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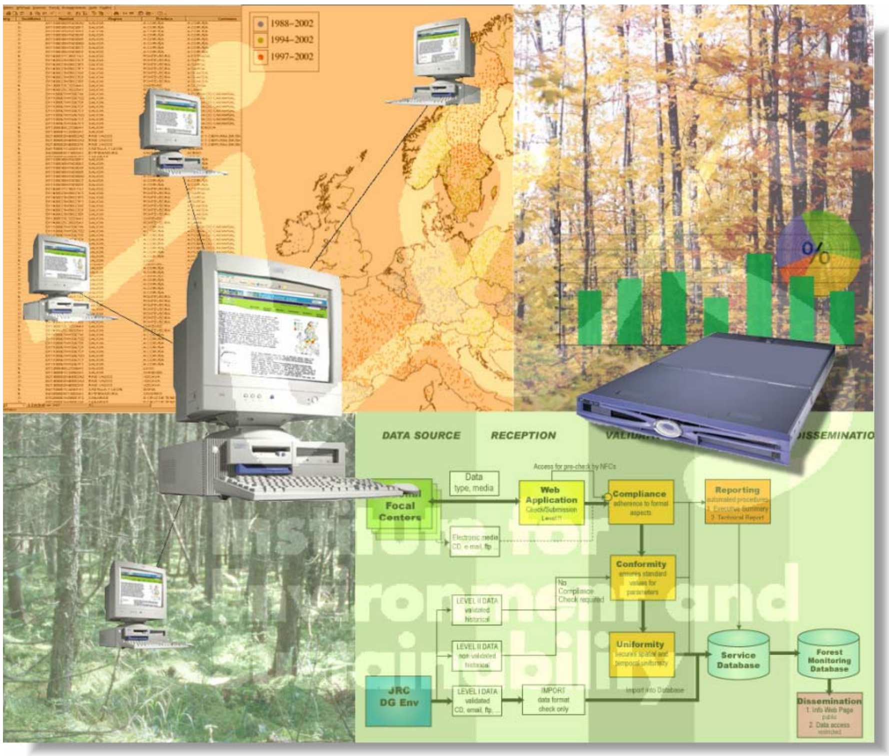
Forest Focus Monitoring Database System

TECHNICAL REPORT 2001 LEVEL II DATA

Hiederer. R. T. Durrant, O. Granke, M. Lambotte, M. Lorenz. B. Mignon



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List of Survey Codes

Code	Survey Name
AQ	Air Quality
CC	Crown Condition
DP	Deposition
FO	Foliar Chemistry
GR	Growth and Yield
GV	Ground Vegetation
LF	Litterfall
MM	Meteorology
OZ	Ozone Injury
PH	Phenology
SI	System Instalment
SO	Soil Condition
SS	Soil Solution

List of Acronyms and Abbreviations

CODE	DESCRIPTION
ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
BFH	Federal Research Centre for Forestry and Forest Products Bundesanstalt für Forst- und Holzwirtschaft
CD-ROM	Compact Disk - Read Only Memory
CLRTAP	Convention of the Long-Range Trans-boundary Air Pollution
CSV	Comma-separated value
DAR-Q	Data-accompanying Report Questionnaires
DG AGRI	Agriculture Directorate General
DG ENV	Environment Directorate General
DVD	Digital Video Disk
EC	European Commission
EU	European Union
FFMDb	Forest Focus Monitoring Database
FFCC	Forest Foliar Co-ordinating Centre
FIMCI	Forest Intensive Monitoring Coordinating Institute
FSCC	Forest Soil Co-ordinating Centre
ftp	file transfer protocol
HTML	HyperText Mark-up Language
ICP Forests	International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests
IES	Institute for Environment and Sustainability
JRC	Directorate General Joint Research Centre
kbs	Kilo bits per second
LM&NH	Land Management & Natural Hazards Unit
MS	EU Member State
NFC	National Focal Centre
NSI	Nouvelles Solutions Informatiques s.a.
PCC	Programme Coordinating Centre
PDF	Portable Document Format
SQL	Structured Query Language
XML	Extended Mark-up Language

1 BACKGROUND

Forest Focus (Regulation (EC) No 2152/2003[1]) is a Community scheme for harmonised, broad-based, comprehensive and long-term monitoring of European forest ecosystems. Under this scheme the monitoring of air pollution effects on forests is carried out by participating countries on the basis of the systematic network of observation points (Level I) and of the network of observation plots for intensive and continuous monitoring (Level II).

The Forest Focus monitoring activity continues from the network and plots established and implemented under previous schemes. From 1986 until the end of 2002 data were reported under the Council Regulation (EEC) No 3528/86[2]. The Regulation was later modified by Regulation (EC) No 804/2002, which amended Council Regulation (EEC) No 3528/86[3]. In 1991 a common monitoring system was agreed upon between the EU scheme and the *International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests* (ICP Forests) under the *Convention of the Long-Range Trans-boundary Air Pollution* (CLRTAP).

Monitoring on Level II plots started in 1994. National Focal Centres (NFCs) compile and submit the data sampled on an annual basis. Until the monitoring year 2002 Level II data was processed and stored by the *Forest Intensive Monitoring Coordinating Institute* (FIMCI) under contract of DG AGRI. Following paragraph 15 of Forest Focus DG JRC is in charge of processing the monitoring data and has implemented for this purpose a Forest Focus Monitoring Database System (FFMDb). The system was developed and realized under contract by a Consortium, coordinated by I-MAGE Consult with Nouvelles Solutions Informatiques s.a. (NSI) as consortium partner and the Bundesforschungsanstalt für Forst- und Holzwirtschaft (BFH) as sub-contractor.

Forest Focus stipulates that data from all Level I and Level II surveys be integrated in a single system. Accordingly, the new system also includes data collected under the previous schemes, which for Level II surveys are referred to as *legacy data*. This report details the situation of the Level II legacy data for 2001 with respect to the validation process applied to data collected under Forest Focus. The main aim of processing the data is to identify any consequences of the legacy data on the results of validating data from subsequent years.

[1] OJ L 324, 11.12.2003, p. 1-8
[2] OJ L 326, 21.11.1986, p.2-4
[3] OJ L 132, 17.05.2002, p.1-2

2 General Information on Legacy Data

An overview over the generic flow of data in the operational system and the various stages of data processing of Forest Focus and the legacy data are presented in form of a schematized standard data flow in Figure 1.

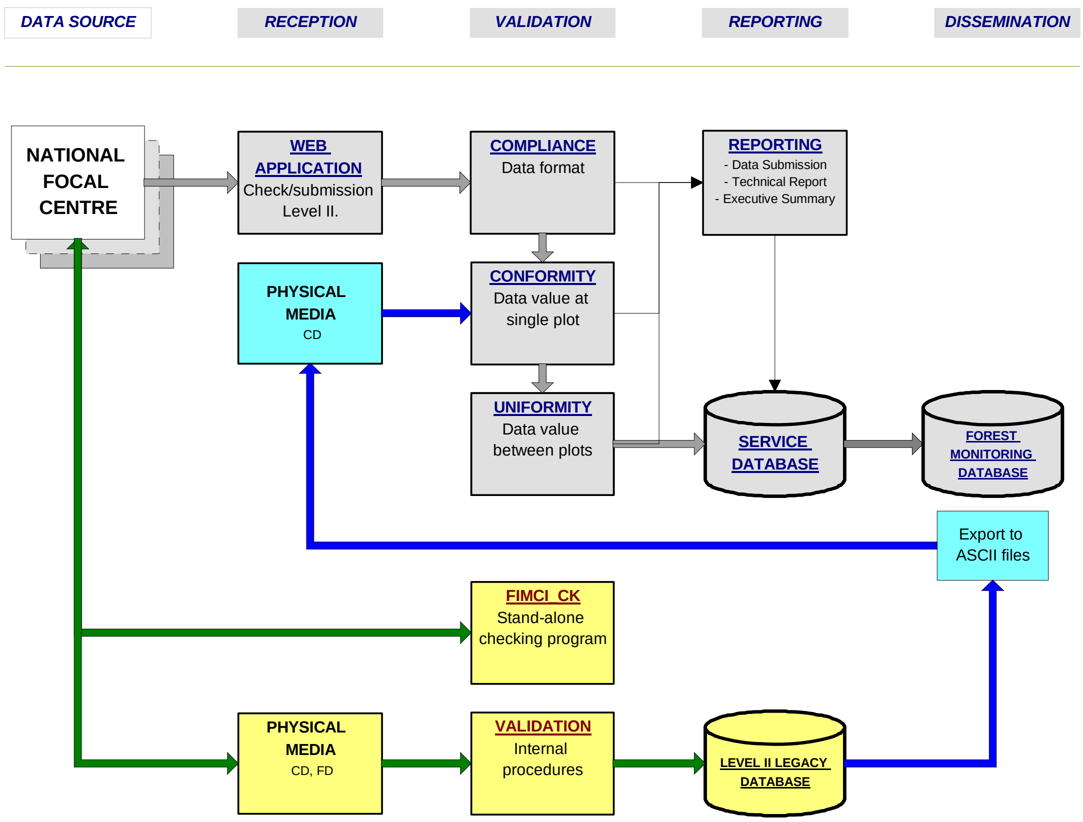

Figure 1: Schematized Standard Data Flow

The graph shows that the integration of Level II legacy data into the FFMDb followed a very different path from data collected under Forest Focus for subsequent years.

Under Forest Focus all Level II data pass through the Web-based Data Submission Module. The module provides on-line tests for data compliance. Only data submitted through the module enter the subsequent processing stages. In contrast, under the previous scheme the data could be verified by NFCs using an independent checking program (FIMCI_CK). The program went through several stages of improvement and the latest version issues to NFCs was V. 5.2. The use of the program was under the responsibility of the NFCs. Data were then sent by NFCs to FIMCI on physical media, generally on 3.5” floppy disk and later also by electronic mail. Data received by FIMCI were subjected to a series of validation procedures and up-loaded into the legacy database.

2.1.1 Data Sources

Under the previous schemes data were collected at the systematic (Level I) and intensive (Level II) monitoring plots by EU Member States and countries participating in the common monitoring scheme through bodies designated by the responsible national institutions. The data gathered were forwarded by the designated authorities and agencies (NFCs) to the institution identified to receive and process the data. This procedure has not been modified significantly under Forest Focus.

However, the data received from DG AGRI and FIMCI only covered the information stored in the legacy database. The legacy data stored in the FFMDb originates from a delivery made by FIMCI to DG AGRI from August, 2003. The data were stored on CD and in ASCII text format. The files provided contained the data as processed by FIMCI. Not provided were any original data as sent by the NFCs to either FIMCI or DG AGRI. The sources of the data integrated into the FFMDb are therefore not the NFC, but data exported from the legacy database.

2.1.2 Data Validation

Under Forest Focus data are validated based on the principle that it is not possible to identify the correctness of a value, but rather that it may be possible to identify the probability that a value represent valid measurements. This probability is expressed by grading data using a sequential procedure, which assesses various characteristics and applies increasingly involved checks. When the grading is such that an error situation is generated data cannot be further processed. NFCs are informed about the status of their data when submitting surveys by an instantly generated Compliance Check report. Once processed for conformity NFCs are informed by DG JRC about the status through electronic mail. Corrected data can also be re-submitted by NFCs during fixed periods.

For all legacy data it is assumed that the surveys are fully validated according to the procedures applied at the time. The data are therefore not validated, but analysed with respect to the validation procedures applied under Forest Focus. Because original data are not available the check of formats of data submitted by NFCs in the ASCII files is not applicable. The lack of the original files also prevents a comparison between data submitted by NFCs and data stored in the database. The initial check of the data based on a stand-alone program also allows data to be submitted, which were not passed through the program.

Under the validation procedure of Forest Focus the first group of checks are applied at the time of data submission. The check concerns the compliance of the data with the format specifications stipulated in the Technical Specifications of DG JRC. Such checks cannot be applied to the legacy data, because only data from the validated database are available.

Legacy data from 2001 were therefore processed using the tests for Conformity and Uniformity. However, in case of an error the situation was treated differently from normal routine. Because it had to be assumed that all data were previously validated and found correct the tests could only trigger a warning and thus allow the data to be passed on to the next stage of processing.

2.1.3 Dissemination

Legacy data are distributed as any other Forest Focus data using the Data Dissemination Module of the system. Compared to data collected under Forest Focus the number of surveys and NFCs is reduced. Some surveys were only introduced after the period covered by the legacy data, such as the Ozone Injury survey. Other NFCS of Forest Focus only started submitting data with the 2002 monitoring year or later.

2.2 Reporting

For data collected under Forest Focus a *Technical Report* should be compiled for each monitoring year. The main objective of those Technical Reports is to provide a description of the results obtained during the validation process. For the *2001 Technical Report* the main area of interest is, however, the effect of the legacy data on the results of the validation process of data collected under Forest Focus.

This report presents the changes between the legacy data of 2001 and data form subsequent years processed under Forest Focus mainly for static parameters. In addition it includes analyses of spatial variability and temporal trends of parameters. Maps, graphs and tables are included in the report and serve as support for this analysis. Comments on the data status for each NFC with respect to the parameter assessed are provided in the Annex.

3 DATA PROCESSING OF 2001 LEVEL II LEGACY DATA

The data processing stages described hereunder present the procedure adapted from the Forest Focus validation process to analyse legacy data from 2001. Legacy data have already been validated. Thus, consultations with NFCs at the various stages of the previous validation process have already taken place. It has to be assumed that following those consultations any data stored in the legacy database have been confirmed by the NFCs. As a consequence, this *2001 Technical Report* is limited to the application of Forest Focus tests under the Conformity and Uniformity validation checks.

3.1 Surveys Monitored

In a first step after importing the legacy data into the FFMDb the number surveys and forms for 2001 were compared to those submitted by NFCs under Forest Focus.

3.1.1 Surveys for 2001 Monitoring Year

An overview of the number of NFCs and surveys with data include in the export files from 2001 legacy data is given in Figure 2.

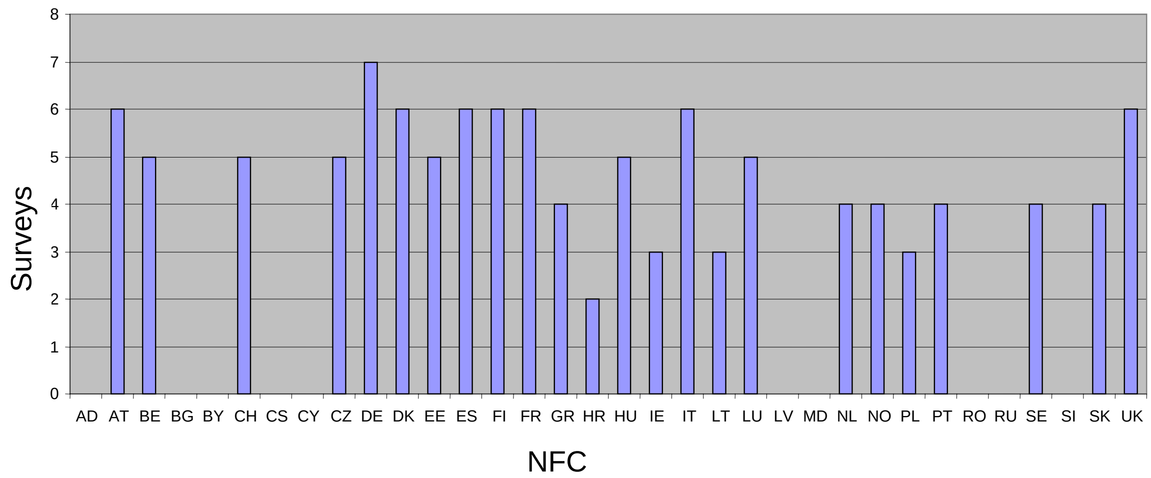

Figure 2: Number of Surveys in 2001 Level II Data

As indicated in the graph data from 24 NFCs are included in the files received. More detailed information on the data found in the legacy database for 2001, which also shows data for individual surveys, is given in Table 1.

Table 1: Surveys Exported from Legacy Database for the Year 2001

2001	SI	CC	SO	SS	FO	GR	DP	MM	GV	AQ	TOTAL
Austria		X		X	X		X	X	X		6
Belgium		X		X	X		X	X			5
Bulgaria											
Croatia		X			X						2
Cyprus											
Czech Republic		X		X	X		X	X			5
Denmark		X		X	X		X	X		X	6
Estonia		X		X	X		X		X		5
Finland		X		X	X		X	X	X		6
France		X		X	X	X	X			X	6
Germany		X		X	X	X	X	X	X		7
Greece		X			X		X	X			4
Hungary		X			X		X	X	X		5
Ireland		X			X	X					3
Italy		X		X	X		X	X	X		6
Latvia											
Lithuania		X		X			X				3
Luxembourg		X			X		X	X		X	5
Netherlands		X		X	X		X				4
Norway		X		X	X		X				4
Poland		X			X		X				3
Portugal		X			X		X		X		4
Romania											
Slovenia											
Slovak Republic		X			X	X	X				4
Spain		X		X	X		X	X		X	6
Sweden		X		X			X	X			4
Switzerland		X		X	X		X	X			5
United Kingdom		X		X	X		X	X	X		6
TOTAL		24		16	22	4	22	14	8	4	114

The total number of survey for year 2001 is 114. The number of survey varies according to the NFC: it ranges from 2 surveys for Hungary to 7 surveys for Germany. Data for the mandatory Crown Condition survey, which is assessed on an annual basis, have been submitted by all 24 NFCs. No data were included for Soil Condition, which is sampled every 10 years. The surveys for Phenology, Ozone Injury and Litter Fall were added to the list of surveys only after 2001 and thus no data are available. In addition, no data could be specified for System Instalment forms. The corresponding files would only have been available in original formats from NFCs.

3.1.2 Data Submission for 2002, 2003, 2004 and 2005

For data submitted under Forest Focus the total number of survey submitted by NFCs between December 2005 and April 2007 (year 2002 up to 2005) is 647[4]. Figures for surveys submitted by reporting year of Forest Focus are:

- 2002: 130
- 2003: 152
- 2004: 176
- 2005: 189

A graphical representation of the number of surveys tested by NFC and monitoring year is given in Figure 3.

