 years ago (Yes = 1, no = 0)	(36)		Optional
98 to 102	Basal area per plot 25 years ago (maximum 999,9 m²/plot)	(34)		Optional
104 to 108	Volume per plot 25 years ago (maximum 999,9 m3/plot)	(35)		Optional
110 to 120	Other observations (word)			

7.2.6 Forms for measurement of deposition

7.2.6.1
File: XX1996.PLD
Contents of reduced plot file to be used in combination with the deposition measurements

Sequence	Country	Observation Plot #	Sampler Code	Latitude Coordinate (+ D D M M S S)	Longitude coordinate (+- D D M M S S)	Altitude	1st period Start date (D D M M Y Y)	last period final date (D D M M Y Y)	number of periods	Observations
1---4	6--7	9---12	14	16 - - - - - 22	24 - - - - - 30	32–33	35 - - - - 40	42 - - - - 47	49 – 50	52 - - - 62
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										

Column		See explanation item #
1 – 4	Sequence number of plots (1 to 9999)	
6 – 7	Country Code (France = 01, Belgium = 02, etc.)	
9 – 12	Observation plot number	*(1)*
14	Sampler code	*(2)*
16 – 22	Latitude in +DDMMSS (e.g.+505852)	*(37)*
24 – 30	Longitude in (+ or –)DDMMSS (e.g. +035531)	*(4)*
32 – 33	Altitude (in 50 meter classes from 1 to 51)	*(4)*
35 – 40	First date of monitoring period	*(7)*
42 – 47	Final date of monitoring period	*(38)*
49 – 50	Number of (equal) measuring periods	*(38)*
52 – 62	Other observations (word)	*(39)*
		(12)

7.2.6.2
File: XX1996.DEM
Contents of datafile with deposition measurements (mandatory)

Sequence Number	Observation Plot #	Period	Samp Code	Quantity (mm)	pH	Conductivity (µS/cm)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	$N-NH_4$ (mg/l)	Cl (mg/l)	$N-NO_3$ (mg/l)	$S-SO_4$ (mg/l)	Alkalinity (µeq/l)	N_{total} (mg/l)	Observation
1 – 5	7 – 10	12–13	15	17–20	22–24	26–29	31–34	36–40	42–45	47–51	53–57	59–63	65–69	71–75	77–80	82–86	88 – – – 98
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
99999	9999	9 9	2		9.9	9999	99.9	999.9	99.9	999.9	999.9	999.9	999.9	999.9	9999	999.9	

Maximum value **)

1 – 5	Sequence Number	Sequence number of samples (1 to 99 999)	
7 – 10	Observation Plot number	Corresponding plotnumber (max. 9999)	(2)
12 – 13	Period	Period number (max 99)	(40)
15	Sampler code	Sampler code (1 = Throughfall, 2 = Bulk, 3 = Wet-only, 4 = Stemflow, 5= Fog, 6 = Fog_{frozen}, 7 = Air concentration, 9 = other)	(37)
17 – 20	Sample quantity	Quantity of total collected sample expressed in mm (max. 9999)	(37a)

	Parameters *)	Units	Throughfall	Bulk or Wet-only	Stemflow Beech	Stemflow Other	Fog Fog_{frozen}	Air Conc.	Remarks
22–24	pH		Man.	Man.	Man.	Opt.	Opt.		
26–29	Conductivity	(µS/cm)	Man.	Man.	Man.	Opt.	Opt.		
31–34	K^+	(mg/l)	Man.	Man.	Man.	Opt.	Opt.	Opt.	
36–40	Ca^{2+}	(mg/l)	Man.	Man.	Man.	Opt.	Opt.	Opt.	
42–45	Mg^{2+}	(mg/l)	Man.	Man.	Man.	Opt.	Opt.	Opt.	
47–51	Na^+	(mg/l)	Man.	Man.	Man.	Opt.	Opt.	Opt.	
53–57	$N-NH_4$	(mg/l)	Man.	Man.	Man.	Opt.	Opt.	Opt.	
59–63	Cl^-	(mg/l)	Man.	Man.	Man.	Opt.	Opt.		
65–69	$N-NO_3$	(mg/l)	Man.	Man.	Man.	Opt.	Opt.	Opt.	
71–75	$S-SO_4$	(mg/l)	Man.	Man.	Man.	Opt.	Opt.	Opt.	
77–80	Alkalinity	(µeq/l)	Man.	Man.	Man.	Opt.	Opt.		(if annual median pH >5)
82–86	N_{total}	(mg/l)	Man.	Opt.	Man.	Opt.	Opt.		
88 – 98	Observation	Words							

*) Methods and recomputations that have been used shall be described in detail in an annex to the deposition report.

**) Maximum values as mentioned in the bottom line of the table are to be used whenever the actually registered value is equal or higher than the maximum possible values in these columns.
When the actually registered value is below the minimum value that could be entered, the minimum value shall be used.
If no quantity could be measured (i.e. below detection limits) a special code −1 (minus 1) will be used. When no analysis has been carried out for this parameter a zero or blank shall be used.

7.2.6.3
File: XX1996.DEO
Contents of datafile with deposition measurements (optional)

Sequence Number	Observation Plot #	Period	Samp Code	Al^{3+} (µg/l)	Mn^{2+} (µg/l)	Fe^{3+} (µg/l)	PO_4^{3-} (mg/l)	Cu (µg/l)	Zn (µg/l)	Hg (µg/l)	Pb (µg/l)	Co (µg/l)	Mo (µg/l)	Cd (µg/l)	S_{total} (mg/l)	N_{org} (mg/l)	C_{TOC} (mg/l)	C_{DOC} (mg/l)	P_{total} (mg/l)	Observation
1 – 5	7 – 10	12 – 13	15	17 – 20	22 – 26	28 – 32	34 – 37	39 – 42	43 – 46	48 – 51	53 – 56	58 – 61	63 – 66	68 – 71	73 – 76	78 – 81	83 – 86	88 – 91	93 – 96	98 – 108
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Bottom line: 99999 9999 9 9 9 9999999.9999.999.999.999.999.999.999.999.999.999.999.999.999.999.9

maximum value**)

Column			See explanation item #
1 – 5	Sequence Number	Sequence number of samples (1 to 99 999)	(1)
7 – 10	Observation Plot number	Corresponding plotnumber (max. 9999)	(2)
12 – 13	Period	Period number	(40)
15	Sampler Code	Sampler code (1 = Throughfall, 2 = Bulk, 3 = Wet-only, 4 = Stemflow, 5= Fog, 6 = Fog_{frozen}, 7 = Air concentration, 9 = other)	(37)

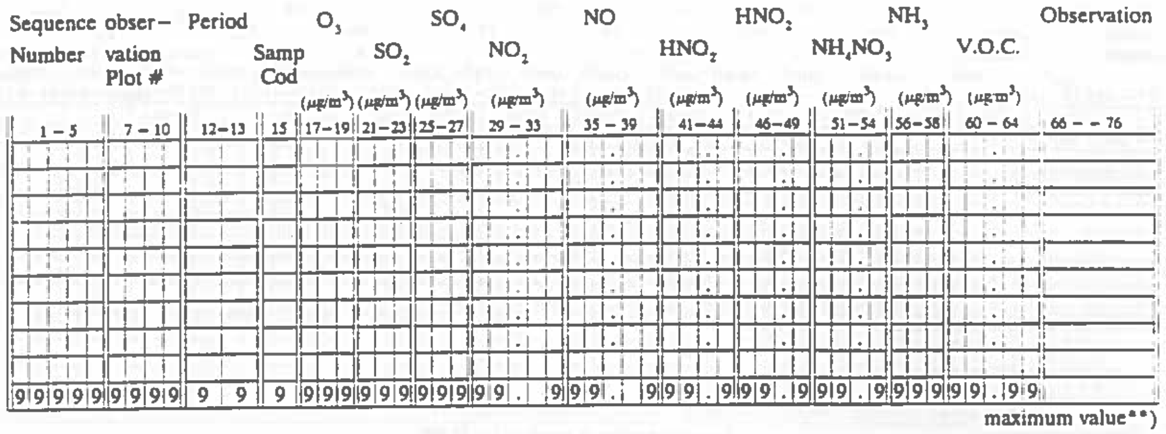
	Parameters *)	Units	Throughfall	Bulk or Wet-only	Stemflow	Fog	Air Conc	Remarks
17 – 20	Al^{3+}	(µg/l)	Opt.	Opt.	Opt.	Opt.		
22 – 26	Mn^{2+}	(µg/l)	Opt.	Opt.	Opt.	Opt.		
28 – 32	Fe^{3+}	(µg/l)	Opt.	Opt.	Opt.	Opt.		
34 – 37	PO_4^{3-}	(mg/l)	Opt.	Opt.	Opt.	Opt.		
39 – 42	Cu	(µg/l)	Opt.	Opt.	Opt.	Opt.		
43 – 46	Zn	(µg/l)	Opt.	Opt.	Opt.	Opt.		
48 – 51	Hg	(µg/l)	Opt.	Opt.	Opt.	Opt.		
53 – 56	Pb	(µg/l)	Opt.	Opt.	Opt.	Opt.		
58 – 61	Co	(µg/l)	Opt.	Opt.	Opt.	Opt.		
63 – 66	Mo	(µg/l)	Opt.	Opt.	Opt.	Opt.		
68 – 71	Cd	(µg/l)	Opt.	Opt.	Opt.	Opt.		
73 – 76	S_{total}	(mg/l)	Opt.	Opt.	Opt.			
78 – 81	N_{org}	(mg/l)	Opt.	Opt.	Opt.			
83 – 86	C_{TOC}	(mg/l)	Opt.		Opt.			
88 – 91	C_{DOC}	(mg/l)	Opt.		Opt.			
93 – 96	P_{total}	(mg/l)	Opt.	Opt.	Opt.	Opt.		
98 – 108	Observation	Words	Opt.		Opt.			

Opt. = Optional, blanc = Not required

*) Methods and recomputations that have been used shall be described in detail in an annex to the deposition report.

**) Maximum values as mentioned in the bottom line of the table are to be used whenever the actually registered value is equal or higher than the maximum possible values in these columns.
When the actually registered value is below the minimum value that could be entered, the minimum value shall be used.
If no quantity could be measured (i.e. below detection limits) a special code −1 (minus 1) will be used. When no analysis has been carried out for this parameter a zero or blank shall be used.

7.2.6.4
File: XX1996.DEA
Contents of datafile with air concentration measurements (optional)



Column			See explanation item #
1 – 5	Sequence Number	Sequence number of samples (1 to 99 999)	*(1)*
7 – 10	Observation Plot number	Corresponding plotnumber (max. 9999)	*(2)*
12 – 13	Period	Period number	*(40)*
15	Sampler Code	Sampler code (1 = Throughfall, 2 = Bulk, 3 = wet–only, 4 = Stemflow, 5 = Fog, 6 = Fog_{frozen}, 7 = Air concentration, 9 = other)	*(37)*

	Parameters *)	Units	Air Conc.	Remarks
17 – 19	O_3	(μg/m³)	Opt.	
21 – 23	SO_2	(μg/m³)	Opt.	
25 – 27	SO_4	(μg/m³)	Opt.	
29 – 33	NO_2	(μg/m³)	Opt.	
35 – 39	NO	(μg/m³)	Opt.	
41 – 44	HNO_2	(μg/m³)	Opt.	
46 – 49	HNO_3	(μg/m³)	Opt.	
51 – 54	NH_4NO_3	(μg/m³)	Opt.	
56 – 58	NH_3	(μg/m³)	Opt.	
60 – 64	Volatile Organic Compounds (V.O.C.)	(μg/m³)	Opt.	Non–methane
66 – 76	Observations	Words		

*) Methods and recomputations that have been used shall be described in detail in an annex to the deposition report.