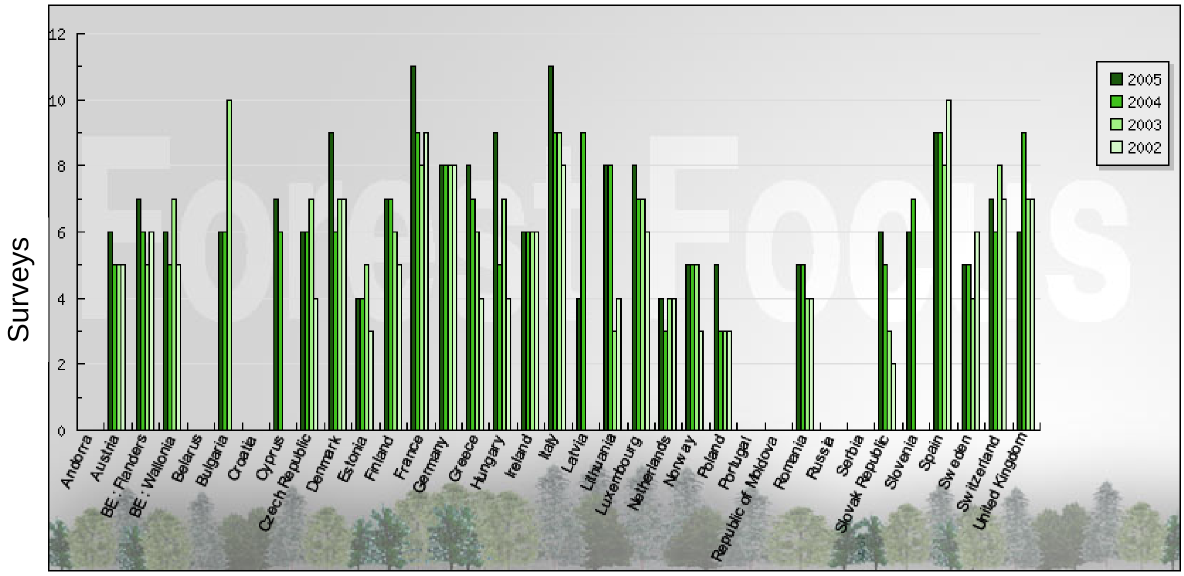

Figure 3: Number of Surveys Submitted by NFCs under Forest Focus (2002, 2003, 2004 and 2005)

Not included in the number of surveys counted is any additional information submitted in form of Data Accompanying Reports or free format text files.

3.2 Conformity Analysis

An overview on the number of tests performed on the data for Conformity and the respective number of tests generating a message (warning or error) is given in Table 2.

[4] Only 2005 Level II data was processed as an operational service.

Table 2: Summary Conformity Test for all Countries, year 2001

Country	Number of Tests for Conformity	Number of Tests with Messages
Austria	110	9
Belgium	153	25
Bulgaria		
Croatia	30	1
Cyprus		
Czech Republic	124	5
Denmark	101	7
Estonia	70	2
Finland	152	19
France	124	4
Germany	179	41
Greece	72	9
Hungary	103	13
Ireland	52	4
Italy	148	28
Latvia		
Lithuania	40	1
Luxembourg	118	7
Netherlands	75	2
Norway	55	0
Poland	68	3
Portugal	49	3
Romania		
Slovak Republic	78	5
Slovenia		
Spain	71	15
Sweden	76	8
Switzerland	102	14
United Kingdom	110	6
TOTAL	**2260**	**236**

In total 2260 tests were performed on the surveys. The surveys passed 90% of the tests, but 236 tests caused the system to highlight a situation with a message. Some errors or warnings were detected in one or more surveys from all NFCs. All results of the tests are stored in the FFMDb, which will allow an improved evaluation of the data quality for further use of the data.

3.2.1 Results of Range Tests

The range tests of the Conformity Check triggered numerous warnings, especially for data of the Meteorological survey. Over 80% (18555 from a total of 23083) of all messages generated in the tests were due to values out range for the various parameters of the survey. One reason for this situation is the comparatively large amount of data of the meteorological survey (573579 observations in 2001) and, therefore, a higher probability of identifying outliers. Additionally, the ranges were derived by the legacy data (95% confidence interval) afterwards also tested on the legacy data so that approximately 5% of all data from the meteorological measurements should trigger messages at least for those parameters where the range tests were derived from the legacy data (Annex I). In fact 3.2% of all observations stored in the Meteorology survey triggered a warning message.

The ranges used in the tests are set globally and are not specific by region. This means that countries with an intermediate climate tend to receive fewer warnings with the risk in these cases that some outliers may be overlooked. However, the range values cannot be set too large or values reported in different units, (e.g. dm instead of cm for tree diameter) or parameter values submitted in the wrong column, would not be highlighted during the tests.

Besides the numerous warnings for values outside the ranges in the meteorological surveys the most common warnings and errors were caused by:

- changes in static parameters, e.g. plot coordinates, tree species;
- discontinuity of typical changes for variable parameters, e.g. growth;
- the use of value “0”.

Most of the detected errors in changes of static parameter were due to the occurrence of new trees on the plots, individual trees that changed species type over time, and changes in coordinates or altitudes. Reasons for these changes were that a plot or a tree was assessed for the first time, the location of a plot has changed, or the previous submitted value was incorrect or less accurately measured. The following paragraph gives an overview of the amount and type of messages generated while processing data for Conformity for each survey. No data are available in the files exported for 2001 for the System Instalment and surveys of Soil Condition, Phenology, Ozone Injury and Litterfall.

3.2.2 Crown Condition

For the Crown Condition survey data from 730 plots located in 24 NFC were received. Only single value parameter range checks for static parameters were performed on data of the survey. A summary of the results is presented in Table 3.

Table 3: Number of Messages Triggered by Conformity Check in Crown Condition Data

	Changed			New trees	Out of Range		Multi-param. range tests
	Latitude	Longi-tude	Altitude		Latitude	Longi-tude	
Number of messages	1	1	3	410	1	1	-
Number of NFC	1	1	2	14	1	1	-

For a relatively large number of plots it was found that that new trees were detected in the data for 2001 when compared to data from the previous monitoring year. In most cases this did not indicate erroneous data but could be explained by the substitution of dead trees by new trees or the instalment of new Level II plots. For new plots the condition will always generate a message, because no previous trees must exist.

3.2.3 Soil Solution

Data from 216 plots in 16 NFC were received for the Soil Solution survey. Table 5 provides a summary of the tests for static parameters.

Table 4: Number of Messages Triggered by Conformity Check in Soil Solution Data

	Changed			New trees	Out of Range		Multi-param. range tests
	Latitude	Longi-tude	Altitude		Latitude	Longi-tude	
Number of messages	-	116	50	NA	-	-	-
Number of NFC	-	16	1	NA	-	-	-

The comparatively high number of changes in plot coordinates and altitude are caused by data inconsistencies in only two plots, which have a high number of occurrences due to the number of measurements recorded.

Table 5 and Table 6 show the maximum and minimum values found for each parameter collected in the survey. Only for pH the values for single plots in France, Germany and Switzerland were out of the range but still possible. The NFC of France later confirmed the value reported as an actual measurement.

Table 5: Minimum and Maximum Value for Mandatory Parameters of Soil Solution Data

Variable	Min	Max
pH	3.02	8.99
K	0	61.2
Ca	0	173.8
Mg	0	175
N_NO_3	0	90.19
S_SO_4	0	417
Al	0	128
DOC	0	393.1
ALKALINITY	0	4640

Table 6 shows that only the maximum of zinc is much higher than the set limit (1000). In total, 42 out of 3021 non-null values (1.4%) exceed 1000, mostly from the same country (Germany and Finland). Also in later monitoring years high values for zinc were submitted for those plots, which make it likely that these values are actual measurement and found at the plots for which they are reported.

Table 6: Minimum and Maximum Value for Optional Parameters of Soil Solution Data

Variable	Min	Max
CONDUCTIVITY	2	1529
WATER CONTENTS		
Si	0	29.76
Na	0	72
Cl	0	162.4
N_NH_4	0	38.9019
P	0	2.6
AL_LABILE	0	57.4
Mn	0	9.62
Fe	0	21.9
Cu	0	909.7
Zn	0	3786
Pb	0	2295
Ni	0	833.4
Cr	0.1	33.3
Cd	0	30.5
ALKALINITY*	0.2	11906

* optional (if pH > 5)

The signification of 0 as the minimum value is uncertain. It can indicate various conditions, such as not measured, below the minimum of the detection limit of the instrument or too small to be reported in the dimension of the corresponding field.

3.2.4 Foliar

Data for the Foliar survey were received from 613 plots in 22 NFC. The results of the tests on static parameters are given in Table 7.

Table 7: Number of Messages Triggered by Conformity Check in the Foliar Data

	Changed			New trees	Out of Range		Multi-param. range tests
	Latitude	Longi-tude	Altitude		Latitude	Longi-tude	
Number of messages	46	47	8	172	1	1	-
Number of NFC	3	4	2	15	1	1	-

On plots of several NFCs new trees were detected in the data for 2001. In most cases this could be explained by the substitution of dead trees or the instalment of new Level II plots. Furthermore, also a different order in storing the tree number from the previous year is very likely a reason for highlighting the condition. Slight changes in the stored coordinates mainly in Spain resulted in errors in the temporal consistency checks for latitude and longitude values. A re-assessment of the coordinates with a GPS yielding more accurate co-ordinates explained those changes.

All the values for variable parameters are within the limits set by the checking routines for single parameter checks and no warnings were triggered by the process.

3.2.5 Growth

Data from 23 plots in 4 NFC were received for the Growth survey. Results of the tests for static parameters are given in Table 8.

Table 8: Number of Messages Triggered by Conformity Check in the Growth Data

	Changed			New trees	Out of Range		Multi-param. range tests
	Latitude	Longi-tude	Altitude		Latitude	Longi-tude	
Number of messages	-	-	-	1113	-	-	891
Number of NFC	-	-	-	3	-	-	3

Numerous plots for the survey contain new trees in the data for 2001. In most cases this could be explained by the substitution of dead trees or the instalment of new Level II plots or first measurements of increment data. Warnings concerning continuity of changes with an abnormal progression were mainly found with the aid of the multiple parameter tests, for instance "shrinking" trees, meaning the diameter or the height is smaller than in the previous measurement. However, an unusual time interval between two measurements, inconsistent measuring techniques, or stem breaks could also explain these warnings. Also measurements of tree height have *per se* a high variance, especially in dense stands.

All values for variable parameters are within the limits set by the checking routines for single parameter checks and no warnings were triggered by the process.

3.2.6 Deposition

For Deposition data from 482 plots in 22 NFC were received. As shown in Table 9, some plots were found with changes in the static parameters of the plot form.

Table 9: Number of Messages Triggered by Conformity Checks in Deposition Data

	Changed			**New trees**	**Out of Range**		**Multi-param. range tests**
	Latitude	**Longi-tude**	**Altitude**		**Latitude**	**Longi-tude**	
Number of messages	3	4	6	NA	1	1	-
Number of NFC	1	2	2	NA	1	1	-

All the static values tested for the survey are within the limits set by the checking routines for single parameter checks and no warnings were triggered by the process.

3.2.7 Meteorology

Meteorological observations are collected on a sub-set of Level II plots and data from 169 plots in 14 NFC were received. It is also the survey which contains by far the most data and the one which generates most messages. Of all 18555 single parameter range checks 18860 were detected in data of the Meteorology survey.

Table 10 provides a summary on the tests performed on static parameters in the survey.

Table 10: Number of Messages Triggered by Conformity Checks in the Meteorology Survey

	Changed			New trees	Out of Range		Multi-param. range tests
	Latitude	Longi-tude	Altitude		Latitude	Longi-tude	
Number of messages	10	18	59	NA	-	1	-
Number of NFC	1	2	2	NA	-	1	-

The relatively high number of changes in plot coordinates and altitude are due to just a few plots, which have a high number of observations made by different measuring instruments.

Table 11 and Table 12 show the maximum and minimum values found in the 2001 data for each parameter tested. The mandatory parameter Air Temperature triggered warnings both at daily minimum and maximum values as well as for the mean value. Most values are still within plausible ranges taking in consideration the geographical location and the altitude. But at least eight values are definitively wrong: On Plot No.12 in Finland are stored values between 72.8 and 149.8 °C for the minimum daily value of air temperature for the 27th July and 30th July, 2001. Supporting this assumption of those values comprising erroneous entries is the fact that the completeness of the measurements is given as zero.

The “0” values for Relative Humidity, Wind Direction and Wind Speed triggered also numerous messages in the range tests. It is not clear, if the value represents and actually measured value, which is unlikely at least for daily mean and maximum values or a code for a missing value. Maximum values for Solar Radiation, Precipitation, and Wind Speed are substantially outside the ranges and must be considered as very unlikely.

Table 11: Minimum and Maximum Value for the Mandatory Parameters in Meteorology Data

VARIABLE	Min of VALUE	Min of MINIMUM	Min of MAXIMUM	Max of VALUE	Max of MINIMUM	Max of MAXIMUM
Air temperature	-32.9	-39.3	-27.7	32.6	149.8	46.1
Precipitation	0			930		
Relative humidity	0	0	0	100	100	100
Solar radiation	0			667.3		
Wind direction	0			360		
Wind speed	0	0	0	14.825	6.6	41.5

Values outside the defined ranges were also found in the data of the optional parameters of the Meteorology survey (see Table 12). Yet, an incorrectness of the data cannot be verified for any of the situations found.

Table 12: Minimum and Maximum Value for the Optional Parameters in Meteorology Data

VARIABLE	Min of VALUE	Min of MINIMUM	Min of MAXIMUM	Max of VALUE	Max of MINIMUM	Max of MAXIMUM
Air pressure	969.8	591.2	991	1040	1039	1041
Metric potential in soil	-58.7825	-59.22	-58.19	878.9	874.7000122	886
Net radiation	-27	-83.5	15.1	209.1	-3.5	751
Snow depth	0			115.7		
Stem flow	0			10.7		
Soil temperature	-19.3	-29.4	-17.6	27.4	26	40.62
Through fall	0			104.6		
UV b radiation	0			1		
Water content in soil	0.3	1.8	2.1	100	100	100

In the optional parameters the Italian NFC has also stored numerous mandatory parameters which are responsible for a more than 2000 of the warning messages. These values belong to the measurements in the stand.

Unexpected is the dimension of some parameters in the legacy data, in particular for the metric potential in the soil. According to the definition of the field format data should have been recorded with just one decimal. Yet, the maximum value of the minimum for this parameter shows 7 digits. It should not have been possible to record such data in the files. The source of this inconsistency and any implications on the reliability of the data could not be determined.

3.2.8 Ground Vegetation

Data for the Ground Vegetation survey were received from 122 plots located in 8 NFCs. A summary on the checks of key static parameters is presented in Table 13. All the variables are within the limits set by the checking routines for single parameter checks and no warnings were triggered by the process.

Table 13: Number of Messages Triggered by Conformity Check in Ground Vegetation Data

	Changed			New trees	Out of Range		Multi-param. range tests
	Latitude	Longi-tude	Altitude		Latitude	Longi-tude	
Number of messages	8	18	8	NA	1	-	-
Number of NFC	1	2	1	NA	1	-	-

The comparatively high number of changes in plot coordinates and altitude were found for just two plots but occur for several different surveys.

3.2.9 Air Quality

Data from the Air Quality survey were received for 40 plots in just 4 NFCs. A summary of the tests on static parameters is given in Table 14.

Table 14: Number of Messages Triggered by Conformity Check in Air Quality Data

	Changed			New trees	Out of Range		Multi-param. range tests
	Latitude	Longi-tude	Altitude		Latitude	Longi-tude	
Number of messages	-	44	-	NA	-	18	-
Number of NFC	-	1	-	NA	-	2	-

Changes to plot coordinates (longitude) as well as coordinates (longitude) outside the boundaries of Spain occurred in the PPS form for the survey. This could be explained by the missing of the minus sign for the longitude value. According to the Spanish NFC, in 2001 the maximum number of characters for longitude defined for the storage of the parameter in the form was five. This dimension of the filed was not enough for submitting the also the minus.

All the values for variable parameters were found to be within the limits set by the checking routines for single parameter checks. Consequently, no messages were triggered by the process.

3.2.10 Conformity Status of 2001 Data

The data conformity status for the surveys of the 2001 monitoring year is summarized in Table 15. Most of the messages detected by the single parameter range checks were located in the Meteorology survey. The survey with the second-frequent messages is soul solution. The proportion of the number of messages for Soil Solution is low by comparison: not even 2% (305 of 18860) of the messages were triggered by values received in the Soil Solution data. It is remarkable that no unusual situations were found in the data of the Deposition survey by the single parameter range checks.

Table 15: Data Conformity Status 2001 by NFC and Survey

2001	SI	CC	SO	SS	FO	GR	DP	MM	GV	AQ
Austria		✓		✓	N		✓	N	✓	
Belgium		N		✓	N		✓	N		
Bulgaria										
Croatia		N			✓					
Cyprus										
Czech Republic		✓		✓	N		✓	N		
Denmark		N		✓	N		✓	N		N
Estonia		✓		✓	N		✓		✓	
Finland		N		N	N		✓	N	✓	
France		N		N	N	N	✓			✓
Germany		N		N	N	N	N	N	✓	
Greece		✓			N		✓	N		
Hungary		N			N		✓	N	✓	
Ireland		✓			N	N				
Italy		N		✓	N		N	N	✓	
Latvia										
Lithuania		N		✓			✓			
Luxembourg		N			✓		✓	N		✓
Netherlands		N		✓	N		✓			
Norway		✓		✓	✓		✓			
Poland		N			N		✓			
Portugal		✓			✓		✓		N	
Romania										
Slovenia										
Slovak Republic		N			N	N	✓			
Spain		✓		✓	N		✓	N		N
Sweden		✓		✓			N	N		
Switzerland		N		N	N		✓	N		
United Kingdom		N		N	N		N	N	N	
Conform		**9**		**11**	**4**	**0**	**18**	**0**	**6**	**2**
Rel. %		**37.5**		**68.8**	**18.2**	**0.0**	**81.8**	**0.0**	**75.0**	**50.0**

✓: Data conform
N: Data not conform

All messages triggered by the range test for the spatial position of a country were caused by an incorrect setting in the checking routine for Estonia. The settings were corrected in the routines of the Conformity Check of the operational system. Except for Air Quality all errors in the range test for the longitude coordinate were due to an incorrect minus for one plot in Germany.

Most of messages in the tests for temporal consistency were caused by new trees in the data. Additional multi-parameter range checks have found 891 situations in the Growth survey data, which have triggered messages. Those situations were found in only three NFC (France, Germany and the Slovak Republic).

3.2.11 Temporal Consistency in Legacy Data

All surveys of the legacy data, including those for 2001, were already checked and validated. Under Forest Focus only files having passed the Compliancy Check may be tested for conformity. This condition is very important, since one of the objectives of the data Conformity Check is to ascertain the data values and the suitability of the data for further comparative temporal analysis.

Any temporal analysis within a given survey will not be possible if, for example, 2002 data for a survey are compliant (Forest Focus validation), but 2001 data (legacy data) were found not to be conform. The validation can only be completed when all years preceding the year to be assessed are fully validated. The legacy data, which is part of time-series analyses of data collected under Forest Focus, is considered validated. Any inconsistencies found in the legacy data can only be noted, but the data have to be included in the validation procedure of later surveys.

The status of the legacy data has a number of surveys, for which data are collected annually. For those surveys a time-series can be constructed with relative ease. Yet, for surveys which are performed at less frequent intervals the period covered by a time-series is considerably longer and also varies between NFCs and plots even for a given survey. When the monitoring of non-annual surveys is implemented by rotating monitoring between plots files will be submitted every year. However, the file then contains only the portion of all plots monitored and an assessment of the completeness of the time-series requires more advanced data queries. The effect of the legacy data on the validation of Forest Focus data is thus prolonged for non-annual surveys, for example for the Soil Condition survey the data collection interval is 10 years.

With the understanding of the values reported following the communication with the NFC from the validation process of the data from the monitoring years 2002 to 2005 it was in some cases possible to explain why data triggered messages during the Conformity Check. Corresponding observations are given in the country specific test results presented in the Annex.

Warnings concerning continuity of changes with an abnormal progression of values were mainly found in the data of Growth Assessment survey. An example are “shrinking” trees, meaning the diameter or the height is smaller than in the previous measurement. However, an unusual time interval between two measurements, incorrect measuring technique, or stem breaks could also explain these warnings. Also the direct comparison between the first measured diameter (DIAMETER_1) and the second measured diameter (DIAMETER_2) between two measurements could explain warning messages, because this test may highlight in some cases only the variance in non-circularly stems and not a time inconsistency. It is planned to modify this test for further checks.

Some of the warnings, mainly found in the Soil Solution and Deposition surveys, were due to the use of “0” values. The “-1” values, which were very present in the data of the monitoring years 2002 to 2004 used as a code signifying a measurement below the detection limit of instrument, were lacking in the 2001 data. Also the value “0” was used relatively rarely to signify several diverse conditions, such as to code the absence of a measurement, for values outside the field format limit (rounded to “0”) and measurement outside the detection / quantification limit. For example in the optional deposition measurements (DEO) the value ”0” is beside a few times for the sample quantity totally missing.

It is not possible to determine the meaning of zero entries as either missing values (blank) or as values which were below the detection / quantification limit. The latter could be stored as a blank or as the half value of the instrument specific detection limit.

3.3 Uniformity Analysis

The tests of data Uniformity provide an interpretation of temporal and spatial development of parameters using data from more than one plot. Under Forest Focus only surveys passing the Conformity Check are subjected to tests for Uniformity. For the analysis of the legacy data all surveys were used in the process. The tests include an automatic procedure for generating maps for various key parameters monitored. In general, the map depicts the status of a given parameter for the monitoring year. Where appropriate a status map is supplemented by a map showing changes over a previous monitoring year. While the compilation of the maps is relatively straightforward for continuous surveys the process is less apparent for surveys with longer monitoring intervals, such as Growth or Soil Condition. The main obstacle for comparing data to results from other plots or analysing changes over time is the lack of data for any given monitoring year. This is most extreme for the Soil Condition survey with a repeat cycle of 10 years. On average one would expect data for 10% of all plots for a monitoring year, which is largely insufficient for a comparative analysis. Therefore, for non-annual surveys data from several preceding years are used in the analysis.

Special conditions are defined for mapping data to allow a meaningful interpretation. Some of the conditions merely define a minimum number of plots with data. Others are more complex, e.g. data for Soil Solution are only mapped when the sample has been taken from the mineral soil layer with a layer depth of at least 30cm and a sampling period of no less than 300 days.

In the subsequent section only the results from those checks are presented, which allow some interpretation of a spatial or temporal trend. For several validated parameters the interpretation of the results was assisted by results obtained from Level I plots for the same monitoring period.

3.3.1 Crown Condition

Mean plot defoliation in 2001 is mapped for the six main tree species *(Pinus sylvestris, Picea abies, Fagus sylvatica, Quercus robur and Q. petraea, Quercus ilex and Q. rotundifolia, Pinus pinaster).* The maps show those Level II plots on which at least three trees of the respective tree species were assessed in the reporting year. For each plot, mean defoliation is classified into 6 classes (0-10%, 11-20%, 21-30%, 31-40%, 41-50%, 51-100%).

The mean plot defoliation of *Pinus sylvestris* in 2001 is presented in Figure 4. The highest density of validated mean defoliation data for *Pinus sylvestris* is found in southern Sweden and Poland. Many plots in Sweden show a mean defoliation between 0 and 20%, but there are also some plots showing defoliation of up to 30% and one with up to 50%. Most of the plots in Poland reach values between 11 and 30% defoliation and a few trees reach up to 40% mean defoliation.

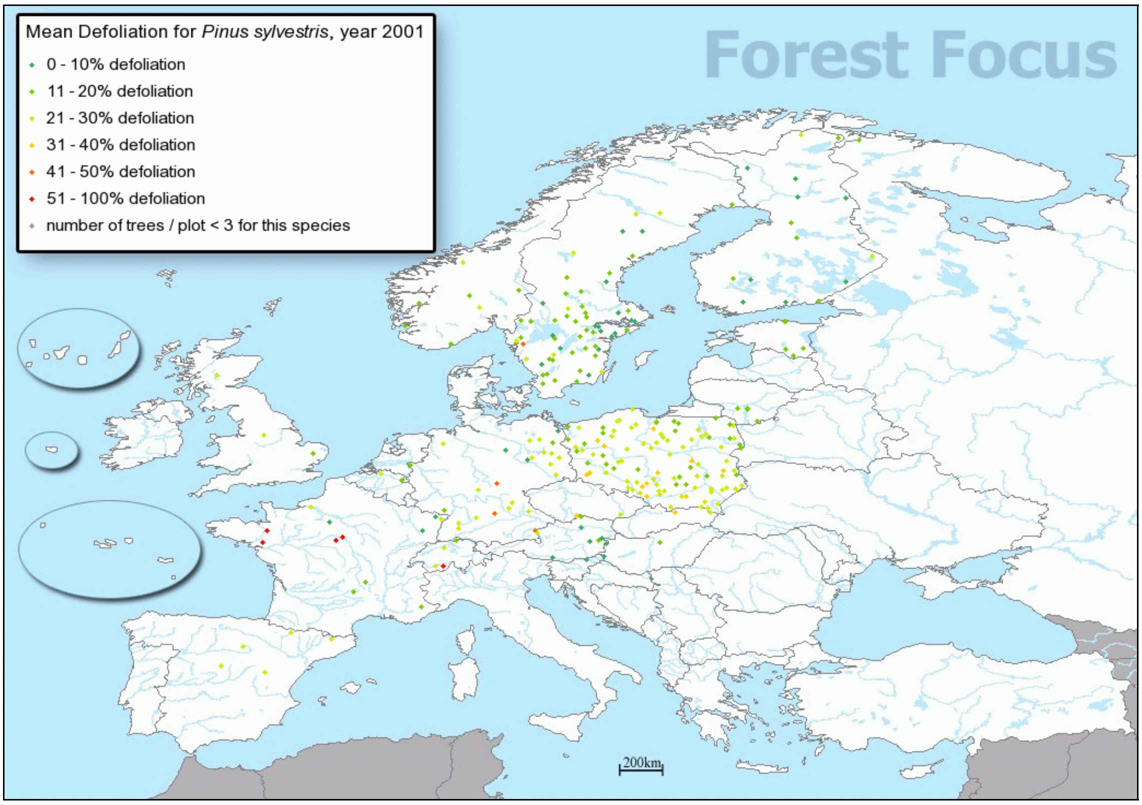

Figure 4: Mean Defoliation for Pinus Sylvestris

The high density of Level II plots in southern Sweden and Poland suggests a comparison with defoliation assessed on Level I plots in the same regions. The comparison shows that defoliation assessed at the two monitoring levels is quite similar. Most of the Swedish Level I plots show also a mean defoliation between 0 and 20%, many plots reaching between 21% and 30% and a few plots even 31% to 40% defoliation (Lorenz *et al*., 2002). Mean plot defoliation on Level I plots in Poland ranges between 21 and 40%, i.e. it is slightly higher than on the Level II plots.

The variability of defoliation on most of the plots in Norway, Finland, Estonia, Lithuania, Austria, Belgium, United Kingdom, and Spain is similar to the one describe on the Swedish and Polish plots. There are, however, three plots with defoliation ranging from 41% to 50% (in Germany) and four plots ranging from 51% to 100% defoliation (in France and Switzerland).

The spatial variation of mean plot defoliation for *Picea abies* is shown in Figure 5. By far the largest amount of validated data is available for plots located in southern Sweden, Austria and Germany. Defoliation on the plots in Austria is mostly not higher than 10%. Also in southern Sweden those plots with defoliation up to 10% are dominating, but there are also several plots showing defoliation of up to 20%. The same applies to the much scarcer plots in Finland, Lithuania, Denmark, the north of Italy and the central and eastern parts of France. Higher variability and much higher levels of mean plot defoliation, sometimes exceeding 50%, were reported for plots in Norway, Czech Republic, Slovak Republic, Switzerland, and Germany. These results are comparable to those described for the Level I plots for the year 2001 (Lorenz *et al.*, 2002).

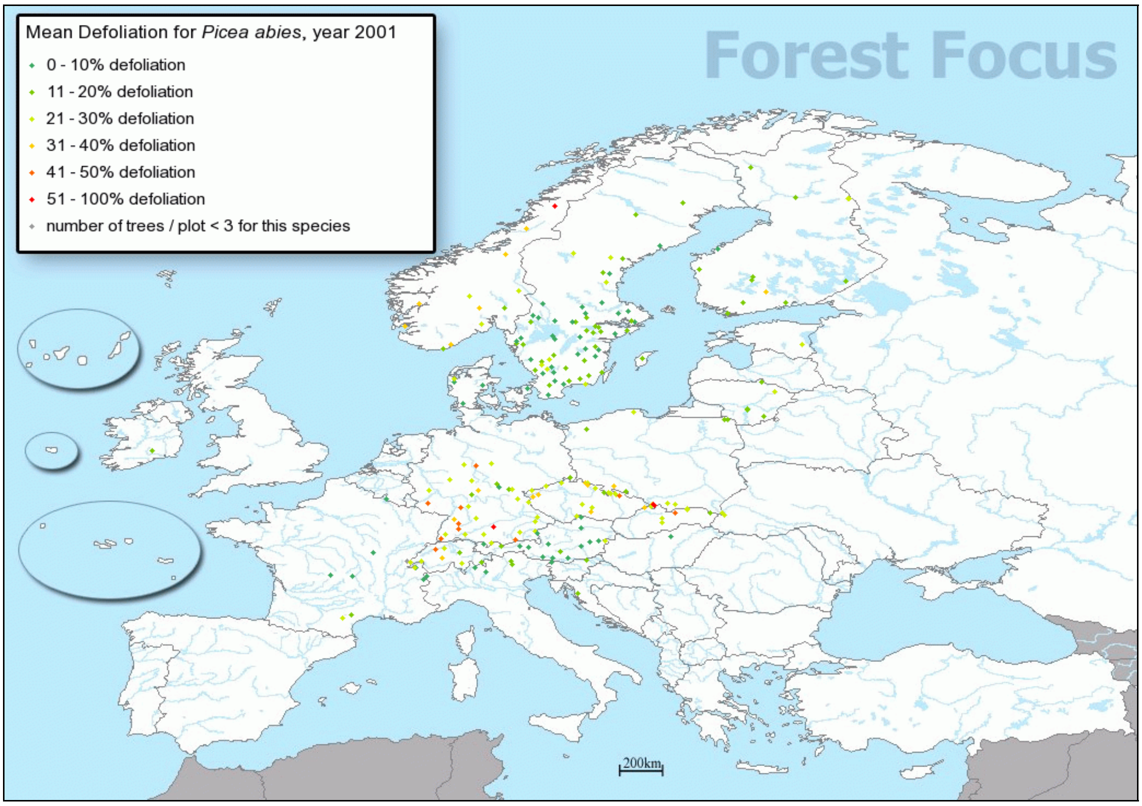

Figure 5: Mean Defoliation for Picea Abies

A map of mean plot defoliation of *Fagus sylvatica* on Level II plots in 2001 is given in Figure 6. Mean plot defoliation is lowest in Austria, Denmark, Belgium, Switzerland, Hungary and Italy with mainly up to 10% and only in exceptional cases with 11% to 20%. In southern Sweden, Poland, Germany, France, Spain, Czech Republic and Slovak Republic the mean plot defoliation is more variable with maximum values of up to 40%. Defoliation is smaller on the *Fagus sylvatica* plots than on the *Pinus sylvestris* and *Picea abies* plots at Level II. This does not coincide with the findings from Level I in 2001. The reason for this lies clearly in the different densities of the Level I and Level II samples. For instance, in Italy mean plot defoliation is maximally up to 20% on the Level II plots but may reach up to 50% on some Level I plots.

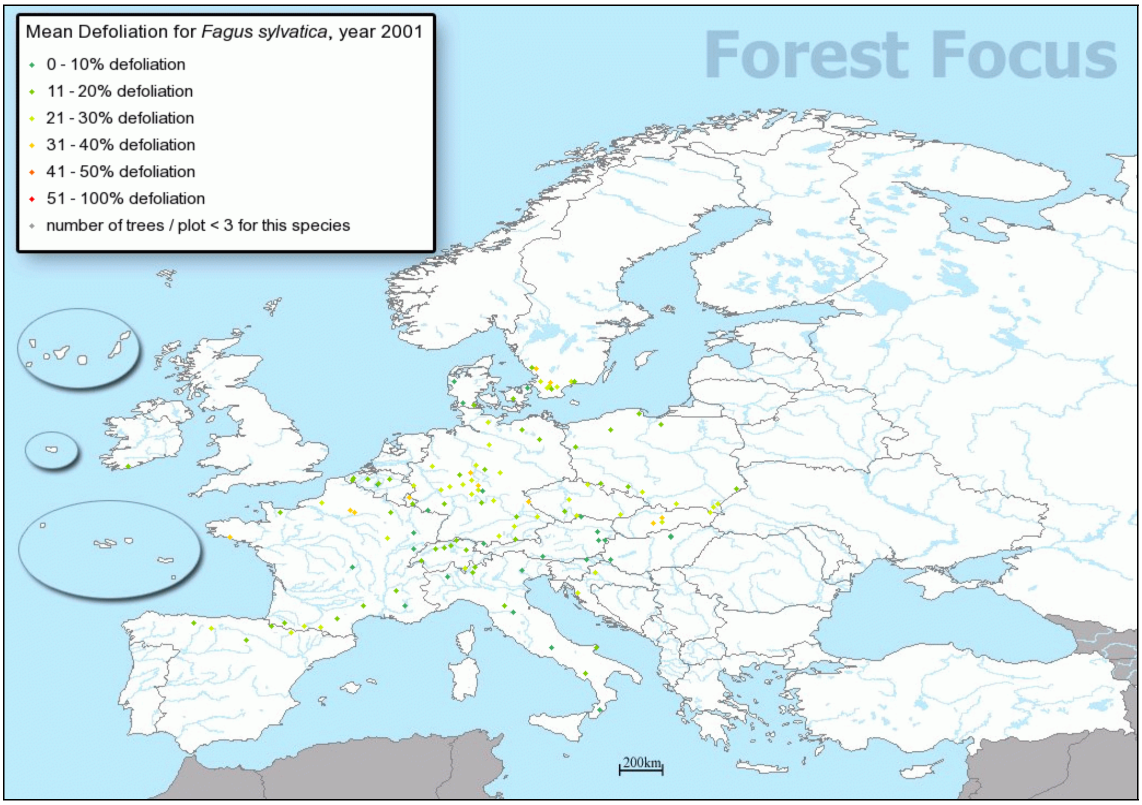

Figure 6: Mean Defoliation for Fagus Sylvatica

Mean plot defoliation of *Quercus robur* and *Qu. petraea* in 2001 is mapped in Figure 7. For these species the Level II plots show a wide range of defoliation. Defoliation is particularly low on plots in Denmark, Austria, Hungary and some parts of France and the United Kingdom with values below 20%. For the plots in southernmost Sweden, Germany, Czech Republic and Spain much higher levels of mean defoliation were reported, partly exceeding 50%. Due to the limited geographic spread and the high spatial variation a comparison with the results of the assessment on Level I plots would be inappropriate. However, the relatively high defoliation showing high spatial variation is also found at Level I.

The number of Level II plots of *Quercus ilex* and *Qu. rotundifolia* is very small due to the limited geographical spread of these two species (see Figure 8). The plots are confined to Spain and to Italy. Most of the plots in Spain show a mean defoliation between 21% and 30%, but there are also two plots showing defoliation of 31% to 40% and one with 41% to 50%. Two of the three plots in Italy have a defoliation of up to 10%, whereas the third one has defoliation larger than 50%.