**) Maximum values are used when the actually registered value is equal or higher than the maximum value. When the actual registered value below the minimum value that could be entered, the minimum value shall be used. If no quantity could be measured (i.e. below detection limits) a special code – 1 (minus 1) will be used. When no analysis has been carried out for this parameter a zero or blanc shall be used.

7.2.7 Code list and explanatory notes

Information on plot level

(1) *Country*

1= FRANCE
2= BELGIE-BELGIQUE
3= NEDERLAND
4= DEUTSCHLAND
5= ITALIA
6= UNITED KINGDOM
7= IRELAND
8= DANMARK
9= ELLAS
10= PORTUGAL
11= ESPAÑA
12= LUXEMBOURG
13= HELVETIA
14= ÖSTERREICH
15= MAGYAR
16= ROMANIA
17= POLSKA
18= SLOVENSKO
19= NORGE
20= SVERIGE
21= SUOMI
22= LIETUVA
23= HRVATSKA REP.
24= CESKA REP.
25= EESTI
26= SLOVENIJA
27= MOLDOVA

(2) *Observation plot number*

The observation plot number corresponds to a unique number given to the permanent plot during the selection or installation.

(3) *Date of observation, date of assessment, date of analysis*

Dates shall be completed in the following order day, month and year:

Day	Month	Year
0 8	0 9	9 4

(4) *Latitude-/ longitude coordinates*

Fill in the full six figure latitude and longitude coordinates of the centre of the observation plot.

e.g.

	+/-	Degrees		Minutes		Seconds	
— latitude	+	5	0	1	0	2	7
— longitude	-	0	1	1	5	3	2

the first box is used to indicate a + or - coordinate

(5) *Availability of water to principal species (estimate)*

1: Insufficient
2: Sufficient
3: Excessive

(6) *Humus type*

1: Mull
2: Moder
3: Mor
4: Anmor
5: Peat
6: Other
7: Raw (Roh)

(7) *Altitude*

1: ≤ 50 m	18: 851— 900 m	35: 1 701—1 750 m
2: 51— 100 m	19: 901— 950 m	36: 1 751—1 800 m
3: 101— 150 m	20: 951—1 000 m	37: 1 801—1 850 m
4: 151— 200 m	21: 1 001—1 050 m	38: 1 851—1 900 m
5: 201— 250 m	22: 1 051—1 100 m	39: 1 901—1 950 m
6: 251— 300 m	23: 1 101—1 150 m	40: 1 951—2 000 m
7: 301— 350 m	24: 1 151—1 200 m	41: 2 001—2 050 m
8: 351— 400 m	25: 1 201—1 250 m	42: 2 051—2 100 m
9: 401— 450 m	26: 1 251—1 300 m	43: 2 101—2 150 m
10: 451— 500 m	27: 1 301—1 350 m	44: 2 151—2 200 m
11: 501— 550 m	28: 1 351—1 400 m	45: 2 201—2 250 m
12: 551— 600 m	29: 1 401—1 450 m	46: 2 251—2 300 m
13: 601— 650 m	30: 1 451—1 500 m	47: 2 301—2 350 m
14: 651— 700 m	31: 1 501—1 550 m	48: 2 351—2 400 m
15: 701— 750 m	32: 1 551—1 600 m	49: 2 401—2 450 m
16: 751— 800 m	33: 1 601—1 650 m	50: 2 451—2 500 m
17: 801— 850 m	34: 1 651—1 700 m	51: >2 500 m

(8) *Orientation*

1: N
2: NE
3: E
4: SE
5: S
6: SW
7: W
8: NW
9: flat

(9) *Mean age of dominant storey (years)*

1: ≤ 20
2: 21— 40
3: 41— 60
4: 61— 80
5: 81—100
6: 101—120
7: > 20
8: Irregular stands

(10) *Soil unit*

Fluvisols

101 Eutric Fluvisols
102 Calcaric Fluvisols
103 Dystric Fluvisols
104 Mollic Fluvisols
105 Umbric Fluvisols
106 Thionic Fluvisols
107 Salic Fluvisols

Gleysols

108 Eutric Gleysols
109 Calcic Gleysols
110 Dystric Gleysols
111 Andic Gleysols
112 Mollic Gleysols
113 Umbric Gleysols
114 Thionic Gleysols
115 Gelic Gleysols

Regosols

116 Eutric Regosols
117 Calcaric Regosols
118 Gypsic Regosols
119 Dystric Regosols
120 Umbric Regosols
121 Gelic Regosols

Leptosols

122 Eutric Leptosols
123 Dystric Leptosols
124 Rendzic Leptosols
125 Mollic Leptosols
126 Umbric Leptosols
127 Lithic Leptosols
128 Gelic Leptosols

Arenosols

129 Haplic Arenosols
130 Cambic Arenosols
131 Luvic Arenosols
132 Ferralic Arenosols
133 Albic Arenosols
134 Calcaric Arenosols
135 Gleyic Arenosols

Andosols

136 Haplic Andosols
137 Mollic Andosols
138 Umbric Andosols
139 Vitric Andosols
140 Gleyic Andosols
141 Gelic Andosols

Vertisols

142 Eutric Vertisols
143 Dystric Vertisols
144 Calcic Vertisols
145 Gypsic Vertisols

Cambisols

146 Eutric Cambisols
147 Dystric Cambisols
148 Humic Cambisols
149 Calcaric Cambisols
150 Chromic Cambisols
151 Vertic Cambisols
152 Ferralic Cambisols
153 Gleyic Cambisols
154 Gelic Cambisols