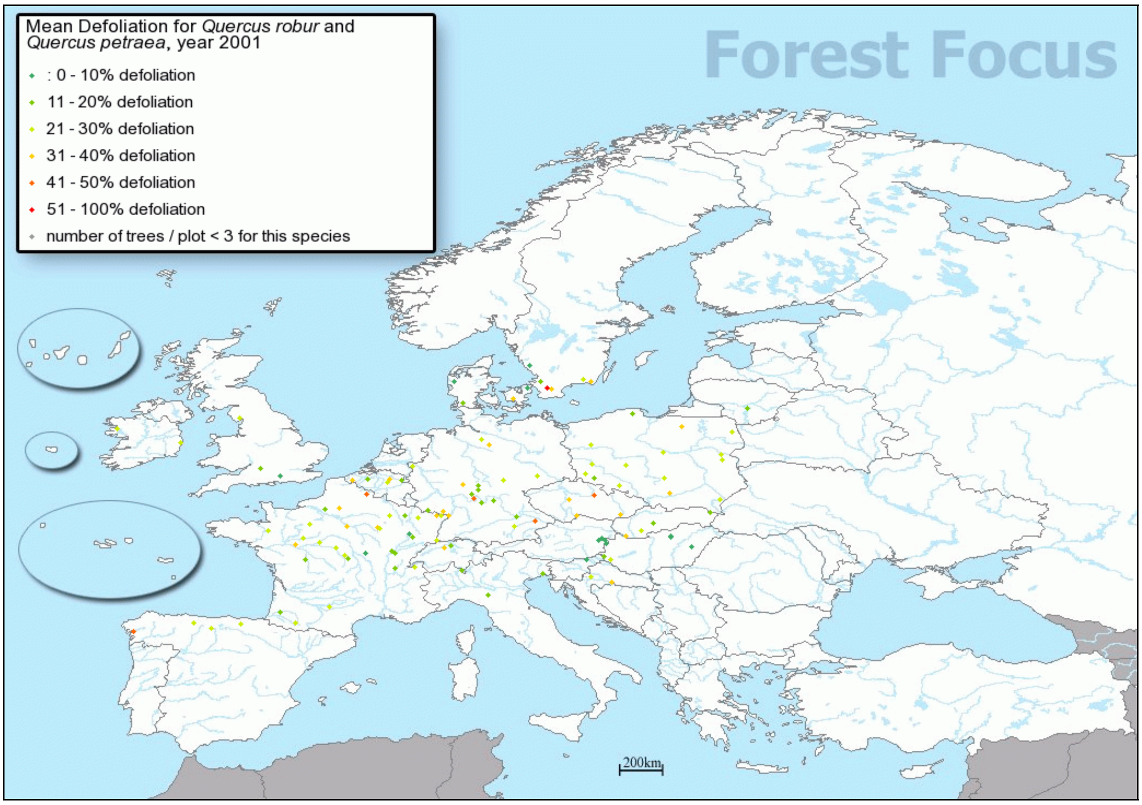

Figure 7: Mean Defoliation of Quercus Robur and Qu. Petraea

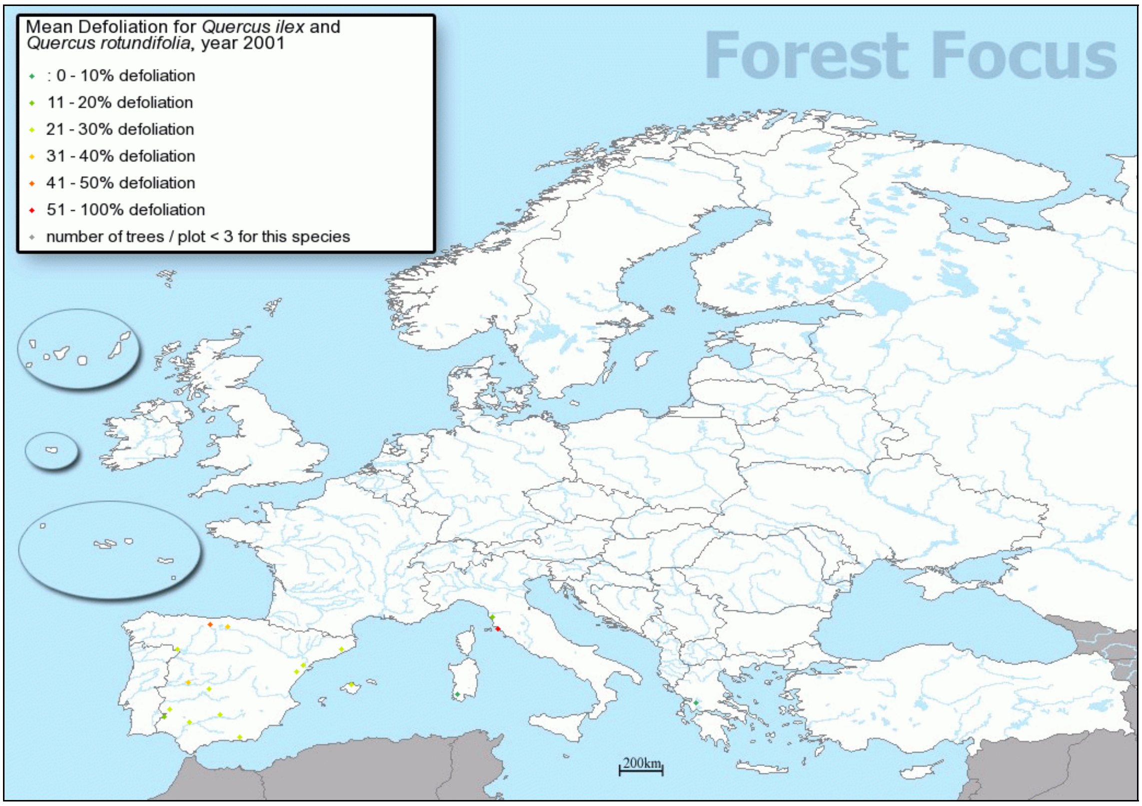

Figure 8: Mean Defoliation of Quercus Ilex and Qu. Rotundifolia

Much as for *Quercus ilex* and *Quercus rotundifolia*, the limited geographical coverage of *Pinus pinaster* yields a small Level II plot sample for this species. Mean plot defoliation for this species is mapped in Figure 9.

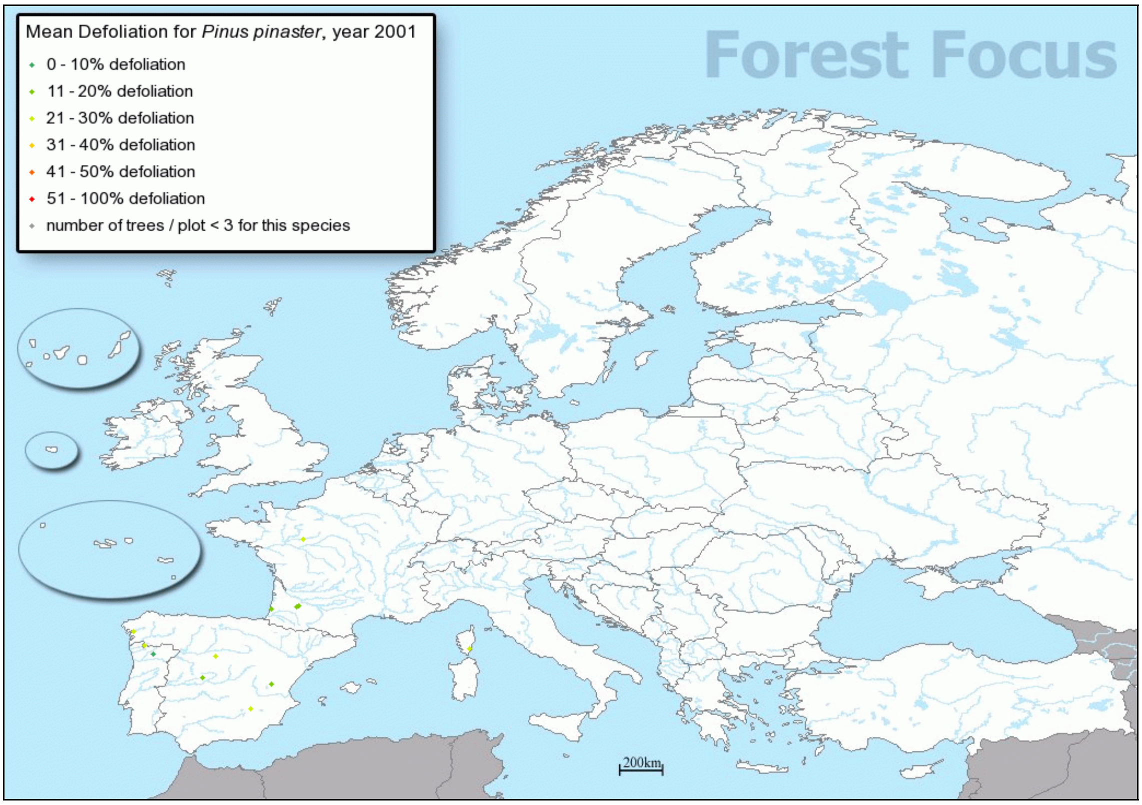

Figure 9: Mean Defoliation of Pinus Pinaster

The assessed plots can be found in Portugal, Spain and in the western part of France. The level of defoliation and its variability are low. Mean defoliation ranges mainly between 11% and 30% at the maximum. Though the low Level II plot density forbids comparisons with the defoliation of Level I plots, it is worth mentioning that also at Level I *Pinus pinaster* had the lowest defoliation among the six main species in 2001.

3.3.2 Soil Condition

A parameter of the Soil Condition survey frequently referred to in scientific analyses is the pH ($CaCl_2$) for the upper mineral layer per plot. The distribution of pH on Level II plots is mapped in Figure 10. In 2001 none of the NFCs submitted new data. Therefore, only pH-values from previous years are shown in the map. The map shows pH values for the latest available year for each plot. The pH values are taken from the layer M01 (0-10cm), alternatively from layers M05 (0-5cm) and M51 (5-10cm), or from the M02 (0-20cm) layer in this order.

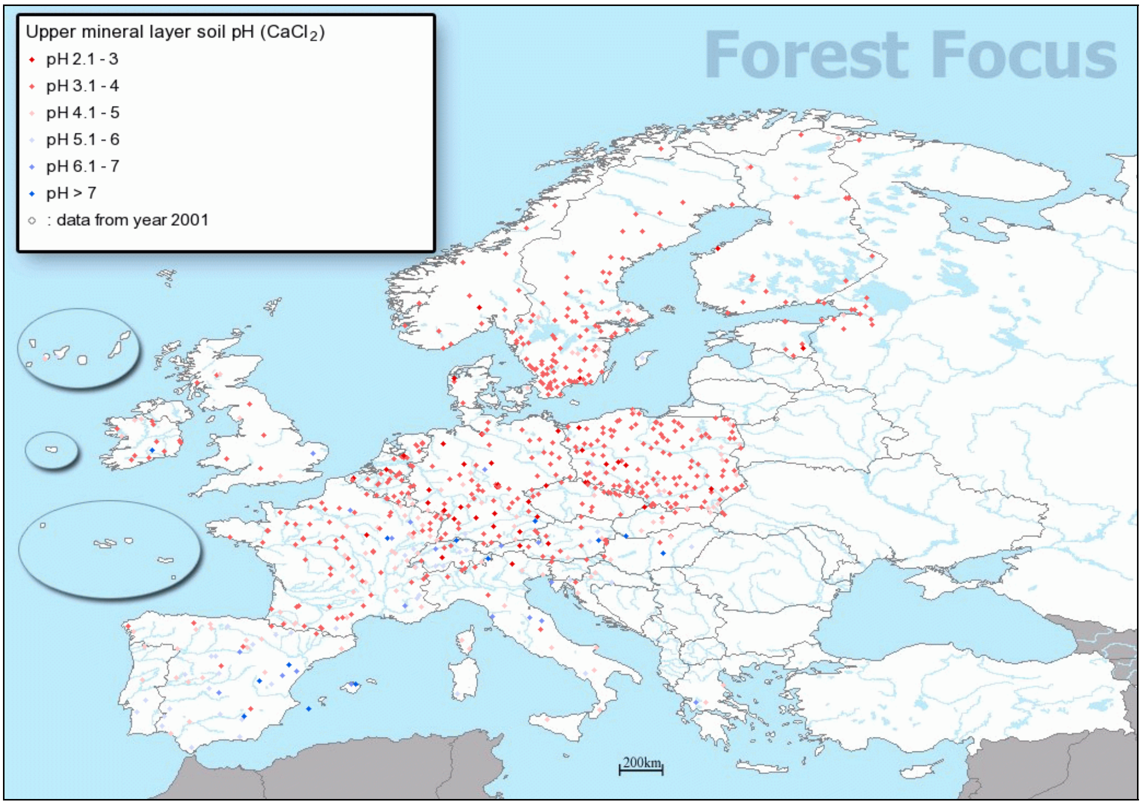

Figure 10: pH ($CaCl_2$) for Upper Mineral Layer

The majority of plots show pH-values between 3 and 5 with many of them located in Scandinavia as well as in central Europe. The lowest pH-values (around 3) can be found on plots in central Europe, while most plots with high pH-values (around 6) are located in the Mediterranean region or in the Alps. This difference between pH-values in the Alps and in the Mediterranean region on the one hand and the other parts of Europe on the other hand can also be observed at Level I. In the Alps, high pH-values result from the buffer capacity of calcareous soils. In the Mediterranean region depositions of Saharan dust yield a high buffering capacity of the soils.

3.3.3 Soil Solution

Key parameters of the Soil Solution survey testes are the concentrations of sulphur (S-SO_4), and nitrogen (N-NO_3 and N-NH_4). The difference between the time-weighted mean concentration in the reporting year and the average of the weighted mean concentration of the five preceding years is evaluated as part of the tests. Not all soil solution data stored in the FMD are necessarily displayed on the map. For plots to appear on the map, the following conditions apply:

- the sample has to be taken from the mineral soil layer;
- the layer depth must be at least 30cm;
- the total sample period must be more than 300 days.

The data for 2001 for the parameter S-SO_4 are shown in Figure 11. For plots located in Norway, the United Kingdom, Germany, France, Switzerland, Austria, and Belgium as well as for one plot in Lithuania and one plot in Estonia the S-SO_4 concentration ranges between below 50% and 100% of the average concentration measured for the previous five years. For two plots in Germany and three plots in Finland the reported concentrations were above 126% of the average concentration measured for the previous five years. Data for 2001 were also available for plots in Germany, Italy and Spain, but no values were available for any of the previous five years.

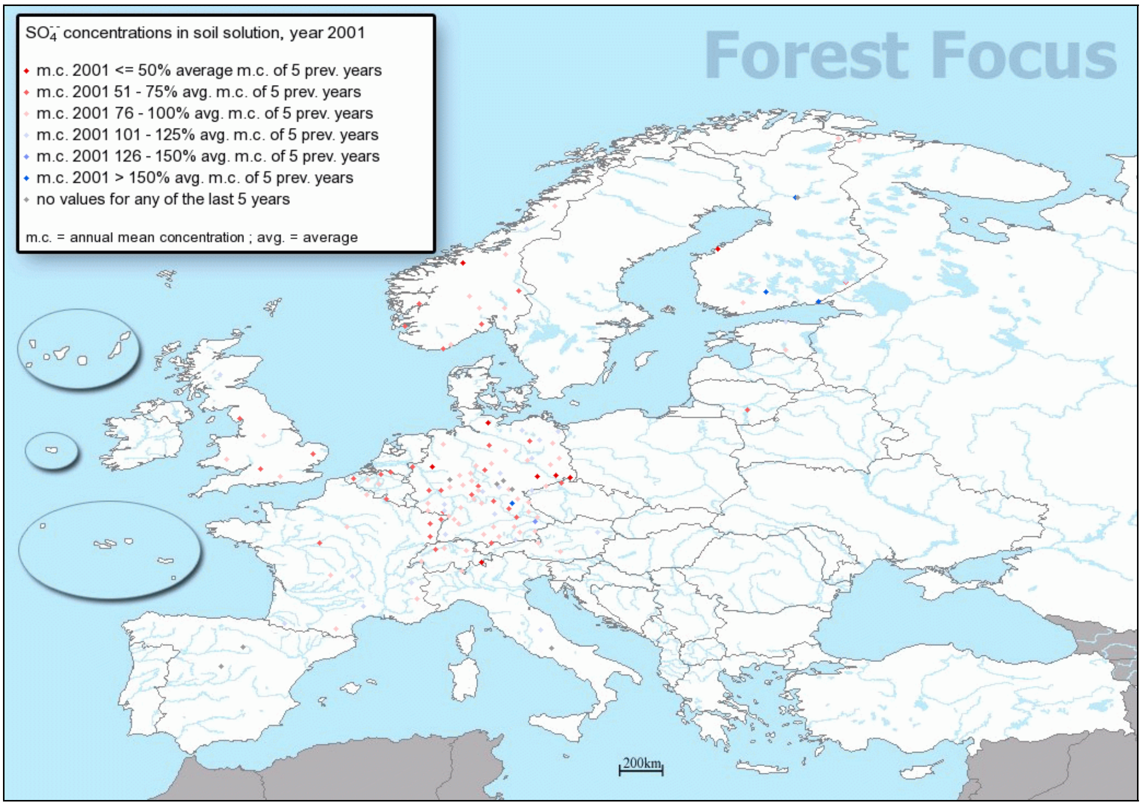

Figure 11: Breaks on SO_4 Concentrations in Soil Solution

N-NO_3 concentrations are mapped in Figure 12. The majority of nitrate concentrations reported are below 50% of the average concentration measured for the previous five years. These are almost all plots in Norway. Furthermore such plots can be found mainly in Germany, but also in other parts of Europe. For several plots concentrations above 150% were observed, namely in Germany, France, United Kingdom and on one plot each in Finland, Norway and Lithuania. Also a limited number of plots with no values for any of the last five years were detected in Finland, Germany and Spain.

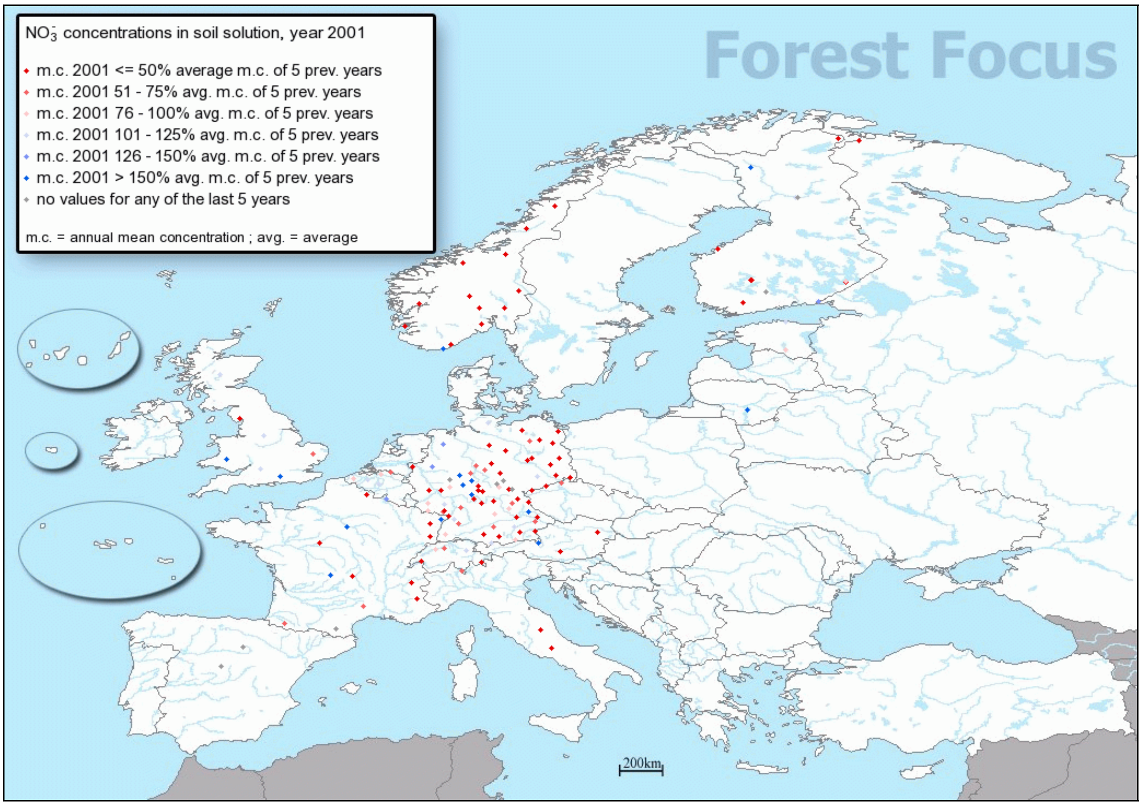

Figure 12: Breaks on NO_3 Concentrations in Soil Solution

The data monitored for N-NH_4 are mapped in Figure 13. The geographic distribution of plots with available data and the observed trend for ammonium concentrations is similar to that found for nitrate. For the majority of plots the NH_4 concentrations reported are below 50% of the average concentration measured for the previous five years. Most of those plots are located in Germany and also in Finland, Italy, United Kingdom and in central Europe. Furthermore some plots with concentrations above 150% were detected in Finland, Germany and France.