Calcisols

155 Haplic Calcisols
156 Luvic Calcisols
157 Petric Calcisols

Gypsisols

158 Haplic Gypsisols
159 Calcic Gypsisols
160 Luvic Gypsisols
161 Petric Gypsisols

Solonetz

162 Haplic Solonetz
163 Mollic Solonetz
164 Calcic Solonetz
165 Gypsic Solonetz
166 Stagnic Solonetz
167 Gleyic Solonetz

Solonchaks

168 Haplic Solonchaks
169 Mollic Solonchaks
170 Calcic Solonchaks
171 Gypsic Solonchaks
172 Sodic Solonchaks
173 Gleyic Solonchaks
174 Gelic Solonchaks

Kastanozems

175 Haplic Kastanozems
176 Luvic Kastanozems
177 Calcic Kastanozems
178 Gypsic Kastanozems

Chernozems

179 Haplic Chernozems
180 Calcic Chernozems
181 Luvic Chernozems
182 Glossic Chernozems
183 Gleyic Chernozems

Phaeozems

184 Haplic Phaeozems
185 Calcaric Phaeozems
186 Luvic Phaeozems
187 Stagnic Phaeozems
188 Gleyic Phaeozems

Greyzems

189 Haplic Greyzems
190 Gleyic Greyzems

Luvisols

191 Haplic Luvisols
192 Ferric Luvisols
193 Chromic Luvisols
194 Calcic Luvisols
195 Vertic Luvisols
196 Albic Luvisols
197 Stagnic Luvisols
198 Gleyic Luvisols

Lixisols

199 Haplic Lixisols
200 Ferric Lixisols
201 Plinthic Lixisols
202 Albic Lixisols
203 Stagnic Lixisols
204 Gleyic Lixisols

Planosols

205 Eutric Planosols
206 Dystric Planosols
207 Mollic Planosols
208 Umbric Planosols
209 Gelic Planosols

Podzoluvisols

210 Eutric Podzoluvisols
211 Dystric Podzoluvisols
212 Stagnic Podzoluvisols
213 Gleyic Podzoluvisols
214 Gelic Podzoluvisols

Podzols

215 Haplic Podzols
216 Cambic Podzols
217 Ferric Podzols
218 Carbic Podzols
219 Gleyic Podzols
220 Gelic Podzols

Acrisols

221 Haplic Acrisols
222 Ferric Acrisols
223 Humic Acrisols
224 Plinthic Acrisols
225 Gleyic Acrisols

Alisols

226 Haplic Alisols
227 Ferric Alisols
228 Humic Alisols
229 Plinthic Alisols
230 Stagnic Alisols
231 Gleyic Alisols

Nitisols

232 Haplic Nitisols
233 Rhodic Nitisols
234 Humic Nitisols

Ferralsols

235 Haplic Ferralsols
236 Xanthic Ferralsols
237 Rhodic Ferralsols
238 Humic Ferralsols
239 Geric Ferralsols
240 Plinthic Ferralsols

Plinthosols

241 Eutric Plinthosols
242 Dystric Plinthosols
243 Humic Plinthosols
244 Albic Plinthosols

Histosols

245 Folic Histosols
246 Terric Histosols
247 Fibric Histosols
248 Thionic Histosols
249 Gelic Histosols

Anthrosols

250 Aric Anthrosols
251 Fimic Anthrosols
252 Cumulic Anthrosols
253 Urbic Anthrosols

(11) *Size of total plot, size of sub-plot*

The size of the total plot, or sub-plot shall be stated in 0,0001 ha.

(12) *Number of trees in total plot*

The total number of trees in the total plot. All trees from 5 cm (DBH) and more are counted.

(13) *Yield estimates*

The yield estimates consist of an absolute and a relative yield estimate. The absolute estimate will be the estimated average yield over the total life period of the stand. The relative yield will indicate whether the absolute yield estimate is considered to be low, normal or high for the stand. The following codes will be used:

Absolute yield code

0 = 0,0— 2,5 m^3 per hectare per year
1 = 2,5— 7,5 m^3 per hectare per year
2 = 7,5—12,5 m^3 per hectare per year
3 = 12,5—17,5 m^3 per hectare per year
4 = 17,5—22,5 m^3 per hectare per year
5 = >22,5 m^3 per hectare per year

Relative yield code

1 = Low
2 = Normal
3 = High

(99) *Other Observations*

Relevant information concerning the plot shall be stated here.

Information on tree level

to be used in the crown assessment

(14) *Sample tree number*

The tree number is the number which has been assigned to the tree during the installation of the plot.

(15) *Species* (Reference *Flora Europaea*)

Broadleaves (* = species to be used for the foliage inventory)