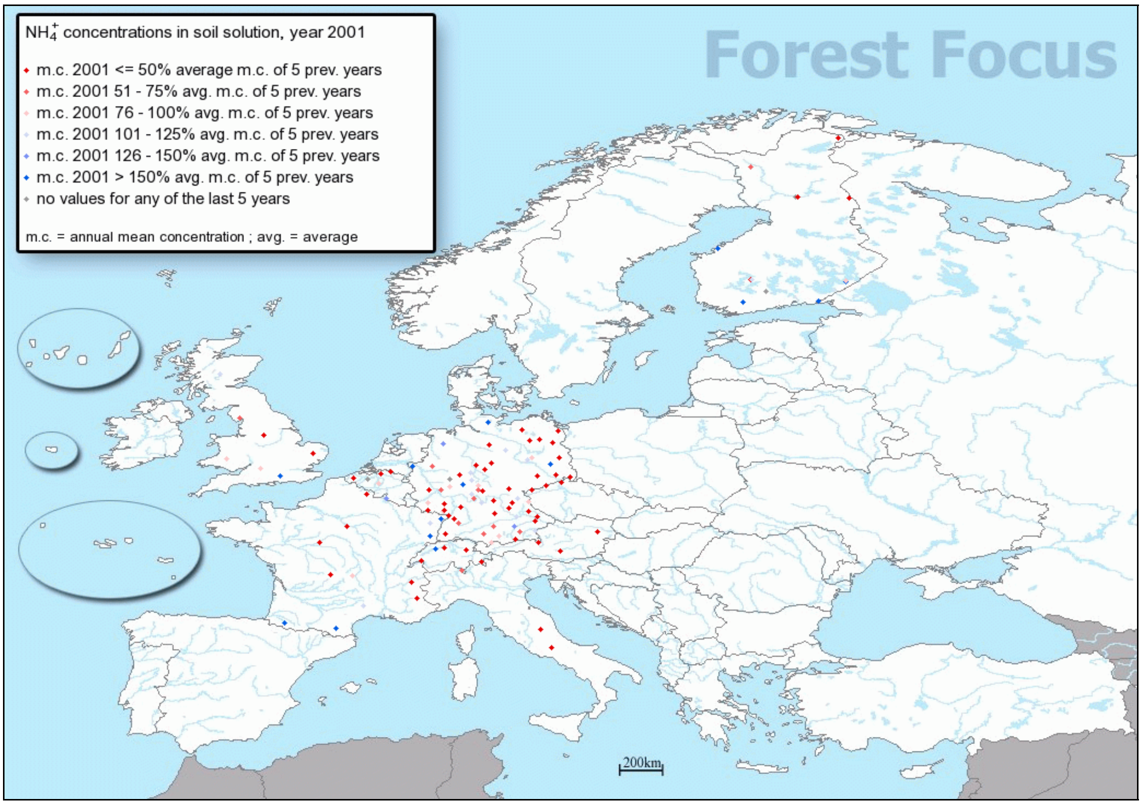

Figure 13: Breaks on NH_4 Concentrations in Soil Solution

3.3.4 Foliar Condition

Foliar condition is described by means of the chemical composition of needles and leaves. The concentrations of chemical elements in the foliage constitute indicators for the functioning of the trees and response parameters for air pollution effects. Their spatial variation can give hints on the completeness and correctness of measurements in the participating countries. Concentrations of nitrogen and sulphur are mapped for *Pinus sylvestris*, *Picea abies*, *Fagus sylvatica*, *Quercus robur* and *Q. petraea*, *Quercus ilex* and *Qu. rotundifolia*, and *Pinus pinaster*. For each reporting year, mean plot concentrations are calculated by species and plot and are then classified into five classes of equal relative frequency (pentiles). The minimum of the first class is the minimum of the measured values, the maximum of fifth class is the maximum of the measured values.

The very limited number of plots with data does not allow a meaningful interpretation of the situation for the following checks:

- Foliar Nitrogen Concentrations for *Quercus ilex* and *Qu. rotundifolia*
- Foliar Sulphur Concentrations for *Quercus ilex* and *Qu. rotundifolia*
- Foliar Nitrogen Concentrations for *Pinus pinaster*
- Foliar Sulphur Concentrations for *Pinus pinaster*

Nitrogen and sulphur concentrations of the evaluated tree species and regions are characterised by high ranges between minimum and maximum values as well as by high spatial variability. The high variation of foliar concentrations across Europe is a fact well known from the scientific literature, national surveys and surveys at Level I and Level II. One of the main reasons for the spatial variation is considerable local influences. These may result from soil chemistry and exposition as well as from nearby emission sources. Moreover, it cannot be excluded that the spatial variation in some cases actually reflects the naturally high temporal variation. Changes in wind direction and precipitation yield considerable changes in foliage composition over time. These may reveal themselves in the maps if plots were assessed at different times. The relatively low density of the Level II plots does not permit to detect small scale spatial patterns which become visible in national studies on denser (e.g. Level I) grids. The spatial variation becomes additionally obvious due to the use of the relatively fine classification of pentiles. Other studies often confine themselves to tercentiles.

The foliar concentrations of nitrogen and of sulphur in needles of *Pinus sylvestris* in the year 2001 are mapped in Figure 14 and Figure 15. The majority of the plots are situated in Poland and in eastern Germany. Measured nitrogen concentrations range from 8.7 to 26.1 g/kg. The highest nitrogen concentrations ranging from 17.495 to 26.1 g/kg are measured on plots in Poland and Western Europe. In Western Europe, particularly in The Netherlands and in Belgium, high nitrogen concentrations may be attributed to ammonium depositions resulting from animal husbandry. In Poland several plots of high nitrogen concentrations are situated in Sub-alpine mountain ranges bordering the Czech Republic and the Slovak Republic. In contrast, the eastern and western parts of Poland show mainly plots of low nitrogen concentrations in needles of *Pinus sylvestris* ranging from 8.7 to 14.11 g/kg. The plots in Finland show almost exclusively concentrations within this lowermost pentile.

The concentrations of sulphur in the needles of *Pinus sylvestris* are about an order of magnitude lower than those of nitrogen. Sulphur concentrations range from 0.635 to 1.910 g/kg. Also of sulphur the highest nitrogen concentrations ranging from 1.365 to 1.910 g/kg are measured on plots in Poland. Similar to the nitrogen concentrations, several plots of high sulphur concentrations in Poland are situated in Sub-alpine mountain ranges bordering the Czech Republic and the Slovak Republic. This pattern coincides partly with the one of sulphate depositions in this region, suggesting an impact of industrial emissions. Also similar to the nitrogen concentrations, the spatial pattern of sulphur concentrations in needles of *Pinus sylvestris* show high spatial variability. Besides the plots with highest sulphur concentrations, also many plots of the lowermost pentile occur in Poland, with concentrations ranging from 0.635 to 1.010 g/kg. Also the plots in Finland and eastern Germany show nearly exclusively concentrations of this lowermost pentile.

The high variation of element concentrations in needles of *Pinus sylvestris* reported by Poland is not suspected to be a data quality problem, as the Polish laboratories have qualified for the analyses in several ring tests.

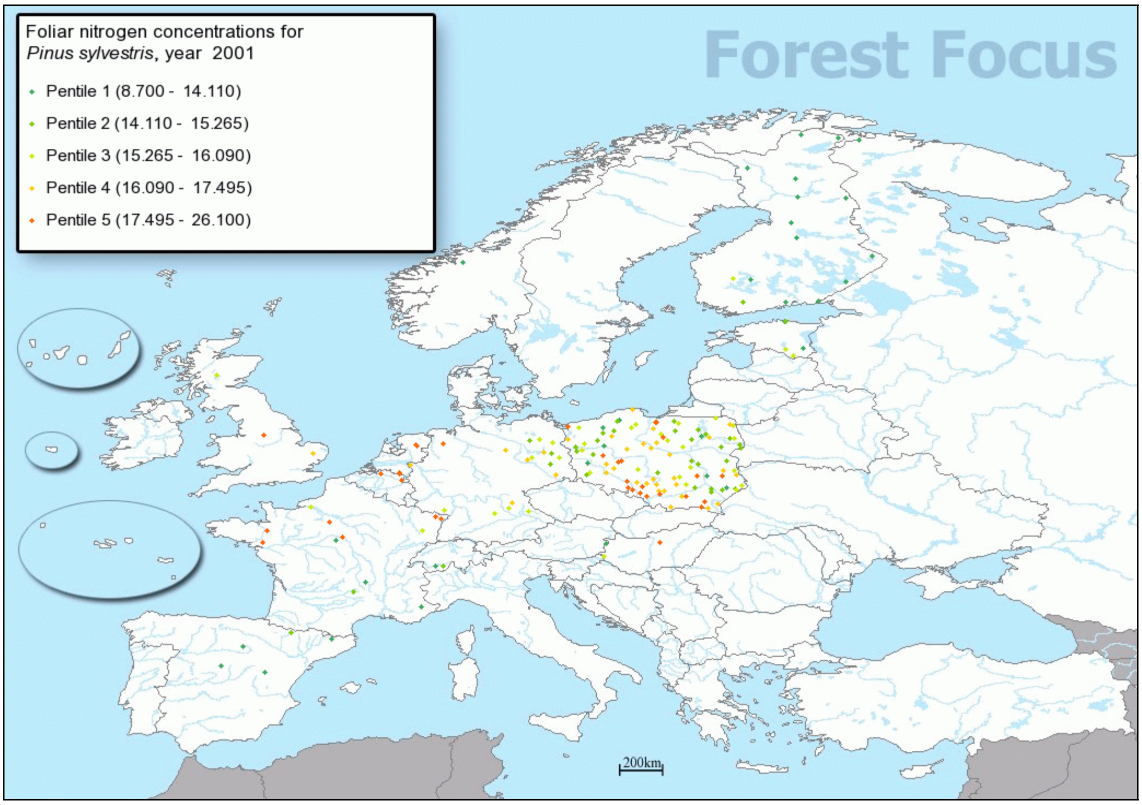

Figure 14: Foliar Nitrogen Concentrations for Pinus Sylvestris

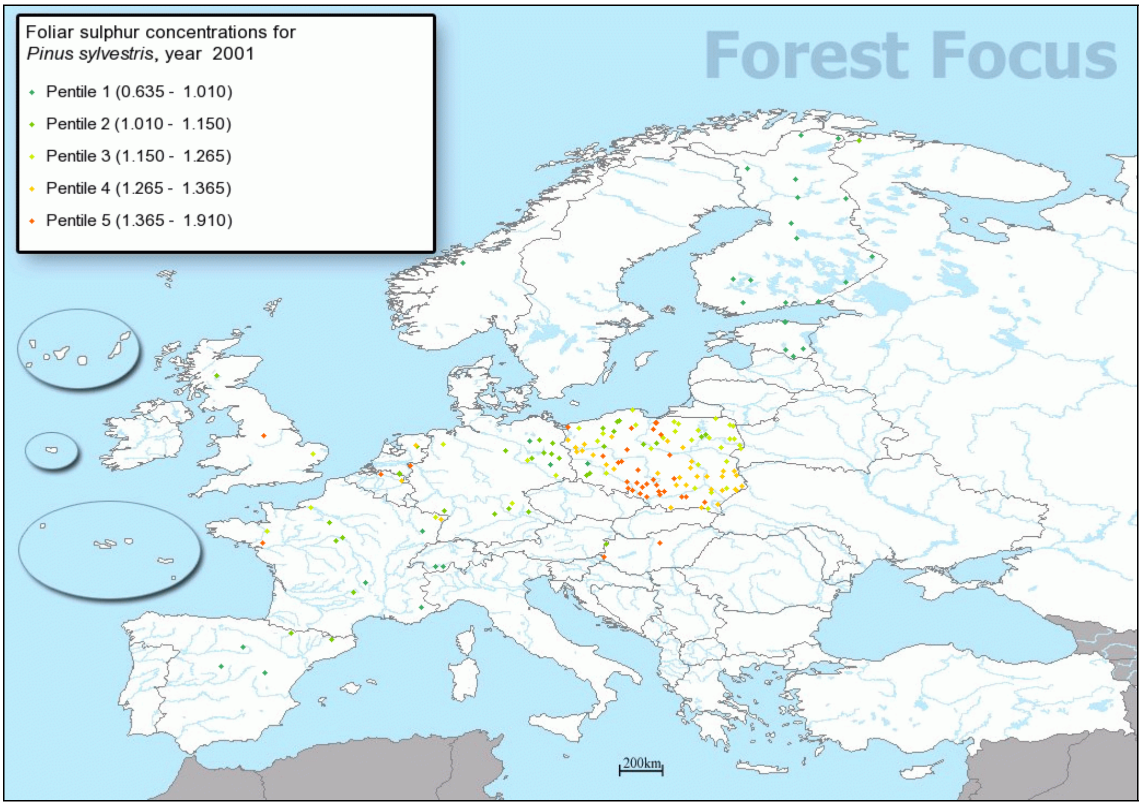

Figure 15: Foliar Sulphur Concentrations for Pinus Sylvestris

The plots of *Picea abies* assessed for foliar concentrations of nitrogen and sulphur are mainly situated in the Alpine regions of Switzerland, Austria and southernmost Germany, as well as in the Sub-alpine mountain ranges of southern Germany and the border between Poland, the Czech Republic and the Slovak Republic (see Figure 16 Figure 17). The spatial variability of element concentrations in needles of *Picea abies* is as high as that in needles of *Pinus sylvestris*. Nitrogen concentrations range from 9.100 to 19.560 g/kg and sulphur concentrations range from 0.645 to 2.405 g/kg. Concentrations of both nitrogen and sulphur are lowest in northern Europe, in south-western Germany as well as in Switzerland and Austria. These are the concentrations of the two lowermost percentiles. For nitrogen they lie between 9.100 and 12.855 g/kg. For sulphur they range from 0.645 to 0.900 g/kg.

The foliar concentrations of nitrogen and of sulphur in leaves of *Fagus sylvatica* in the year 2001 are mapped in Figure 18 and Figure 19, respectively. The number of *Fagus sylvatica* plots is smaller than that of *Pinus sylvestris* and *Picea abies* and the plots are scattered mainly across central Europe.

Nitrogen concentrations in *Fagus sylvatica* leaves range from 19.000 to 32.530 g/kg. Plots with low concentrations of 19.000 to 23.610 g/kg are most abundant in central Germany. Most plots in the other regions of Europe show higher nitrogen concentrations.

Sulphur concentrations are about an order of magnitude lower than the nitrogen concentrations and range between 0.300 and 3.250 g/kg. Also the plots showing the lowest sulphur concentrations (0.300 to 1.510 g/kg) are situated in central Germany. Several plots with highest sulphur concentrations (1.800 to 3.250 g/kg) are situated in the Sub-alpine mountain ranges between Poland, Czech Republic and Slovak Republic.

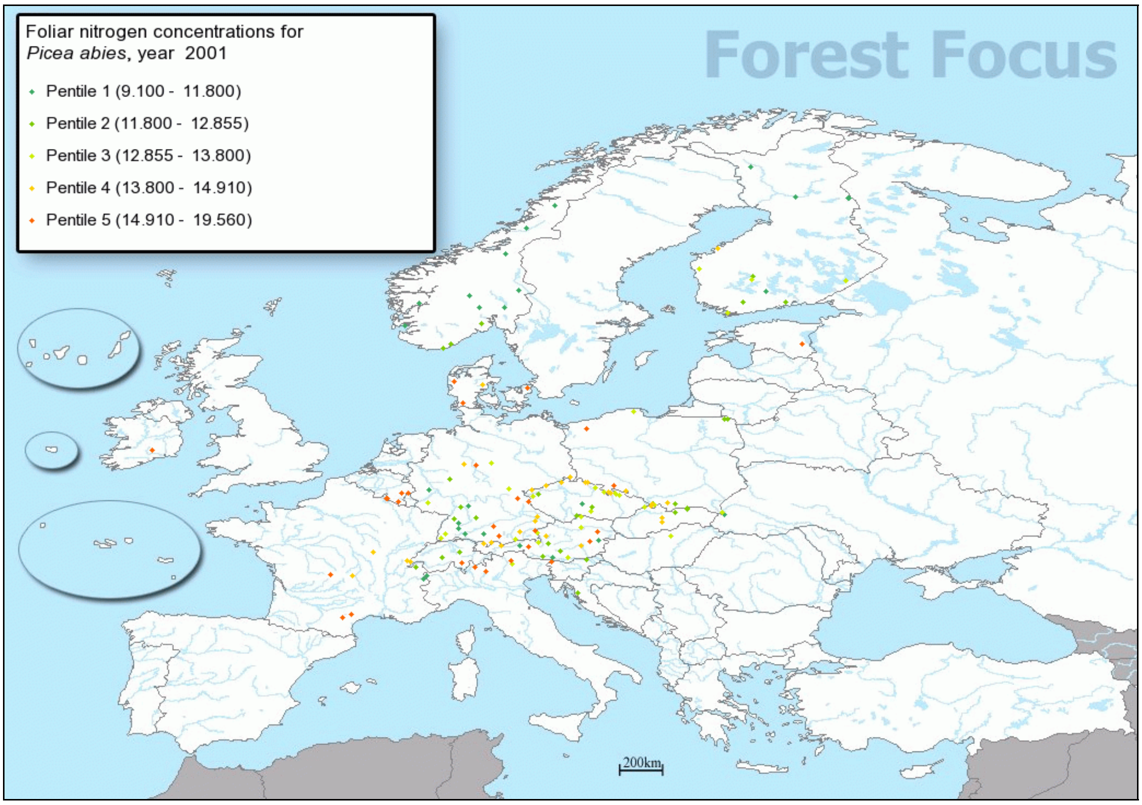

Figure 16: Foliar Nitrogen Concentrations for Picea Abies

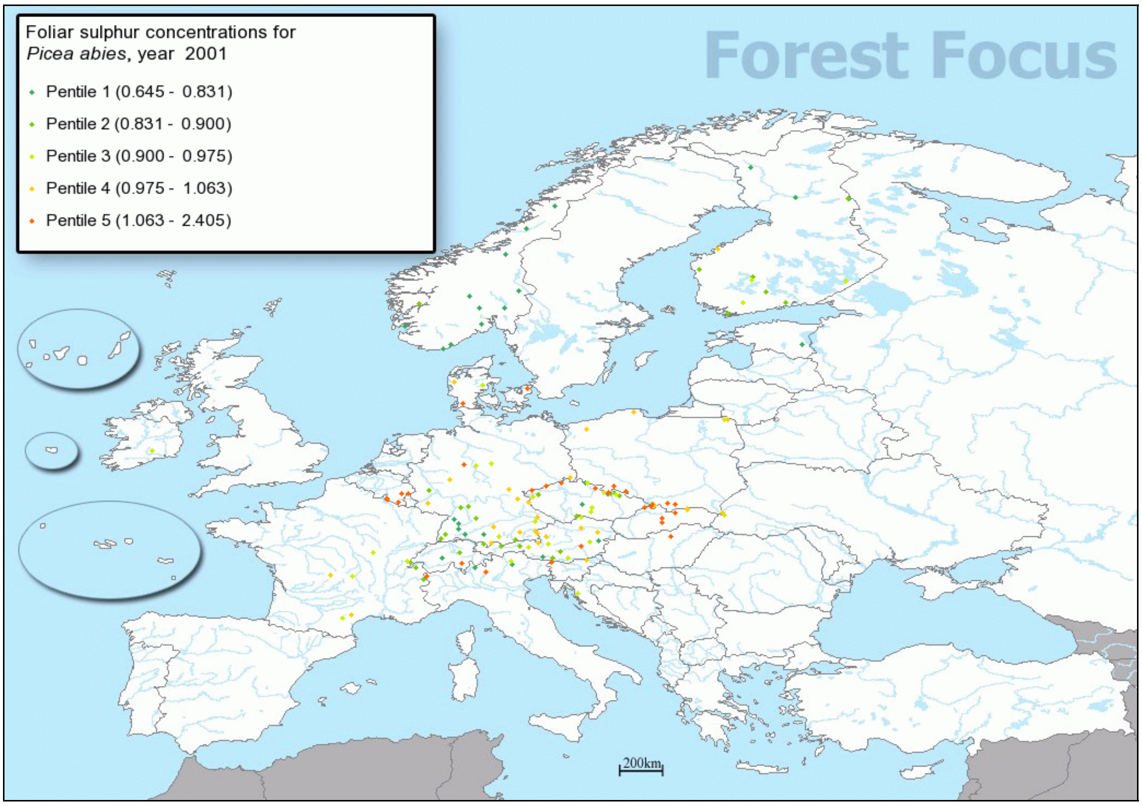

Figure 17: Foliar Sulphur Concentrations for Picea Abies

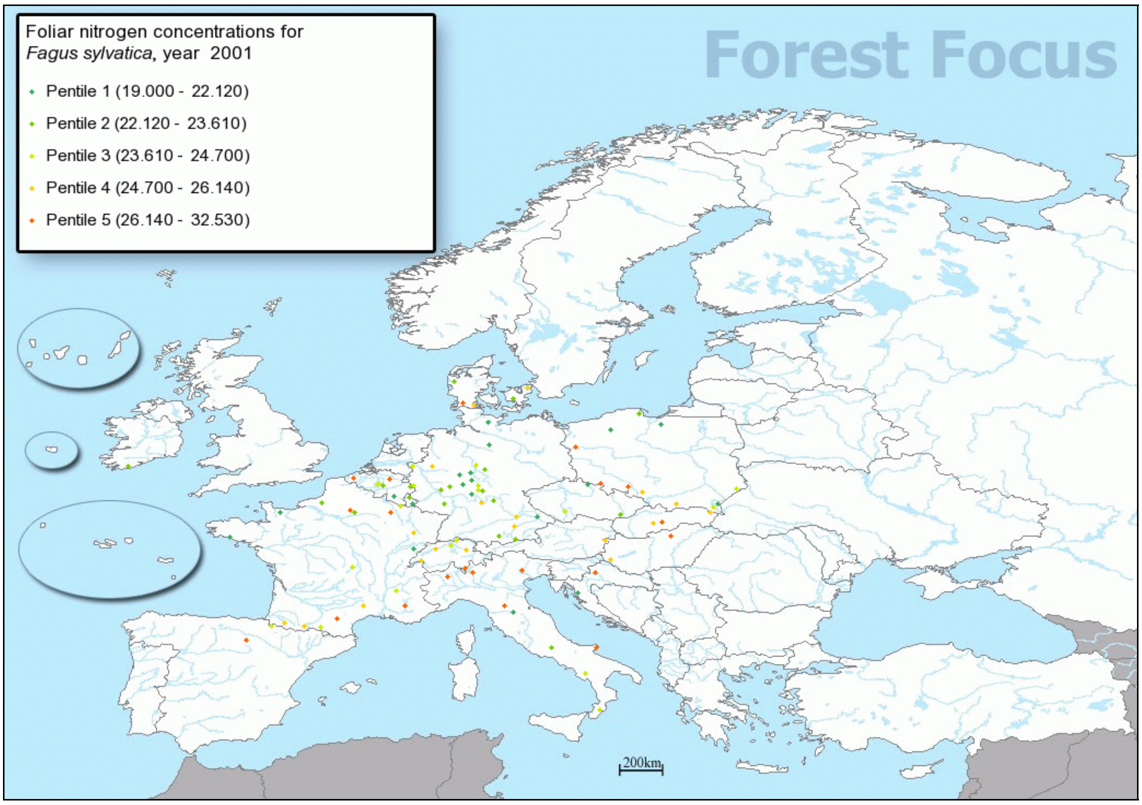

Figure 18: Foliar Nitrogen Concentrations for Fagus Sylvatica

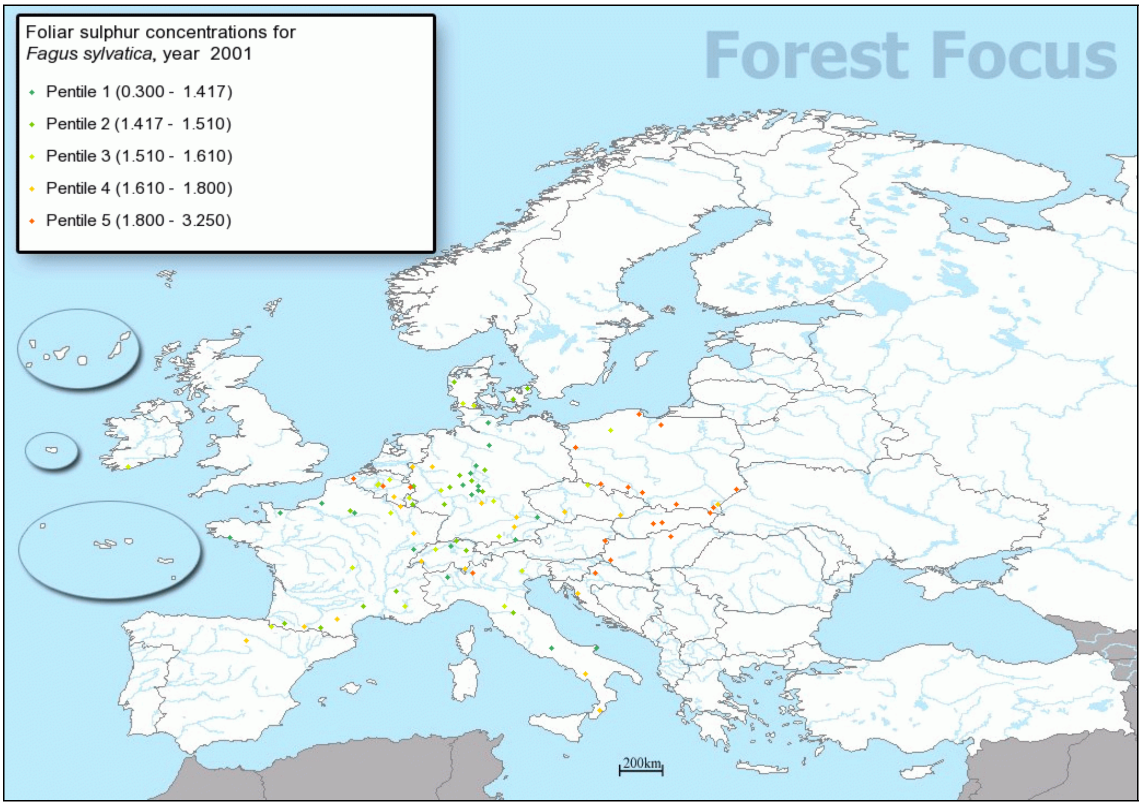

Figure 19: Foliar Sulphur Concentrations for Fagus Sylvatica

Figure 20 and Figure 21 show the spatial variation of foliar concentrations of nitrogen and of sulphur in leaves of *Quercus robur and Quercus petraea* in the year 2001. Similar to *Fagus sylvatica*, the number of *Quercus robur* and *Quercus petraea* plots is smaller than that of *Pinus sylvestris* and *Picea abies.* The plots are scattered mainly across central and western Europe.

Nitrogen concentrations in *Quercus robur and Quercus petraea* leaves range from 20.200 to 33.380 g/kg. Sulphur concentrations being about an order of magnitude lower than the nitrogen concentrations lie between 1.290 and 3.400 g/kg.

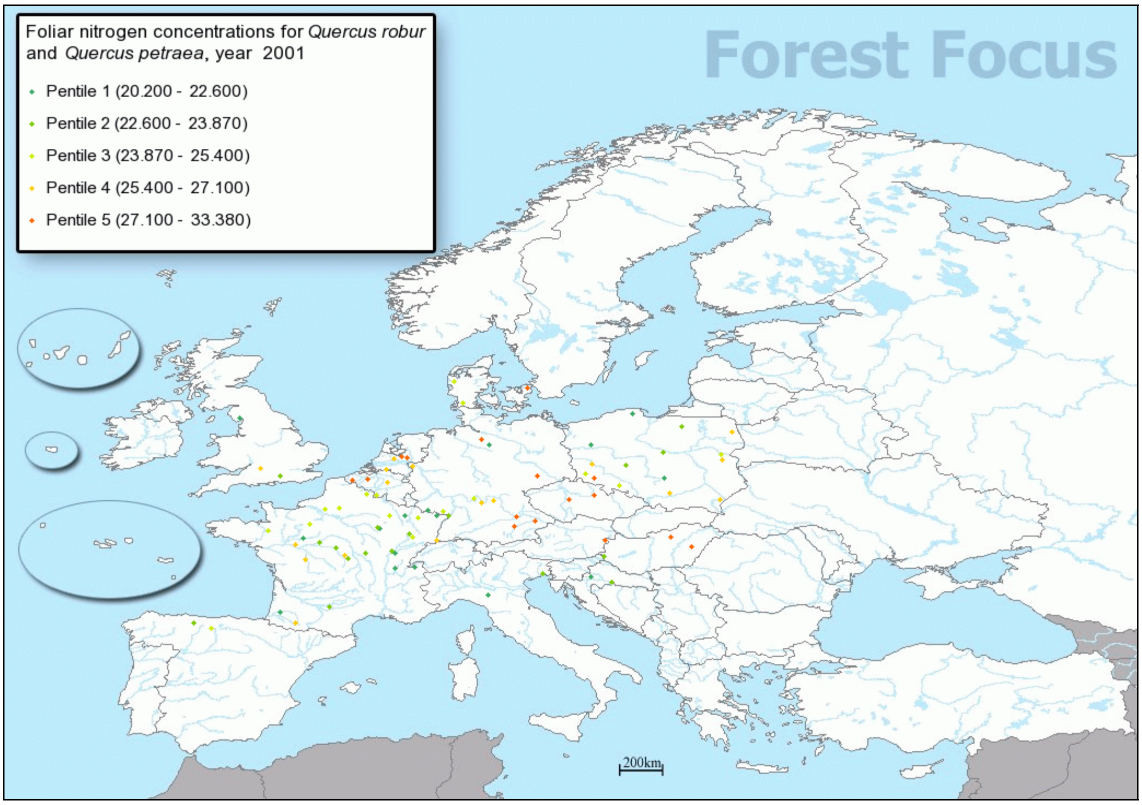

Figure 20: Foliar Nitrogen Concentrations for Quercus Robur and Qu. Petraea

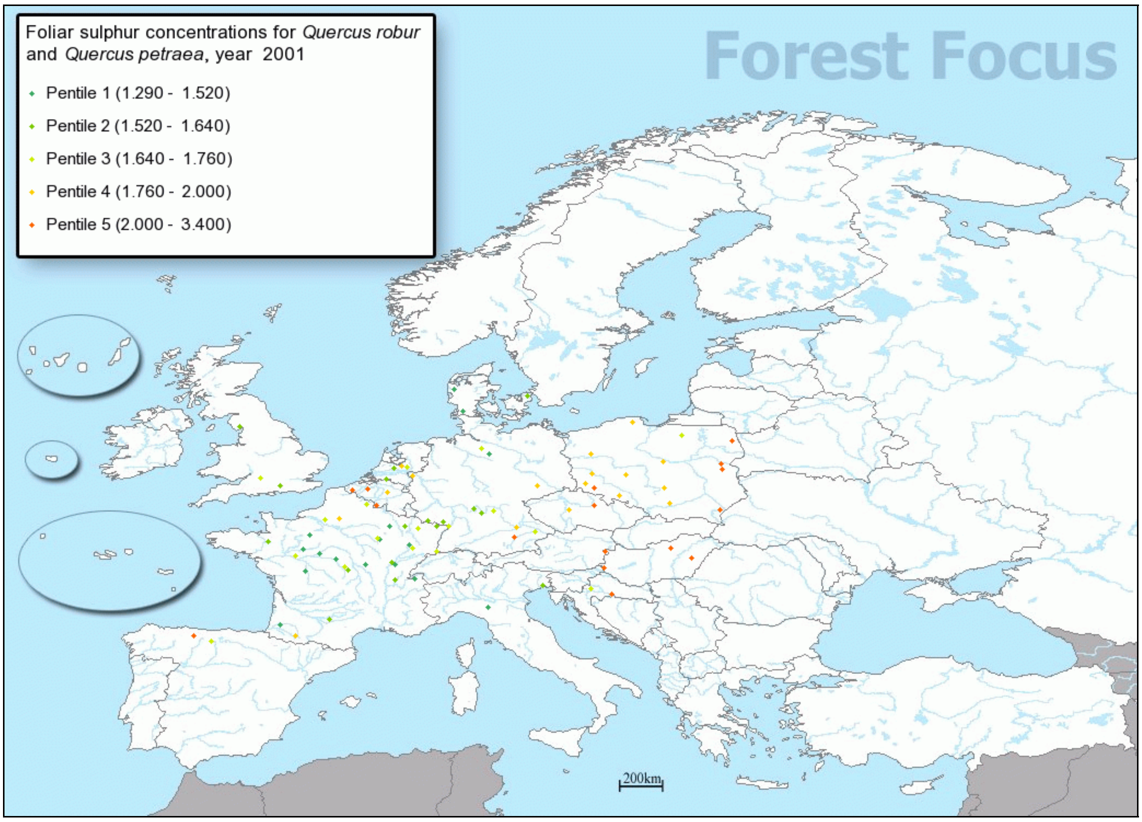

Figure 21: Foliar Sulphur Concentrations for Quercus Robur and Qu. Petraea

3.3.5 Deposition

Atmospheric depositions have been known for centuries to affect tree health close to point sources. Since the early 1980s depositions due to long-range trans-boundary air pollution has been considered as one of the main stress factors influencing the state of the forest environment at the European-wide scale. As long as air pollution continues despite the undeniable successes of air pollution control policies by UNECE and EU, atmospheric deposition will remain at the focus of forest health monitoring and forest damage research.

Uniformity tests for deposition data are based on showing the values reported for S-SO_4, N-NO_3 and N-NH_4 in two series of maps. The first series shows the plot-wise quantity weighted (volume of sampled precipitation) mean concentration of bulk deposition for S-SO_4, N-NO_3 and N-NH_4 in mg/l for the year 2001. The value is calculated as:

$$Quantity-weighted\ \ mean\ \ concentration_{dep} = \frac{\sum deposition \times quantity_{dep}}{\sum quantity_{dep}}$$

The calculations of quantity weighted mean concentration is necessary, because various instances of periodic measurements are submitted for a particular year. The calculations are only applied to data of plots for which data were submitted for at least 300 days (plot specific sum of period lengths in the PLD form). The resulting mean concentrations are grouped into 5 classes with 20% of relative frequency (pentiles, minimum of first class = minimum of values, maximum of fifth class = maximum of values).

Within the interpretation, precipitation of the respective year has to be taken into account as a major additional influence on the concentrations. The purpose of this second series of maps is intended to reveal sudden changes in concentrations of the depositions related to the amount of water (quantity of precipitation) in the bulk deposition.

The difference between the quantity weighted mean concentration in 2001 (first series) and the average of the weighted mean concentrations of the five preceding years is presented for 2001. The differences are grouped into five equidistant classes; minimum of 1st class is {-1*[max(-1*min;max)]}, maximum of 5^{th} class is [max(-1*min;max)].

In central Europe the density of plots for which quantity weighted mean concentrations in bulk deposition could be validated for the year 2001 is high enough to reveal clear spatial patterns. These patterns of concentrations of $S\text{-}SO_4$, $N\text{-}NO_3$, and $N\text{-}NH_4$ in bulk deposition are shown in Figures 25, 26, and 27, respectively. They coincide largely with the spatial patterns of concentrations and depositions of the same three elements described by ICP Forests in several of its annual reports (Lorenz et al. 2005, 2006 and 2007).

As depicted in Figure 22 plots of highest $S\text{-}SO_4$ concentrations ranging from 1.414 to 6.899 mg/l prevail in a region covering large parts of Poland and extending into the Czech Republic and the Slovak Republic. Some of these plots are also found in northern Germany and in Belgium. Depositions of $S\text{-}SO_4$ in Belgium could be shown by ICP Forests to be correlated with Na depositions pointing at sea salt as an origin of sulphur inputs. Concentrations decrease from central Europe towards the north and southwest of Europe. Plots of lowest concentrations ranging from 0.090 to 0.395 mg/l are particularly frequent in Switzerland, Austria and southern Germany. They dominate in northern and in south-western Europe.

The spatial patterns of the nitrogen concentrations are similar to those of the sulphur concentrations and shown in Figure 23. Plots of highest $N\text{-}NO_3$ concentrations ranging from 0.617 to 3.015 mg/l are most frequent in Poland and parts of the Czech Republic, the Slovak Republic and Germany. Smaller numbers of these plots are found in northern Italy and loosely scattered across Sweden.

Also the plots of highest $N\text{-}NH_4$ concentrations between 1.357 and 8.347 mg/l are particularly numerous in Poland, as shown in Figure 24. Plots with lowest concentrations of the two nitrogen compounds are most frequent in a region covering Switzerland, Austria and southern Germany. They also prevail in parts of Poland as well as in south-western and northern Europe.