001: *Acer campestre* *
002: *Acer monspessulanum* *
003: *Acer opalus*
004: *Acer platanoides*
005: *Acer pseudoplatanus* *
006: *Alnus cordata* *
007: *Alnus glutinosa* *
008: *Alnus incana*
009: *Alnus viridis*
010: *Betula pendula* *
011: *Betula pubescens* *
012: *Buxus sempervirens*
013: *Carpinus betulus* *
014: *Carpinus orientalis*
015: *Castanea sativa (C. vesca)* *
016: *Corylus avellana* *
017: *Eucalyptus sp.* *
018: *Fagus moesiaca* *
019: *Fagus orientalis*
020: *Fagus sylvatica* *
021: *Fraxinus angustifolia* spp. *oxycarpa (F. oxyphylla)* *
022: *Fraxinus excelsior* *
023: *Fraxius ornus* *
024: *Ilex aquifolium*
025: *Juglans nigra*
026: *Juglans regia*
027: *Malus domestica*
028: *Olea europaea* *
029: *Ostrya carpinifolia* *
030: *Platanus orientalis*
031: *Populus alba*
032: *Populus canescens*
033: *Populus hybrides* *
034: *Populus nigra* *
035: *Populus tremula* *
036: *Prunus avium* *
037: *Prunus dulcis (Amygdalus communis)*
038: *Prunus padus*
039: *Prunus serotina*
040: *Pyrus communis*
041: *Quercus cerris* *
042: *Quercus coccifera (Q. calliprinos)* *
043: *Quercus faginea* *
044: *Quercus frainetto (Q. conferta)* *
045: *Quercus fruticosa (Q. lusitanica)*
046: *Quercus ilex* *
047: *Quercus macrolepis (Q. aegilops)*
048: *Quercus petraea* *
049: *Quercus pubescens* *
050: *Quercus pyrenaica (Q. toza)* *
051: *Quercus robur (Q. peduculata)* *
052: *Quercus rotundifolia* *
053: *Quercus rubra* *
054: *Quercus suber* *
055: *Quercus trojana*
056: *Robinia pseudoacacia* *
057: *Salix alba*
058: *Salix caprea*
059: *Salix cinerea*
060: *Salix eleagnos*
061: *Salix fragilis*
062: *Salix sp.*
063: *Sorbus aria*
064: *Sorbus aucuparia*
065: *Sorbus domestica*
066: *Sorbus torminalis*
067: *Tamarix africana*
068: *Tilia cordata*
069: *Tilia platyphyllos*
070: *Ulmus glabra (U. scabra, U. montana)*
071: *Ulmus laevis (U. effuša)*
072: *Ulmus minor (U. campestris, U. carpinifolia)*
073: *Arbutus unedo*
074: *Arbutus andrachne*
075: *Ceratonia siliqua*
076: *Cercis siliquastrum*
077: *Erica arborea*
078: *Erica scoparia*
079: *Erica manipuliflora*
080: *Laurus nobilis*
081: *Myrtus communis*
082: *Phillyrea latifolia*
083: *Phillyrea angustifolia*
084: *Pistacia lentiscus*
085: *Pistacia terebinthus*
086: *Rhamnus oleoides*
087: *Rhamnus alaternus*
099: *Other broadleaves*

Conifers (* = species to be used for the foliage inventory)

100: *Abies alba* *
101: *Abies borisii-regis* *
102: *Abies cephalonica* *
103: *Abies grandis*
104: *Abies nordmanniana*
105: *Abies pinsapo*
106: *Abies procera*
107: *Cedrus atlantica*
108: *Cedrus deodara*
109: *Cupressus lusitanica*
110: *Cupressus sempervirens*
111: *Juniperus communis*
112: *Juniperus oxycedrus* *
113: *Juniperus phoenicea*
114: *Juniperus sabina*
115: *Juniperus thurifera* *
116: *Larix decidua* *
117: *Larix kaempferi (L. leptolepis)*
118: *Picea abies (P. excelsa)* *
119: *Picea omorika*
120: *Picea sitchensis* *
121: *Pinus brutia* *
122: *Pinus canariensis*
123: *Pinus cembra*
124: *Pinus contorta* *
125: *Pinus halepensis* *
126: *Pinus heldreichii*
127: *Pinus leucodermis*
128: *Pinus mugo (P. montana)*
129: *Pinus nigra* *
130: *Pinus pinaster* *
131: *Pinus pinea* *
132: *Pinus radiata (P. insignis)* *
133: *Pinus strobus*
134: *Pinus sylvestris* *
135: *Pinus uncinata* *
136: *Pseudotsuga menziesii* *
137: *Taxus baccata*
138: *Thuya sp.*
139: *Tsuga sp.*
199: *Other conifers*

(16) *Defoliation*

Defoliation figure for each sample tree expressed as a percentage (in steps of 5 %) compared with a tree with complete foliage. The actual percentage is used.

0 = 0 %
5 = 1– 5 %
10 = 6–10 %
15 = 11–15 %
etc.

(17) *Discolouration codes*

0: no discolouration (0–10 %)
1: slight discolouration (11–25 %)
2: moderate discolouration (26–60 %)
3: severe discolouration (>60 %)
4: dead

(18) *Easily identifiable causes of damage*

Add a mark (1) in the corresponding column(s).

T1 = game and grazing
T2 = presence or traces of an excessive number of insects
T3 = fungi
T4 = abiotic agents (wind, snow, frost, drought, . . .)
T5 = direct action of man
T6 = fire
T7 = known local/regional pollutant
T8 = other

(19) *Identification of damage type*

Where possible, further identification of the damage type should be added, e.g. for insects: the species or group (e.g. 'bark beetles').

(20) *Other observations on tree level*

Any additional observations which may be of interest shall be clearly noted on the form, (e.g. possible influencing factors (recent drought, temperature extremes); other damage/stress symtoms).

Information with regard to the soil inventory

(21) *Code for depth level*

O = Organic layer (see footnote in paragraph II.4 for definition)
H = Organic layer (see footnote in paragraph II.4 for definition)
M05 = Mineral soil between 0 and 5 cm (optional)
M51 = Mineral soil between 5 and 10 cm (optional)
M01 = Mineral soil between 0 and 10 cm (mandatory)
M12 = Mineral soil between 10 and 20 cm (mandatory)
M24 = Mineral soil between 20 and 40 cm (mandatory)
M48 = Mineral soil between 40 and 80 cm (mandatory)

(22) *Code of sampling analysis method (SAM)*

For each parameter that has been determined in one or more soil samples, one of the following codes is included in the first dataline, and used to indicate the sample type under sample code:

0 = no deviation from approved method
1 = parameters have been determined through an alternative method (details to be included in an annex to the soil condition report), or first (sub)sample
2–8 = codes to be used for any subsequent subsamples
9 = parameters have been determined through recomputation of data determined through a different method (details to be included in the annex to the soil condition report)

Information with regard to foliar analysis

(23) *Sample code*

The sample code for the foliage inventory consists of the tree species code (see explanation item 15) followed by the code for leaves/needles of the current year (=0) or of the current + 1 leaves/needles (1). e.g. the sample of the needles of last year (1) of the *Picea abies* (118) is thus: 118.1

(24) *Tree numbers of the sample*

As in some samplings (foliage, increment) trees outside the normal plot (or sub-plot) have to be used, special numbers have to be applied. The numbers of these trees will start with a letter (F = foliage, R = ring analysis by increment borings, D = discs analysis) followed with a sequence number (e.g. F001). The numbers are to be reported.