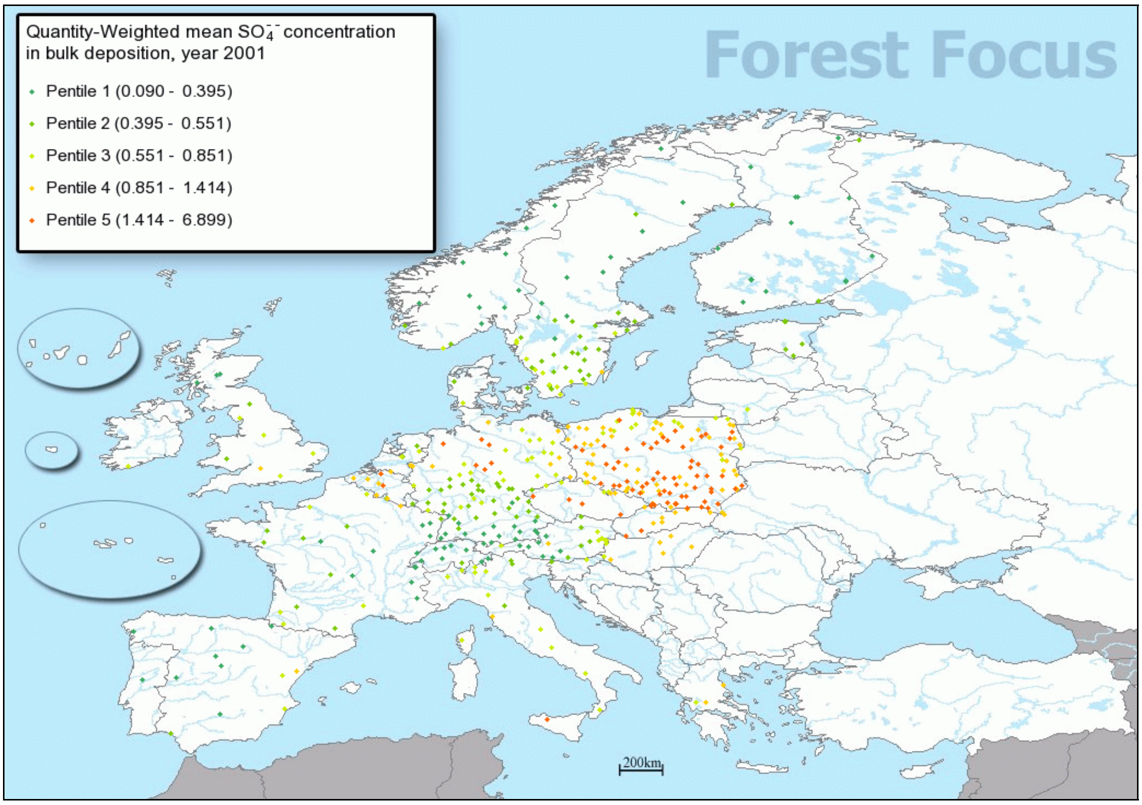

Figure 22: Quantity-Weighted Mean SO_4 Concentration in Bulk Deposition

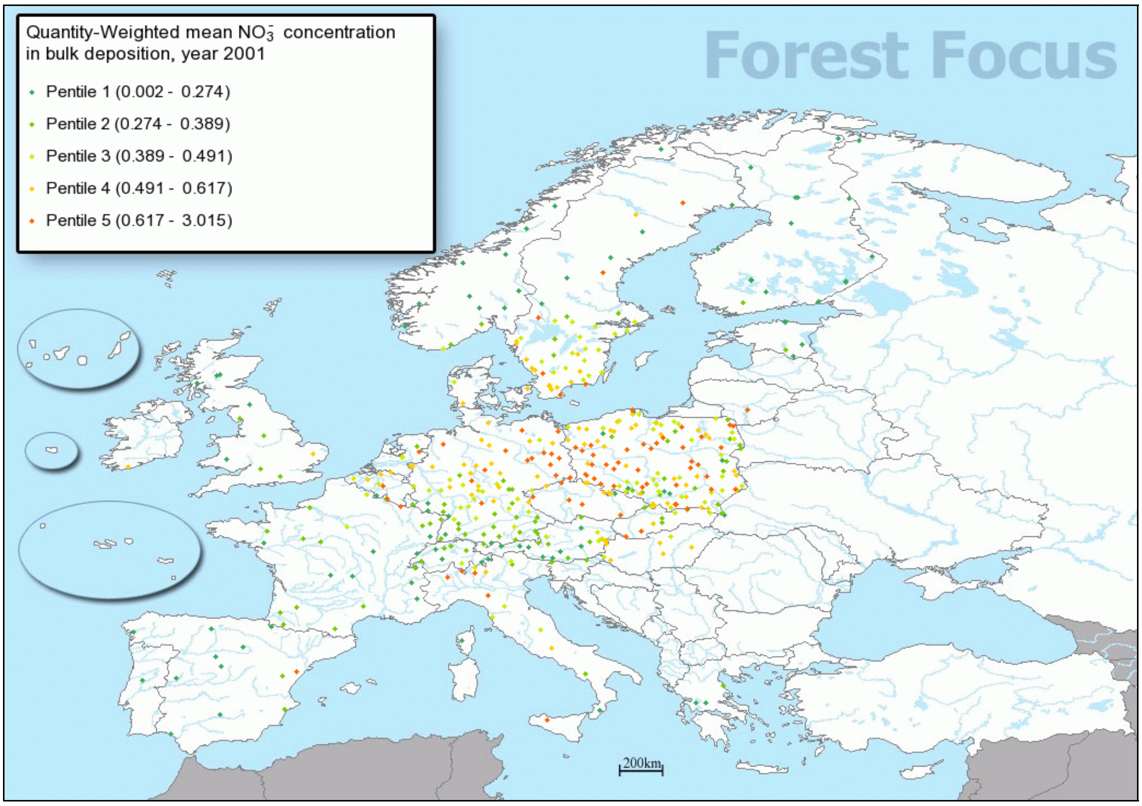

Figure 23: Quantity-Weighted Mean NO_3 Concentration in Bulk Deposition

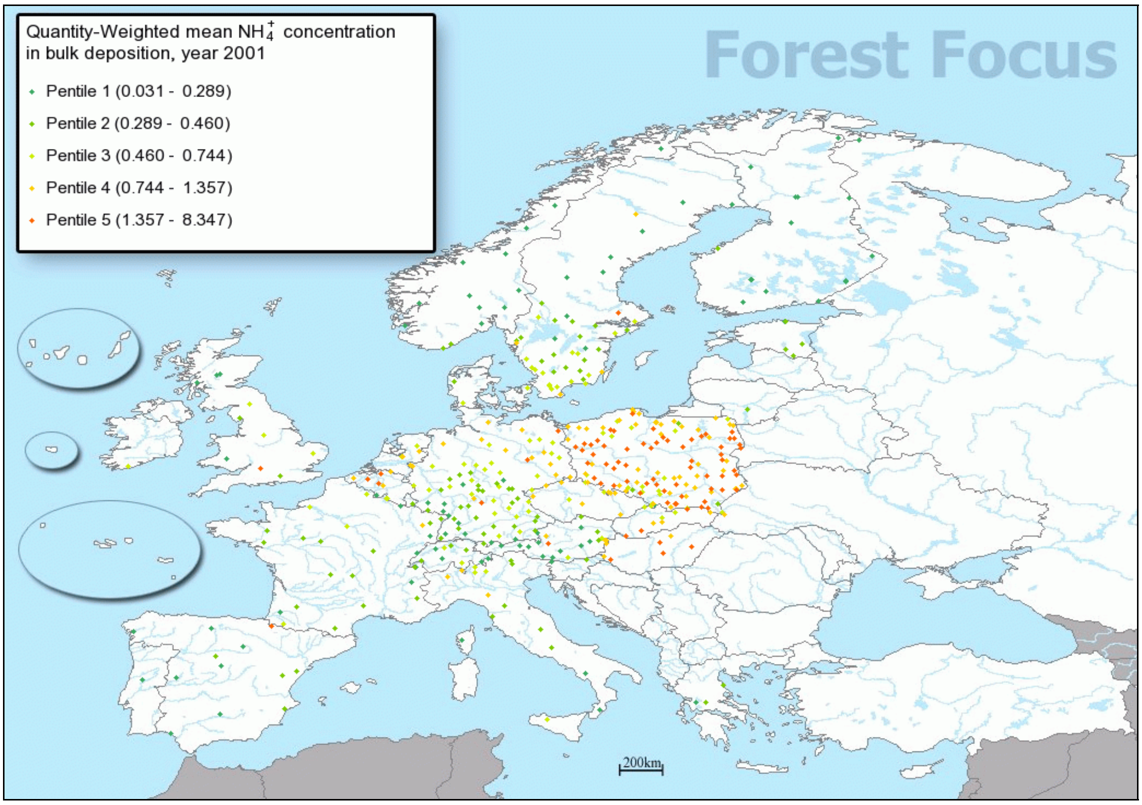

Figure 24: Quantity-Weighted Mean NH_4 Concentration in Bulk Deposition

The data for deviations in the quantity-weighted mean depositions of the monitoring year from the average deposition reported over the previous 5 years are presented for the three selected parameters in Figure 25 (S-SO_4), Figure 26 (N-NO_3) and Figure 27 (N-NH_4). For the overwhelming majority of the plots the element concentrations in bulk deposition in the year 2001 are below the average values of the previous 5 years. This situation is particularly obvious for sulphate and less obvious for nitrate and ammonium. It reflects the finding by ICP Forests that concentrations in bulk deposition decreased clearly for sulphur and less obviously for ammonium and nitrogen (Lorenz *et al*. 2004). A small number of plots show an increase in concentrations in comparison to the previous five years. However, the respective 2001 values were not found to be outside the range of observations.

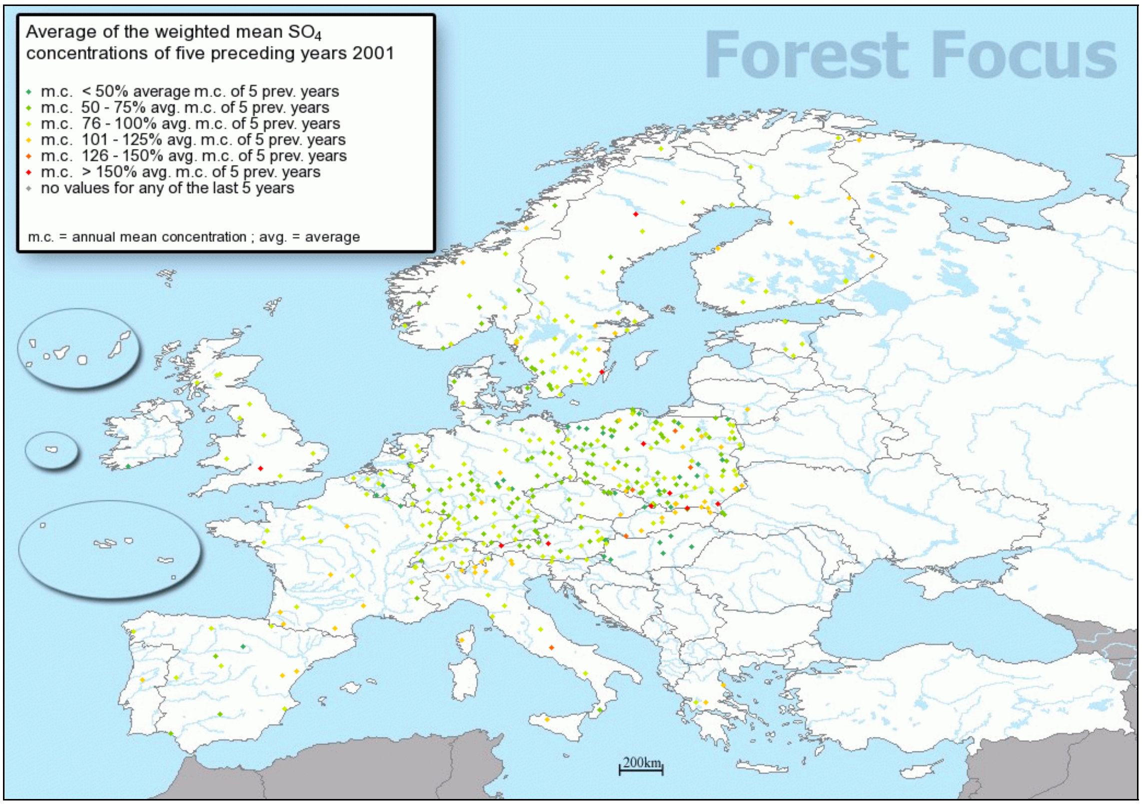

Figure 25: Average of Weighted Mean SO_4 Concentration over 5 Years

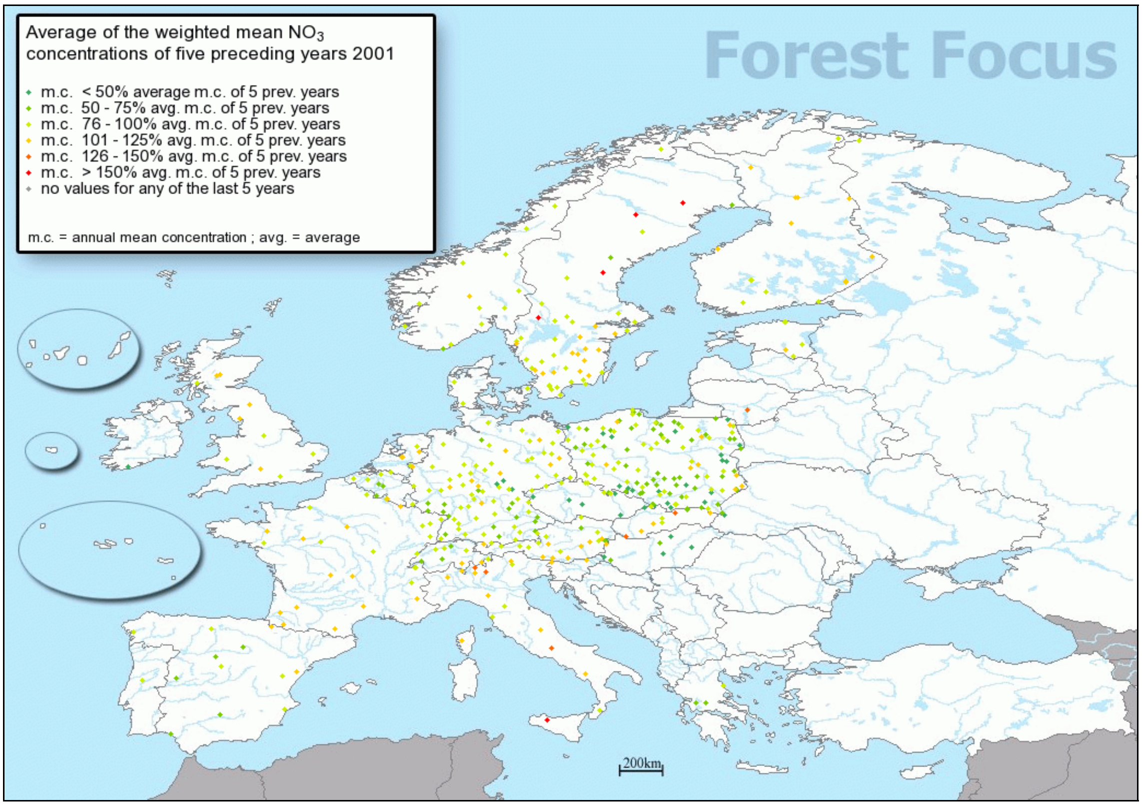

Figure 26: Average of Weighted Mean NO_3 Concentration over 5 Years

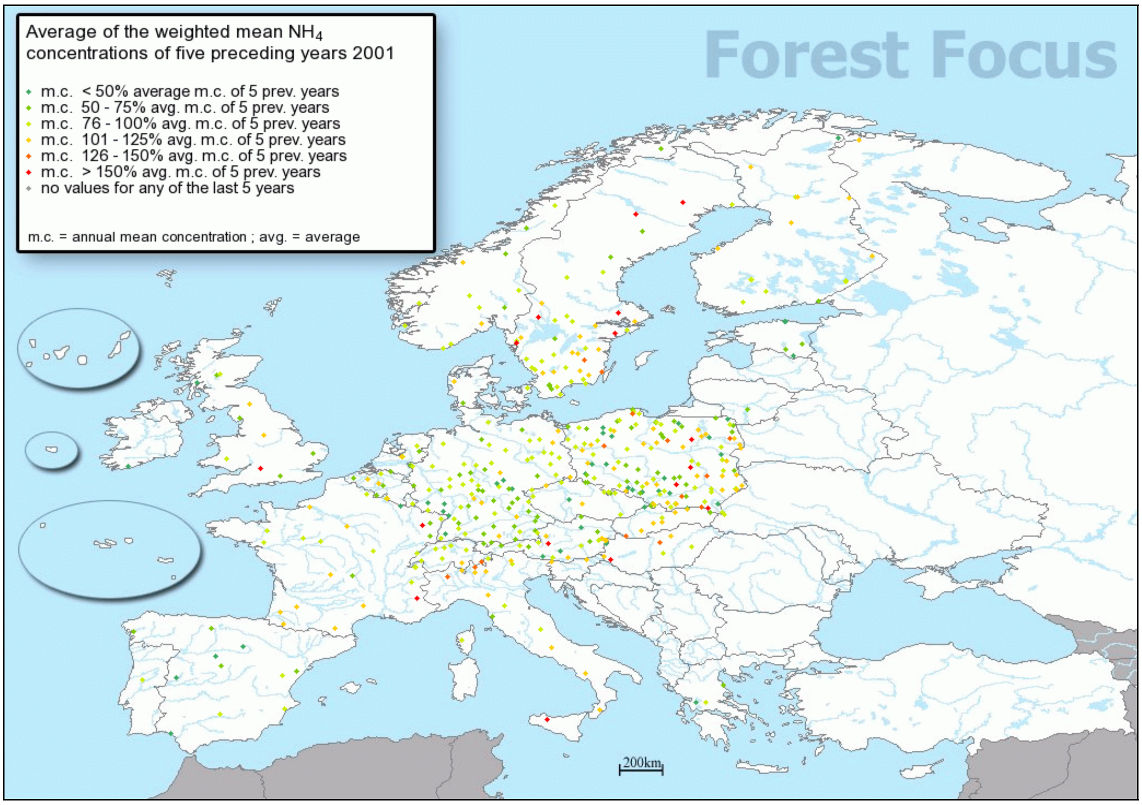

Figure 27: Average of Weighted Mean NH_4 Concentration over 5 Years

3.3.6 Meteorology

Meteorological data of the year 2001 from the Level II plots are mapped for mean annual Temperature in °C. For display purposes the data are grouped into 5 pentiles with 20% of relative frequency. Data were plotted in the map under the following preconditions:

- Mean daily air temperature had to be measured for at least 300 days (continuity during year);
- Air temperature measurements of at least 90% per day (continuity during day).

The distribution of the mean annual temperature of plots with appropriate data is given in Figure 28. Data could be mapped for plots in Austria, Belgium, Czech Republic, Finland, Germany, Greece, Hungary, Italy, The Netherlands, Spain, Sweden, Switzerland, and United Kingdom. The mean values do not show any particular deviations from the general pattern of the distribution of temperatures in Europe, which could not be explained by local conditions of plot aspect and elevation.

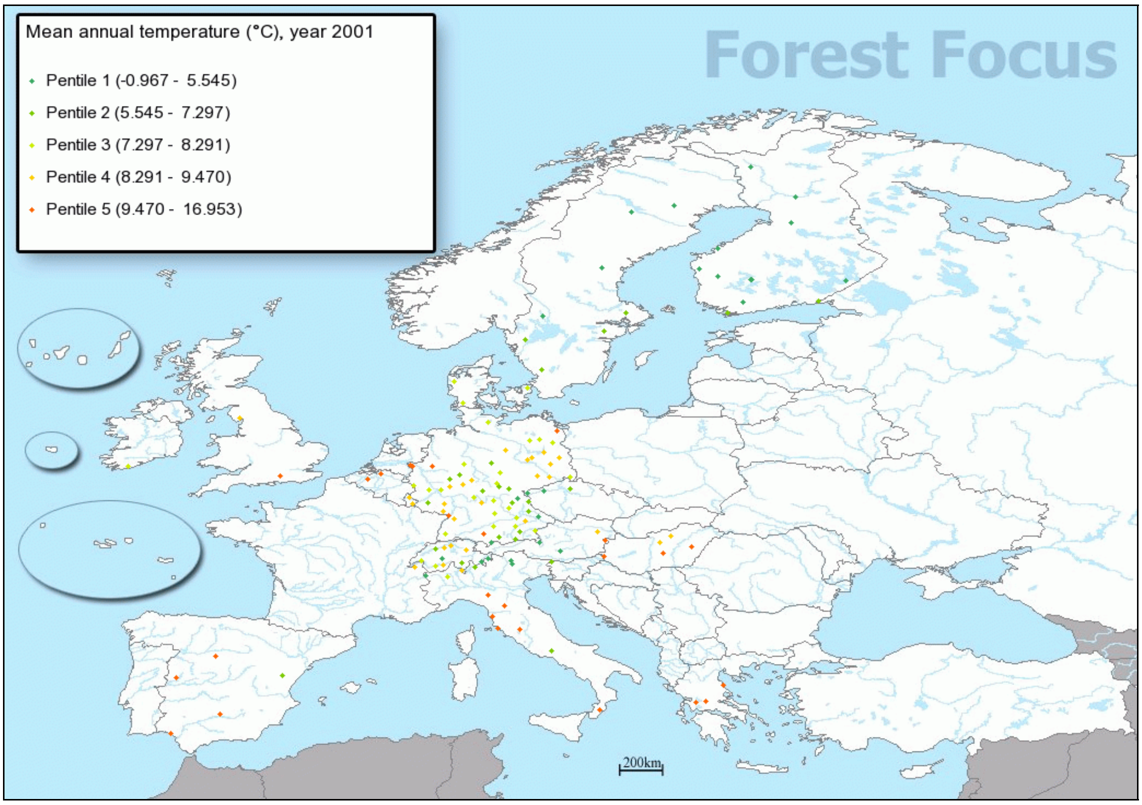

Figure 28: Mean Annual Temperature (°C)

3.3.7 Ground Vegetation

Results of the ground vegetation survey are mapped in Figure 29. It shows the plant species richness as the number of reported species over all layers (tree, shrubs, herbs and mosses) and surveys per plot in the year 2001. If a particular species code is submitted more than once per plot and year it is included only once. Resulting numbers are grouped and mapped using the following classes:

<20, 20-40, 41-60, 61-80, >80 species.