(25) *Mass of 100 leaves or 1 000 needles*

The mass is determined of 100 leaves or 1 000 needles (oven-dry) in grams.

(26) *Shoot mass*

The mass of the shoot is determined (oven-dry) in grams.

Information with regard to the estimation of growth and yield

(27) *Diameter at breast height (DBH)*

The diameter at breast height (1,30 m) over bark in 0,1 centimetres.
When a diameter tape is used a single value will be needed. When calipers are used the maximum and the minimum diameter (over bark) shall be determined and reported (diameter 1 and diameter 2).

(28) *Bark*

The thickness of the bark at 1,30 m, expressed in centimetres with one decimal.

(29) *Height of the tree*

The height of the tree expressed in metres and rounded off to the nearest 0,5 metres.

(30) *Tree volume*

Based on the measured diameter(s) and height, the tree volume can be estimated using locally known form factors or through the use of valid volume tables. The tree volume shall be expressed in cubic metres (m^3) with three decimals.

(31) *Crown length*

The length of the crown rounded off to the nearest 0,5 metres is determined from the tip of the stem to the lowest live branch excluding water shoots.

(32) *Crown width*

The average crown width is determined by the average of at least four crown radii, multiplied by two, and rounded off to the nearest 0,5 metres.

(33) *Diameter under bark*

The actual diameter under bark is calculated as the diameter over bark deducted with the width of the bark at the two sides. The diameter under bark of five years ago is calculated as the actual diameter under bark less the increment of the last five years of the tree at both sides. The diameter under bark is expressed in 0,1 centimeters.

(34) *Basal area per plot*

The actual basal area per plot is calculated as the total basal areas of all the trees in the plot. The basal area per plot of five years ago is calculated on the basis of the estimated diameter under bark of five years ago of all the trees in the plot. Basal area per plot is expressed in 0,1 m^2.

(35) *Volume per plot*

The actual volume per plot is calculated as the total volume of all the trees in the plot. The volume per plot of five years ago is calculated on the basis of the estimated diameter under bark of five years ago of all the trees in the plot. Volume per plot is expressed in 0,1 m^3.

(36) *Thinnings*

If a thinning has taken place in the five-year period between the two years of determination of diameter, basal area per plot and volume per plot, this will be indicated (Yes = 1, No = 0). In an additional part the details of this thinning will be described as detailed as possible (including: thinning method, exact year of thinning, thinning intensity expressed as number of trees, basal area/ha, volume/ha).

(99) *Other observations*

Relevant information shall be stated here and explained in the corresponding evaluation report

Information with regard to the deposition mornitoring

(37) *Sampler code*
The following codes shall be used for the samplers for deposition.

1 :	throughfall	5 :	fog
2 :	bulk deposition	6 :	frozen fog (rime)
3 :	wet-only deposition	7 :	air concentration
4 :	stemflow	9 :	others

Details on the equipment used shall be stated in an Annex to the document with the background information.

(37a) *Sample quantity*

The total collected quantity of the sample(s) shall be divided by the catchment area of the collector(s) and shall be reported in mm.

(38) *First and final dates of the monitoring period*

The first and final dates of each monitoring period shall be stated on the forms, using the same format as the date of observation, assessment and analysis (see item 3).
A monitoring period shall consist of one or more measuring periods. The measuring periods within one monitoring period should have the same length. The minimum length of a measuring period is one week, the maximum one month.
When it is necessary to use different measuring periods during the year (e.g. weekly in summer and monthly in winter), two separate monitoring periods shall be identified and the results shall be reported separately on the forms.

(39) *Number of measuring periods*

The number of measuring periods in each monitoring period shall be indicated in the forms.

(40) *Period*

The measuring period number in which the sample has been collected shall be stated. Each year (on or around 1 January) a new set of measuring periods will be started. When samples from several measuring periods are combined before analysis, the exact details of the mixing shall be stated in the Annex to the document with background information. The number of the first measuring period shall be used to indicate the period for analysis (e.g. when the samples from period 9, 10, 11 and 12 are combined into a single sample for the analysis, this sample will be given the period number 9).

7.3 Code list from the ICP on Integrated Monitoring

PARNCC	LIST	NAME
ACI_	DA	ACIDITY
ACI_E	DA	ACIDITY EXCHANGEABLE
ACI_N	DA	ACIDITY NONFILTERED
ACI_S	DA	ACIDITY BY STRONG ACIDS
ALK_	DA	ALKALINITY HCO3
ALK_N	DA	ALKALINITY HCO3 NONFILTERED
AL_	DA	ALUMINIUM
AL_A	DA	ALUMINIUM DIGESTIBLE
AL_D	DA	ALUMINIUM DISSOLVED
AL_E	DA	ALUMINIUM EXTRACTABLE
AL_L	DA	ALUMINIUM LABILE
AL_N	DA	ALUMINIUM NONFILTERED
AL_T	DA	ALUMINIUM TOTAL
AS_	DA	ARSENIC
AS_A	DA	ARSENIC DIGESTIBLE
AS_D	DA	ARSENIC DISSOLVED
AS_I	DX	ARSENIC DISINTEGRATED
AS_N	DA	ARSENIC NONFILTERED
AS_T	DA	ARSENIC TOTAL
BASA_	DA	BASE SATURATION
BASA_C	DA	BASE SATURATION CALCULATED
B_	DA	BORON
B_A	DX	BORON DIGESTIBLE
B_N	DA	BORON NONFILTERED
CA_	DA	CALCIUM
CA_A	DA	CALCIUM DIGESTIBLE
CA_C	DA	CALCIUM CENTRIFUGED
CA_D	DA	CALCIUM DISSOLVED
CA_E	DA	CALCIUM EXTRACTABLE
CA_N	DA	CALCIUM NONFILTERED
CA_R	DA	CALCIUM RESPIRABLE SUSPENDED
CD_	DA	CADMIUM
CD_A	DA	CADMIUM DIGESTIBLE
CD_D	DA	CADMIUM DISSOLVED
CD_E	DA	CADMIUM EXTRACTABLE
CD_N	DA	CADMIUM NONFILTERED
CD_R	DA	CADMIUM RESPIRABLE SUSPENDED
CD_T	DA	CADMIUM TOTAL
CL_	DA	CHLORIDE
CL_A	DA	CHLORIDE DIGESTIBLE
CL_D	DA	CHLORIDE DISSOLVED
CL_F	DA	CHLORIDE FILTERED
CL_N	DA	CHLORIDE NONFILTERED
CL-R	DA	CHLORIDE RESPIRABLE SUSPENDED
CNR_	DA	COLOUR NUMBER
CNR_C	DA	COLOUR NUMBER CENTRIFUGED
CNR_F	DA	COLOUR NUMBER FILTERED
CNR_N	DA	COLOUR NUMBER NONFILTERED
CO2R_	DA	CARBON DIOXIDE RESPIRATION

PARNCC	LIST	NAME
CO2R_N	DA	CARBON DIOXIDE RESPIRATION NONABSORBED
CO2_	DX	CARBON DIOXIDE
CO2_N	DX	CARBON DIOXIDE NONFILTERED
COR_	DA	CARBON ORGANIC
COR_D	DA	CARBON ORGANIC DISSOLVED
COR_F	DA	CARBON ORGANIC FILTERED
COR_N	DA	CARBON ORGANIC NONFILTERED
COR_T	DA	CARBON ORGANIC TOTAL
CP_	DA	CHLOROPHYLL A
CP_A	DA	CHLOROPHYLL A ACETONE EXTRACTABLE
CP_I	DA	CHLOROPHYLL A IN VIVO
CP_M	DA	CHLOROPHYLL A METHANOL EXTRACTABLE
CR_	DA	CHROMIUM
CR_A	DA	CHROMIUM DIGESTIBLE
CR_D	DA	CHROMIUM DISSOLVED
CR_I	DX	CHROMIUM DISINTEGRATED
CR_N	DA	CHROMIUM NONFILTERED
CR_T	DA	CHROMIUM TOTAL
CTY_	DA	SPECIFIC CONDUCTIVITY
CTY_20	DA	SPECIFIC CONDUCTIVITY AT 20 C
CTY_25	DA	SPECIFIC CONDUCTIVITY AT 25 C
CU_	DA	COPPER
CU_A	DA	COPPER DIGESTIBLE
CU_D	DA	COPPER DISSOLVED
CU_E	DA	COPPER EXTRACTABLE
CU_I	DX	COPPER DISINTEGRATED
CU_N	DA	COPPER NONFILTERED
CU_T	DA	COPPER TOTAL
FE_	DA	IRON
FE_A	DA	IRON DIGESTIBLE
FE_D	DA	IRON DISSOLVED
FE_E	DA	IRON EXTRACTABLE
FE_N	DA	IRON NONFILTERED
FE_T	DA	IRON TOTAL
HG_	DA	MERCURY
HG_A	DA	MERCURY DIGESTIBLE
HG_D	DA	MERCURY DISSOLVED
HG_N	DA	MERCURY NONFILTERED
HG_S	DA	MERCURY ON SORBENT
HG_T	DA	MERCURY TOTAL
HH_R	DA	HUMIDITY RELATIVE
K_	DA	POTASSIUM
K_A	DA	POTASSIUM DIGESTIBLE
K_C	DA	POTASSIUM CENTRIFUGED
K_D	DA	POTASSIUM DISSOLVED
K_E	DA	POTASSIUM EXTRACTABLE
K_N	DA	POTASSIUM NONFILTERED
K_R	DA	POTASSIUM RESPIRABLE SUSPENDED
MG_	DA	MAGNESIUM
MG_A	DA	MAGNESIUM DIGESTIBLE

PARNCC	LIST	NAME
MG_C	DA	MAGNESIUM CENTRIFUGED
MG_D	DA	MAGNESIUM DISSOLVED
MG_E	DA	MAGNESIUM EXTRACTABLE
MG_N	DA	MAGNESIUM NONFILTERED
MG_R	DA	MAGNESIUM RESPIRABLE SUSPENDED
MN_	DA	MANGANESE
MN_A	DA	MANGANESE DIGESTIBLE
MN_D	DA	MANGANESE DISSOLVED
MN_E	DA	MANGANESE EXTRACTABLE
MN_I	DX	MANGANESE DISINTEGRATED
MN_N	DA	MANGANESE NONFILTERED
MN_T	DA	MANGANESE TOTAL
MO_	DA	MOLYBDENIUM
MO_A	DA	MOLYBDENIUM DIGESTIBLE
NA_	DA	SODIUM
NA_A	DA	SODIUM DIGESTIBLE
NA_C	DA	SODIUM CENTRIFUGED
NA_D	DA	SODIUM DISSOLVED
NA_E	DA	SODIUM EXTRACTABLE
NA_N	DA	SODIUM NONFILTERED
NA_R	DA	SODIUM RESPIRABLE SUSPENDED
NH4N_	DA	NITROGEN AMMONIUM
NH4N_D	DA	NITROGEN AMMONIUM DISSOLVED
NH4N_F	DA	NITROGEN AMMONIUM FILTERED
NH4N_N	DA	NITROGEN AMMONIUM NONFILTERED
NH4N_R	DA	NITROGEN AMMONIUM RESPIRABLE SUSPENDED
NI_	DA	NICKEL
NI_A	DA	NICKEL DIGESTIBLE
NI_D	DA	NICKEL DISSOLVED
NI_E	DA	NICKEL EXTRACTABLE
NI_I	DX	NICKEL DISINTEGRATED
NI_N	DA	NICKEL NONFILTERED
NI_T	DA	NICKEL TOTAL
NO3N_	DA	NITROGEN NITRATE
NO3N_D	DA	NITROGEN NITRATE DISSOLVED
NO3N_F	DA	NITROGEN NITRATE FILTERED
NO3N_N	DA	NITROGEN NITRATE NONFILTERED
NO3N_R	DA	NITROGEN NITRATE RESPIRABLE SUSPENDED
NTOT_	DA	NITROGEN TOTAL
NTOT_D	DA	NITROGEN TOTAL DISSOLVED
NTOT_F	DA	NITROGEN TOTAL FILTERED
NTOT_L	DA	NITROGEN TOTAL DESTILLABLE
NTOT_N	DA	NITROGEN TOTAL NONFILTERED
NTOT_R	DA	NITROGEN TOTAL RESPIRABLE SUSPENDED
O2_	DA	OXYGEN
O2_D	DA	OXYGEN DISSOLVED
O2_S	DA	OXYGEN SATURATION
O3_	DA	OZONE
O3_N	DA	OZONE NONABSORBED
PB_	DA	LEAD