The second map presents changes in species richness per plot compared to the most recent previous survey. Results are grouped into the following classes:

<-10, <-2, < +2, <+10, > +10 species.

The classification of the groups allows distinguishing between plots and regions in which an increase in species numbers was observed and those where the number of species decreased.

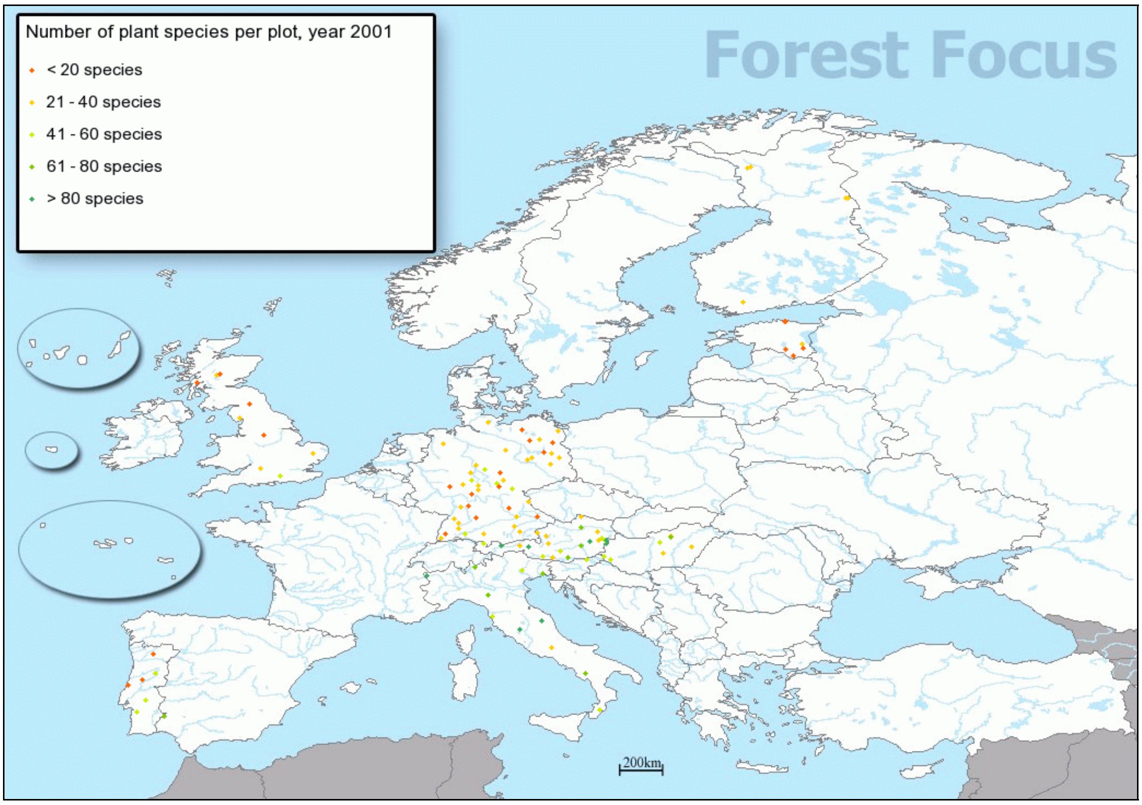

Figure 29: No. of Plant Species per Plot

The comparison between the number of species per plot in the reporting year with that observed in previous years should not yield extreme differences. Any changes in number or species composition of ground vegetation may indicate natural disturbances or management effects as well as errors in data submission. Extreme changes need to be followed by the validating expert.

Plant species richness as the number of reported species over all layers (tree, shrubs, herbs and mosses) and surveys per plot are presented in Figure 30.

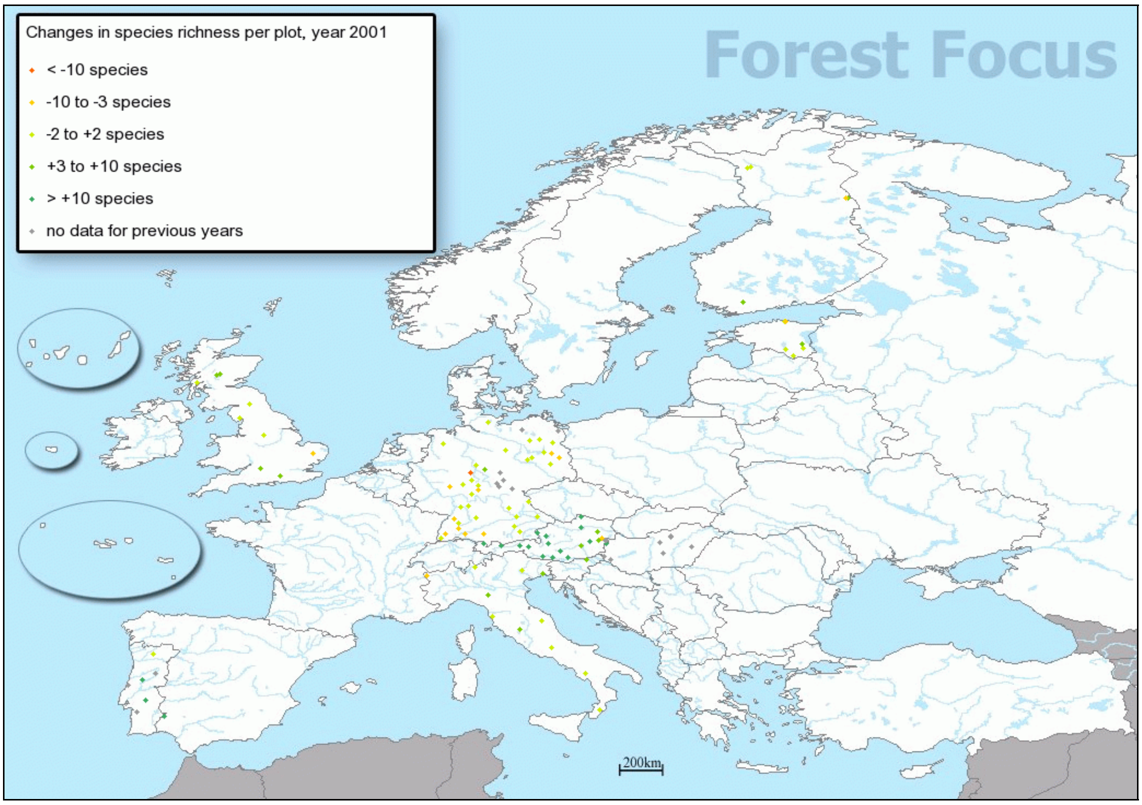

Figure 30: Species Richness per Plot

On most plots the species richness has changed only slightly in comparison with the previous survey. Only in a few cases the species richness varied by more than 2 species. For some plots in Germany were detected a decrease of 3 to 10 species on one plot a loss of more than 10 species was reported.

For all plots in Austria a considerable increase of species over the previous survey was reported. This could be explained by the fact that in contrast to 2001 in the previous assessment year (1995 or 1996) bryophtes were not taken into account.

3.4 Data Stored in Forest Focus Monitoring Database

The legacy data provided in the exported ASCII files have been imported into the FFMDb as received. The upload includes all data from the 114 surveys for 2001. In order to be consistent with other Technical Reports on overview of the surveys is given in Table 16.

Table 16: 2001 Legacy Data Uploaded to the FFMDb

Country	Survey									
	SI	CC	SO	SS	FO	GR	DP	MM	GV	AQ
Austria		✓		✓	✓		✓	✓	✓	
Belgium		✓		✓	✓		✓	✓		
Bulgaria										
Croatia		✓			✓					
Cyprus										
Czech Republic		✓		✓	✓		✓	✓		
Denmark		✓		✓	✓		✓	✓		✓
Estonia		✓		✓	✓		✓		✓	
Finland		✓		✓	✓		✓	✓	✓	
France		✓		✓	✓	✓	✓			✓
Germany		✓		✓	✓	✓	✓	✓	✓	
Greece		✓			✓		✓	✓		
Hungary		✓			✓		✓	✓	✓	
Ireland		✓			✓	✓				
Italy		✓		✓	✓		✓	✓	✓	
Latvia										
Lithuania		✓		✓			✓			
Luxembourg		✓			✓		✓	✓		✓
Netherlands		✓		✓	✓		✓			
Norway		✓		✓	✓		✓			
Poland		✓			✓		✓			
Portugal		✓			✓		✓		✓	
Romania										
Slovenia										
Slovak Republic		✓			✓	✓	✓			
Spain		✓		✓	✓		✓	✓		✓
Sweden		✓		✓			✓	✓		
Switzerland		✓		✓	✓		✓	✓		
United Kingdom		✓		✓	✓		✓	✓	✓	
Total	**0**	**24**	**0**	**16**	**22**	**4**	**22**	**14**	**8**	**4**

3.5 Specific Considerations for Legacy Data

3.5.1 Limits of Data Analysis

During the process of validation data are not tested for being correct, but for the probability that a value is outside of what could be expected as admissible. For a given parameter the ranges are set globally and are not specific for countries or bio-geographic regions, which results in a higher probability of the oversight of outliers in countries with intermediate conditions. Whenever a parameter is similar in the range of observations to another parameter, e.g. for chemical elements, entering the parameter in the wrong column or even reporting the wrong parameter will also not be detected by the tests. When data are recorded correctly in the forms there may still be differences in measurement methods between NFCs or laboratories.

The assessment of the legacy data is further limited by the lack of the original data and information from NFCs on how to interpret certain situations, such as the treatment of missing values.

3.5.2 Submission Method of Legacy Data

Under Forest Focus Level II data management the observations sent by NFCs are only validated, but never modified. All original data are stored as part of the system. In the legacy some inconsistency seems to exist between data stored by NFCs in their national database and the data in the monitoring database. Following the information sent to NFCs as part of the Conformity Check and the availability of the Data Dissemination Module in 2006 NFCs had the possibility to download their data as stored in the database. It transpired that some data in the legacy data as stored in the FFMDb do not correspond to the data assumed to be sent by NFCs at the time as data submissions. This situation is quite apparent for static parameters, such as plot coordinates and tree species. It is much less evident to what degree variable parameters are affected by the condition.

Sources for the inconsistency between data assumed to be submitted by an NFC and found in the database are numerous. One source is the use of physical storage media for transmitting data. The date of data processing, of writing files to the media and of sending the CDs or floppy disks is necessarily different. An earlier version can be sent at a later date than a more up-to-date version of a file. It is also possible that data were copied between files and years, which can then lead to a continuation of data irregularities. This seems to have happened in some cases of plot coordinates.

3.5.3 Data Storage Formats in Legacy Database

The data formats used in storing data submitted by NFCs do not conform to the formats specified in the ICP Forests Manual valid at the time. Frequently values are found with more digits than specified in the data format tables. This situation could be taken care of by extending the number of digits used in the FFMDb. Thus, no information should have been lost in the transfer. However, because the values are outside the limits of the filed this poses the question how such values could be reported in the fixed format files. It can only be assumed that they were treated as special cases and transmitted separately.

3.5.4 Coding of Missing Data

Legacy data contains a lack of consistent coding for recording the various conditions leading to missing data. Recording instances of measurements below the detection limit of the instrument used as 0.5 * detection limit was frequently used. Coding those conditions by a value of -1 was rather rare. Measurements of very small values were rounded to 0 when the field format was found insufficient to hold the value. Measurements of values too large were recorded by a series of 9s in the field. In both cases some NFCs reported the actual measured values ion the comment field. This was truncated to 10 characters in most cases in the export files and as a consequence this information is frequently lost.

3.5.5 Legacy Database Export Format

The legacy data were stored in an Oracle database. The various tables were exported into ASCII files and no database dump file was made available. As a consequence, all links were lost, the original database could not be recreated and the completeness of the data cannot be verified. Also lost was information stored in the comment field. The text was at times truncated to the 10 characters specified in the forms, which indicates that more information was stored in the field. In addition to the loss of explanatory information actual data may have been lost, too from the truncation of the filed size. Some NFCs followed a recommendation to store actual values in the comment field and a series of 9s in the parameter field in case a measured value exceeded the size of the field. To what degree such data were moved from the comment field into the parameter field is not known and cannot be reconstructed.

3.5.6 Effect of Legacy Data on Subsequent Data Validation

All legacy data have to be considered validated, although they have not passed through the Forest Focus validation process. They are of impact on the validation under Forest Focus in as much as they are included in the time series analysis of the Conformity and Uniformity Checks. When verifying data consistency of static parameters during the validation process of the data from the monitoring year 2002 to 2004 it became obvious that in some cases the legacy data was different from data of later monitoring periods. In these cases, messages were triggered by the tests of the Conformity Check for the respecting year although the data submitted for the later year were correct. These data were uploaded after the confirmation by the NFC in the database and were the reference for the following monitoring years.

The main reasons found for discrepancies between legacy and newly submitted data are:

(1) Plot Coordinates
A more accurate data e.g. due to the use of GPS to identify the coordinates.

(2) Altitude
Same as plot coordinates.

(3) Tree species
Different surveyor or better determination of tree species.

The values of the legacy data now declared incorrect will still be stored in the database. All well-known cases are mentioned in Annex II. For 2001 the NFCs from France, Norway and Spain reported about erroneous legacy data. Furthermore also Belgium (Walloon), Denmark, and the Slovak Republic stated, that the reasons for messages in the conformity checks from the years 2002 to 2004 could be found in the legacy data, but in monitoring years before 2001.

3.5.7 Up-dating Legacy Data

Several requests have been received from NFCs for up-dates of values in the legacy data. The up-dates are of two forms:

- Up-date of static values to be applied to previous years.
- Up-date of values for variable parameters.

Up-dates for static parameters are generally the result of improved methods of assessing the plot position. For the permanent plots a more accurate value for a static parameter could also be used for surveys from previous monitoring campaigns. It would be conceivable to up-date the fields of all previous years with the latest information on plot positions. Such a data maintenance procedure is technically possible. However, it would be a deviation from the principle of not making any modifications to the data submitted by NFCs. The same result of improved values for static parameters could be achieved when analysing the data. This approach has the advantage that no information would be dropped from the database.

Up-dates of values for variable parameters and adapted coding for missing data could improve the value of the database. The problem posed by such modifications is the status of the data. In order to enter the FFMDb it would have to be subjected to the validation routines of data processed under Forest Focus. Replacing data in the database can also potentially alter the evaluation of data from temporally adjacent monitoring years, e.g. for the Growth survey.

The problem of up-dating the database is not restricted to legacy data, but also affects data processed under Forest Focus when data for historic monitoring periods are corrected and re-submitted.

4 SUMMARY AND RECOMMENDATIONS

For data from the 2001 monitoring year a total of 114 surveys received by 24 NFCs are stored in the Forest Focus Monitoring Database. In total 287 forms from 8 surveys were evaluated for Conformity and Uniformity. The number of data submissions for the surveys ranges from four for Growth and Air Quality to 24 for the Crown Condition survey.

Although the 2001 data are validated the procedures applied at the time deviate significantly from the validation process applied for Forest Focus data. The Compliance Check on data formats is not applicable to the legacy data. Data can, however, be evaluated on the basis of the Conformity and Uniformity Checks. This process allows highlighting outliers in the data or values which are very likely incorrect. The evaluation of the legacy data from 2001 would thus allow a better understanding of the data quality for further analyses. The experience obtained in the data from the communication with NFC during the validation process of the data from the monitoring years 2002 to 2005 allowed in most cases to explain the reasons for the messages raised by the tests.

More than 80% of the warning and error messages generated by the various tests for Conformity were found in the data of the Meteorology survey, mainly caused by values outside the expected ranges. Very few errors were found in the data of the monitoring year 2001. Most situation raising error messages could be plausibly explained. The main reason for error messages were changes in presumed static parameters, such as the occurrence of new trees on the plots or changes in plot coordinates or altitude. Anomalies from the generally expected trend, e.g. shrinking trees, could usually be declared extreme events or inaccuracy in measuring. In those cases were legacy data were already declared as incorrect by the respecting NFC this circumstance is mentioned in the report, but the data have not been changed in the FFMDb.

In contrast to the monitoring years under Forest Focus the coding of missing data and values below the detection/quantification limits with “-1” is totally missing in the legacy data. Also the use of a zero value seems to have been applied without consistency between NFCs.

In case data from the monitoring years 2002 to 2005 triggered messages due to wrong or less accurate entries in the legacy data, these data were uploaded after the confirmation by the NFC in the database and became the reference in the checks for the following monitoring years.

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Abstract

Forest Focus (Regulation (EC) No 2152/2003) is a Community scheme for harmonized, broad-based, comprehensive and long-term monitoring of European forest ecosystems. Under this scheme the monitoring of air pollution effects on forests is carried out by participating countries on the basis of the systematic network of observation points (Level I) and of the network of observation plots for intensive and continuous monitoring (Level II).

The Forest Focus monitoring activity continues from the network and plots established and implemented under previous schemes. From 1986 until the end of 2002 data were reported under the Council Regulation (EEC) No 3528/86. The Regulation was later modified by Regulation (EC) No 804/2002, which amended Council Regulation (EEC) No 3528/86. In 1991 a common monitoring system was agreed upon between the EU scheme and the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) under the Convention of the Long-Range Trans-boundary Air Pollution (CLRTAP).

Monitoring on Level II plots started in 1994. Until the monitoring year 2002 Level II data was processed and stored by the Forest Intensive Monitoring Coordinating Institute (FIMCI) under contract of DG AGRI. Following paragraph 15 of Forest Focus DG JRC is in charge of processing the monitoring data and has implemented for this purpose a Forest Focus Monitoring Database System. Forest Focus stipulates that data from all Level I and Level II surveys be integrated in a single system. Accordingly, the new system also includes data collected under the previous schemes, which for Level II surveys are referred to as legacy data.

This report details the situation of the Level II legacy data for 2001 with respect to the validation process applied to data collected under Forest Focus. The main aim of processing the data is to identify any consequences of the legacy data on the results of validating data from subsequent years.

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