PARINCC	LIST	NAME
PB_A	DA	LEAD DIGESTIBLE
PB_D	DA	LEAD DISSOLVED
PB_E	DA	LEAD EXTRACTABLE
PB_I	DX	LEAD DISINTEGRATED
PB_N	DA	LEAD NONFILTERED
PB_R	DA	LEAD RESPIRABLE SUSPENDED
PB_T	DA	LEAD TOTAL
PH_	DA	PH
PH_E	DA	PH EXTRACTABLE
PH_L	DA	PH OF LIQUIDS
PNP_	DA	PHOSPHATASE ACTIVITY
PNP_F	DA	PHOSPHATASE ACTIVITY FILTERED
PO4P_	DA	PHOSPHOROUS PHOSPHATE
PO4P_C	DA	PHOSPHOROUS PHOSPHATE CENTRIFUGED
PO4P_D	DA	PHOSPHOROUS PHOSPHATE DISSOLVED
PO4P_E	DA	PHOSPHOROUS PHOSPHATE EXTRACTABLE
PO4P_F	DA	PHOSPHOROUS PHOSPHATE FILTERED
PO4P_N	DA	PHOSPHOROUS PHOSPHATE NONFILTERED
PTOT_	DA	PHOSPHOROUS TOTAL
PTOT_A	DX	PHOSPHOROUS TOTAL DIGESTIBLE
PTOT_D	DA	PHOSPHOROUS TOTAL DISSOLVED
PTOT_E	DA	PHOSPHOROUS TOTAL EXTRACTABLE
PTOT_F	DA	PHOSPHOROUS TOTAL FILTERED
PTOT_I	DX	PHOSPHOROUS TOTAL DISINTEGRATED
PTOT_N	DA	PHOSPHOROUS TOTAL NONFILTERED
PTOT_R	DA	PHOSPHOROUS TOTAL RESPIRABLE SUSPENDED
PTOT_T	DA	PHOSPHOROUS TOTAL TOTAL
Q_	DA	FLOW
Q_D	DA	FLOW DIRECT
Q_I	DA	FLOW INDIRECT
RE_	DA	RESIDUE
RE_F	DA	RESIDUE FIXED SUSPENDED
RE_G	DA	RESIDUE FIXED TOTAL
RE_S	DA	RESIDUE SUSPENDED
RE_T	DA	RESIDUE TOTAL (DRY WEIGHT)
RE_V	DA	RESIDUE VOLATILE SUSPENDED
RE_Y	DA	RESIDUE VOLATILE TOTAL
RR_	DA	PRECIPITATION
RR_P	DA	PRECIPITATION PARTIAL
RR_T	DA	PRECIPITATION TOTAL
SIO2_	DA	SILICA
SIO2_D	DA	SILICA DISSOLVED
SIO2_N	DA	SILICA NONFILTERED
SO2S_	DA	SULPHUR SULPHUR DIOXIDE
SO2S_A	DA	SULPHUR SULPHUR DIOXIDE ABSORBED
SO2S_F	DA	SULPHUR SULPHUR DIOXIDE FILTERED
SO2S_N	DX	SULPHUR SULPHUR DIOXIDE NONABSORBED
SO4S_	DA	SULPHUR SULPHATE
SO4S_A	DA	SULPHUR SULPHATE DIGESTIBLE
SO4S_D	DA	SULPHUR SULPHATE DISSOLVED
SO4S_F	DA	SULPHUR SULPHATE FILTERED

PARNCC	LIST	NAME
SO4S_N	DA	SULPHUR SULPHATE NONFILTERED
SO4S_R	DA	SULPHUR SULPHATE RESPIRABLE SUSPENDED
SOL_U	DA	INSOLATION UV-RADIATION
STOT_A	DA	SULPHUR TOTAL DIGESTIBLE
T_	DA	TEMPERATURE
T_A	DA	TEMPERATURE OF AIR
T_W	DA	TEMPERATURE OF WATER
WC_	DA	WATER CONTENT
WC_T	DA	WATER CONTENT TOTAL
WL_	DA	WATER LEVEL
WL_F	DA	WATER LEVEL FREE
WL_P	DA	WATER LEVEL UNDER PRESSURE
ZN_	DA	ZINC
ZN_A	DA	ZINC DIGESTIBLE
ZN_D	DA	ZINC DISSOLVED
ZN_E	DA	ZINC EXTRACTABLE
ZN_I	DX	ZINC DISINTEGRATED
ZN_N	DA	ZINC NONFILTERED
ZN_T	DA	ZINC TOTAL